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TRANSLATION

TECHNICAL-ECONOMIC FOUNDATIONS OF STANDARDIZATION IN MACHINE BUILDING

By

A. A. Kokhtev

FOREIGN TECHNOLOGY DIVISION

AIR FORCE SYSTEMS COMMAND

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BY: A. A. Kokhtev

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The second edition of this book considers a considerably wider range of problems pertaining to the theory, methodology and practice of standardization, normalization, unification, typification and aggregation in machine building than the first edition. It illuminates their role in creating the material and technical base of Communism, including increased productivity of labor, specialization and automation of production. Special attention is paid to the development of component part specialization. Problems of the economic effectiveness of standardization and its varieties, creation of dimensional [progression] series and parametric standards and also of design-unified machine and equipment series are considered in detail. It shows ways for coordination of standardization and normalization work and an expedient system of standards and normal standards. It presents refined basic concepts and terms, standardization principles, systems for classification and coding of machine-building production and other problems.

It presents the methodology for elaboration and adoption of standards and normal standards. It illuminates the problems of the work of local and base standardization and normalization organs, their functions, structures and staffs. It illuminates the experience of foreign standardization. It includes information on the new international systems of measurement units SI (measuring system).

The book is intended for engineering-production workers of machine-building plants, SKB [Special Design Offices], OKB [Experimental Design Offices], TsKB [Central Design Offices], NII [Scientific Research Institutes], Sovnarkhozes and other organizations; it can also be useful

to lecturers and students of machine-building and economic institutes.

FOREWORD

The first edition of this book was published by Mashgiz [State Machine-Building Publishing House] in 1958 under the title "Technical and Economic Principles of Standardization in Machine-Building."

The published reviews and other critical statements and remarks about the book have shown that it, as a whole, has met with a positive reception, although it did have a number of shortcomings.

The method of presentation which was employed has made difficulties for the reader in finding the necessary information. He had to successively look over a number of chapters in order to get an answer to the problem of interest to him. A desire was expressed for another type of presentation of material in the second edition so that each chapter would give an exhaustive illumination of these or other problems pertaining to the theory, methodology and practice of standardization.

The first edition of the book was prepared and published before major organizational measures which had as their purpose more extensive development and application of standardization and normalization in the machine-building industry of the Soviet Union were carried out. In the last few years many plants have begun to organize departments, offices or groups for standardization and normalization, and those enterprises at which these existed already have substantially extended their activities. As a result of these measures the ranks of standardization and normalization workers have increased substantially in the years 1959-1962. The increase including junior specialists, who have not as yet

mastered the bases of standardization, its methodology and practice.

This group of readers has expressed their desire that the book take on a more encyclopedic character and that it include tabulated data on practical and methodological problems.

The substantial shortcoming of the first edition was the almost total absence of information on foreign and international standardization and on the origin and development of foreign standardization methods. Such important problems as the general system of organization of standardization and normalization work, a system of expedient standards and normal standards in machine-building, standardization of the machine-quality indices and a coding system for the machine-building products were given in a general form only. This could not satisfy the needs of the considerably increased contingent of readers, especially of those who have just had their first encounter with the problems of elaboration and adoption of standards and normal standards.

In the preparation of the second edition of the book, which has been called "Technical and Economic Bases for Standardization in Machine-Building," we have taken into consideration all the above shortcomings and desires of the workers of the industry. The arrangement of the book has been revised and its contents have been reworked and considerably expanded. The circle of problems being illuminated was widened considerably. We have included in the book tabulated data touching upon the multifaceted activity of local and base standardization and normalization organs, including their functions, structure and staffs.

The contents of the new book were subordinated to the main problem, i.e., mobilization of all means and methods of standardization to the service of accelerating the creation of the material and technical base of Communism. It has formulated the basic standardization problems,

has shown their role in achieving specialization and automation of production. It illuminates the problems of elaboration of component-part and assembly specialization on the basis of standardization, normalization and unification. It considers the problems of standardization of service life and reliability indices for machines and equipment. We have paid the necessary attention to the methodology of elaboration and adoption of design-unified machine and equipment series with the purpose of more complete satisfaction of the requirements of all branches of the national economy in high-productivity specialized equipment. We have also included information on the new international universal system of units SI.

The second edition of the book has not included a large amount of information which was presented in the first edition. We have retained in the second edition only those examples which retain their methodological value for a long time and can be successfully used in the machine-building practice.

Discussions of the first edition of the book by its readers has made it possible to expose a number of practical problems, which are of theoretical, methodical and practical interest to a wide circle of workers of the industry. The author has endeavored to solve and illuminate all these problems in this new edition within the limits of possibility.

The author expresses profound gratitude to all persons who participated in discussing the first edition.

Chapter 1

STANDARDIZATION AND ITS VARIETIES

In the time of creation of the material and technical base of Communism we witness the tremendous development of machine-building - the heart of heavy industry - which has resulted in the necessity to pay the necessary attention to the problems of standardization and normalization. Plants, design offices and engineering organizations expand the activities of the standardization and normalization departments (OSN), and when these do not exist, appropriate subdivisions are formed. The work of the OSN has come to embrace an ever-increasing number of engineers, technicians and economists, the results of whose work depend largely on the fact of how skillfully and purposefully they will act. Of certain help to them can be a short presentation on the origin of standardization, its varieties and scientific substance.

1. ORIGIN OF STANDARDIZATION

Standardization has originated in remote antiquity, but has been officially formalized only at the beginning of the 20th century. Literacy, chronology, counting systems, monetary units, units of weights and measures - all these are demonstrations of standardization. It has developed gradually and its achievements have promoted cultural economic and technological progress in all stages of civilization.

In the field of construction we know that actually standardization had found a perceptible application in ancient Egypt in the construction of pyramids. The stones which were used had strictly defined dimensions, without which it would be impossible to ensure correct geo-

metric shape of pyramids and their longevity. The quality and precision of the work of the pyramid builders, who lived 47 centuries ago, is very high. The stones are precisely finished and so closely adhere to one another that, according to K. Keral, it is impossible to drive a needle between them.

The construction of the tower of Babel which was 90 meters high involved the laying of 85 million fired bricks of strictly defined dimensions, here the binding element was natural asphalt. The upper floor of the tower 15 meters high was faced with blue glazed bricks, the fabrication of which required close adherence to dimensions and a preset raw material content.

In ancient Greece, the development of architecture had resulted in the appearance of structural elements – columns and porticos, and then of other components the shapes and sizes of which have now become classical. The actual standardization of these has withstood the test of time during millenniums.

The precision of fabrication and mating closeness of large panels and other structural components is of tremendous importance in our time. Actually, they determine the quality and longevity of residential and industrial structures. But the precision of fabricated structural components depends largely on the equipment used [for their manufacture]. This is the reason why standards, which determine the precision of the operation of equipment used at plants manufacturing large panels, sections, blocks and other building materials is so important. However, such standards do not exist. Their elaboration in the near future is not even contemplated [2].

This example shows how standardization can lag behind life and how, conversely, it can become the leading, determining factor, if standards for operational precision of the given equipment would have

been elaborated in time. Of no smaller significance are those basic principles which serve as a basis for these standards. They can reflect the leading experience of operation of existing equipment at individual plants, but can also establish requirements to the precision of operation of equipment, on the basis of the needs of the building industry and the necessity for ensuring higher quality of assembly of residential and other structures from structural components prefabricated at plants. In the latter case, standards are an obligatory technical goal for all organizations engaged in planning and design work for creating of new building equipment.

The use of standardization principles in ancient Egypt was not limited to structural techniques. There, approximately 4200 years ago, use was made in the design and production of catapults (war machines of that time) the so-called system of relative parameters, according to which the dimensions of all components depended on one main parameter, which was the length of the arrow thrown by the given catapult. This method of design and denotation of component dimensions, described by Vitruvius 2000 years ago, was forgotten and has found its second application in the machine-building technology only in the middle of the past century, i.e., after the passage of many centuries.

The method of relative parameters, which is based on the major parameter, is based on the assumption that all the dimensions of any machine part are interrelated by certain functional relationships, which are an outgrowth of a number of factors. From this appeared the tendency to express all the dimensions of any component as a function of a certain parameter (dimension), which can be taken as the major parameter. The value of the load is the quantity closest related to it. The major dimension frequently establishes the necessary distances and design dimensions of the given part. It can be found that not one, but

more such parameters are needed, for example, the diameter and travel of the pump piston. In such cases, the remaining dimensions of the part are frequently expressed as a function of the two major parameters.

The very extensive use of the method of relative dimensions in the 19th century industry was enhanced by the very time-consuming methodical work performed by the German professor Rodtenbacher relative to all component parts of a large number of machines of that time. He has derived a number of simple equations, determining all design dimensions of these parts as a function of one, and sometimes two major dimensions. Study of parts manufactured by the relative parameters method shows that, despite the large variety and diversity of factors which influence the choice of parameters of individual parts, the relationships between dimensions (obviously, with certain exceptions) are found to be linear. The method of relative parameters, recommended and introduced by professor Rodtenbacher, was actually found to be convenient to and within reach of persons of various skills, and for this reason it has spread very rapidly. However, with the passage of time and with the appearance of new, more complex machines and also of new methods of strength calculations, technical instructions, textbooks and handbooks on machine components, conditions have gradually developed such that instructors have refused to utilize the method of relative parameters; this has resulted in the cessation of instructions in the method in technical schools and of its popularization. As a result of scientific and technological progress the method of relative dimensions was again forgotten, but not for long. The above method was again utilized (already for the third time) in standardization of components of machines, certain tools and production equipment elements. But now it is frequently called the proportionality principle, and sometimes the modeling principle.

In the age of Renaissance a new stimulus appeared in the field of standardization. The development of Venetian economic connections has resulted in a large demand for seagoing merchant ships and navy vessels for their protection. The construction of both of these was organized in a single flow. Unified hulls were launched into water and were led into a narrow straight and long channel, with workers and materials and products needed for finishing these ships and vessels in water placed on both its banks. As the hull moved along the channel it was equipped by mast and yards, rigging and all kinds of equipment and also with weapons and ammunition. A very high degree of unification of the hull elements, equipment and outfitting of civil ships and navy vessels was achieved. At the ends of the channel the ships were loaded with fresh water and provisions, given a crew, the flag was raised and the new vessel (or ship) sailed into the sea. Then this experience was forgotten. During centuries, construction of vessels and ships was performed on an individual basis, although the necessity of unification of shipbuilding products was beyond any doubt. The construction of seagoing and river transportation and industrial vessels and navy ships by the flow method was renewed only in the Thirties of the 20th century. This has become possible as a result of the extensive development of standardization.

The origin of industrial standardization in our country belongs to the beginning of the 18th century when a number of directives by Peter the 1st and the Governing Senate on measures in the shipbuilding and other fields, which by their significance had the character of standardization were published. The earliest of the so-far discovered directives by Peter the 1st refers to the year 1701. Several characteristic directives from among the above were published by Academician A.N Krylov in 1929. In addition, a number of authors have described a series

of galleons and fire boats constructed in 1694-1696 according to specimens approved by Peter the 1st. The objects unified included anchors, ship equipment and armaments, which has promoted the development of the corresponding native industries.

One of the most important elements of standardization is interchangeability. In our country, it originated in the 19th century in the defense industry in the process of organization of mass production of rifles and their spare parts. The problem under consideration is closely related to the history of the Tulsa rifle plant, in which, for the first time in Russia, was born production based on interchangeability. The high level of interchangeability existing at this plant has ensured the production of 7000 rifles per month as early as at the beginning of the Fatherland War of 1812 [3]. In order to check for interchangeability of rifle parts, the locks of approximately 30 rifles were disassembled (these rifles were taken from a batch arbitrarily), and their parts were mixed together, whereupon the locks were reassembled. It was repeatedly pointed out in reports that the locks thus assembled "ran together so freely as the parts were purposely fitted together." Significant achievements in the field of interchangeability were recorded also by the Izhev plant, which as early as in 1837 has manufactured 30,000 rifles per month [3]. In these achievements in the field of interchangeability a great role was played by the art of Russian arms craftsmen, especially of gauge makers who have produced complex gauges with a high degree of accuracy.

Railroad construction, begun in Russia in the middle of the 19th century, has resulted in the standardization of the track gauges on main lines, railroad car colors, height of coupling devices, wheel diameters and other rolling stock elements. Together with this, however, was forgotten such an important question as regulation of the side on

which trains move with the result that trains on the Moscow-Ryazan' line up to the present day move on the left side, which is opposite to that for other railroads of our country.

Standardization embraces a very wide circle of problems, but the subject field and its goals are subjected to periodic changes.

2. GENERAL INFORMATION ABOUT STANDARDIZATION

Planning and design work in the field of elaboration of machines, mechanisms, apparatus, devices and various mechanization and automation facilities include the elaboration of drawings, specifications, engineering requirements, instructions, catalogs, etc., and also of production processes, control and acceptance methods, testing rules for finished products as well as for subassemblies, components, semifinished articles and materials, used at various production stages.

The entire work is substantially accelerated and made easier by the existence of the necessary standards and normal standards and also of catalogs, handbooks, guiding technical materials and textbooks, which, in their turn, are compiled with extensive usage of standards and normal standards.

When training the industrial workers – engineers and technicians – they should be accustomed to the most complete utilization of standards and standard norms.

Progress or lagging behind in the development of machine-building and instrument-making is characterized not only by the parameters of machines and other articles being produced. Their engineering parameters can be quite advanced, but the machines, apparatus and instruments can be found to be unreliable and to have a short service life. An opposite situation is also possible: machines, instruments and other products can be fully reliable and have a long service life, but their parameters could lag behind the present day level. In addition, all

these products can be found to be very work-consuming and to require for their manufacture expensive or scarce materials and semi-finished products. Standardization is called upon to find an expedient technological and economical solution of this state-wide problem, the importance of which requires no proof.

Standardization combines within itself elements of new techniques and production efficiency. But it is not infrequent that one hears the following question: isn't standardization a brake of technological progress? Frequently also experimental specialists consider standardization as a synonym of limitation and stagnation, characterizing all that is standard as trite and even regressive. Meanwhile standardization is a natural development of modern technology, the basis for consolidation and centralization of production and machine-building and instrument-making, the necessary prerequisite condition for the development of extensive specialization and complete automation.

Of substantial value is the methodology of standardization. First priority is assigned to integrated typification of machines, mechanisms, apparatus, instruments and automation facilities as a basis for the following standardization of their assemblies, subassemblies and components. Historical development of standardization in the USSR went in the opposite direction. This is due to the fact that the first steps in the field of standardization in the USSR were made toward the end of the restoration period and were based on relatively stable, at that time, objects of production, general-purpose equipment and production processes which had not necessitated the utilization of special tooling. But in the years of the first and second five-year plans the USSR has performed technological reconstruction of basic machine-building branches, many new machines and production processes which were new then were assimilated. The problem of selection and assimilation of such types of

machines, mechanisms and other products whose designs and parameters would correspond to conditions of the socialist industry and collectivized agriculture has become acutely felt. It is for this reason, despite the still extensively held opinion to the effect that typification is not peculiar to standardization, that it (typification) has gradually become the basis of the entire standardization work in a number of branches of native machine-building.

A number of peculiar problems related to the systematic adoption of new equipment and ensurance of high-quality production has arisen under conditions of socialist machine-building and instrument-making, the solution of which can be considerably accelerated and made easier by standardization methods. However, it still happens very frequently that workers in the industry undervalue precisely this goal of standardization. As a result of this, there exists a certain break between the possibilities offered by standardization and its utilization in the industry. Integrated typification is characterized by the fact that it enjoys the participation of large circles of specialists, including consumers, whose collective thoughts guarantee that no serious technological errors will be committed. Integrated typification includes weighing of all production and service problems and determination of optimal fields for the application of individual types of typified machines.

A large part of standards and normal standards in operation in the native machine-building industry were elaborated by the unification method. Types of machines and other products, their subassemblies and parts and also engineering specification for their fabrication, testing methods, packaging and transportation and also, in individual cases, the conditions for storage of the production are unified. It follows from this that unification touches upon not only dimensions and parame-

ters, characterizing the types of objects of production and their subassemblies and components, but also engineering characteristics, determining the quality of manufacture and the longevity of the standardized or normalized production. Unification also touches upon the methods of production control. The significance of unification increases with the passage of every year and it is now impossible to find a branch of industry where it is not used.

Simplification, which originated in the USA during the First World War, constitutes the most simplified method of standardization and in translation into Russian it means simple limitation or simplification. Typification, unification and simplification are the most prevalent methods of standardization and also independent measures in the field of regulation of technical documentation.

Aggregation is one of long-range standardization and normalization methods which, unfortunately, is still not very extensively used in the working practice of the domestic machine-building and instrument-making industry. Aggregation consists in the fact that general subassemblies suitable for use in different machines, mechanisms, apparatus instruments or automation facilities are isolated and provided with a formalized design in the firm of independent products, the production of which can be centralized in a specialized plant (shop, section). General assemblies make it possible to assemble machines of various types made for specialized purposes with a minimal number of special subassemblies and components. For example, general mechanisms (main and auxiliary) can be with equal success used in vessels of different types and service designations, e.g., river transportation or sea fishing, with different operational characteristics. The problem of production of different types and models of automobiles, road-building and other machines can be solved in a similar manner on the basis of utilization

of general assemblies. The achievement of aggregation, especially under the conditions of development of plant specialization, requires conformity with interchangeability practices.

The use of aggregation opens new practical possibilities for standardization and normalization. Instead of the opinion, still held by industrial workers, that standardization inevitably limits the type range of machines and other products (according to this opinion, to the detriment of the interests of the national economy), it, with the use of the aggregation principle, can enhance the substantial expansion of the type range of machines and other products being manufactured and can ensure a more complete supply of equipment needed by all branches of the national economy. Here use is made of all the advantages of large-series and even flow production, based on interchangeability [4].

Methodical work in the field of development of the interchangeability principle is now performed in all countries. The ideas of interchangeability have penetrated all branches of machine-building, even those in which very recently manual adjustments and finishing on the spot were considered a normal phenomenon, the expedience of which was beyond doubt. It can be ascertained that at the present time the production in the machine-building and instrument-making industry possesses a very important method for parts manufacture, i.e., the method of interchangeability, based on standardization. As a result it is possible to manufacture any assemblies, subassemblies and components at different specialized plants and to ensure their assembly into high-quality machines, mechanisms, apparatus, instruments and automation facilities at any location.

Specialization and coordination of production present additional requirements relative to the concept of norm-setting documentation. In particular, more substantial significance is acquired by the problems

of establishment of a single engineering terminology and system of denotations since it is most expedient to name and denote the same finished and semifinished products and materials identically, independent of the existing traditions. For example, the name used for turnbuckles in the ship-building industry is turnbuckles and in the aircraft industry they are called strainers, and very recently parallel state standards existed for turnbuckles and strainers. It is important that the same finished and semifinished products and materials have the same numerical denotations, applicable to all interested branches of industry and making possible organization of mechanized accounting.

Measures which were given the names of standardization, normalization, typification, unification, simplification and aggregation and also work in the field of interchangeability, terminology, classification and designation of production have a lot in common. The norm-setting documentation, created as a result of the above work, sometimes goes through prolonged and sometimes through accelerated deliberations and discussions. However, the degree of justification, scientific and production worth and also of stability is independent of the number of departments and the length of discussions but on the quality of the working up and soundness of the standards.

The principal basis of the common features of all the various standardization work is the fact that all of them are directed toward increasing the quality of production, lowering the labor time required for its output, acceleration of the production cycle and the development of specialization and coordination of plants and shops. Standardization is instrumental in accelerating assimilation of the production of new machines, instruments and other products, and also in adoption of assembly-replacement repair methods, based on the use of interchangeable components and subassemblies. In the final analysis all this re-

sults in a substantial increase in the productivity of labor, which is the main goal, main task of the enumerating creative work, unified by the general concept of "standardization."

The basic varieties of the present-time standardization thus are normalization, simplification, unification, typification and aggregation, with the latter four varieties also being methods of standardization and normalization.

Why is it possible to speak about normalization, simplification, unification, typification and aggregation as about varieties of standardization? Because in the machine-building and instrument-making industries they are frequently used as independent effective technical measures, which are in no way related to the elaboration of standards and thematic standardization plans. Examples of this are:

a) normalization, conducted at individual plants independent of the general problems of state standardizations, interbranch and branch normalization;

b) simplification, directed toward elimination of orders for unnecessary basic and auxiliary materials and various purchased products;

c) unification, periodically achieved at plants and in design organizations with the purpose of economical improvement of the designs of machines and equipment by revision of brands of materials, rolled shape assortments, hole diameters, types of threaded joints, tolerances and fits, antifriction bearings, etc.;

d) unification, conducted in branches of industry with the purpose of discontinuing the production of obsolete articles and also of cessation of purchases of unnecessary types of outside products, etc.;

e) typification, achieved by branch scientific research institutes and design organizations in the elaboration of dimensional progression series of machines and equipment, needed by the socialist national econ-

omy taking into account the long range plans of its development; this activity actually is an unofficial form of standardization, since the elaborated dimensional series and parametric standards have the same goal;

f) aggregation, achieved by branch scientific research institutes and design organizations and also by individual plants in order to expand the type range of specialized machines and equipment which they produce on the basis of the creation of design-unified series (in those cases when the applicable state standards for parameter series embrace only basic types of machines and equipment and do not provide for expedient modifications, which are usually called versions.

Other varieties of standardization include work in the field of establishment of scientific-technical terminology, classification, designation systems, metrology and interchangeability.

3. SCIENTIFIC SUBSTANCE OF STANDARDIZATION

Workers of plants, design offices, scientific research institutes and Sovnarkhozes frequently question the scientific substance of standardization. What is standardization – a science or only empiricism? Before we give an answer to this question, we should consider what is science generally and how does it originate.

Marxism-Leninism classics in their works point out that science is necessary for powerful development of mechanized industry and that it is impossible to perfect the industry on the basis of the production experience only. They point out that science originates on the basis of development of practical experience, on the basis of generalization of experience. The degree of perfection of science depends on the degree of development of production forces and in the first place on the production facilities, i.e., equipment. The interrelationship between science and technology is well expressed in F. Engels' works [5]. Among

the existing definitions of the term "science" the formulation, proposed by K.A. Timiryazev is one which deserves consideration. In his words, science is the sum total of positive knowledge about reality; the field of science is followed by the region of ignorance; almost each science is indebted for its origin to technology [6]. The basis for the development of technical sciences is an ensemble of knowledge, united by a rigorously defined qualitative relationship. Science can thus be regarded as an ensemble of accumulated knowledge.

How does it originate? The specialist, having acquired certain experience notices that isolated facts, taken separately are of no interest, but taken together they begin to acquire substantial significance. It becomes necessary to correlate the known facts, interrelate them and to reduce them to a certain system. Thus, even in the field of standardization, for example, the first correlation works have made their appearance.

In the relatively recent past (within the memory of engineers of the older generation) the machine-building technology was not even recognized as an applied science. It constituted a description of fragmentary information about the methods of fabrication of individual components and about assembly of certain machines. But gradually the attitude toward technology is changing and it is beginning to be recognized as a science. A developed network of scientific research technological institutes is now in existence. The ranks of major industrial specialists include also production engineers. Technological [production] problems became the themes of many candidate and doctoral dissertations. This process will inevitably also touch upon standardization.

The history of science attests to the fact that theoretical development of one or another problem and its practical utilization are not infrequently removed in time. Thus, also certain standardization work

frequently require considerable time before it is recognized and adopted. They are ahead of technology or, conversely, lag behind it. All depends on the theoretical prerequisites and guiding principles on which the standardization work is developing. The standardization theory should not only base itself on the practice, but should itself point the way for the practice, creating in practicants confidence in the actions they undertake.

Science in its development usually passes through a number of stages, which can be shown through an example of applied technological sciences, which have passed in their time a period of accumulation of factual material. This initial period was followed by transition to a higher degree of putting the science into order, whose main problem was systematization and correlation of the accumulated material. Further follows a still higher step, of the science, i.e., finding of profound governing laws and relationships in the phenomena under study and then full-valued control of these phenomena; but technological sciences have not as yet reached this stage. Thus, the development proceeds from explanatory science to science that transforms.

The question can be asked: at which stage is the science of standardization at the present time? There is no doubting the fact that it has not as yet become a science that transforms, but that it nears this stage of its development. To accelerate the given process it is necessary to penetrate its substance more profoundly. The standardization science should be studied and developed.

Standardization is a new branch of knowledge, it studies the action of standards in the national economy, their influence on productivity of labor, on technological progress, on specialization and automation and, in the final analysis, on the acceleration of the creation of the material and technical base of Communism. Standardization as a

science is characterized by close interaction with a number of related scientific disciplines in the field of design of machines and instruments, the production process by which they are manufactured, physical metallurgy, organization and economics of production. All these scientific disciplines branch out and give birth to new ones in the process of their development. Science becomes ever-increasingly profound and its branches touch one another and permeate one another, then hybrid science[s] ar[ise] at the points at which they touch. This is the process which has given rise to the science of standardization, the existence of which becomes increasingly noticeable. Mathematics has begun to invade standardization, which opens up new possibilities.

Possibilities provided by standardization and its richness can be characterized by the following example. In the same manner as on the basis of the simple sound series "do"-"ti," being guided by the theory of music one can create an unlimited treasure of musical creations, so from the relatively small number of standard assemblies it is possible, with the appropriate development of the standardization theory, to achieve a tremendous variety of all kinds of machines, mechanisms, apparatus, etc.

Standardization is distinguished by many more or less explicitly expressed qualitative governing relationships, depending on the conditions of its origination and achievment. Accumulation and correlation of methodological information became the characteristic trait of the first stage in the development of theoretical bases of standardization. It should be noted that this problem is complicated also by the fact that standardization has many varieties. However, to establish the origin of standardization and normalization is still not too difficult. The problem one must deal with is their interrelationships and mutual influences.

The appearance of something new in science and technology is usually accompanied by creative discussions, which help in finding the most expedient ways for further development. It is pointed out in the new Program of the CPSU [Communist Party of the Soviet Union] that: "A necessary condition for the development of science is free comradely discussions, which enhance creative solution of a maturing problem." The absence of creative discussions on standardization is one of the basic causes of the weak development of theoretical investigations and also of series of shortcomings in practical work. During the last 25 years only one discussion of applied problems took place, but even it gave many useful recommendations. Standardization has to live through different times – bad and good, and through different attitudes toward it on the part of economists – positive and negative, and through different criticisms – primitive and rigorously scientific.

In each sphere of creative activity, including also the field of standardization, it is necessary to have a certain concept, creative idea. It is necessary to have a point of view, a guiding principle, which makes it possible to find one's bearings among a multiplicity of facts, observations and opinions. Standardization workers want to learn to analyze and synthesize, to compare and seek, to find and to bring into motion production reserves. They want to actively and successfully fight for the acceleration in the creation of the material and technical basis of Communism. We are faced with the problem of imparting to standardization workers with such knowledge which will help them in perceiving that which is beyond the limit of their personal experience and observation. Whether standardization will develop creatively or passively exist will be decided by them.

The underestimating of methodological investigations and theoretical work in the field of standardization results in ineffective practi-

cal results, as can be graphically shown through the following examples.

Example 1. The official classification chart of the state standards of the USSR provides group G11 for components and subassemblies which are common to various machines and mechanisms. The 1962 index of standards contains only 16 standards in this group; in addition, some of them are not used in all branches of the machine-building industry. The weak development of standardization of general machine-building subassemblies and components is a result of the underestimating methodical investigations in this field and of the absence of theoretical prerequisites. It is still unclear what degree of content completeness these standards should have, from what their elaboration should begin and what interrelationship with standard norms and catalogs should here be ensured. If the practice of 30-35 years has not worked out satisfactory recommendations, then theory should be called upon for help.

Example 2. The existing standards for general-purpose steel ropes (cables) provide for 59 types, 1049 standard dimensions and 11,898 versions. Who is brave enough to state that all these are actually needed by our economy? Would it not be more correct to assume that these standards have been elaborated by a methodology which is in explicit contradiction with the problems of consolidation of production? They direct the industry toward individual orders and small-series production. If the practice of elaborating such standards has not created effective methods, should we not perform theoretical investigations to find more expedient principles for the establishment of standards for cables and other products?

Example 3. The machine-building industry is the basic consumer of rolled steel. Machine-building plants are not indifferent to the state in which the metal is supplied by metallurgical plants. The absence of a scientifically substantiated standardization of rolled steel has re-

sulted in a tremendous variety of rolled stock specifications in the as-received state, which doubtlessly has a negative effect on the productivity of metallurgical plants. Thus, for example, the existing standards for rolled steel stock provide for 76 different gradations of its as-supplied state, including 11 different requirements as to the fabrication precision, 10 hardness gradations, 9 surface finish gradations, etc.

The overwhelming number of these gradations is an expression of very conditional requirements, characteristic of some isolated standard. Formulations of any standard, taken separately, do not attract any attention, but in their totality they take on substantial significance, they result in superfluous unjustified variety of requirements by the consumer and in a superfluous amount of modifications (versions) of rolled steel stock, which cannot always be discerned in the accompanying documentation. Storage of rolled stock in warehouses with a distinct subdivision of its versions is a very complex problem. The variegated rolled stock specifications existing at the present time can be made uniform by elaboration and adoption of a single classification and numerical system for designation of metal and alloy brands as well as of engineering characteristics of the rolled stock in the as-supplied state. This is a highly complex scientific undertaking of great national importance.

Example 4. The absence of a single classification of materials and of a designation system based on scientific considerations has resulted in designations of their varieties in such a complicated manner that nobody can readily explain without a special reference, what, for example, hides behind codes as: PELShKD, SKTVF, 10G2SD, PE-450, TIK-0, M16S, KNRETP, AABGV, ED-13, KMK-218, 09G2, PEVKE-2, K-110-2, LPRGS, SKF-32, K-78-51, AVRBG, MFK-20, K-293, and the like, without even men-

tioning designations of alloyed steels. But such integrated handbooks, in which an explanation of these codes could be found, are not in existence.

To what do all these facts attest? Standardization has not as yet emerged from this initial stage when individual standards have been elaborated without the necessary consideration of all consequences to the national economy which they bring about. The period of accumulation of factual material has passed. Transition to a higher degree of production regulation by standards requires profound methodological and theoretical work.

The enumerated examples show that the time has come to discover the more profound peculiarities of standardization and to assign to it that role which corresponds to the problems of achievement of integrated mechanization and automation in the industry.

At the given stage of development of standardization as a scientific discipline considerable importance is acquired by problems pertaining to its system. What should, at the present time, be understood by the term standardization system? These firstly, are the basic trends of its development and principles for achievment, interrelationship, limiting features, coordination and coding of standards and normal standards of different levels; their relationship with working drawings, engineering specifications, catalogs and handbooks; secondly, conditions of stability and progressiveness of standards and normal standards, methodologies of elaboration and adoption of various standards and normal standards, methodologies of construction of [dimensional] series and the application of mathematical methods; thirdly, the selection and justification of production quality indices; scientific bases of classification and designation of finished and semifinished products and materials of all types, interrelationship between standardization,

specialization and automation of production; economic efficiency of standardization and normalization, and also the most expedient organizational forms and their achievement in all links of the national economy.

Each of the enumerated problems has its aspects, hence the elaboration of a standardization system is a problem of great complexity. The necessity of creation of a domestic standardization system is beyond doubt [7].

Chapter 2

DEVELOPMENT OF DOMESTIC STANDARDIZATION IN MACHINE-BUILDING

A systematized outline of the development of standardization in the USSR machine-building industry and a detailed bibliography are presented in Reference [1]. Below in the most compressed form we present the basic information about the given problem and we also illuminate the causes of the repeated reorganization of standardization and modification of the varieties of standards.

1. STANDARDIZATION IN THE RESTORATION PERIOD

The development of heavy industry in prerevolutionary Russia was not accompanied by the creation of national standards. The majority of machine-building plants was owned by foreign firms, and these were not interested in the appearance of Russian standards. American, English, Belgian, German, French and other firms have used their own standards and normal standards, which have provided them with convenient economical and technological connections with their foreign home bases and which has made very difficult the mobilization of the domestic industry in the years of the First World War. The presence in the country of three systems of measurement (the arshin [Russian], inch [English] and metric) also did not promote the establishment of single national standards.

The necessity for regulation and correlation of the tolerance and fit systems which was brought about by the war has resulted in the unification of the efforts of I.I. Kukolevskiy and L.P. Smirnov, two MVTU [Moscow Technical College] professors, with whose participation the

Standards Workshop of the Zemgor (The Territorial Council and Council of Municipalities) has elaborated measures for organization of interchangeable production of armaments and ammunition at domestic machine-building plants. During this same period, the MVTU and other higher scientific schools of Russia have performed work which has originated the science of machine-building technology.

The Chairman of the Council of the People's Commissars of RSFSR [Russian Soviet Federated Socialist Republic] V.I. Lenin has issued, on 14 September 1918 a decree about the introduction of the metric system of weights and measurements, which has established a stable foundation for extensive development of standardization work. It would be incorrect to assume that the implementation of this major standardization measure came about immediately and without difficulty. Fifteen (15) more years of systematic work were required before the metric system had been firmly established in the national economy of the Soviet Union.

Of not unimportant significance to the timetable for adoption of the metric system was the circumstance that in the period of restoration and reconstruction of the domestic industry, and of machine-building in particular the Soviet Union was forced to purchase and import large amounts of equipment produced on the basis of the English system. The new Soviet plants have produced automobiles by the English system, however, the tractor industry has immediately, despite the great difficulties, utilized the metric system.

In the transition period between the Civil War and peaceful construction the national economy was faced with complex problems: it was required not only to restore an industry and transportation system system devastated by the war, but also to achieve such a reconstruction of the national economy, which would result in the construction of a so-

cialist society.

Standardization work during this period has arisen at many enterprises, however, it was of narrow local significance and was deprived of any general direction. On the basis of the necessity to regulate and develop standardization, the People's Commissariat of Workers and Peasants Inspection organized in 1924 within itself a Central Standardization Office. In the same year, by the initiative of F.E. Dzerzhinskiy the Office of Industrial Standardization of the Main Economic Administration of the VSNKh [All-Union Council of National Economy] of the USSR came into being. The inclusion of this office into the Main Economic Administration has shown the important economic goals which were put before standardization. Simultaneously, branch Main Administrations of the VSNKh of the USSR have also begun to create working commissions, specialized by production types, for the elaboration and industrial standards (promstandards) drafts for various branches of the national economy. Soon the number of these specialized commissions reached 120. The commissions have elaborated a very effective method for the development of standards, the restoration of which under present conditions is very desirable.

The organizers of Soviet standardization have been able to interest, in the period being considered, in standardization work,a large number of known specialists, including A.N. Bakh, V.V. Bekhterev, A.M. Bochvar, A.V. Vinter, V.P. Goryachkin, N.T. Gudtsov, I.M. Gubkin, G.M. Krzhizhanovskiy, N.A. Minkevich, M.A. Saverin, V.L. Pozdyunin, D.M. Pryanishnik, S.A. Chaplygin, M.A. Shatelen and others, whose efforts have enhanced the development of domestic standardization.

The Council of People's Commissars of the USSR on 15 October 1925, adopted a resolution about the organization of a Standardization Committee at the Council of Labor and Defense and also a Standardization

Office at the People's Commissariat of Workers and Peasants Inspection, which was the secretariat of the Standardization Committee. It was then also determined that All-Union standards "OST" be given the force of a national law and their use is therefore obligatory over the entire territory of the USSR. V.V. Kuybyshev, who occupied at that time the position of the People's Commissar of Workers and Peasants Inspection, was designated as the Chairman of the Standardization Committee. All this attests to the importance of the role of standardization in uplifting and developing the national economy of the country.

In July of 1926, 24 standards of ferrous rolled stock were approved, which to a significant degree has regulated the production of rolled stock, resulted in specialization of rolling mills and has made it possible to decrease the nomenclature of rolled products by a factor of 6 (from 4742 to 785 standard dimensions). As a result of this standardization, the productivity of rolling mills of domestic metallurgical enterprises was increased by 7-10%, and for individual mills even by 40%. This work, which was of great significance for the state, was based on unification, based on the elimination of parallel standard dimensions and brands of rolled stock, joining of profiles with similar major dimensions and profile characteristics and the inclusion of new standard dimensions of rolled stock profiles.

The expedient technical and economic principle which served as a basis of elaboration of the aforementioned 24 standards, has ensured their adoption by enterprises which produce the metal as well as by those which consumed it. According to calculations of specialists, as a result of the decreased assortment of rolled shapes which was achieved, it has become possible to increase their output by 750,000 tons per year, which during this period (1926) of acute metal scarcity in the country represented a serious measure of state-wide significance. The

adoption of these standards has exerted a favorable influence also on the development of machine-building, which is the main consumer of metal.

The first all-union standards in the field of machine-building were OST 32 for metric threads for diameters from 6 to 68 mm and OST 33 for inch threads produced by the Whitworth system with and without clearances for crests and roots for diameters from 3/16" to 4". It should be noted that OST 32 was in force about 30 years, which affirms not only the high quality of the work performed for standardization of threads, but also the correctness of principles upon which its authors have based their work. The work on standardization of threads has continued into 1927-1928 and was culminated by the approval of standards: for metric threads with diameters from 1 to 5 and from 72 to 600 mm, for piping threads, small metric threads and other special purpose threads. Thus, by 1928 all basic types of threads were already standardized. The following years were taken up by work of making individual, already existing standards more precise and of development of new standards for certain types of narrowly specialized designation threads, needed in the electrical engineering, instrument-building, optical and other branches of industry. This is an example of solution of a major practical standardization problem in short time.

The development of domestic industry was greatly influenced by the elaboration of a standard for normalized diameters, which represented a basis was the development of work in the field of interchangeability. This standard was approved in 1926 and its basic propositions have retained their timeliness up to the present time. In 1927, the work establishing the first standards in the field of tool production was completed, among which we should primarily include standards for tool squares and tapers. Of no lesser significance was work for standardiza-

tion of bolts and nuts with metric and inch threads, and also preparation of standards for washers, pins, dovels, rivets, screws and other fastening components.

In the task of adoption of interchangeability into the industry, an important role was played by standardization of tolerances and fits. Work in this direction was begun as early as 1919 but was halted temporarily by the Civil War. This work, of great importance for the entire subsequent development of domestic machine-building was renewed by the Committee of Gauges and Standards under the leadership of professor A.D. Gattsuk as late as 1924 and was completed in 1929, when after extensive deliberations the All-Union Committee of Standardization established a series of OST's for tolerances and fits, which are in force without substantial changes up to the present time.

This single all-state standard system of tolerances and fits has, in 1931-1932, served as the basis of all-union standards for gauges, which have served as a sound foundation for ensuring interchangeability and correct organization of gauge maintenance at enterprises of the machine-building and instrument-making industries of our country.

The significance of this work is difficult to overestimate, keeping in mind the fact that it immediately preceded a stage of intensive development of the entire national economy of the USSR and of machine-building in particular. We should recall that the Soviet Union has received in the years of the first five-year plan equipment produced in different countries, which had different systems of measures and various tolerances and fit systems. Regulation on a state-wide scale of material brands, rolled stock and fastening component assortments and joining dimensions for tools, could not but promote rapid assimilation of new equipment.

Of substantial significance to the development of machine-building

was work performed for regulation of the formalization of working drawings. In 1928, first recommended standards were approved, which were called "Drawings for all Varieties of Machine-Building," the repeated refinement of which has gradually made it possible to more fully reflect the specific peculiarities of many branches of machine-building and to subsequently pose the problem of elaboration of a single system of drawing procedures for the entire USSR.

2. STANDARDIZATION DURING THE YEARS OF THE FIRST FIVE-YEAR PLANS

The construction and reconstruction of many machine-building enterprises which took place over the entire country, organization of new production units with a tremendous volume of complex planning and design work were not in a sufficient measure reinforced by the necessary standards for the type range of machines and equipment subject to assimilation at our plants. At this time, extensive use was afforded to the practice of the so-called counterproposed standards (i.e., when the interested organizations proposed their version of the standard draft instead of that received by request). This practice has not lost its significance at the present time; under the new conditions it can be found to be quite effective.

The Council of Labor and Defense, having listened, in 1929, to a report by the Standardization Committee, has decided that the subject field, volume and rate of standardization work lag considerably behind the requirements of the national economy and has suggested to expand standardization work in all possible ways. It should be noted that at about this time, together with the tremendous quantitative growth of production, there begun to appear in the industry cases of decreasing quality of products and materials which were produced. Certain economists have attempted to solve the very important problem of lowering the net cost and increasing the productivity of labor by lowering the

quality of production. Decrees about the obligatory character of standards were given in the decision of the TsIK [Central Executive Committee] and the SNK [Council of National Economy] of the USSR of 23 November 1929 about the criminal responsibility for the production of low-quality articles and for non-conformance to the obligatory standards.

Taking into account the increased significance of standardization for the general increase of the level of the industry, the SNK of the USSR in August 1930, approved a new arrangement, whereby the Committee for Standardization was given the status of the All-Union Standardization Committee (VKS) at the Council of Labor and Defense. Government decrees have initiated state planning of standardization with the result that the volume of work in the field has increased sharply.

What new advantages were obtained by the domestic industry by the planned administration of standardization? First of all, it was made apparent that standardization was the weakest developed in heavy industry and, in particular, in machine-building. In the meantime, it could have played a significant role as a factor, promoting organization of flow production, specialization and coordination of machine-building plants. Certain branch machine-building combines have not fulfilled a single subject provided by the plan. They included industrial combines specializing in the output of steam turbines, boilers, [steam] locomotives, [railroad] cars, diesels and other important machines. It is characteristic that standards in the field of agricultural machine building were at this time elaborated only for track-laying transportation facilities; no standards existed for agricultural machines. A similar situation was observed also in river shipbuilding, where standardization extended only to door knobs and window jalousies. The same traits were peculiar also to other branches of machine-building.

Certain work which was performed in the field of standardization

of machine components with the purpose of specializing their production could actually not be utilized since the machine-building industry, as we know, has developed in the prewar period, along the lines of creation of combines with a closed production cycle. This lack of coordination between the general course of standardization and the actual development of machine-building is due not only to the uncritical copying of foreign standardization methods and also in underestimating the value of standardization as a factor of technological progress.

Technical journals of that time have raised important questions which could have promoted the improvement of the standardization task, but the industry reacted very weakly to them. The state of standardization during the first five-year plan was best described by V.V. Kuybyshev, who noted that there exist different types of standards; there are those which count as our achievements and at the same time are in no way a rationalizing beginning, and that we also have standards which simply state the existing situation. Although these standards introduce uniformity, it is impossible to mention them when speaking about standardization as about an important means of rationalization and reconstruction of the entire national economy. V.V. Kuybyshev spoke in 1929 about creative standards, which are capable of changing the character of production.

Recognizing that it would be expedient for the leadership of the entire standardization task to be in close ties with the general national economic planning, the SNK of the USSR in February of 1931, decided to transfer the All-Union Standardization Committee (VKS) with all its institutions to the administration of the Gosplan (State Plan) of the USSR, with the VKS retaining its functions and rights, in particular, approval of all-union standards, establishment of basic construction of planning norms and also inspection of the industrial pro-

duction.

To stimulate standardization work the TsIK and SNK of the USSR have, in September of 1931, decided to expand the prevailing arrangement about bonus funds for achievements in fulfillment and overfulfillment of the industrial and financial plan and also for inventions, technical refinements and efficiency suggestions to include achievements in the field of standardization.

Despite the quite significant volume of standardization work, no major work of decisive significance was performed during this period. The comradeship between standardization and national economy planning workers was not found to be fruitful, since in fact they have followed different paths. In November of 1931 the SNK of the USSR has deemed it necessary to transfer the VKS from the administration of the Gosplan of the USSR back to the administration of the Council of Labor and Defense.

It follows from the above that during 1931 only several important organizational measures were taken with respect to standardization. However, in the middle of 1932 it became completely obvious that the VKS, instead of concentrating its attention on the creating of standards of decisive significance, has taken to the path of elaboration of a large number (about 9000) second-ranking standards.

The standards of the 1929-1932 period can be divided into four groups. The first, most prevalent group is made up of elementary standards, which can be characterized as the first attempt of regulation of technical documentation and of the produced articles. The second group includes standards, establishing the selection of one or another technical indices from among those already existing. The third group was made up of standards, created on the basis of scientific and technological reworking of engineering specifications, while the fourth was made up of a comparatively small number of standards, elaborated on the sci-

entific basis.

From the total number of 1115 machine-building, instrument-making and metallurgical industry standards [7] only 106 standards were included in the fourth group (tolerances and fits, threads, rolled stock assortments, etc.), but they did not include standards for integrated series of machines and equipment needed by the national economy. This idea was put forward much later, in 1942, when the author of the present book [1] and [8] justified the necessity of revision of the goals of national standardization in the direction of elaboration of standards for complex series of objects of production taking into account long-range plans for the development of the national economy.

The problem of attracting to standardization work of branch scientific research institutes of the industry was previously and is now of great significance; of 238 institutes of the Narkomtyazhprom [People's Commissariat of Heavy Industry] existing in 1932, only 60 institutes (about 25%) have participated in standardization work. No organizationally stable form of work of the branch scientific research institutes was developed. They, as a rule, were little interested in standardization, or they entirely declined to do any work of standards elaboration. This was due to the fact that the institutes workers were unfamiliar with the technical and economical principles of standardization and treated it as a measure of secondary importance and even as one interfering with their work in creating new machines.

The individualized trend in designing new machines was at this time not only governing, but it was thought to be expedient. New, more progressive ideas of simultaneous planning of machine series were accepted very slowly.

The initial plan assignments, including numerous actual machine-building themes, were performed very slowly. The lack of not only

standardization specialists but also of the necessary methodological manuals, especially in the field of elaboration of parametric series of machines and equipment have exerted their effect.

The decisions of the SNK of the USSR of 15 June 1932 and 5 July 1933 were of course-setting significance. The first required giving priority to the plans for standardization of machine-building objects and their components. The second decision called the attention of machine-building workers to the progressive role of standardization in the task of assimilation of new production, ensuring quality requirements, specialization and coordination of plants and the achievement of one of the most important tasks of standardization, i.e., of interchangeability of parts.

These decisions have not lost their important significance also at the present time. The decision of the SNK of the USSR of 15 June 1932 pointed out the fact that standardization work should take on major significance in the task of increasing the rates of socialist construction, development of new production units, assimilation of new techniques, acceleration of the turnover of capital and improvement of the economics of enterprises. In accordance with these decisions, the work of the VKS, which up to that time was expressed in the preparation of a tremendous number of comparatively unsubstantial standards, should have concentrated on the development of standards for the basic technological problems of the national economy.

To reinforce the insufficiently developed departmental standardization, it was found necessary to organize at economic Peoples Councils, branch standardization committees, to attract to them new workers and to make these committees responsible for the development of standardization in each department. One of the tasks of the VKS of this period (1932) was the approval standards for simplification of products.

The practice of subdivision of standards into All-Union (OST) and departmental (VEST), existing until March of 1933, was changed. The new order provided for classification of standards by the spheres of their obligatory application, namely:

a) standards of all-union purpose (OST of the VKS), the use of which is obligatory over the entire territory of the USSR, approved by the All-Union Standardization Committee at the Council of Labor and Defense

b) branch standards (OST of NK) [People's Commissariat]), the use of which is obligatory over the entire territory of the USSR, approved by the People's Commissariats standardization committees;

c) limited application standards (ST), approved by departmental organs.

In the field of heavy machine building typfication and rolling and forge-pressing equipment, cranes, ore mining and enriching equipment, excavators and dredges, cocling, geologic prospecting and other equipment on a considerable scale and with a large nomenclature of included machines was begun in this period (1932), but was left unfinished. Major work for typification and standardization was proposed in the electrical industry. Here, the problem of paramount importance was the ensurance of interchangeability both in the geometric as well as electrical meaning of the word. However, the work of standardization of electrical products was performed without a plan and not at a sufficiently intensive rate. From the total number of 3396 all-union standards approved toward 1 October 1931, only 44 pertained to strong and weak current engineering. But, in the same year of 1931, as a result of conferences between representatives of plants, institutes and other organizations of the electrical industry, a long range plan was elaborated for the standardization of 493 objects in the field of electrical engineer-

ing, of important significance to the national economy.

The acceptance of this plan has served as a point of departure for the development of standardization in the electrical industry, the economic effectiveness of which was found to be quite considerable, since standardization has touched upon a wide range of problems. The elaboration of standards for general norms and requirements in the field of electrical engineering was begun. In connection with the construction in Khar'kov of one of the world's largest turbogenerator plants, it has become necessary to establish a standard for the scale of generator capacities and to refine requirements put to the electrical as well as to the steam parts of turbogenerators, which are the basis for the development of power generation in our country.

The petroleum industry toward the beginning of 1932 not only did not have a single standard, but has not even begun unification of equipment. For example, the threads of casing and drilling pipes used in the Baku and Grozny petroleum industries were different, which has made it necessary to use different attachments. The technological shortsightedness of the leading personnel has resulted in the fact that the central organizations of the petroleum industry (the petroleum sector of NKTP [People's Commissariat of the Peat Industry] and "Soyuzneft" [Union petroleum]) did not have a single standardization organ, which would be central for the entire petroleum industry. Neither the scientific research, design or construction organizations, nor the operational trusts had standardization engineers. This shows the tremendous significance of organizational problems, without correct solution of which the development of standardization is impossible even in those fields where the necessity for it is beyord doubt.

The position of typification of industrial and exploitation equipment was not better, despite the fact that the petroleum machine-build-

ing branch, which was new to the USSR, was just being created and it was very important to determine the optimal nomenclature of the necessary equipment taking into account the long-range plans for the development of the petroleum and petroleum processing industry. If about 20 types of different pipe stills and cracking towers were in existence in the USA at that time (as a result of capitalist competition between individual companies), the scientific-technological organization of the USSR could have properly selected several types of these installations, satisfying the current demands, and several for long-range application. The equipment in the Soviet Union was produced by enterprises of several departments, which have not paid any attention to the elementary standardization problems. As a result, the new typical pipe still, produced by "Krekingstroy" according to the engineering specifications of the "Neftezavodstroy" [Petroleum Plant Building Trust], has not taken into consideration the utilization of domestic materials, and the planned designs of purification installations developed by the "Neftezavodstroy" were not in accordance with the plant equipment, etc., [1].

With the organization of departmental standardization committees, a new period of development of domestic standardization in the machine-building field has begun. The radical change in the structure of the standardization organs has resulted in the subsequent elimination of the central standardization organ – the VKS. The activity of branch standardization committees has resulted in the appearance of a large number of all-union standards of branch and departmental character, since these committees had the right to elaborate, approve, modify and revoke the corresponding all-union standards. As a result, alongside with OST and OST of the VKS, OST of the NKTP, OST of the NKPS, OST of the TsM, OST of the El, OST of the NKVod, OST of the NKM, OST of the NKTM, OST of the NKSM, OST of the NKOM, OST of the NKMP and many others

have begun to apply in the machine-building industry. In addition, the People's Commissariats and the other departments have issued a large number of ST, main administration standards, (they were frequently called glavk standards), the field of application of which was limited to the enterprises of the given main administration. These standards, by their contents and sphere of applicability were practically both branch and departmental, in the same manner as certain OST's, approved by People's Commissariats and other departments.

The system for development of standards by different departments was not distinguished by its universality and stability. Many standards were given in a compressed form, but some of them went into unnecessary detail. These, for example, include the OST of the NKPS 7042/83 under the name "Signal lantern hooks for freight and passenger railroad cars," which actually included not only 18 individual standards, but also instruction on the order of implementation of this standard.

Toward the beginning of the second five-year plan, all-union standards of state-wide significance, all-union standards of branch and departmental significance and main administrations standards, practically frequently having the character of branch standards, but absolutely nonbinding also on other main administrations of their People's Commissariat and more so on other People's Commissariats and departments, have thus existed in the machine-building and instrument-making industry of the Soviet Union. In addition, normal standards, the contents of many of which did not at all differ from that of the enumerated standards, have operated at the enterprises. Such a system of standards had its advantages and disadvantages. The advantages include, first of all, the possibility of rapid solution of a problem relative to the standardization of any object or of the revocation of an obsolete standard. The negative side includes the possibility of issuance of parallel

standards, if the analogous standards operating in another department for some reason do not satisfy the requirements of the given department.

The period of the second five-year plan included the appearance of a considerable number of standards which are of slightly more interest in comparison with those elaborated previously. In this period were approved the first standards for the basic parameters of lathes, which has already laid the foundation for the standardization of machine series. However, in the field of agricultural machine-building, only the blades of horse-driven plowshares and the teeth of horse-driven rakes were standardized at that time. The standardization of only individual parts of spinning and weaving looms was begun in the textile industry.

The purpose and economic principle of this standardization was the tendency to ensure the possibility of purchasing interchangeable finished products and components as opposed to manufacture by internal resources, i.e., specialization of production and its coordination. However, no measures were taken for developing specialized production of these articles. In elaboration of these standards the economic effect calculations were made on the basis of organization of large specialized plants, which reached considerable sums, but this effect has practically remained on paper, since no concrete steps were taken toward more extensive development or stimulation of organization of specializing plants.

Organization of branch standardization committees has substantially changed the goals and problems of standardization and has made it nearer to the production unit. It has promoted the adoption of interchangeability in a number of machine-building branches, which has resulted in increasing the productivity of labor by virtue of decreasing the volume of work for adjustment of components and subassemblies in the process of machine assembly. But this work was not stimulated every-

where. It has moved ahead considerably in the auto-tractor, machine-tool building and aircraft industries, partially in agricultural, textile, food and transportation machine-building. In heavy machine-building, this field of work was forgotten, which exerts its negative influence now, when the rates of development of heavy machine-building became more considerable, and the prerequisite conditions for its specialization and aggregation on the basis of interchangeability were not developed in time.

The departmental committees have performed a large volume of work in revising many previously introduced standards with the purpose of improving them. In particular, new standards for bolts have taken into consideration their fabrication by upsetting, which has given a 22% economy of metal and has increased several-fold the productivity of labor. Decreasing the height of standard nuts has resulted in a 20% saving of metal. The standardization was instrumental in lowering the cost of mass-produced parts by 6-10%. 4500 general-union standards were approved in the years of the first five-year plan, i.e., by a factor of 12 more than in the preceding five years. Toward the end of 1933, standards were already elaborated in 120 scientific research organizations and planning institutes.

Assimilation of new production has made it necessary to elaborate standards for methods of testing of individual kinds of machines and mechanisms, standards for different types of processes and raw materials used in many machine-building branches, including tractor-building, boiler and turbine building which required new brands of steels, i.e., high chrome content, molybdenum, heat-resistance, etc., and also a number of standards for nonferrous materials brands.

Standardization work has acquired a new significance and was substantially expanded which has resulted in more operational activity by

local and branch standardization organs. Conversely, the rate of work of the VKS which has limited its activity to a narrow circle of problems, which in addition required more extensive consultations, has decreased considerably, which was determined by the absence of the necessary organizational reconstruction of its work. The VKS has not found major national economic problems which it could solve. As a result, a decision of the Government of the USSR about liquidation of the VKS followed in June of 1936, and the entire standardization work, including approval and recording of general-union standards was transferred to the People's Commissariats and departments. Standardization on the scale of the entire national economy was completely decentralized, with the branch standardization committees partially reorganized so that they could cope with their new tasks.

More than 4600 standards, the overwhelming part of which represented revision of those already in force, were elaborated and approved in the years of the second five-year plan. Among the more substantial standards from among those elaborated during this time we should count standards for basic parameters, precision norms and testing methods for certain metal cutting machine-tools and for methods of typical tests of passenger cars and trucks.

After decentralization on a state scale of the entire standardization work, serious shortcomings, primarily pertaining to the general direction of its development, have appeared together with positive instances. Decentralization has begun to interfere with the utilization of standardization in the interest of further development of the national economy and of its leading branch represented by machine-building. Instead of interrelating standardization work and making its development more purposeful, the departments have attempted to satisfy only their own departmental interests.

Toward the beginning of 1940, the number of departments which had the right to approve all-union standards and also to modify and recall them had reached 26. Each of them had developed its own operational system, its own standardization principles and methods for elaboration of standards, its own structure of standardization organs in the central and local offices. It had become necessary to radically reconstruct the standardization work. The absence of a central organ, which would control all attitudes in the field of standardization on the scale of the [entire] national economy was being felt.

The decision of the SNK USSR and the TsK VKP(b) [Central Committee of the All-Union Communist (bolshevik) Party] on 2 July 1940 organized a central organ — the All-Union Standardization Committee in the SNK of the USSR, which was immediately renamed the All-Union Standards Committee in the SNK of the USSR. The comparison of these two names shows a substantial difference in the purpose and functions of the central standardization organ. The first name points to the fact that the given committee should occupy itself with standardization on the scale of the entire national economy, while the second name stated that the committee will occupy itself by state standards only.

The period of development of centralized state standardization preceding the Second World War was very brief. The organization of the All-Union Standards Committee, the staffing work and expansion of its work have practically taken up the entire last part of 1940. Only a small number of state machine-building standards were elaborated and approved during this period.

The state standard as a legal document has taken on significant importance in questions pertaining to improving the quality of production of all production branches. Standards have afforded an increasingly larger amount of space to sections pertaining to engineering speci-

fications, testing methods, rules of acceptance, packing, storage and transportation, and also to other technical characteristics, which have directly or indirectly established requirements to the quality of produced articles.

Together with engineering specifications standards, extending to groups of machine-building products (for example, common engineering specifications for electric motors of various service designations), state standards for engineering specifications have appeared for specific mass produced machines. These standards were called brand standards.

The year 1941 was actually the first year of state standardization in the full meaning of the word. The standards have acquired a great importance, they actually were the law of the state and the most important of them were approved by the Government of the USSR. The large amount of organizational work performed in 1940 by the All-Union Standards Committee at the SNK of the USSR has given certain perspectives for the development of state standardization in the national economy of the USSR, reducing departmental normalization to a secondary rank.

3. STANDARDIZATION IN THE YEARS OF THE SECOND WORLD WAR AND DURING THE POST-WAR PERIOD

The war, which started in 1941, put new problems to the state standardization. As a result of the complicated war-time conditions, departmental normalization practically ceased. It was replaced by temporary engineering specifications, since it was no longer possible to adhere to many of the state standards then in force. The war-time conditions have required new solutions, more flexible and conforming closer to the reality.

The standardization work in all its manifestations was, in the war years, subjected primarily to the necessity of providing for more efficient consumption of the available material resources, especially those

of strategic importance and to stimulation of utilization of less scarce processed and raw materials.

The war-time state standards, denoted as GOST-V [All-Union State Standards-War-Time], had remained in force during several years after the end of the war and were only gradually replaced by permanent state standards.

The scale of this work can be characterized by the fact that more than 2000 standards were approved in the war years and more than 1000 previously introduced standards were modified in accordance with war-time requirements. Many steam locomotive and railroad car subassemblies and components have been standardized which has facilitated and accelerated repairs of the rolling stock. Standardization of instrument parts has made it possible to consolidate their production and use more productive production processes. The new standard for transformers has lowered the metal consumption and the labor input required for their production by 50%. *

A state standard for surface finish, which was of exclusive importance for the entire subsequent development of the domestic machine-building and instrument-making industry, was approved at the war's end It was instrumental in the creation of very interesting designs of instruments for estimating the surface quality.

The war-time standardization, when the domestic machine-building was severely limited, and the production of war equipment was very developed, was thus found to be a very effective measure, instrumental in the solution of many practical problems of our country's defenses. The limited possibilities of this time not only have not lowered the significance of the previously known standardization principles and methods, but have enriched the domestic standardization by a new principle of efficient utilization of resources.

Of great methodological importance was the work performed in investigating domestic and foreign standards (for certain branches of industry) by workers of the All-Union Standards Committee in 1942. The purpose of this work: to find, quickly, efficient ways and principles for post-war standardization to expedite the acceleration of the restoration of the national economy. It should be said that this methodical work, performed at a very difficult time in the country's history, exerted a large influence on standardization methods in machine-building. This work was performed scientifically. Facts were systematized and compared, not only individual standards but characteristic groups of standards were analyzed, conclusions about the content of standards and the completeness with which they covered certain types of machine-building products were made.

In the field of shipbuilding, this investigative work [9] was performed by the author of the present book. It showed that the fundamental standardization principle for going "from the particular to the general," which has existed for a number of years, is insufficient both from the theoretical and practical point of view. In order to ensure, with minimal expenditure of effort and means, more radical results in the field of specialization and coordination of plants, expansion, rather than contraction of the type range of objects of production and of more extensive adoption of aggregation and interchangeability, another standardization principle is necessary. A new principle, which was called the principle of standardization "from the general to the particular," was proposed. Simultaneously, it was shown that both fundamental standardization principles (the old and the new) not only do not contradict one another, but conversely, they complement one another and both of them make standard[illegible] more effective and purposeful.

Certain changes, the [illegible]eance of which followed from underesti-

mating the significance of scientific methodical work, took place in the field of standardization in the years of the postwar five year plan (1946-1950). Shortcomings of practice deprived of a theoretical basis had become apparent. The most immediate problem was the creation and development of the standardization science, in order to illuminate the theoretical aspect of practical experience in the interests of more correct development of the latter.

In demobilizing the industry and in assimilating peace-time production, it was extremely important to have state parametric standards for types of machines and equipment which were needed by the national economy taking into account long-range plans for its further development; however, these standards were not prepared in time. Only an opinion to the effect that such standards should be elaborated beforehand was expressed in 1942. But their elaboration required a large amount of time and trained specialists. No conditions for the elaboration of such GOST's existed during the war and only parametric standards for river shipbuilding, which exerted a great influence on the restoration of the fleet were ready toward the beginning of the first post-war five-year plan [9].

It was very natural that in the first post-war years the following problem arose: what should be the task of state standardization in the machine-building field and what should be its guiding principle ?

The incorporation of the All-Union Standards Committee into the Gostekhnika [State Committee of the Council of Ministers USSR for New Technological Methods] at the beginning of 1948 can be taken as an indicator of the significance and role of standardization in the introduction of advanced technology into the national economy; the standard, having the force of a law has become an effective weapon in the fight for rapid adoption of new technological achievements into the indus-

trial practice. However, standardization has not found its proper place in Gostekhnika and has become isolated. Instead of elaboration of parametric standards for types of machines and equipment needed by the national economy, a new standardization trend, based on the principle of standardization of produced goods was initiated.

Without being being theoretically substantiated and being provided with an analysis of economical and technological experience, the given standardization principle, as a result of an administrative decision, was in force from the end of 1947 to 1950.

Measures for ensuring the required quality of machines and equipment have not lost their importance also in the post-war years. The newly assimilated machines had higher speeds, increased working parameters and more intensive working conditions. It would seem that by achieving standardization of engineering specifications can rapidly and radically solve the problem of ensuring the proper quality of actually produced machines, which is of great importance to the national economy. These considerations have influenced the decision to develop state standardization namely in the direction of elaboration of standards only for production being planned, the basic content of which were engineering specifications. The shortcoming of this standardization principle was the fact that many important machine-building and instrument-making problems may be found to be outside the sphere of state standardization. This situation is characterized by the following examples.

Example 1. The most important unit of the diesel locomotive is the diesel engine. If the production of diesel engines is planned as independent objects of production foruse in vessels or as spare assemblies, then diesels of this type will be included in the nomenclature of the planned production. In this case, it is possible to standardize the diesel engine. In the opposite case the object of standardization will

be the diesel locomotive, and not the locomotive diesel engine and all the requirements with respect to the diesel engine (for example, the rating, fuel consumption, time covered by the guarantee) will be included in the standard of engineering specifications for the diesel locomotive as a whole. In the meantime, the locomotive diesel engine, its subassemblies, and certain parts are of significant interest to standardization.

Example 2. The interrelationship between weight and dimensional parameters for buses, trolleybuses, trucks, track-laying and wheel tractors, trailers and semitrailers, automotive trains and other transportation facilities with norms for construction and reconstruction of roads, bridges, rights of way and tunnels is a very important problem from the national point of view. However, standards of these general norms cannot be referred to standards of planned production and these problems would have been inevitably found outside the sphere of standardization. Actually, after accepting the above standardization principle as the guiding principle, the work on this topic which had been developed before, has ceased. Work on this topic was renewed only recently.

Example 3. To increase the economic effectiveness of utilization of such powerful and high-productivity machines as contemporary excavators and dumping trucks operating as a team, it is necessary to ensure that the capacity of the excavator shovel and of the dumping truck body be matched. Otherwise, both machines can be found to be out of proportion to one another and will be utilized inefficiently, lowering the productivity of the service personnel and increasing the net cost of the performed work.

Example 4. The dimensions of color and finishing equipment in the textile industry is not correlated with those of the looms which, ac-

cording to professor A. P. Rybkin, results in incomplete utilization of the latter. But standards for parameters of machines operating in conjunction with one another were not subjected to the operation of the standardization principle being discussed.

In addition, the elaboration of engineering specifications standards will, according to this principle, be directed toward freezing of technical indicators already achieved. As a result of this, these standards do not enhance technological progress. Not each elaborated draft of such a standard could be approved as a state standard. Parameters of goods manufactured by the machine-building and instrument-making industries in many cases did not conform with the present-day technological level, which has resulted in the rejection of some standards drafts. Here are a few examples.

The draft of the engineering specifications standard for wide-gauge railroad freight cars (boxcars, gondolas and flatcars) was elaborated on the basis of cars already in existence. But these cars have no longer satisfied the increased requirements put to railroad transportation with respect to the load and holding capacity of the car bodies and also with respect to the strength of individual structural elements. In addition, examination of the draft of the standard presented for approval by railroad car manufacturers has revealed the desirability of changing specifications for the automatic coupling installation, modification of the distance between center sills, production of gondolas with a metal body only, reinforcement of the car roof structure, covering the part of the boxcar floor facing the doors by sheet steel, etc.

One of the departments of the former Gostekhnika of the USSR has also requested that the door space be widened since some self-propelled loader could not get into the boxcar.

The draft of a standard when using the above standardization prin-

ciple was based entirely on the description of the design of already manufactured (planned) cars. It was elaborated without taking into account the new needs of railroad transportation, of the contemporary achievements of foreign railroad car building technology, the necessity of modernization of the existing car designs and without taking into account the long range plans for the development of the national economy. The proposed standard was rejected. But no practical conclusions were drawn from this fact. The industry continued to produce obsolete cars and the Ministry of Communications continued to accept them into service. Money and the time of skilled workers expended on the elaboration of a useless standard proposal have been spent in vain, which was a direct result of application of a standardization principle, incorrect with respect to technical and economic considerations.

Not less characteristic is the example of the S-80 tractor, which has been extensively used in our country's agriculture, although its prototype, as we know, was intended for construction work only. The state standard proposal has actually repeated the facts which were already contained in the catalog and which were peculiar to the design of the tractor, including its individual service shortcomings. For example, the air taken in by the tractor engine reached it through a nozzle, the end of which was placed in the driver's cab. A large amount of dust entered the cab together with the air, which was detrimental to the driver's working conditions. In addition, the cab floor was produced from metal, as a result of which the drivers were either overheated or subjected to extreme cold. The tractor also had other defects, the necessity and feasibility of whose elimination was beyond any doubt. However, the proposal for the standard for the S-80 tractor was elaborated as a standard for a planned object and did not take into account the necessity to improve its design.

The putting in force of this standard would have been definitely detrimental, since it would have been possible for the plant to retain for a number of years the tractor design without taking any steps for improving it by referring to the state standard as justification. Branch standards for automobiles which have made it possible for plants to produce automibiles of existing designs for a number of years without modernizing them should be subjected to the same kind of evaluation.

It became clear that standardization of planned production in the form in which it has been conducted has not justified itself. A proposal for the 1950 state standardization plan, based on this principle, was rejected by the Council of Ministers of the USSR. The standardization plan was revised and its form was changed. Many standard proposals, elaborated by ministries and departments according to previously approved governmental standardization plans, actually could not be approved as standards. As a way out of this situation, a resolution was adopted to permit the ministries and departments which have elaborated these standard proposals to approve them as their own departmental normal standards. This act has resulted in an intensive development of departmental normalization in machine-building and instrument-making which, in addition, was parallel, with respect to the subject field, to governmental standardization.

That ill-defined boundary which after all did exist up to 1948 between governmental standards and departmental normal standards was erased. This could not but influence the further direction of the development of governmental standardization and departmental normalization in the machine-building and instrument-making industries. If we take into account that departmental considerations have made it more convenient for machine-building ministries to have their own normal standards, which they could modify and revoke without any coordinattion with other

ministries and departments, then it will be easier to understand the reasons for the more rapid development of departmental normalization in machine-building and instrument-making in comparison with the development of governmental standardization in these branches of industry.

The aforementioned circumstances had an ill effect on the work of standardization and normalization organs at plants, in [scientific research] institutes and ministerial main administrations. Their work has taken on a formal and even bureaucratic character, caused by the bureaucratic methods for approving standard drafts, which have taken roots in the previous years. Many standardization workers transferred to other work, since the stagnation and indefiniteness of purpose in the goals and tasks of standardization could not promote the development of creative ideas. Different points of view about the causes of the unsatisfactory condition of standardization and normalization in machine-building have arisen and many suggestions were made about ways for reconstruction of this work. A brief illumination of these is necessary in order to prevent the recurrence of similar errors in the future.

The following questions have arisen:

1) What should be the goals and tasks of governmental standardization in the machine-building field relative to the needs of the rapidly developing national economy;

2) What should be the system and methodology of all types of work in the field of standardization, their interrelationship and the organizational structure of local, branch and central standardization organs;

3) is the elaboration of governmental or branch standards for parameters of machines, subjected to planning and assimilation in the future, expedient;

4) does perspective exist for and, is it expedient to develop branch standardization and what should be the methodology of approval

of proposals of standards and normal standards;

5) is the existence of recommended standards expedient and what should be the degree to which terminological standards are to be made compulsory;

6) what should be the organizational forms of control of the adherence to standards and normal standards;

7) is it expedient to establish scientific research work in the field of machine-building standardization and also the establishment of courses on standardization fundamentals in machine-building institutes and technical schools;

8) what fundamental shortcomings are peculiar to present-day normalization and standardization [10].

A lively discussion of all these problems has taken place in the scientific and technical journal "Herald of the Machine-Building Industry" (1951-1953). The discussion was productive and has made it possible to evaluate different points of view. The content of the individual points of view is given in a systematic form in the first edition of this book [1].

The present-day goals and tasks of governmental standardization in the machine-building industry were formulated by the author of this book [11], [12]. In brief, these goals and tasks reduce to the following:

1. Standardization of types and basic parameters of machines, mechanisms, apparatus, instruments and automation facilities, needed for complete (integrated) satisfaction of all branches of the national economy, with the purpose of timely adoption of new equipment and maximal mechanization and automation of production in all branches of the national economy.

2. Standardization of indicators, characterizing the quality of

produced machines and equipment, their service life and reliability, in order to ensure service requirements and more efficient utilization of the metal used up in the fabrication of machines and equipment.

3. Standardization of engineering specifications for interchangeability in order to expand the field of mass production, lowering the labor time going into manual operations, development of coordination and adoption of assembly-replacement methods of machine repair under service conditions.

4. Standardization of types, engineering [technical] characteristics and dimensions of subassemblies and components which are common to machines, mechanisms, apparatus, instruments and automation facilities with different service purposes, in order to organize specialization of production units, consolidation and automation of production.

Extensive deliberation of all these problems has made it possible to put on the order of the day the elaboration of the necessary measures. The initiative was taken by the Organizational Office of the former All-Union Scientific Engineering and Technical Society of Machine-Building and Instrument-Making Industries, VNITOMashpribor,* which has prepared the necessary draft of the proposal and has presented it for consideration by the Council of Ministers of the USSR [12]. In June of 1955, this proposal after appropriate refinements, was accepted by the Council of Ministers of the USSR as an order, which, alongside with governmental standards has provided for branch normal standards; their application extends to all enterprises and organizations of the given machine-building or instrument-making branch without exception and independent of their departmental or territorial subordination.

4. STANDARDIZATION AT THE PRESENT STAGE OF ITS DEVELOPMENT

The necessity for reforms in the field of standardization coincided with the abolition of the many machine-building industries. This has

upgraded the role of branch standardization and has also made it necessary to create a new stage - general machine-building normalization - which would replace the abolished departmental normalization. All these problems were solved in October of 1959 with the issuance of appropriate decisions of the Council of Ministers of the USSR.

Elaboration of machine-building normal standards for the entire complex of tools, diesets, fixtures and other general purpose production equipment, and also machine-building standards and normal standards for common machine subassemblies and parts and the more important mechanization and automation facilities was provided for in order to develop specialization of production and establishment of uniform normal standards in the USSR. The more important problems in the field of standardization and normalization for the next few years are:

a) establishment of the type range and basic parameters of production, transportation and power equipment, machines and mechanisms extensively used in the national economy;

b) elaboration of typical elements of automatic lines and multi-spindle machine-tools;

c) increasing the productivity and reliability of lifting and transportation equipment, machines and equipment for the building materials, construction, road-building and excavation industries with the purpose of integrated mechanization of labor-consuming and heavy work and in particular for mechanization of loading-unloading operations;

d) elaboration of uniform assembled unified control and adjustment systems for more important production processes and also measuring and control elements of these systems of pickups, converters, secondary instruments and actuators;

e) improving the measurement precision and control reliability of automated production processes;

f) further development of work for interchangeability of subassemblies and parts in all machine-building and instrument-making branches.

First priority was given to unification of equipment for the chemical, petroleum-chemical, petroleum processing and related branches of industry and the establishment of rational series of parameters and dimensions for vessels and apparatus, filters, separators, autoclaves, centrifuges and pumps, and also of equipment for the rubber industry and for the production of plastics and organic synthetics.

The stated tasks in the electrical engineering and radio industry fields is improving the quality and power indicators of electric motors, high and low voltage apparatus, transformers and cable products, and also to establish basic parameters and quality indicators for radio installation apparatus. Of great significance is unification of basic subassemblies and components of radio and electronic apparatus and also the adoption of aluminum to the production of conductors, cables and electrical equipment as means of replacing copper.

In order to coordinate the standardization and normalization work of the appropriate types of goods and to ensure technical uniformity in the different branches of the national economy, the leading branch scientific research institutes, planning and design organizations and principal enterprises have been charged with the responsibilities of base organization with respect to standardization and normalization.

The base organizations should:

a) elaborate proposals of governmental standards and normal standards;

b) compile plans for coordination of the work of leading enterprises, scientific research and planning and design organizations with respect to the elaboration of branch normal standards for the corresponding types of goods;

c) control the fulfillment of plans for normal standards elaboration;

d) to conduct scientific investigations and experimental work related to the elaboration and adoption of governmental standards and normal standards;

e) prepare proposals for timely revision of standards and normal standards which do not conform with current requirements.

The base organization were given the right to:

a) present for approval drafts of state standards and normal standards for machine-building elaborated for production assigned to the base organizations;

b) control the adoption of and conformance with standards and normal standards in organizations and at enterprises;

c) to assign, through the appropriate sovnarkhozes, State Committees of the Council of Ministers for technological branches, ministries and departments, performance of standardization and normalization work to enterprises and organizations which produce and plan the corresponding production.

Normal standards elaborated by enterprises and planning and design organizations for their internal needs (except for limit standards) must, in the appropriate manner, be approved by the appropriate base organizations. The approval of machine-building normal standards is entrusted to the All-Union Scientific Research Institute for Machine-Building Normalization, the VNIINMASh. Interbranch machine-building normal standards and branch normal standards elaborated and approved in the prescribed order become mandatory upon all enterprises and organization regardless of their subordination.

The existing system of standards has an omission, however. The role of sovnarkhozes in the future development of all varieties of

standardization has not been concretely defined in the decisions now in force. The absence of the necessary contact between the base organizations and sovnarkhozes and other organizations has resulted in the appearance of new varieties of normal standards which are in force in individual sovnarkhozes.

It should be noted that the system of standards and normal standards now in force includes also various engineering specifications of interrepublican, republican, branch, departmental, oblast and local significance. All these engineering specifications are limited in the sense of the sphere of application but are not thematically defined.

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[Footnotes]

44 A detailed description of the peculiarities of war-time standardization is presented in Reference [1].

54 Later, the VNITOMashpribor served as the basis for organizing the NTO Mashprom [Scientific Technical Society of the Machine-building Industry] and of the NTO Priborprom [Scientific and Technical Society of the Instrument-making Industry].

Chapter 3

DEFINITION OF FUNDAMENTAL CONCEPTS AND TERMS IN THE FIELD OF STANDARDIZATION

1. CAUSES OF THE INSTABILITY OF ANY TECHNOLOGICAL TERMINOLOGY

Any technological terminology cannot remain constant for a long time. It is continuously modified and refined with the progress of science and technology, with increasing extension and profoundness of that theoretical and practical knowledge which is touched upon by the terminology. Subjective factors also influence the establishment of terminology.

A characteristic example of divergence in definitions is the term "electric motor." In the eighties of the past century it was defined as follows: 1) electrical exciter or 2) bodies, exciting electricity on contact. At present, the term "electric motor" denotes a machine which converts electrical energy into mechanical energy.

The concept "interchangeability," as all other concepts in the field of standardization, was subjected to substantial modifications or refinements not only with accumulation of experience and deepening of investigations, but also as a result of changing the technological level of production. As early as in the relatively recent past, the German standardization theoretician Dr. of Engineering Kincle has defined the concept "interchangeability" as the "state of products, which makes it possible from a multitude of components to pick one and to place it without adjustment into any group of its mating components in such a manner that they would mate satisfactorily and in accordance

with prescriptions." But, this definition admittedly, is obsolete at the present time and does not reflect satisfactorily the substance of the problem.

The sharp increase in the working speed of machines, temperatures and stresses in their elements, the simultaneously increased requirements with respect to assembly precision, reliability and long service life of machines has resulted in the fact that ensuring interchangeability of components on the basis of dimensions and surface finish only is no longer sufficient at the present time. Now it is necessary to ensure interchangeability with respect to the riveting depth, character of residual stresses, etc. Of great significance in instrument making is interchangeability with respect to elastic, magnetic, electrical and other physical parameters and properties.

The second Leningrad conference on interchangeability and new methods of [production] control has proposed the following definition of the given term: "Interchangeability is an integrated concept, embracing problems of design, fabrication and operation of machines and instruments. By interchangeability one should denote the property of designs to satisfy requirements put to them, which embrace all aspects of high-quality operation of machines and instruments and economy in the production process, set up on the basis of independent manufacture of individual parts (components, subassemblies)."

To what fact do these examples attest? Primarily about the complexity involved in the solution of any problem of terminology, about the direct dependence of accepted or recommended definitions on the present level of scientific and technological development, on the state of the production processes and production organization. All this pertains in the same degree to the terminology of standardization, its varieties and methods.

2. A BRIEF SURVEY OF THE EXISTING STANDARDIZATION TERMINOLOGY

The term "standardization" has appeared in the Russian language only in the post-revolutionary period, when, under the influence of the study of American industrial production experience, the concept denoted by the term "standardization" had acquired in our country a wider universal meaning than the term "normalization." But the terms "normalization" and "normalizing" have a long history in the Russian language and they have been retained up to the present time and are sometimes used for denoting the term "standardization."

The industry does not always pay attention to differentiation between standardization and normalization. For example, it is pointed out in Reference [14] that design and technological work performed at enterprises, in planning organizations and scientific research institutes, the results of which are formalized by issuance of normal standards is called normalization. It can be concluded from this that the totally similar work which is culminated by the issuance of standards will already be called standardization.

The terms "unification" and "typification," are frequently understood by authors of many works as different stages of the same process. Thus, for example, it is noted in Reference [13] that unification is usually used to denote the selection of several types of products and the elimination of the superfluous assortment of goods, with the determining instant in this work, in distinction to other varieties of standardization, being the absence of introduction of any modifications. This interpretation of unification completely corresponds to the generally assumed definition of the term "simplification."

It follows from a number of references which were analyzed that the term "unification" was, during the initial period of development of domestic standardization, used in the following sense: 1) as synonymous

with standardization; 2) as limitation of assortments; 3) as typification; 4) as reduction to one type (unification). Toward the end of the Forties, it became customary in machine-building to denote by the term unification an integrated group of measures having as their purpose reduction to a sensible minimum of the number and standard dimensions of machines and equipment, their assemblies, subassemblies and components and also of brands and assortments of materials used in their production.

While the term "standardization" does not meet with any objections, the term "simplification" is met with prejudice bordering on the negative on the part of some standardization workers. The substance of the problem, obviously, consists not in the term proper, but in the content of effective work characterized by this concept.

Taking into account the importance of simplification to the national economy, the Government of the USSR, as early as 1932, issued a decree about extensive adoption of simplification into the practice of the Soviet industry. This decree was unjustly forgotten by the economists, although it has retained its timeliness up to the present time. The readers will find sufficient material about simplification in a number of chapters.

The term "typification" has not as yet been established in the practice of the domestic industry. Many works, presenting extensive treatments of typification in different branches of the national economy were published, but only a few of these works provide any answers to the problem of what is typification and what is its substance. Typification makes it possible to achieve better substantiated specialization of plants, shops and sections, to normalize production equipment, to facilitate and accelerate production preparations and to decrease the time of assimilation of new machines and other articles. Typifica-

tion as a creative field of work for many designers and production engineers is widely utilized in the practice of domestic machine-building and instrument-making plants, design and technological organizations and branch scientific research institutes.

In addition to the concepts pertaining to standardization, its varieties and methods which were enumerated and described above, the terms "nomenclature" and "classification" are frequently encountered in the machine-building and instrument-making practice. The term "nomenclature" is defined in Reference [13] as an assembly of concepts of terms and designations used in a certain field of science, technology, etc. This term is defined in the Encyclopedia Britannica in approximately the same manner. The term "classification," according to the Minor Soviet Encyclopedia is defined by arrangement of articles by classes on the basis of similarity. In the standardization practice, the terms "nomenclature" and "classification" are sometimes used as indistinguishable concepts. However, a standard for the nomenclature of any given product establishing a uniform terminology may not possess the properties of classification. Nevertheless, the majority of these standards are elaborated on a scientific basis. On the other hand, classifications standards which do not pretend to be scientifically substantiated are also in existence; they are substantially nothing more than the enumeration of kinds of types of products which are also subdivided by some of their features.

Classification is usually the first and imperative step which must be taken for any more or less scientifically substantiated standardization.

Correlating the above information, we can make the following conclusions.

The instability of the standardization terminology is primarily

due to those changes in science, technology and production methods which have influenced and are influencing the goals and tasks of standardization in all its manifestations. The statements to the effect that a standard is a specimen, encountered in scientific and technical literature, has anhistorical background. Standardization was officially formulated earliest of all in England, and it had as its main goal to enhance British trade and its struggle in world markets. This has predetermined the purpose of the British standard, i.e., to describe the stable quality of traded goods. A product described by this standard became a specimen. Subsequently, other tasks of standardization have arisen. It was supposed to influence the development of production, and its specialization and to increase the output of goods. Definitions attesting to the fact that standards establish weights and measures, and various comparison units (physicotechnical, chemical, visual, etc.), have appeared in conjunction with this. The development of large-series and mass production has resulted in the fact that standardization was being determined by problems of interchangeability, etc.

The inconsistencies of standardization terminology are due to the fact that methodological work in this field was begun only toward the end of 1956. The push for this type of work was provided by a discussion in the journal "Herald of the Machine-Building Industry" in 1951-1953 and, by the All-Union Conference on Problems of Standardization and Normalization which took place in Leningrad in 1954. The absence of uniform methodological recommendations has inevitably resulted in differences and inconsistencies in approaches to the goal and tasks of standardization, which was also reflected in the terminology. A unity of approaches has not been ensured even in the Soviet encyclopedias. Thus, for example, the Great Soviet Encyclopedia defines standardization as the establishment of uniform quality indicators and requirements

put to raw and processed materials, semifinished and finished goods; the norms and specifications established in the process are formulated in a document which is called the standard. According to the above formulation, the all-union standard is the basic means for increasing the quality of production put out by Soviet enterprises, means of rationalization of production, means for amplifying control of production processes and fight with economic irresponsibility.

As opposed to standardization, normalization is treated in the Great Soviet Encyclopedia as the establishment of uniform norms and specifications for types, brands, parameters, dimensions and quality of products or their individual subassemblies and components, and also for methods of production and testing, designations, branding and storage rules, etc.

Another definition is given in the Minor Soviet Encyclopedia, where it is said that the standard is "a typical or specimen kind of product ," satisfying certain requirements with respect to the measure, weight, quality, etc., and standardization is the reduction of many kinds of products to a small amount of typical specimen of certain quality, shape and dimensions.

The basic shortcoming of the definitions given in the Soviet encyclopedias is the absence of perspective. They point only to that which is available and what can be done by limitation, but they are silent about the long-range role of standardization, about the fact that standards establish the type range for machines and equipment needed by the national economy taking into account the long range plans for its development, that standards are the base for development of production specialization. The encyclopedic formulations not only have not eliminated but, conversely, have promoted the development of inconsistencies in the standardization terminology.

3. PRINCIPLES FOR THE ESTABLISHMENT OF AN EXPEDIENT TERMINOLOGY IN THE FIELD OF STANDARDIZATION

The technical terminology of standardization recommended for practical purposes (see below, in this chapter) is based on the following principles.

1. The terminology should constitute a system of interrelated concepts and definitions. When terminology ceases to be interrelated, parallelism between individual varieties of standardization, for example, between standardization and normalization, or between republican engineering specifications and state standards, is inevitable.

2. The terminology should not remain stable for an unlimited length of time. The terminology must be systematically refined and revised, otherwise, it will slow down progress and will improperly orient industrial workers.

3. The terminology should actively take part in the development of specialization, coordination and automation of production in the machine-building industry of our country and to help in solving problems pertaining to the creation of the material and technical base of Communism and the development of production of high-productivity machines and equipment.

4. The terminology characterizing such varieties of standardization as unification, simplification, typification and aggregation, should orient the industrial workers toward extensive utilization of these measures in the interests of the entire national economy, in the interests of improvement of the economic indicators of the work of the machine-building industry. The terminology should promote the exposure of new problems which can be solved by standardization methods.

5. The terminology should contribute to better coordination of the elaboration of machine building standards and normal standards for com-

mon subassemblies and components of machines, tools, components of fixtures, diesets, etc.

6. The terminology should create the prerequisite conditions for further improvement of the existing standardization and normalization systems.

7. The elaboration of terminology should not result in encumbering the Russian technical language by new, unsubstantiated terms and concepts.

8. The terminology should be as clear and brief as possible. At the same time, it should be kept in mind that briefness is not always synonymous with clarity.

9. The terminology should take into account the fact that standardization is an important element of scientific organization of labor.

4. STANDARDIZATION TERMS

1. Standardization (general definition) is a field of creative work of scientists, engineers and economists in establishing:

a) kinds, types, assortments and sorts of new products of all classes, their basic parameters and dimensions, engineering characteristics and other indicators satisfying the requirements of the national economy and taking into account long-range plans for its development;

b) kinds and service purposes of raw and processed materials, semi-finished goods, fuel and lubricants, their technical characteristics, physiochemical and other indicators which determine the quality and grades;

c) classifications and designation systems for products of all intended purposes and their elements, conventional codes and conversion tables, and also scientific and technical terms and designations;

d) unity of weights and measures, interchangeability systems, norms, rules and recommendations;

e) engineering requirements to the goods being produced with the purpose of ensuring the necessary kind and stability of their quality, and also of retention of this quality for the time period covered by the guarantee;

f) accelerated testing methods, having as their purpose all-sided control of the established production quality;

g) requirements toward packing, transportation and storage of products with the purpose of preserving the established quality and ensuring better utilization in service;

h) special requirements to the production of articles and their elements for ensuring safety in both the manufacturing process and in the process of operation, expedient for the given period of development of production forces.

Standardization has several varieties and manifests itself in two forms: 1) in the form of standards, 2) in the form of other technical documents, including mandatory ones.

2. State Standardization is the form of development of standardization as a state measure, conducted according to uniform state plans tied to general problems of national economic planning and the needs of production, as well as with scientific requirements.

3. National standardization is standardization performed on a national scale, independent of the state, social or mixed form of leadership.

4. International standardization is standardization conducted by the specially created International Standardization Organization (ISO) with the purpose of facilitating and developing of international trade, scientific, technological and cultural relations and community of men. International standardization does not have as its purpose unification of national standards.

5. Regional standardization is standardization conducted by a certain group of nations with the purpose of unification of their national standards for ensuring the development of production specialization, extending the fields of coordination, adoption of interchangeability, development of the raw products base, joint utilization of scientific and technological achievements and also deepening of economic relations and of the community of men.

6. Standardization in machine-building is the most complex and multifaceted field of standardization on the national, international and regional scales. Standardization in machine-building embraces the establishment of:

a) integrated groups or individual types of machines, mechanisms, apparatus, instruments and automation facilities needed by all branches of the national economy, including power generation, transportation, communications and scientific investigations, and also of assemblies, subassemblies and components of machines and other products of the machine-building, metal working, instrument making, shipbuilding and electrical branches of the industry;

b) classifications and designation systems for machine-building products;

c) requirements put to the metal and nonmetal, basic and auxiliary materials, semifinished products, fuel and lubricants which are being used;

d) requirements put to interchangeability and conditions for ensuring it;

e) requirements put to the production quality and external appearance of the products of machine-buildings and of guarantee periods, corresponding to progressive service life and operational reliability indicators;

f) accelerated methods for testing machines, equipment and other products, their assemblies, subassemblies and components with the purpose of verification of fulfillment of service life and reliability requirements and also requirements put to the retention of the appropriate external appearance;

g) requirements put to the integrated shipping of components of large machines and equipment and also to packing, transportation and storage of machine-building products;

h) requirements put to ensuring safe and efficient operation of machines and equipment and their assemblies, subassemblies and components, including transportation facilities for carrying passengers;

i) norms and other specifications along the lines of industrial hygiene.

7. Branch standardization is achieved in individual branches of industry in order to ensure uniformity of engineering specifications and norms which are in force in the given branch, and also with the purpose of creating conditions for the development of intrabranch production specialization and coordination. This kind of standardization is now called in the Soviet Union by the name of branch normalization.

8. Departmental standardization is achieved in individual departments and ministries with the same purposes as branch standardization, but only on the scale of the given department (ministry).

9. The level of standardization describes the field of extension of the applicable standards or of standards still in the process of elaboration. The highest level is international standardization, followed by national, branch and local standardization. Each level may have its own subject field which ensures proper coordination and interaction between standards of different levels. The conformance with this condition is especially important in those cases when standards, normal

standards and republican engineering specifications, the fields of influence of which can be found at different levels, are simultaneously in force. The level of standardization is sometimes called the standardization scale.

5. NORMALIZATION TERMS

1. Normalization (General definition) is synonymous with standardization in individual countries and in the Soviet Union it is a particular case of standardization, its basic variety, peculiar to machine-building, instrument-making, shipbuilding and electrical industry only and also to railroad transportation. Normalization pertains to the field of subassemblies and components of machines, mechanisms, apparatus, instruments and automation facilities, tools and fixture components, diesets and other production process equipment. Normalization embraces of the following expedient:

a) types, subassemblies and components of machines, mechanisms, apparatus, instruments and mechanization facilities, their structural elements, fabricated (or fundamental) and associated dimensions;

b) types and dimensions of tools and components of fixtures, diesets and other production equipment;

c) classifications and designation systems for components and subassemblies of machines and of the entire production equipment;

d) requirements put to the quality of production of subassemblies of machines and production equipment and their testing methods;

e) requirements put to the packing, transportation and storage in those cases when it is necessary to conform to special conditions;

f) norms pertaining to the field of scientific organization of labor.

Normalization can be interbranch, interdepartmental, branch and local.

2. Interbranch normalization (general machine-building normalization) is a variety of normalization the objects of which are characteristic of all or several branches of machine-building.

3. Interdepartmental normalization is a variety of normalization the objects of which are used in several departments and which for this reason together approve the corresponding normal standards for these objects and their elements.

4. Branch normalization is a variety of normalization having very considerable perspectives for development necessary for the achievement of component-part specialization, automation and coordination in branches of machine building on a wide scale.

5. Local normalization is a variety of normalization which has developed mostly at machine-building plants. Its subject field depends on the general purposes of standardization and normalization in the nation and on systems of standardization and on the development of general machine-building and branch normalization.

6. STANDARDS AND NORMAL STANDARDS TERMINOLOGY

1. Standard (general definition) is a technical document of international, national, branch or local significance. The standard can be mandatory, recommended or experimental, fully or partially describing that object or problem to which its force extends. The content, purpose and effectiveness of a standard depend on those problems which will be solved by it during the time it is in force and also on those basic principles which serve as the basis for the elaboration of the given standard. The contents of the standard depend, in addition, on the requirements put to it, which depend on its intended purpose (parametric standards, dimensional standards, engineering specifications standards, testing methods standards, etc.,), and also on periodically changing requirements with respect to the arrangement formalization of standard

proposals.

2. State standard (GOST [All-Union standard]) is at the present time the only official form of standards in the Soviet Union. The application of state standards is mandatory upon all organizations and persons in the entire territory of the USSR. The state standards have the power of a law, they are published as an official publicqtion only and their reprinting is forbidden. The state standards are classified by three features with respect to content and field of application: divisions, classes and groups of production. The standards are numbered in numerical sequence with the addition of numbers giving the year in which the standard was approved. The standards are not coded with respect to branch or other features.

3. International standard is for the most part formulated as an international recommendation. The degree to which these standards are mandatory depends on the consent of the given country. In the positive case, the contents of the international standard or international recommendation are transferred to the appropriate standard (in the USSR – to the state standard).

4. Regional standard, unlike its international counterpart, is in force only in a certain group of countries in which case it is formalized in each country as its own national standard (in the USSR – as the appropriate state standard), with an index which may be in one or another manner different from the other national standards.

5. Parametric standard is at the present time an important kind of standard acting in the machine-building industry of the USSR. The types and varieties of machines and equipment described by concrete indicators, which are being established by parametric standards, are the basis for the development of planning-and-design work. Parametric standards may have two degrees of completeness:

1) standards including principal parameters of basic types of machines or other equipment only;

2) standards including principal and auxiliary parameters of machines and other equipment, for their basic types (basic models) as for all expedient modifications (versions) of specialized intended purpose.

Parametric standards can be integrated, embracing the appropriate types of various jointly operating machines. These standards should facilitate the creation of automatic production units (plants, shops, lines) on the basis of utilization of not only narrowly specialized equipment designed for the given automated production unit, but also of serially produced equipment (with a uniform control principle).

6. Standards of engineering requirements differ from other technical documents (in particular, from engineering specifications) by the fact that it provides for themore important operational indicators of machines and other machine-building products including indicators describing their service life and reliability. These indicators predetermine requirements put to the design and manufacture of objects of production. Standards of engineering requirements supplement parametric standards and together with them are specific specifications for the elaboration of new equipment.

7. Standard of testing methods has three aspects:

a) establishment of typical testing methods for the products of machine-building conducted on proving grounds and in service with the purpose of finding ways for further improvement of their quality;

b) establishment of accelerated testing methods conducted under laboratory conditions with the purpose of rapid clarification of the quality of newly elaborated or modernized machines, mechanisms, apparatus, instruments and automation facilities;

c) establishment of arbitrary testing methods for tests conducted

for determining the conformance of produced goods to the engineering specification, parametric and other standards which are in force.

8. The dimensional standard is characterized by three varieties:

a) standard of fabricated dimensions for components, subassemblies, tools, etc.;

b) standard of basic (including joining) dimensions of components, etc.;

c) standard of basic dimensions of components, etc., including supplements which contain the fabricated dimensions of these components, etc., and also the necessary directions with respect to the production process.

The elaboration of working drawings is not necessary for the adoption of standards of varieties "a" and "c." The adoption of standards of the "b" variety requires either the elaboration of unclassified working drawings, which are issued to all interested enterprises, or the issuance of detailed catalogs (if the production of the given standardized products has been organized at specialized enterprises), or the elaboration of appropriate machine-building or branch normal standards containing fabricated dimensions.

9. Priority of standards is a very important but not always observed condition for coordinated development of standardization and normalization. When parallel standards and normal standards exist, a certain subject field, depending on the circumstances, can be referred to state standards and machine-building normal standards or to machine building and branch normal standards, etc. This is the reason why the priority of the standard over the machine-building normal standard, of the machine-building normal standard over the branch normal standard and of the branch normal standard over the plant normal standard must beretained. Defining the boundaries of the subject fields of standards

and normal standards promotes proper establishment of the levels of standards and normal standards.

10. Normal standard (general definition) is a technical document of general machine-building, interdepartmental, branch or local significance. The normal standard can be mandatory, recommended, temporary or experimental, fully or partially characterizing objects and problems to which its force extends. Normal standards are elaborated for subassemblies and components of machines, mechanisms, apparatus, instruments and automation facilities, for structural elements of components, for tools, components of fixtures, diesets and other production equipment. The normal standards can establish fabricated dimensions of the enumerated products, including all their versions, or only the basic dimensions.

11. Machine-building normal standard (MM) is a general machine-building or interbranch mandatory normal standard extending to all or a part of machine-building or instrument-making branches. Machine-building normal standards are of four varieties:

1) Normal standard for fabricated dimensions of components and tools, not requiring working drawings for its adoption;

2) normal standard for types and basic dimensions requiring further detalization in the elaboration of working drawings;

3) normal standard for types and basic parameters requiring further planning and design elaboration;

4) normal standard for types and basic parameters which is a development of the state standard for types and basic parameters of the same products.

In the last case, the machine-building normal standard, although developing the corresponding standard, actually duplicates it, in connection with which it should be formulated as a revised standard or it

is necessary to revoke this standard which is developed by the given normal standard only partially, without continuing its development to the fabricated dimensions stage.

12. Branch normal standard (ON) is a mandatory normal standard extending to all enterprises, design and other organizations of the given machine-building branch, independent of their territorial or departmental subordination. Branch normal standards are of four varieties:

1) normal standard for limiting the applicable state standard relative to the needs of its machine-building branch;

2) normal standard for limiting the applicable state standard and its related machine-building normal standard;

3) normal standard for types and basic parameters requiring further detalization in working drawings;

4) normal standard for general requirements put to the design of objects of production of the given branch and to their fabrication.

Unlike machine-building normal standards, the branch normal standards are elaborated for assemblies, subassemblies and components with application limited to the given branch and also for special types of tools and production equipment used only by the given machine-building branch.

13. Local normal standard (N) pertains primarily to plant normal standards elaborated and approved by plants for their internal needs. Plant normal standards are of three varieties:

1) normal standard for limiting the applicable state standard, machine-building or branch normal standard in conformance with internal needs;

2) normal standard for types and dimensions of subassemblies and components of basic products manufactured by this plant only, and also for certain special types of tools and other production equipment used

by this plant only;

3) normal standards embracing different engineering problems related to scientific organization of labor, design of objects of main and auxiliary production, regulating of documentation existing at the plant, etc.

The local normal standards include similar engineering documents elaborated by various installation, design and other organizations for their internal needs. All the local normal standards are mandatory upon those organizations which have elaborated and approved them.

14. Temporary normal standard is elaborated and used in those individual cases when the central or special design organization has its own general-technological and normal standard documentation while the plant at which the objects which are designed by this design organization has a different type of documentation. The temporary normal standards are supposed to eliminate the difference in engineering documentation and to find ways for adoption of uniform branch normal standards to replace the departmental or local normal standards which are now in force.

15. Normal standards for engineering requirements and testing methods are, by their contents, similar to standards for engineering requirements and testing methods.

7. TERMS DESCRIBING THE VARIETIES OF STANDARDIZATION

1. Unification is one of the varieties of standardization, which is frequently performed as independent creative work; at the same time, unification is one of the more extensively used and effective methods of standardization and normalization. Unification in the machine-building industry is regarded as a measure directed toward:

a) the reduction of the multitude of existing types and standard dimensions of articles and their components, materials and semifin-

ished products to a smaller number of types and standard dimensions by modification, in the appropriate cases, of designs or structural elements, basic or secondary dimensions, engineering directions, material brands, tolerances and fits, methods of fabrication and the types of blanks used, methods of heat or chemically assisted heat treatment, metal coatings, etc;

b) such a modification of the designs and fabricated dimensions materials brands and heat or chemically assisted heat treatment and fabrication precision of similar components produced at different plants which will make possible efficient fabrication on automatic lines without resetting or minimal resetting the latter;

c) the development of an integrated group consisting of a limited number of unified interchangeable assemblies, subassemblies and components from the various combinations of which it would be possible to assemble a considerably larger nomenclature of machines, mechanisms, apparatus, instruments and automation facilities with the addition of a certain amount of special subassemblies and components (for example, various multispindle machine-tools intended for special purposes, apparatus for the chemical industry, hulls of tankers of various capacity, etc.);

d) the revision of the types and standard dimensions of produced or purchased products used for assembly of product sets, in order to replace obsolete or not sufficiently reliable products by more modern and higher-quality goods.

All these four unification trends are used both in the elaboration of proposals for standards and normal standards as well as in the capacity of operations performed outside of standardization plans. In the latter case, unification solves local problems of individual plants, design and technological planning organizations. Unification on the

scale of an entire branch of machine-building or of a sovnarkhoz is performed more infrequently.

2. Simplification is the simplest economically desirable and, from the engineering point of view, the most accessible variety of standardization; at the same time, simplification is one of the most extensively used standardization and normalization methods. Simplification denotes simple limitation of the brands and assortments, grades and other varieties used in the main and auxiliary production of materials, semifinished products, fuel, lubricants and other materials and purchased products. Together with this, simplification results in simplification of production by eliminating superfluous standard dimensions especially in the field of production equipment, unnecessary types of accounting and documentation, combination of different norms for material and semifinished products supply stocks, etc. Simplification is most frequently used at plants for limiting the force of one or another state standards, machine-building normal standards, branch normal standards, republican and departmental engineering specifications and also departmental orders for all kinds of materials, semifinished and finished products, etc.

3. Typification is one of the varieties of standardization, which is conducted as independent creative work of designers and production engineers; at the same time, typification is one of the very little used standardization methods which, nevertheless have great utility for the future. Unlike unification, typification can solve general problems of development of an entire machine-building branch. Typification has a long range promise also for normalization as a method which makes it possible to solve problems of normalization of machine subassemblies and components in those cases when this cannot be achieved by unification methods. Typification is conducted on the basis of a system of

preferential quanties:

a) in the establishment of dimensional (parametric) series of machines, mechanisms, apparatus, instruments and automation facilities, taking into account not only present but also future needs;

b) in the elaboration of parametric standards for machines and other objects of production taking into account current and future needs;

c) in the normalization of machine components in those cases when a parametric (dimensional) series of the components being normalized cannot be created by unification or mathematical statistics methods;

d) in the standardization or noamalization of tools forthe typified production processes.

Typification is used also in the adoption of group methods of component machining by grouping them in optimal batches but this belongs to the field of production engineering and organization and is therefore not illuminated in the present book.

4. Aggregation is one of the more interesting but as yet insufficiently utilized varieties of standardization; at the same time, aggregation is one of the effective standardization and normalization methods. Aggregation is conducted most frequently as inedpendent creative work of designers in the field of objects of main production and production equipment. Aggregation is donducted in order to:

a) extend the field of utilization of certain general-purpose machines by creating conditions for rapid replacement of the working parts of the equipment; in this case, the general purpose machines acquire the properties of specialized machinery, ensuring high labor productivity and the required quality of operation;

b) extend the type range of machines and equipment being produced by modifying their basic types and creating different versions better

suited to the operational requirements than the basic types (basic models) of general purpose machines and equipment;

c) ensure assembly of certain mechanisms, apparatus, devices and other equipment of different functional purpose from unified assemblies, subassemblies and components;

d) expand the nomenclature of instrument-making goods by using the block (assembly) method in designing them;

e) create fixtures and other complex mechanized and automated production equipment from common assemblies and subassemblies.

5. Dimensional series of machines and equipment are by their content similar to parametric standards for machines, mechanisms, apparatus, instruments and automation facilities (except that they have not been agreed upon, formulated and approved as state standards). The establishment of dimensional series is a hidden form of standardization completed by the issuance of guiding technical materials. Practice shows that dimensional series formulated as guiding materials, i.e., not completed to the point of approval as a standard, lose their significance very rapidly.

6. Design-unified series of machines and equipment* are by their content similar to certain parametric standards, including, in addition to basic types, all the expedient modifications. They are elaborated in those cases when parametric standards for specific machines or equipment do not exist at all, or when the existing parametric standards provide only for basic types of machines or equipment but do not give engineering instructions about expedient modifications (versions) for specialized purposes.

Equivalent parametric standards for machines and equipment provide all expedient versions and in this case it is no longer necessary to elaborate design-unified series.

8. VARIETIES OF ENGINEERING SPECIFICATIONS

1. Interrepublican engineering specifications (MRTU) are approved by the corresponding state committees of the Council of Ministers of the USSR for technology branches, by departments and central institutions of the USSR for coordination with Councils of Ministers of the Union Republics, as mandatory upon all enterprises of the country independent of their departmental subordination. The nomenclature of products for which interrepublican engineering specifications are approved is determin[illegible]tively by the state committees of the Council of Ministers of [illegible]SR for branches of technology, ministries, departments and central institutions of the USSR in coordination with the Councils of Ministers of the Soviet Republics and other interested organizations. They are not established for consumer goods; which attests to the fact that the MRTU is actually a parallel form of mandatory standards used over the entire territory of the USSR.

2. Republican engineering specifications (RTU) is actually also a parallel lawful form of mandatory standards in the USSR which, however, is used in the territory of the given Union Republic. These engineering specifications are approved by the Council of Ministers of the Union Republic. They constitute technical documentation, defining the quality of production-engineering products and consumer goods.

By their content the RTU are fully similar to standards. The RTU are approved in those cases when no state standards are available for the given products and also when special production and service conditions require the establishment of special specifications.

3. Sovnarkhoz engineering specifications (STU) are approved by the sovnarkhoz for goods produced by enterprises subordinated to the given sovnarkhoz. The nomenclature of products covered by the STU is established by the given sovnarkhoz. The STU actually are one variety of lo-

cal normalization.

4. Enterprise engineering specifications are approved by: a) enterprises, for goods produced for a certain consumer, b) all-union and republican ministries and also by public and cooperative organizations and executive committees of the Councils of Workers Deputies for goods produced by enterprises under their control.

5. Priority of engineering specifications. Engineering specifications issued by sovnarkhozes, enterprises and other organizations cannot be approved for those types of goods for which republican or interrepublican engineering specifications exist. The existing sovnarkhoz, enterprise and organizational engineering specification become inapplicable with the approval of RTU and MRTU for similar goods. Coordination of MRTU and RTU with respect to state standards and with respect also to machine-building and branch normal standards has not been concretely defined.

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[Footnote]

82 At the initial stage of development of methodical work in the field of standardization (1956-1958) it was assumed that the proper term is "design-normalized machine and equipment series." However, a study of this problem has shown that the subassemblies and assemblies of machines and equipment of these series are unified, rather than normalized. In addition, no necessity exists for normalizing all subassemblies and assemblies (in all cases).

Chapter 4

BASIC TRENDS AND PRINCIPLES OF STANDARDIZATION IN MACHINE BUILDING

1. BASIC TRENDS OF THE DEVELOPMENT OF STANDARDIZATION IN MACHINE BUILDING

How should standardization be developed? What should be its basic goal? Which important development trend should be chosen for planning the subject field and all measures for further perfection of establishing standardization in the domestic machine-building industry? These questions gave and give rise to different answers, among them about the role of standardization in the scientific organization of labor and in the progress of production forces.

The development of standardization can follow two basic trends. The first of these is characterized by developing standardization starting with basic parameters and dimensions of machines, mechanisms, apparatus, instruments and automation facilities and their assemblies, subassemblies and components. This standardization development trend, as was pointed out before, can be briefly called "from the general to the particular." It, to the highest degree, corresponds to the feasibility of achieving integrated standardization and normalization in the machine-building and instrument-making industries.

The basic advantage of this standardization trend consists not only in the all-aided inclusion of machine-building objects and their elements, but also in the feasibility of achieving, at considerably larger scales, of unification of all types of subassemblies and components, set assemblying machines, equipment and other manufacturing ob-

jects. After establishment of dimensional series and parameters for the given products it becomes possible, on simultaneously designing them, to achieve at the most extended scales aggregation of designs with very extensive utilization of unified subassemblies and components. This kind of unification not only completely replaces normalization but also ensures complete adoption into production of the smallest possible nomenclature of subassemblies and components, i.e., it makes it possible to most painlessly achieve extensive standardization in practice.

The second standardization development trend can be called "from the particular to the general."

This standardization development trend was during many years regarded as the only feasible and expedient, by virtue of the fact that designs of any machines and equipment can be created efficiently by fashioning them from standardized and normalized components and subassemblies only, in conjunction with which the basic emphasis was put on standardization and normalization of components and subassemblies of machines and also tools and other production equipment. However, this theoretical sssumption has not yet been proved in practice.

The number of designations of standardized and normalized main production components in our country is still not so great, while the actual nomenclature of components being produced is measured now in many hundreds of thousands and, possibly, even by millions. Practice has evolved a certain limited nomenclature of components used in their normalization, which has become "classical."

The tasks before us is to find methods for substantial expansion of this nomenclature and for inclusion in the sphere of normalization such components which are still fabricated by individual drawings. As typical representatives of these components we can name gears, the total annual demand for which comprises tens or even hundreds of millions

of pieces.

It is shown by the analysis of all types of normalization in its various stages that normalization of tools and fixture components has always found overwhelming acceptance. Other types of production equipment, especially in the field of casting and forge and press production, was normalized at a considerably lesser scale. Main production components have, during many decades, been subjected to normalization at a nonsufficiently large scale. This is characteristic of the majority of machine-building branches. Design and production process inheritance promotes the retention in production of previously assimilated components, the replacement of which by standardized and normalized components is always accompanied by adoption difficulties (which are sometimes considerable).

However, it would be incorrect to assume that the "from particular to the general" standardization trend has lost its significance and is no longer of practical interest. Conversely, in many cases this trend is perfectly expedient and effective. It is successfully employed in the standardization of various types of fastener components, antifriction bearings and other common components and subassemblies, the parametric and dimensional chains of which cannot and should not be related to parametric standards and dimensional series of machines.

Not infrequently instructions and other guiding materials of standardization have pointed to the necessity of reflecting many design data and service indicators in the standards for machine types, without which the standard as if it did not conform to its intended purpose. Most unsuccessful in this respect were methodical instructions of the former Standardization Committee of the NKTP [People's Commissariat of Peat Industry], which have made it mandatory upon the originators of standards proposals to include in them not only the basic indicators but al-

so all types of descriptions, schematics, drawings, fabricated dimensions, etc.

The nonfeasibility and senselessness of the majority of such requirements have resulted in diminishing the amount of standards elaborated for machine and equipment series.

As a result of substantiation of the expediency in the "from the general to the particular" standardization trend, Reference [1] showed that identicality of machines and other articles produced according to standards is achieved not by the number of indicators and other technical characteristics included in the standard, but by the system of proposals elaboration and of their approval. This proof has made it possible to limit the content of parametric standards to a moderate number of the more important indicators (see below).

At the present stage the expediency of developing the domestic standardization in thedirection "from the general to the particular" has received its deserved recognition. The decision of the July Plenary meeting of the Central Committee of the CPSU (1960) notes the necessity of elaboration of dimensional series of machines and equipment and of standardization of their subassemblies and components; this can be most successfully implemented by developing standardization in the direction "from the general to the particular" in conjunction with general machine-building normalization of common machine subassemblies and components, achieved, as was pointed out above, in the direction "from the particular to the general."

Harmonious combination of the above two basic trends in the development of standardization and normalization can give a tremendous economic effect and can serve as a basis for product, assembly and component specialization of machine-building industry enterprises.

2. MAIN STANDARDIZATION PRINCIPLES

1. Principle of standardization integrality. The given principle has two aspects: 1) integrality of standardizationalone, 2) integrality of standardization and normalization. These aspects should be considered separately.

The integrality of standardization at the present time can be conceived as the creative activity of scientists and engineers in the creation of integrated groups of machines which ensure smoothness of production and make possible automatic control of production processes as well as extensive mechanization of labor processes. This concept of an integrated group of machines has been suggested by the President of the Academy of Sciences of the USSR, Academician M.V. Keldysh.

Interrelationship between standards and normal standards, their content and also their subject field and the goals and tasks of stqndardization and normalization are, for a number of reasons, not distinguished by their stability. Standardization and normalization can develop as independent measures in the field of preparation of technical documentation and at the same time can be achieved in an integrated manner, supplementing one another. But what should the term integrated standardization and normalization denote in the given case?

It is frequently assumed that development of standardization and normalization along uniform thematic plans in itself ensures their integrality. However, the substance of the problem consists not only in the uniformity of thematic planning but in the actual integrality of the engineering solution of the raised problems. Planning uniformity, of course, promotes this goal, but by far does not always ensure integrated development of standardization and normalization.

It should not be assumed that integrated achievement of standardization and normalization requires simultaneous elaboration of the ap-

plicable standards and normal standards. In a number of cases this is unfeasible and as a whole it is not necessary. Dimensional and parametric series of machines and equipment provide the basis for normalization of their subassemblies and components. This means that first priority should be given to the elaboration of namely state parapetric standards followed by establishment of normal standards related to them. In other words, when developing work according to the above principle, the advance elaboration of parametric standards is accompanied by subsequent elaboration of standards for technical requirements, testing methods and all necessary interbranch and branch normal standards for common subassemblies and components of the given machines. Here the subject field of standards and normal standards, the completeness of their content, time of issuance and adoption and the time during which they remain in force are interrelated in a certain manner.

Achievement of standardization and normalization without calling for their integrality results in randomness of thematic planning. Elaboration of parametric standards for machine types is very frequently not accompanied by elaboration of corresponding standards for engineering requirements and testing methods. Integrality in the field of standardization is manifested primarily in the interaction of normal standards of different levels. Elaboration of machine-building normal standards for the given subassemblies and components is performed independently of the elaboration of branch normal standards for similar subassemblies and components of narrow branch significance.

Branch normal standards are elaborated independently of general machine-building normal standards, i.e., parallel elaboration of normal standards of different levels and the appearance of the design of the same subassemblies and components outside of the normal standards is possible in both cases.

2. Gradation and succession standardization principles. The principles are of significance in establishing a practical scheme for achieving standardization and normalization in the domestic machine-building industry.

During many decades the USSR standardization practice was completely based on the succession principle. It was assumed that a standard gradually increases its level moving from the local to the branch and then to the national and international level. According to this principle the objects of standardization were moving as if by steps from the bottom to the top. However, many instances when the objects of standardization (their subject fields) have moved in the opposite direction are also known. Thus, for example, many all-union standards for heavy machine-building changed their level on revision and were transformed into branch or departmental normal standards.

When standardization is developed on the basis of the succession principle it is inevitable that the subject field move from one standardization level to the other and that parallel standards and normal standards exist at different levels.

The principle of standardization gradation is a more recent one. In this case all standards and normal standards as if a single chain comprise with links corresponding to its different levels. According to this principle the objects of standardization do not move upward or downward, but are always concrete and stable for each level. State stan[illegible] have their optimal objects and interbranch, branch and local normal standards have their objects. Parallelism of standards and normal standards is here totally eliminated. However, successful achievement of standardization and normalization on the basis of the gradation principle requires a more clearly defined thematic planning, overcoming of conservative opinions and better establishment of the cause of stand-

ardization and normalization.

3. Principle of classification of goods being standardized. In the overwhelming majority of cases, any standard is extended to several kinds or types of products, which requires that they be classified The greater the number of products provided for by the given standard, the more complex the classification it employs, which is the basis for the establishment of the properties of goods, their conventional designations and branding. In the absence of uniform classification principles which results in the fact that each standard adopts its own [classification] system, the entire picture becomes very complicated. This has been recognized at the present time; but what is the most efficient solution of this problem? Two solutions are possible here: 1) branch classification; 2) all-union classification.

Branch classifications exist in a number of machine-building branches, for example in the machine-tool, automobile and tractor industries. They, as a rule, are mixed (letter and number) but numerical systems also exist. The basic advantage of branch classification is its good (or satisfactory) conformance with those objects of production or their elements for which the given branch system has been elaborated. But the greatest shortcoming of any existing branch system is the absence of uniformity in principles of classification and designation of common machine subassemblies and components, including parts either analogous or of the same type (fully similar).

The creation of a uniform all-union system of classification and designation of goods can ensure uniformity of principles of classification and designation of common subassemblies and components at different levels of their application, beginning with those actually of general machine-building significance and ending by those specifically characteristic of machines and equipment with a certain functional pur-

pose and design formulation. Branch systems of classification and designations should ensure such uniformity under all conditions. If the given systems do not ensure these conditions, then they cannot be regarded as perfected and progressive. This is the substance of the above principle.

4. Principle of economic resources utilization. This principle was used extensively in standardization work during the years of the Great Fatherland War [World War II]. The standardization of this period was faced with the necessity of maximally improving the utilization of existing material resources and of directing them to the appropriate branches of the national economy in the most expedient manner. While previously standards have provided for one or another type of materials, semifinished and finished goods, described by [their] chemical composition, physiomechanical and other properties and also by dimensions and other technical characteristics, with the necessary grades of materials and varieties of semifinished and finished goods chosen by the consumers proper in accordance with their needs, standards which have appeared during the war years have specified expedient, completely specific fields of application of each variety of materials.

The principle of economic utilization of materials had not lost its important economic significance even after the war. The gigantic growth of production in all branches of the national economy has required a sharp increase in the production scale in machine-building, instrument-making, shipbuilding and other branches of the national economy.

It has become necessary to more rigorously control the consumption of many kinds of materials the number of which primarily includes nonferrous metals and timber. Limitation on the use of nonferrous metals was the subject of a special decree of the USSR government.

Standards must implement this decree and to establish substantiated limitations on the consumption of specific nonferrous metals and alloys. The consumption of lumber of different kinds and grades is regulated by standards for specific objects of machine-building and shipbuilding.

The extension of the above principle to different kinds of steel and nonmetallic materials used in machine-building will promote the regulation of tools, equipment and materials supply to plants and decreasing the tremendous nomenclature of steel brands. This contains the resources for increasing the productivity of metallurgical plants, but unification of brands is difficult without attendant transition to a uniform numerical system of designations (see Chapter 12). We recall that actually more steel brands are used in the USSR than in the USA.

5. Principle of standardization of planned production. The virtues of this principle include the fact that it makes it possible to embrace by standardization many kinds of planned machine-building production in compressed time periods. The shortcomings of this principle include the fact that the standards will make permanent a technological level which has already been achieved. Quality indicators for planned production can pertain only to that article which is already produced, while the national economy of our country is interested in continuous adoption of more refined equipment and the state standards should in every way facilitate this purpose.

It follows from the above that standards which establish parameters and other technical characteristics of machines and equipment being produced inevitably also reflect the shortcomings of their designs which is peculiar to all brand standards. Standards for planned production are brand standards, i.e., standards for specific types, dimensions and properties (brands) of machines, equipment and other ob-

jects. From this inevitably follows the conclusion that standardization of planned production should not be developed. But such a judgement is hasty and incorrect for the following reasons.

Many standards which have established products series ranging from a certain smallest to a certain largest dimension are in existence. They include standards for antifriction bearings, fastening components, and other common subassemblies and machine components.

The number of these standards will increase as the years pass. It is necessary to ensure the proper coordination between the content of standards and planning so that any typical dimension of a product provided for by the standard be produced by the industry and that it be possible to obtain in the planned order.

6. Principle of dimensional standardization. This principle touches upon problems related to the elaboration of standards and normal standards for dimensions of products. What should be standardized: the basic or the fabricated dimensions? Which normalization practice – the French or the German – is more expedient?*

Under the condition prevailing in the standardization and normalization practice of the machine-building industry in the Soviet Union for the last few years, the following versions have been employed:

a) standardization of basic dimensions of common subassemblies and machine components, and also of production equip, only;

b) standardization of basic and fabricated dimensions of common machine subassemblies and components;

c) various mixed standardization systems;

d) standardization of basic dimensions and normalization of fabricated dimensions;

e) standardization of a part of basic dimensions and normalization of the remaining basic dimensions;

f) normalization of basic dimensions (in those cases when state standards do not exist);

g) normalization of basic and fabricated dimensions.

Is it necessary to continue to retain this entire multivariant system for standardization and normalization of product dimensions? If this is not necessary, then which version should be used as a basis for an expedient principle for the standardization of product dimensions? The following answer can be given to these questions. It is expedient to standardize basic parameters of products and basic (overall, installation and joining) dimensions, and the fabricated dimensions should be given in the normal standards or directly in the working drawings without the intermediate stage, i.e., without normalization. But foregoing normalization of supplementary dimensions (in the development of standards) is expedient only in the case when an operating specialized production unit is in existence. In this case, catalogs of plants specializing in the production of common subassemblies and machine components, tools, fixture components, etc., can include also the supplementary technical characteristics of products which are desired by the consumers.

An example of this kind of solution are state standards for antifriction bearings: the standards establish the basic dimensions only, normal standards which would include fabricated dimensions of bearing components are not elaborated and the catalogs give engineering characteristics important in the selection and operation of the bearings.

7. Principle of standardization by selection of products from among those existing. This principle is akin to the principle of standardization of planned production and to the principle of dimensions standardization. If standardization of existing products along is contemplated, then all considerations enumerated with respect to planned

production are retained in selecting products from among those already assimilated. This selection of products is simplification, if these products are not subjected to any modification with respect to dimensions, materials used and the fabrication quality. More frequently, this principle is used in limiting the application of standards, machine-building and branch standards in accordance with the needs of individual enterprises.

Is this principle progressive, if we take into account the fact that it is based on a technological level which has already been reached and assimilated? In a number of cases, this principle is progressive and expedient since it makes possible the use of the experience of leading enterprises by enterprises lagging with respect to technology. Typical for these cases are objects of local and branch normalization, but the transfer of experience is here made difficult by the existence of design and production process inheritance.

8. Principle of correlation of progressive practices. Many standards are based on the correlation of practical experience. Almost the entire standardization and normalization work begins with the selection, analysis and systematization of materials reflecting the state of theory and practice.

Correlation of acquired experience makes it possible to include with confidence into the proposals for standards and normal standards those indicators, parameters, characteristics and properties which are concrete and which at the same time have not lost their stimulating influence on improving the quality of production. Correlation of practical experience makes it possible to put standardization in all its varieties to the service of developing the production forces of the country. At the same time, the correlation of the experience of machine-building accumulated in the process of development of the world science

and technol[illegible] requires critical illumination of achievements in order not to lse the long-range purposes of standardization. This condition is due to tne fact that a long period of time passes from the time of formulation of the standard (normal standard) draft to the time of adopting it into production. Standards and normal standards may be found obsolete and falling short of their goals in this condition is not satisfied.

9. Principle of standardization of engineering directions and requirements. In order to ensure conformance with the preceding principle, standardization has elaborated a methodology according to which the production processes and their features are usually not standardized, with only indicators, characteristics and other engineering requirements, which must be adhered to in manufacture of standardized products by any methods ensuring the required result, included in the standards. This principle had arisen at the beginning of the current century in organizing national standardization in England. It was here assumed that any standardized product can be fabricated by different methods, and these methods may be the property of the firm, to be its secret. Actually, however, the point is not so much the secrecy of the production process but ensuring the feasibility of utilization of the existing equipment.

For example, a crankshaft of a four-cylinder engine can be fabricated by different methods, namely: a) by cutting blanks from a plate; b) forging with the use of subpress dies; c) hammer forging; d) stamping on a special mechanical press; e) shell casting (or some other high-productivity method). The method by which this shaft is produced is of no interest to English standardization, since the firm chooses that which is most expedient for its needs, on the basis of existing manufacturing conditions. But it is not indifferent to Soviet standardiza-

tion which method of fabrication of a given component will be used at the domestic enterprises. The standard should recommend the better, the most efficient method of fabrication.

Taking this into account, it is expedient to include recommendations on progressive manufacturing methods in drafts of standards and normal standards. In this case, standards and normal standards will acquire added value as leaders of new techniques and progressive production processes. They will also stimulate the adoption of more efficient methods of production organization and the development of coordination, since the adoption of these standards will inevitably effect increased productivity of labor and consolidation of production units. This will make it possible to expand the volume of deliveries in accordance with coordination plans.

10. Principle of limiting parameters. In the overwhelming number of cases, standardization also includes the task of establishing such limits of the values of indicators and other quantities being standardized, the expedient upper and lower limits of which would ensure th required quality of finished and semifinished goods and materials and which would ensure stability of this quality. If it is machine-building materials which are standardized, then the content of chemical elements making up these materials and each of the indicators of mechanical properties can be given with certain limits (from to). But in many cases of standardization of machine-building objects it is not desirable to establish regimentation of indicators within the wide limits "from to," since this does not ensure the required homogeneity in a narrow range. The goal sought by standardization of limiting parameters is ensuring the conformance to such indicators which correspond to the achieved technological level and are in accord with operational requirements. The specific weight of the structure, the motor capacity, fuel and lub-

ricants consumption, the average piston speed and the mean effective pressure in the cylinder - these are limiting parameters characterizing the level of technology. The range and draw of fishing boats are also limiting parameters, ensuring the interests of fishing and safe return to the bases. The braking path of an automobile is an important limiting parameter ensuring safety of the movement of conveyances and pedestrians.

The implementation of limiting parameters is tied to conformance to certain requirements put to machines, equipment and other production objects. If these parameters are progressive then the objects of machine-building proper will be progressive also, of course, that part of them which is governed by the limiting parameters. From this follows the necessity to thoroughly choose the nomenclature of these parameters and to include in standardization of machine-building objects also the level and limits of their values.

11. Principle of specific parameters. Specific parameters, unlike limiting parameters, are used in those cases when their numerical values are to be used as starting values by designers. These parameters include, for example, the motor capacity, number of cylinders, fuel capacity, lifting capacity, nominal torque, piston throw, rpm, distance between guides, number of spindles, faceplate diameter, working width of a plow, final compression of a compressor, number of axes, etc.

This principle is used extensively in the elaboration of drafts for normal standards, since they must contain absolute values of the given parameters of products for whicy they are being established. The same condition pertains in the same degree to standards for common machine subassemblies and components.

The principle of specific parameters is thus especially applicable in standardization and normalization of types and dimensions of compon-

ents and subassemblies of machines, mechanisms, apparatus, instruments and automation facilities, while the principle of limiting as well as the principle of specific parameters are extensively used and applicable to standardization of machine and equipment series.

12. Principles of group and local standards. The long established practice of standardization and normalization development has not elaborated uniform approaches and recommendations with respect to this problem. Both group and local standards (normal standards) have been elaborated before and are elaborated now. The term local (brand) standards (normal standards) in this case denotes a standard such as applies to one product only (for example, the "Volga" automobile) or to a number of standard sizes of a certain product (for example, to a number of standard sizes of two-row roller bearings with short cylindrical rollers of an especially light series).

Group standards, unlike local standards, include several different types of products; here some of them (or all) are subdivided into standard sizes. As an example of such a group standard, we can cite the standard for automobile trailers, which provides for characteristics of single and double axis general purpose trailers, heavy-duty trailers with two, three and four axles and semi-trailers with one and two axles with various bodies and tanks.

13. Principle of the expedient standard content completeness. This principle should be mentioned for a number of reasons. Primarily because of the periodically occurring deliberations on the content of machine standards. The standard should be brief and clear, it should include that minimum of indicators which describe the type of product. Normal standards, unlike standards, provide for fabricated dimensions of products and more detailed information about the methods by which they are produced. Hence, the principle of expedient standard (normal

standard) content completeness can be briefly described as follows: on gradual elaboration of standards going "from the general to the particular" the completeness of their content and of the content of the normal standards related to them increases with the achievement of the elaboration of the four levels of standards (see Chapter 7), from the first to the fourth.

14. Principles of standardization of complete and selective interchangeability. Standardization and interchangeability are inseparable, but a number of problematic problems related to the practice of interchangeability application, directed toward increasing the productivity of labor and improving the quality of machines being produced, as well as acceleration of machine repairs under service conditions, do exist Standardization promotes the solution of these problems by ensuring complete interchangeability and adoption of selective interchangeability.

The undervaluation of the significance of selective interchangeability has resulted in halting the elaboration of its theoretical substantiation and of finding methods for its practical adoption. It should be noted that the solution of most important automation problems which are faced by machine-building and instrument-making workers can be accelerated with positive economic results by the use of the selective interchangeability principle.

As an example, we can cite the complete automation of the assembly of ball bearings on the basis of selective interchangeability, achieved by the 1st State Ball Bearings Plant (see Chapter 13).

This example is characteristic by the fact that by dividing dimensional tolerances for mating surfaces of assembled components into a number of groups it is possible to effect tremendous production savings by producing the components with the desired precision and at the same

time sharply increasing the quality of finished products by selective assembly which improves the mating of components. Hence in elaborating standards and normal standards for common subassemblies and components of machines and other production objects it is expedient to provide for achievement of selective assembly. Establishment of gradations of actual parameters subdivided into a number of groups is consistent with this goal.

15. Principles of standardization and normalization of the excessive and differentiated safety factor. The standardization and normalization process includes the establishment of series of dimensions of components, subassemblies or finished products conforming to a more or less established rule, calculated so that the smallest possible number of their standard dimensions will in the most complete manner ensure the satisfaction of the need for these components, subassemblies and finished products. Progressions with various denominators are used in establishing these dimensional series. As a result of the creation of these series, certain dimensions of components, subassemblies and finished products are found to be excluded from the standard and the consumers of these kinds of goods are forced to use neighboring, usually larger, sizes. But, actually, other solutions are available. For example, when the standard establishes a series of nominal truck capacities such as:1; 1.6; 2.5; 4; 6.3 and 10 tons, then the need for 1.5 and 7 ton trucks can be satisfied by producing trucks with capacities of 1.6 and 6.3 tons, i.e., by settling for a certain over or under capacity.

The standardized or normalized common machine parts can be subdivided into two groups: a) purchased and b) produced at the plant. Standardization or general machine-building normalization of purchased components, i.e., of those produced centrally by specialized plants, is achieved for the most part independent of the capacity and dimensions

of the machines and other equipment in which they are used. Local or branch normalization, and also standardization of noncentrally produced components can be performed in accordance with the excess or differentiated safety factor.

In the first case the normalized components which are used will, in principle, have a certain excessive (with respect to that calculated) safety factor which results from the increased dimensions of the component. But this excessive safety factor does not have to exist always, but only in those cases when the dimensions of the components being normalized differ substantially from the calculated [design] dimensions. In the second case, in normalizing by the differentiated safety factor, it is possible to use components with dimensions smaller than that obtained by design calculations but which are produced from higher strength materials which compensates in a certain degree the difference in the component sizes.

The standardization and normalization practice has elaborated rules or designations of certain material brands of determination of their properties. In the first case one or several comparatively equivalent material (steel, cast iron, etc.) brands are pointed out, and in the second case characteristics are given which make it possible to use a number of brands, including also those of higher quality, under manufacturing conditions.

The existing and very widespread opinion to the effect that standardization and normalization result in increasing the weight of articles and excessive materials expenditures in their manufacture is thus not substantiated. In using the standardization and normalization principle of differential safety factors, the excessive weight and, consequently, the excessive metal consumption attributed to the creation of component subassembly and finished product dimensional series can be

efficiently eliminated. With this purpose in mind, it is desirable to give not one but several groups of materials of various qualities in standards and normal standards.

16. Principle of standardization and normalization of components and subassemblies independent of the capacity or size of machines. This principle is a natural extension of all the above. In elaborating standards and normal standards for common machine components and subassemblies it is not possible to exactly establish the kinds, types, characteristics, service conditions and other peculiarities of those machines and equipment in which the standardized (normalized) components and subassemblies will be used. The dimensions of these subassemblies and components comprise standard series (on the basis of progressions) from a certain minimal to a certain maximal (which is expedient at the given time) from which designers choose dimensions of the given components, subassemblies and other products, for example, bolts, nuts, pins, antifriction bearings, etc. But the service conditions of machines are different as also are requirements put to the dimensions and weight of the components and subassemblies which are being used. Very rigorous weight requirements are presented for ships and aircraft.

How, under these conditions, should one properly solve the problem of standardization (normalization) of types and dimensions of products for increasing the scale on which they are produced and for automation of production processes. The answer can be only one: it is necessary to promote the utilization of different brands of materials which will ensure the different strength and service life of the same standard sizes of products which are being used for various purposes; it is necessary to ensure the use of such coatings which will make possible reliable and prolonged service under various climatic conditions (tropical climate, at low temperatures, etc.).

The utilization of several groups of materials and kinds of coatings should be considered as an absolutely necessary part of each standard (normal standard) for common subassemblies and components of machines, the standardization (normalization) of which is achieved on the basis of "from the particular to the general." In this case the excessive metal consumption can be entirely eliminated.

An example of such a solution is the standardization of fastening components (see Chapter 13).

17. Principle of utilization of selective materials brands. Any brands of ferrous and nonferrous materials and alloys are described by their chemical composition and by the physicomechanical properties. In considering the preceding principles we have pointed out the desirability of reflecting in standards and normal standards for common subassemblies and components of several groups of materials. But in a number of cases it becomes necessary to split the material of the given brand into several "particular" brands or in separating from among its general characteristic of a certain limited segment characterized by its chemical composition or various properties. These selective brands are called "select."

These selective brands are undesirable to metal suppliers since they do not contribute to consolidation of production at metallurgical plants. But if the consumers still must have these selective brands (for example, for manufacture of chains by forge welding), then the way out of this situation would be the issuance of a new, independent standard, in this case for chain steel. In the meantime, the steel for chains produced by forge welding is the St. 3 brand of steel with limitations (i.e., select) with respect to the chrome nickel, sulfur and phosphorus content. Under normal conditions for the utilization of St. 3 steel chrome and nickel are desirable additions, while for production of an-

chor chains by forge welding they are harmful impurities, which make achievement of quality welding difficult.

Obviously, not in all cases of standardization and normalization is it expedient to use the principle of selective metal brands, but where special production or service requirements show up, it is expedient to seek a solution not in the creation of new material brands but primarily in selective selection.

18. Principle of design and production process inheritance. Problems of design and production process inheritance in machine-building are so closely related to one another that they should be considered jointly. What is the nature of this inheritance? Design and production process inheritance are historical in origin. Many of existing machines have a development history, which is briefly described by the following examples.

Production machines can be subdivided into three groups by the character of their origin and their further development. The first group includes machines which have appeared before others by refinement of manual tools. This is how hammers, rolls, mills, pulverizes, textile and other machines have originated. They, in turn, have called to life machines supplying the motive power. The second group includes machines which have taken the tool (saw, chisel, cutter, drill and the like) from the hand of the worker, which has sharply increased the productivity of labor. The third group includes machines which have replaced the human hand in these operations where the hands and fingers have served as tools in the processing of wool, flax, clay, etc. Machines of this group have served as the origion of the Industrial Revolution of the 18th century [15].

Gradually perfecting machines and equipment the designers have introduced improvements into kinematic arrangements, have increased the

capacity and productivity, precision and dimensions of articles being produced, parameters and efficiency of utilization of machines and equipment, but their principal designs have retained their stability for a long time. Stability was retained also by the components. On replacement of models and modernization of machines and equipment their many components and subassemblies have, without or with certain changes, passed from the old brands of machines and equipment to the new, which is the origin of design and production process inheritance.

Inheritance has thus been transmitted from ancient times and if it is not regulated within sensible limits, then it can become a brake on the development of branch and interbranch normalization of common machine subassemblies and components and also of production equipment. Design and production process inheritance generate at plants their own local normal standards, which can no longer be unified. The plants get so used to their own normal standards that transition to any general branch or interbranch normal standards frequently becomes an impossible measure.

3. DIRECTIONS FOR PRACTICAL WORK

The following questions frequently arise under practical conditions: what should be the guides in standardization and normalization work, what ways should be chosen? These are completely natural questions. Actually, practical experience of standardization and normalization in different branches of the machine-building industry, as was pointed out above, stated that:

a) two principal directions ("from the general to the particular" and "from the particular to the general") for development of standardization and normalization which not only are not contradictory but complement one another; both these directions for the development of work can one or another hybrid variations combining the basic ideas of each

of the trends;

b) the 18 basic principles for achieving standardization and normalization, applicable both independently as well as in different combinations with others, as a result of which the number of possible combinations of basic principles is considerable.

All this attests primarily to the fact that standardization and the normalization related to it is a creative activity, quite varied and purposeful, requiring extensive initiative by its workers. This points to the fact that standardization is not trite and is not at all monotonous, as this would frequently seem. This also attests to the fact that results of stadanrdization and normalization depend to a large extent on the ideas which are contributed to their development.

Standardization in machine building should be developed from the general to the particular. The general machine-building normalization should, doubtlessly, be developed from the particular to the general. Branch normalization will be effective if developed from the general to the particular, i.e., from concrete machines or other objects characteristic of the given machine-building branch to their assemblies, subassemblies and particular components, but taking into account the related development of general machine-building normalization. Plant and other local normalization should be coordinates with branch and general machine-building normalization. Here both trends should be sensibly combined.

The choice of guiding principles of standardization and normalization depends on long-range thematic plans. Elaboration of these plans is the general tasks of base organizations. They should work out the technical policy for achievement of standardization and normalization in their production branch. The above basic principles can make easier for them the solution of this problem.

But how should one choose those basic principles which best correspond to the standards and normal standards being elaborated? The following principles correspond to the aforementioned drafts of standards and normal standards:

1) to standards of machine, mechanism, apparatus and instrument parameters - principles 1, 3, 8, 10, 12 and 13; of engineering requirements put to them - 1, 2, 8-14; of testing methods for these machines, mechanisms and instruments - 8, 10-13; of their assemblies, subassemblies and components - principles 1-6, 8-13, 16 and 17;

2) to standards for packing, transportation and storage methods - 3, 4, 6, 8, 12 and 13;

3) to machine-building normal standards for main production subassemblies and components - 1, 2, 4-6, 8-17;

4) to machine-building normal standards for production equipment and its elements - 1-6, 8, 9, 11-16;

5) to branch normal standards for main production subassemblies and components - 1-18;

6) to branch normal standards for production equipment and its elements - 1-9, 11-16 and 18;

7) to plant normal standards - 1-9 and 11-18.

Principles for technical specifications (interrepublican, republican, sovnarkhoz, plant, etc.) are chosen in accordance with standards and normal standards of analogous content.

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[Footnote]

95 See Chapter 17.

Chapter 5

THE SUBJECT FIELD, LIMITING FEATURES AND THE STANDARDIZATION AND NORMALIZATION SYSTEM IN MACHINE BUILDING

Different points of view prevail with respect to the feasibility and desirability of setting up limits for the subject fields of standards and normal standards. An extreme view claims that no boundaries between standardization and normalization exist at all, since they can exist side by side, embracing by standards and normal standards of various levels the same objects of machine building and their elements. On the opposite pole we have another opinion, based on the existence at any given instant of expedient boundaries between standardization and normalization and on the presence of certain limiting features separating standardization and normalization into specific regions of their application. This problem was first considered in Reference [1]. which has recommended for the immediate futu5e the following four-level standardization and normalization system: the first level--state standardization, the second level-general machine building normalization, the third level - branch normalization and the fourth level -- local (including plant) normalization.

1. THE MULTI-LEVEL AND MULTI-STAGE STANDARDIZATION SYSTEMS

The following interrelated problems arose in determining of the optimal subject field of state standards and the various machine building normal standards:

1. What should be the system of subdivision of standards and normal standard [illegible]ying the requirements of the national economy for

the foreseeable future?

2. Should this system be multi-level or multi-stage and why?

3. What is the optimal number of levels or stages in the system being established?

4. Should an interrelationship between the standards and normal standards exist and in what should this interrelationship be expressed?

One of the first systems adopted by domestic standardization was the three-level system OST-VEST-N [All-union standards - departmental standards - normal standards].

The concept "defining standards" was used then as a criterion for classifying standards as All-union. This term was interpreted as "basic plus major standards," here all-union or branch standards creating the necessary base for further standardization in a given field were referred to as basic. In contrast with this, the major standards category included those which were of major importanct at the given time. Basic standards of all-union significance, in their turn, were subdivided into five groups, the peculiar features of which were not distinguished by their precise definitions. It is characteristic that major machine building standards were given over to branches. For example, standards for types of anti-friction bearings were considered as branch standards, although they are used by all branches of the national economy and are of extensive interbranch importance.

This division of standards into defining, basic and major with the additional subdivision into standards of all-union and branch significance and into their various groups, separately from the basic division into OST, VEST and N has resulted in the fact that their subject fields in the majority of cases were found to be so overlapping that any distinction between them was lost entirely. As a result of this, the three-level standardization and normalization system became a three-stage

system, to which is peculiar the displacement of standardization and normalization objects from the plant normal standard to the all-union standard and in the opposite direction [also]. Unlike the multistage system, which is characterized by regularly or randomly occurring displacements of the given objects, the multilevel system is based on stable, precisely defined fields of application of the various kinds of standards and normal standards. The loss of the multi-level arrangement has resulted in the liquidation of the OST-VEST-N system, which was replaced by another system for subdivision of standards into all-union standards of state-wide significance ((OST VKS [All-union standards of the All-union Standardization Committee]), all-union standards of branch significance (OST NK [All-union standards of the People's Commissariats]), limited applications standards (ST) and local (primarily plant) normal standards N. The new system was conceived as a four-level system. Here it was assumed that the OST VKS category should include standards of two groups.

1) basic standards, created the basis for subsequent standardization, determining the direction to be taken by the entire system of standards, affecting the entire national economy in all its varieties and in individual branches (units of measurement, classifications of materials and other products, etc.);

2) major standards, of greater importance to the national economy (brands and assortments of materials, antifriction bearings, etc.).

The existence of limit defining characteristics of extremely general character could have resulted in a rapid loss of peculiar features of the specific subject fields of OST VKS, OST NK and N. This was also furthered by the classification of standards of different categories and characteristics performed by the former Standardization Committee of the Narkomtyazhprom [People's Commissariat for Heavy Industry] (KS

NKTP) (see Table 1). All standards were subdivided by their characteristics into ten categories: SO, SK, ST, SR, STU, SP, SETT, SMI, SN and SU and the objects of standardization were subdivided into nine groups with groups 1-4 and 7 and 8 allotted to machine-building.

These six groups, if we also take into account the ten different standards characteristics, thus amounted to 60 subdivisions. But, with rare exceptions, each such subdivision provided for the parallel existence of either OST VKS and OST NK, or of OST NK and SR, or of OST NK, ST and N, or of OST VKS, OST NK and ST, the criteria for differentiating among which, within each subdivision, were entirely lacking. For example, standards for tools, fixtures and inspection-measurement instruments were provided for as OST VKS, OST NK and ST. In a similar manner simultaneous applicability of OST VKS, OST NK, ST and even N was provided for with respect to equipment and machines. It is characteristic that plant normal standards for machines and equipment could have been in force at the same time as or instead of state standards.

The former standardization committee of NKTP has paid considerable attention to standards for operational and engineering requirements (SETT). As applied to machines and equipment, the parameters, dimensions and other engineering characteristics subject to standardization were supposed to be given partially in SETT and partially in nomenclature standards (SO), classification standards (SK) and types standards (ST). This provision for fractioning parameters, dimensions and characteristics of the standardized machines and equipment into four standards of different content and purpose could not but have a negative effect on the standardization practice, since they have complicated its implementation unnecessarily.

The subdivision of standards by characteristics, established by the former KS NKTP was accompanied by a number of rigid, but entirely

TABLE 1

Classification Chart of Basic Trends in Standardization and Standard Characteristics in the Heavy Industry

Основное направление работ по стандартизации A		Группы стандартов B	Характер стандартов и их обозначения C / Стандарты D: Общие, обозначений, величин, терминологии и номенклатур CO E	Стандарты D: Классификаций по основным параметрам СК F
Сырьевая база G	Сырье, полуфабрикаты, основные и вспомогательные материалы, топливо, смазка H	1	ОСТ ВКС ОСТ НКТП — — I	ОСТ ВКС ОСТ НКТП СТ главка — J
Материально-техническая база K	Инструменты, приспособления и контрольно-измерительные приборы L	2	ОСТ ВКС ОСТ НКТП — — I	ОСТ ВКС ОСТ НКТП СТ главка — J
	Оборудование и машины M	3	ОСТ ВКС ОСТ НКТП — — I	ОСТ ВКС ОСТ НКТП — — J
	Детали и узлы машин, арматура, запасные части N	4	С ВКС ОС. КТП — — I	— ОСТ НКТП СТ главка — O
	Части зданий и сооружений и их элементы P	5	ОСТ ВКС ОСТ НКТП — — I	ОСТ ВКС ОСТ НКТП СТ главка — J
	Сооружения Q	6	ОСТ ВКС ОСТ НКТП — — I	ОСТ ВКС ОСТ НКТП — — J
	Энергетика R	7	ОСТ ВКС ОСТ НКТП — — I	ОСТ ВКС ОСТ НКТП — — I
	Транспорт S	8	ОСТ ВКС ОСТ НКТП — — I	ОСТ ВКС ОСТ НКТП — I —
Объекты народнохозяйственного потребления T	Готовые изделия, не входящие в указанные выше разделы, а также предметы широкого потребления U	9	ОСТ ВКС ОСТ НКТП — — I	ОСТ ВКС ОСТ НКТП СТ главка — J

TABLE 1 cont'd.

Группа стандартов B	Характер стандартов и их обозначение C			
	Стандарты D			
	Типов. основных размеров и др. СТ V	Сортаментов и размеров СР W	Технических условий, физико-химических и механических свойств объектов СТУ X	Полной характеристики объектов СП Y
1	— — — —	ОСТ ВКС ОСТ НКТП СТ главка Нормаль Z	ОСТ ВКС ОСТ НКТП СТ главка Нормаль Z	ОСТ ВКС ОСТ НКТП СТ главка Нормаль Z
2	a — ОСТ НКТП СТ главка Нормаль	a — ОСТ НКТП СТ главка Нормаль	a — ОСТ НКТП СТ главка Нормаль	a — ОСТ НКТП СТ главка Нормаль
3	ОСТ ВКС ОСТ НКТП СТ главка — J	— — — —	— ОСТ НКТП СТ главка Нормаль a	— ОСТ НКТП СТ главка Нормаль a
4	— ОСТ НКТП СТ главка Нормаль a	— ОСТ НКТП СТ главка Нормаль a	— ОСТ НКТП СТ главка Нормаль a	— ОСТ НКТП СТ главка Нормаль a
5	— ОСТ НКТП СТ главка O —	— ОСТ НКТП СТ главка O —	— ОСТ НКТП СТ главка O —	— ОСТ НКТП СТ главка O —
6	— ОСТ НКТП СТ главка — O	— — — —	— — СТ главка — b	— — — —
7	— ОСТ НКТП СТ главка — O	— ОСТ НКТП СТ главка — O	— ОСТ НКТП СТ главка — O	— ОСТ НКТП СТ главка — O
8	— ОСТ НКТП СТ главка a Нормаль	— ОСТ НКТП СТ главка a Нормаль	— ОСТ НКТП СТ главка a Нормаль	— ОСТ НКТП СТ главка a Нормаль
9	ОСТ ВКС ОСТ НКТП СТ главка Нормаль Z	ОСТ ВКС ОСТ НКТП СТ главка Нормаль Z	— a ОСТ НКТП Ст главка Нормаль	— a ОСТ НКТП Ст. главка Нормаль

TABLE 1 cont'd.

Группы стандартов B	C Характер стандартов и их обозначений			
	D Стандарты			
	Эксплуатационно-технических требований СЭТТ C	Правил приемки и методов испытаний продукции СМИ d	Норм проектирования и методов расчета СН e	Упаковки, тары и хранения СУ f
1	— — СТ главка — b	ОСТ ВКС ОСТ НКТП — — I	— ОСТ НКТП СТ главка Нормаль a	— ОСТ НКТП СТ главка Нормаль a
2	— — СТ главка — b	ОСТ ВКС ОСТ НКТП — — I	— ОСТ НКТП СТ главка Нормаль a	— ОСТ НКТП СТ главка Нормаль a
3	— — СТ главка — b	ОСТ ВКС ОСТ НКТП — — I	— ОСТ НКТП СТ главка Нормаль a	— ОСТ НКТП СТ главка Нормаль a
4	— — СТ главка — b	ОСТ ВКС ОСТ НКТП — — I	— ОСТ НКТП СТ главка Нормаль a	— ОСТ НКТП СТ главка Нормаль a
5	— — СТ главка — b	ОСТ ВКС ОСТ НКТП СТ главка — J	— ОСТ НКТП СТ главка — O	— — b СТ главка —
6	— — СТ главка — b	ОСТ ВКС ОСТ НКТП СТ главка — J	— ОСТ НКТП СТ главка — O	— — — —
7	— — СТ главка — b	ОСТ ВКС ОСТ НКТП — — I	— ОСТ НКТП СТ главка Нормаль O	— — — —
8	— — СТ главка — b	ОСТ ВКС ОСТ НКТП — — I	— ОСТ НКТП СТ главка Нормаль O	— ОСТ НКТП СТ главка Нормаль O
9	— — СТ главка — b	ОСТ ВКС ОСТ НКТП — — I	— ОСТ НКТП СТ главка Нормаль O	— ОСТ НКТП СТ главка Нормаль O

A) Basic trend of standardization work; B) groups of standards; C) character of standards and their designations; D) standards; E) general, designations, values, terminology and nomenclatures SO; F) classifications by basic parameters SK; G) raw materials base; H) raw materials, semifinished products, basic and auxiliary materials, fuel, lubricants; I) OST VKS, OST NKTP; J) OST VKS, OST NKTP, glavk [Main Administration] ST; K) tools and equipment supply base; L) tools, fixtures and inspection-measuring instruments; M) equipment and machines; N) machine components and subassemblies, fittings, spare parts; O) OST NKTP, glavk ST; P) parts of buildings and structures and their elements; Q) struc-

tures; R) power [supply]; S) transportation; T) objects needed by the national economy; U) finished products not contained in the above divisions and also consumer goods; V) of types, basic dimensions and other ST; W) of assortments and dimensions SR; X) of technical specifications, physiochemical and mechanical properties of the objects STU; complete characteristics of objects SP; Z) OST VKS, OST NKTP, glavk ST, Normal standard; a) OST NKTP, glavk ST, Normal standard; b) glavk ST; c) operational and engineering requirements SETT; d) acceptance rules and testing methods SMI; e) design and computation norms SN; f) packaging and storage

superfluous, literally unnecessary requirements with respect to the standardization of machine types. These requirements were so unrealistic that they have made it practically impossible to standardize machine and equipment types. These guiding directions had a negative influence on the development of parametric standardization in machine building. A large amount of time was required to overcome their influence and to more realistically formulate the problems of possibilities for standardization of machine and equipment types.

The introduction, in 1940, of a new subdivision of standards and normal standards into state standards (GOST), departmental normal standards (VN) and local normal standards (N) has presented a number of problems pertaining to the specification of their specific subject fields and of their interrelation. The revocation of the OST VKS-OST NK-ST-N system and the introduction of the new GOST-VN-N system was not accompanied by specification of their specific subject fields, at least in principle. To this we should add that when the standardization reform was performed in 1940 all the OST VKS and OST NK were given the force of state standards, independent of their content, degree of importance and field of application. This could not but affect the subsequent development of standardization in machine building and the formation of its subject field, which has resulted in parallel existence of many GOST's, VN's and also N's and later also of branch normal standards (ON). As a result of this the multilevel standardization and norm-

alization system has become multistage, with its characteristic parallelism of the subject field of standards and normal standards.

The parallelism of the subject field of state standards and normal standards and of the entire technical documentation connected with it has actually come about in many machine building branches, which can be substantiated by several examples.

The transportation machine building has issued its own normal standards for pneumatic chucks of [general purpose] lathes and turret lathes. At the same time, state standards were in force with respect to these. The road building machines industry has introduced a normal standard for types and basic dimensions of pumps, while state standards were in force for pumps of the most varied surface purposes, including narrowly specialized uses. Normal standards were elaborated for friction, sleeve-pin coupling and other clutches, at the same time as state standards existed for these articles. A similar situation was observed with respect to pressure and bell type lubricators. Excavator shovels were subjected simultaneously to state standards and departmental normal standards. The name parallelism of subject fields and the objects of production related to them is also observed in heavy machine building.

Parallelism of technical documentation is mainly a result of the multistage standardization and normalization system, whose subject field was not specifically defined. Parallelism of the subject fields of standards and normal standards has become a tradition of sorts on which the activity of certain standardization and normalization organs in the industry, for example, of the TsNIITMASh [Central Scientific Research Institute of Heavy Machine Building], is based. The branch and local normal standards are regarded as a preliminary, less critical version of the standard.

An opinion has evolved to the effect that the different kinds of standardization and normalization, before as well as now, are different stages of the same standardization process. And from this appeared opinions that parallel local, branch, departmental and interbranch normal standards and all-union standards can and even should exist.

The multi-level system, independent of the established number of levels, is free of the enumerated shortcomings, but its adoption and further development requires the resolution of the principal problem about specific definition of the subject field of standardization and the various forms of normalization and establisnment of expedient limiting features.

2. EXPEDIENT DIFFERENTIATION BETWEEN THE SUBJECT FIELDS OF STANDARDS AND THE VARIOUS NORMAL STANDARDS

The standardization system in machine building, including the four levels: state standardization, interbranch general machine building normalization, branch normalization and local (plant) normalization, has now become generally accepted and, evidently, will be in existence for a number of years.

The many years of standardization practice in the machine-building industry have shown that the GOST in an overwhelming number of cases should not be detailed to the degree close to working drawings. The state standards, as a rule, establish only the basic dimensions, parameters and technical requirements, leaving the fabricated dimensions and additional requirements to other technical documentation, for example, to normal standards, guiding technical materials, working drawings, engineering specifications, catalogs, instructions, etc.

There is no basis for the asumption that the practice for inclusion in the GOST of only basic dimensions, parameters, etc., has brought about an improper situation.

TABLE 2

Establishing Limits of the Subject Fields of Standardization and Normalization in Machine Building

Объекты стандартизации и нормализации 1	2	3	4	5
Машины, механизмы, аппараты, приборы и средства автоматизации 6	Ряды главных параметров. Типы, основные параметры и размеры. Методы испытаний. Технические требования к проектированию, изготовлению и эксплуатации, включая в необходимых случаях требования к упаковке, транспортированию и хранению. Общая система классифицирования и обозначений 7	—	Системы отраслевых классификаций и условных обозначений. Требования к отгрузке крупногабаритного оборудования 8	—
Агрегаты 9	Типы, основные параметры, и размеры агрегатов, общих для различных машин или автоматических линий. Методы испытаний. Технические требования к проектированию, изготовлению и эксплуатации. Общая система классифицирования и обозначений 10	—	Системы отраслевых классификаций и условных обозначений агрегатов общего и узкоспециального назначения. Типы агрегатов специализированного назначения. Методы испытаний. Технические требования к изготовлению и эксплуатации. Единые унифицированные системы контроля важнейших параметров и производственных процессов 11	Ограничение ГОСТ и ОН 12
Общие узлы и детали 13	14 Типы, основные параметры и размеры узлов и деталей централизованного производства. Методы испытаний. Технические требования к изготовлению, хранению, упаковке и транспортированию. Общая система классифицирования и обозначений	15 Типы и исполнительные размеры (в том числе дополняющие соответствующие ГОСТы на основные размеры)	16 Системы классифицирования и условных обозначений узлов и деталей отраслевого применения. Типы и исполнительные размеры узлов и деталей отраслевого применения. Методы испытаний. Технические требования к изготовлению и упаковке	17 Ограничение ГОСТ, МН и ОН. Типы и исполнительные размеры узлов и деталей, характерных для производства только данного завода. Методы испытаний. Технические требования к изготовлению
Специальные узлы и детали 18	Типы и размеры деталей и узлов особо ответственного назначения, связанных с безопасностью эксплуатации (для пассажиров и обслуживающего персонала) или являющихся объектами международной стандартизации. Методы испытаний. Технические требования к изготовлению, хранению, упаковке и транспортированию 19	—	Системы классифицирования и условных обозначений. Типы и исполнительные размеры узлов и деталей отраслевого применения. Методы испытаний. Технические требования к изготовлению и упаковке 20	Ограничение ГОСТ, МН и ОН. Типы и исполнительные размеры деталей и узлов, характерных для производства только данного завода. 21
Инструменты режущие, вспомогательные и измерительные 22	Типы, основные параметры и размеры. Методы испытаний. Технические требования к изготовлению и упаковке 23	Системы классифицирования и условных обозначений. Исполнительные размеры инструмента общего назначения 24	Системы классификации и условных обозначений. Типы, параметры и исполнительные размеры инструментов отраслевого применения 25	26 Ограничение ГОСТ, МН и ОН. Типы, параметры и исполнительные размеры специального инструмента, применяемого только на данном заводе. Методы испытаний. Технические требования к изготовлению
27 Приспособления, штампы и другая технологическая оснастка, в том числе механизированная	28 Типы, основные параметры и размеры механизированной технологической оснастки. Методы испытаний. Технические требования к изготовлению	29 Системы классифицирования и условных обозначений. Типы и исполнительные размеры общих узлов и деталей приспособлений, штампов и другой технологической оснастки. Методы испытаний и технические требования к изготовлению, упаковке и хранению	30 Системы классификации и условных обозначений. Типы и исполнительные размеры технологической оснастки отраслевого применения. Методы испытаний. Технические требования к изготовлению	31 Ограничение ГОСТ, МН и ОН. Типы и исполнительные размеры технологической оснастки специального назначения, свойственной только данному заводу
Общетехнические нормы 32	Предпочтительные числа. Шероховатость поверхности. Допуски и посадки. Резьбы. Шлицевые и шпоночные соединения. Нормальные конусности. Проточки и т. п. 33	Ограничение ГОСТ. Техническая терминология. Руководящие технические материалы в области технологии и организации производства 34	Ограничение ГОСТ и МН. Техническая терминология. Руководящие технические материалы в области технологии и организации производства 35	Ограничение ГОСТ, МН и ОН. Руководящие технические материалы в области технологии и организации производства 36

1) Objects of standardization and normalization; 2) subject field of state standardization; 3) subject field of general machine-building normalization; 4) subject field of branch normalization; 5) subject field of local normalization; 6) machines, mechanisms, apparatus, instruments and automation facilities; 7) Series of basic parameters. Types, basic parameters and dimensions. Testing methods. Technical requirements put to design, manufacture and operation, including, in the necessary cases, requirements to packing, transportation and storage. General classification and designation system; 8) Branch classification and designation systems. Requirements put to the shipping of bulky equipment; 9) assemblies; 10) types, basic parameters, and dimensions of assemblies common to different machines or automatic lines. Technical requirements to design, manufacture and operation. General classificacation and designation system; 11) Branch classification and designation systems for general purpose and narrow-application assemblies. Types of specialized purpose assemblies. Testing methods. Technical requirements to manufacture and operation. Uniform unified systems for control of major parameters and production processes; 12) limiting the applicability of GOST and ON; 13) Common subassemblies and components; 14) Types, basic parameters and dimensions of centrally produced subassemblies and components. Testing methods. Technical requirements to manufacture, storage, packing and transportation. General classification and designation system; 15) Types and fabricated dimensions (including those complementing the corresponding basic dimensions GOST's; 16) Classification and basic designation systems for subassemblies and components utilized by the branch. Types and fabricated dimensions of subassemblies and components utilized by the branch. Testing methods. Technical requirements to manufacture and packing; 17) limiting the applicability of GOST, MN and ON. Types and fabricated dimensions of subassemblies and components characteristic for the production of the given plant only. Testing methods. Technical requirements to the manufacture; 18) special subassemblies and components; 19) types and dimensions of components and subassemblies of critical importance involving operational safety (for passengers and servicing personnel) or which are objects of international standardization. Testing methods. Technical requirements to manufacture, storage, packing and transportation; 20) Classification and basic designations systems. Types and fabricated dimensions of subassemblies and components used by the branch. Testing methods. Technical requirements to manufacture and packing; 21) limiting the applicability of GOST, MN and ON. Types and fabricated dimensions of components and subassemblies characteristic of the production of the given plant only; 22) cutting, auxiliary and measuring tools; 23) types, basic parameters and dimensions. Testing methods. Technical requirements to manufacture and packing; 24) classification and conventional designations systems. Fabricated dimensions of general purpose tools; 25) classification and conventional designation systems. Types, parameters and fabricated dimensions of tools used by the branch; 26) Limiting the applicability of GOST, MN and ON. Types, parameters and fabricated dimensions of special purpose tools, used at the given plant only. Testing methods. Technical requirements to manufacture; 27) Fixtures, diesets and other production equipment, including mechanized equipment; 28) Types, basic parameters and dimensions of mechanized productive equipment. Testing methods. Technical requirements to manufacture; 29) classification and conventional designations system. Types and fabricated dimensions of common subassemblies and components of fixtures, diesets and other production tooling; testing methods and technical requirements to manufacture, packing and storage; 30) classi-

fication and conventional designations systems. Types and fabricated dimensions of production tooling used in the branch. Testing methods. Technical requirements to manufacture; 31) limiting the applicability of GOST, MN and ON. Types and fabricated dimensions of special purpose production tooling, peculiar to the given plant only; 32) General technical norms; 33) Preference numbers. Surface roughness. Tolerances and fits. Threads. Splined and slotted joints. Normal tapers, bores, etc.; 34) Limiting the applicability of GOST. Technical terminology. Guiding technical materials in the field of production processes and organization; 35) Limiting the applicability of GOST and MN. Technical terminology. Guiding technical materials in the field of production processes and organization; 36) limiting the applicability of GOST, NM and ON. Guiding materials and in the field of production processes and organization.

It is shown by experience that this practice can be appropriqtely developed, which will make the standards more stable, but they should be related to machine-building normal standards by a certain system.

In establishing limits for the subject fields of standardization and normalization it is thus necessary to single out that field in which the aforementioned particularization of standards and normal standards is expedient. This subject field will be the optimal field for interbranch general machine-building normalization.

Under conditions of territorial management of the machine-building industry, the retention and further development of branch standardization is beyond doubt. It cannot be permitted that the same of machines and equipment produced in different regions of the country have different dimensions of the same subassemblies and components, since this would have a negative influence on their operation.

Plant and design organization normal standards (local standards) are the lowest level of the standardization system. The principal defect of the evolved plant normalization is the fact that its subject field is formulated independent of the interest expressed by other similar enterprises in the same normal standards. This has resulted in a tremendous amount of different types of produced components and especially of production tooling. This is due to parallelism of plant normal

standards. Taking this into account, it is necessary to ensure the most complete interrelationship between the subject fields of interbranch, branch and local normal standards. All that can be recognized as useful on a branch scale should be immediately formalized as branch normal standards, unlike the previous practice for performing this in two stages (first as a number of plants as parallel plant standards and then unification of plant normal standards and elaboration of the branch normal standard). It should be noted that this unification was, in the majority of cases, not achieved at all, since each plant tends to retain its designs and has insisted on its own, plant and normal standards. If we take into account these conditions, then this main goal of local (plant) normalization is expedient limitation of the applicability of state standards, machine-building and branch normal standards, and also the performance of certain other tasks (see below).

The limiting conditions described above make it possible to rationally subdivide the subject field of standards and normal standards in each machine-building branch and to set up a table of the type presented in Reference [1], facilitating the planning of subject fields for all kinds of standards and normal standards.

Generalizing the above considerations, we can, in principle, give the differentiation of the subject fields of all the four standardization levels, taking into account characteristics accepted in the instructions of the Committee of Standards- Measures and Measureing Instruments with respect to the order of elaboration of state standards drafts. This differentiation of the subject fields is given in Table 2.

3. CHARACTERISTIC SUBJECT FIELD OF MACHINE BUILDING NORMAL STANDARDS

The basic goal of general machine building normalization is preparation of technical documentation necessary for organization of mass production to fulfill centralized orders of common subassemblies and

components of machines, tools and other production tooling equipment. We can suggest the following rough list of mass utilization products, the manufacture of which is regulated by machine building normal standards.

A. Common Subassemblies and Components

1. Cylindrical, bevel-gear, bevel-gear cylindrical, worm screw and planetary reducers and also motor-reducers.

2. Variable-speed drives with V-belts, chain-[driven], shifting-roller, and the like.

3. General-purpose bevel and cylindrical gears with straight, spiral and other forms of meshing.

4. Sheaves for flat and V-belts.

5. Driving sprockets for all types of chains.

6. Small and large shafts of various types, including flexible wire shafts.

7. Journals and sleeves and also hinge bearings.

8. Antifriction bearing housings and covers.

9. Pumps, plunger-type, vane and gear for hydraulic systems.

10. Safety and nonreturn valves, valves with pressure regulators, throttles, slidevalves, taps, water traps, pressure regulators, gate valves, plunger valves, etc.

11. Fluid lubricant and grease lube fittings, filters.

12. Flanges threaded, for flaring, welded and free.

13. Connecting pipes, elbow pipes, T-pipes, cross pipes, nipples, plugs, etc.

14. Hydraulic and pneumatic cylinders, cylinder heads, pistons, piston rods, packing rings, supporting brackets, etc.

15. Fluid lubricant and greast lubricators.

16. Lubricant distributors, lubricant gages, injectors, pipeline

joints and packing.

17. Controlled, uncontrolled, automatic, overload and other clutches.

18. Cone-type, disk, shoe, belt and other brakes.

19. Friction disks.

20. Shift levers.

21. Buttons.

22. Pilot wheels.

23. General-purpose springs.

24. Forks.

25. Blocks, eye rings, compound pulleys, hook rings and the like.

26. Hopper gates, warehouse loading devices.

27. Various pallets and containers.

28. Metal, solid rubber and tire wheels.

B. Subassemblies and Components of Instruments and Automation Facilities

1. Leveling, separating and settling vessels.

2. Diaphragms and bellows.

3. Belt-driving mechanisms.

4. Semiconductor, electronic and other amplifiers.

5. Instruments of an assembly-unified system.

6. Pneumatic and hydraulic regulators. Pneumatic amplifiers for instruments and regulators.

7. Nozzles and Venturi tubes.

8. Potentiometers, balancing bridges.

9. Resistance thermometers. Thermocouples. Magnetic amplifiers.

10. Relay units. Power units. Semiconductor units.

11. Pickups, pneumoelectric, pneumatic, hydraulic, electric, etc.

12. Remote control and signaling installations.

13. Differential manometers, vacuum gages, vacuum manometers, flow

meters, instruments for measuring and regulation of the flow of fluids, etc.

14. Pyrometric millivoltmeters.

15. Stabilized power sources.

16. Electrical measurement and analysis instruments.

17. Electric, hydraulic, electrohydraulic, electropneumatic, etc., actuating mechanisms.

18. Solenoid valves for gases and fluids. Automatic multipoint operation gas switches, etc.

19. Control and measuring instrument and automatic control panels.

C. Tools and Other Production Process Tooling Equipment

1. High-speed steel and hard alloy tipped cutters. Diamond [tip] cutters.

2. Drills, including those with hard-alloy bits.

3. Single-piece and inserted-blade reamers and counterbores. Countersinks.

4. Boring blades.

5. End, face, disk, cylindrical, slotting, slitting, hobbing, etc., milling cutters.

6. Screw taps and dies. Thread-generating rollers. Screw-cutting heads.

7. Shavers.

8. Slotting and round broaches.

9. Circular, belt and planing wood-cutting saws. Saws for vertical timber-cutting frames. Cutter blocks.

10. Drill chucks, screw tap chucks, collet chucks, end mill arbors. Pneumatic and mechanical chucks.

11. Adapters.

12. Holders, mandrels, collars, etc.

13. Centers.

14. Tool holders, screw die holders.

15. Plane-parallel blocks.

16. Jigs.

17. Rotary and dividing tables.

18. Pneumatic, pneumohydraulic, lever, screw and eccentric vise.

19. Dividing and multispindle heads.

20. Components of universal-knockup, universal-setup and other fixtures.

21. Components and subassemblies of special machine-tool fixtures.

22. Dividers, scribers, marking gages, prick punches, punches.

23. Chisels, clamps, cut-through tools, scrapers, pincers, etc.

24. Screw drivers.

25. Hammers.

26. Flat-nosed pliers, cutting pliers, tongs, combination cutting and twisting pliers, shears, tap wrenches, screw clamps, strippers, vise, files, etc.

27. Electric and pneumatic drills and nut tighteners. [Portable] polishing machines.

28. Hammers, screw drivers and other pneumatic tools.

29. Portable pneumatic presses.

30. Smooth and thread-testing gages. Splined joint gages.

31. Micrometers, slide gages, depth gages, indicators.

32. Gear-checking instruments. Minimeters, Interferometers.

33. Checking plates and angles. Levels.

34. Wire-drawing dies.

35. Diesets for cold upsetting of nuts.

36. Fastening components for diesets and hammer heads.

37. Guillotine and pressure-shear blades.

38. Dieset buffer systems.

39. Feed rollers for automatic cold upsetters.

40. Molds for mass produced components.

41. Straightening machine rollers.

42. Molding and core-making tools.

43. Tools for cleaning of castings.

44. Pneumatic hammer and perforator tools.

45. Flasks, bottom boards, plates for core drying, etc.

46. Gaggers.

47. Subassemblies and components of chill molds, core boxes and molds.

48. Shell casting equipment.

49. Cold pressing blocks and dies.

50. Sleeves and leader pins for diesets.

51. Blocks for crank-type die-forging presses and horizontal forging machines. Universal die blocks. Male die clusters for horizontal forging machines.

52. Inserts for diesets for horizontal forging machines.

53. Lower punching dies. Rapid-replacement punches.

54. Smith tools.

The above list of characteristic objects of general machine-building normalization, even in this foreshortened form, points to the fact that the subject field of machine-building normal standards is not only extensive but also varied. In addition, for the most part, it duplicates the subject field of state standards. This imparts significance to the problem of coordination and coding of standards and normal standards.

4. COORDINATION AND CODING OF STANDARDS AND NORMAL STANDARDS

The overwhelming majority of existing standards have references to

other standards. Correspondingly, also normal standards in many cases refer to standards, but the opposite case, i.e., standards with references to branch and local normal standards, does not exist. References to catalogs and other departmental or local technical documents are encountered in very rare cases.

It seems expedient to modernize the state standard – machine-building normal standard – working drawings system in such a manner that they should comprise a single chain and should have references in two directions, namely: the working drawings should refer to machine-building normal standards, and the latter to the appropriate GOST and vice versa. In this case interrelationship is ensured and a modification of any link in this system of technical documentation should be reflected also in the other links. This will result in achieving integrated documentation and will eliminate the need for several machine building normal standards by adding to the standards complements containing drawings with fabricated dimensions of uncomplicated articles (machine components, tools, etc.).

Coordination of standards and normal standards involves the introduction of supplements, modification and correction. A certain modification of the existing practices is necessary also in this case. It is desirable to introduce into the standardization system a procedure for periodic extension of the period of applicability or for the revision of standards and normal standards at preestablished times (see below). In this case, the year indices will be changed in the standards and normal standards numbers, which will ensure better coordination of the documentation and its conformity with the existing level of science and technology.

A problem unresolved at the present time is the coding of standards and normal standards. If the number of state standards applicable

to machine building is counted in the thousands, and the demand for machine building normal standards is expressed in tens of thousands, then the probable number of necessary branch and various local normal standards will comprise hundreds of thousands. Their coding is a very important problem, since it is impossible to know for which components and subassemblies of machines, mechanisms, apparatus, instruments and automation facilities are normal standards and other technical documentation available. Without a conventional code it is impossible to set up any systematic index of normal standards in force in the machine building industry.

Up to the middle of the '30's the domestic standards, in addition to their number (ordinal) also had a numerical code consisting of a number of symbols according to a certain classification system. Then this practice of standards coding has been revoked and the previously used coding system was forgotten. At the present time the advantage of of introduction of a rational coding system is beyond any doubt. It is necessary to elaborate a classification of industrial production, extending it to components and machines, mechanisms, apparatus, instruments and automation facilities, semifinished products, basic and auxiliary, metal and nonmetal materials. At the present time the necessity for creation of such a classification is not determined solely by the needs of standard and normal standard coding. It is necessary for ensuring the development of specialization and production coordination, for performing on a large scale the unification of subassemblies and components of machines, tools and other production tooling equipment. Chapter 12 considers the principles for constructing numerical systems for classification of machine building products and of the materials used.

5. DATES FOR PUTTING INTO FORCE AND PERIODS OF APPLICABILITY OF STANDARDS AND NORMAL STANDARDS

Of great importance is the problem of ensuring stability of standards and normal standards expressed by the time periods during which they are in force. Many from among the existing state standards of the USSR are very stable, but at the same, evidence exists that the opposite is also true. Thus, for example, the standard for types and basic dimensions of double-row roller bearings with cylindrical rollers (very light series) has lasted only one year. Standards for screw dies were revoked after two years. The standard for end mills was in force only one year.

To what do these facts point? Primarily to the fact that the quality of elaboration of standards (i.e., the methodology and principles on the base of which the standard is evolved) are a decisive factor. Taking into account that the existing standards and also any normal standards are not distinguished by their stability, which is characterized by the time during which they are in effect, it is necessary to elaborate appropriate measures for improving the stability of standards and normal standards. From this point of view it is expedient, even if briefly, to familiarize ourselves with the foreign standardization practices. We have reviewed more than 6000 standards of England, India, the USA, France, German Democratic Republic (East Germany) and the Federal Republic of Germany (West Germany) (DIN normal standards) and of Switzerland, which has made it possible to approximately estimate the time they remain in force. The most stable of these are French standards (more than 80% is in force over 5 years). English standards and the DIN normal standards are also very stable (more than 70% of the standards reviewed are in force for more than 5 years) The applicability of Japanese standards is limited to three years. After being in force for

three years each standard is either extended for another three years or is replaced by a new standard.

We can recommend to adopt the 5 year term of applicability of standards and normal standards for the Soviet standardization practice, whereupon they should be subjected to mandatory review or extension for another 5 years. This order requires both the organizations which elaborate the standards and normal standards as well as organizations charged with approving them to substantially change their systems of operation. It will be necessary to thoroughly study the utilization of standards and normal standards by the industry and to more fundamentally accumulate material pertaining to their progressiveness.

The dates of issuance of standards and normal standards and of any modifications, supplements and corrections to them are not, at the present time, subject to any scheduling. In individual cases they are established on the basis of thorough study of the problem and in other cases this is done approximately, by rule of thumb. But the basic problem here are the times of issuance, and they are more or less uniformly distributed over the year, which is of certain inconvenience to enterprises, since each new data requires additional revision and review of technical documentation.

It is necessary to recommend the use of preferential dates, namely: 1 January and 1 July. In individual cases it is possible to use quarterly dates, i.e., 1 April and 1 October, although long years of standization practice show that this is not really necessary.

The above preferred dates can also be used for the introduction of any modifications, additions and corrections.

Chapter 6

THE MATHEMATICAL BASIS OF STANDARDIZATION

The development of new fields of mathematics has opened in the last few years wide perspectives for further automation of production, control, planning, design and scientific investigation processes. But the scales at which mathematics has been adapted into standardization are still insufficient.

1. FIELDS OF APPLICATION OF MATHEMATICAL METHODS IN STANDARDIZATION

Standardization is a discrete process, whose development is related to overcoming of a number of thematic barriers, characterizing the practical boundaries of one or another standardization method, in connection with which an optimal subject field and fields of application exist for each standardization method. Thus, for example, one of the earliest and simplest methods is simplification.

The possibilities and subject field of unification are much more extensive. Having absorbed all economic and organization advantages of simplification, unification has naturally moved wider apart the boundaries of standardization and normalization. As simplification, unification is based on that which is already available, but introduces a certain order into the variety of existing products, increasing, in individual cases, the technological level of the produced items. However, the boundaries of unification are not limitless and they create that barrier to the development of standardization and normalization which can be overcome only by other methods.

Standardization, developing with respect to methods, has called to

life typification, which has extended the boundaries of standardization even wider in the practical sense. The method of aggregation considerably extends the field of standardization. The boundaries which bound typification can be, in a significant part, extended by using the aggregation method. This method is also expedient for many cases of achieving normalization, especially when it is based on the use of mathematics, which makes itself apparent in the form of normal linear dimensions, preference numbers, mathematical statistics, etc.

The method of normal linear dimensions in fabrication of machine components faciliti ates the use of standard tolerances and fits of threading normal cutting and measuring tools. These tools can be purchased on the outside. And this fact is already a stimulus for the adoption of normal standards for product series created on the basis of typification. If here the product parameters correspond to preference numbers (see below), then the problem of utilization of standards and normal standards is substantially facilitated, and in this case the boundaries of applicability of the typification method are extended somewhat, especially in the field of evolution of parametric standards for machines and equipment. But the problem of substantiation of series of typified products, including of machines and their components, still remains open, since it is unclear what should be the guidelines in choosing the series. And this places a new barrier on the road of development of the subject fields of standardization and normalization. Mathematical methods make it possible to substantially extend the feasibilities and subject field of standardization and normalization in all their manifestations.

The fields of application of mathematics in the elaboration of standards and normal standards are extended with every year. Mathematical methods make it considerably easier and faster to establish sub-

stantiated intermediate values of dimensions and other parameters, pertaining to any kind of machine-building products, and also to find expedient numerical values of the limiting dimensions and parameters in the series being established.

Statistical quality control methods for finished and semifinished products at all stages, operations and production process transitions free large contingents of skilled personnel from nonproductive work for their utilization on basic production process operations. It shouldbe noted that, according to Academician V.I. Dikushin, the number of inspectors relative to the number of production workers comprises from 8 to 40%. The development of passive inspection has resulted in losses from rejects comprising many millions annually. Active inspection facilities can sharply lower losses due to rejects.

Mathematical statistics and other mathematical methods make it possible, in a more substantiated manner, to establish quality indicators for materials, semifinished and finished products and their elements. to find objective solutions of problems pertaining to structural elements, joining dimensions, interchangeability, single-typeness, weight and other indicators of standardized and normalized items. In particular, the probability theory has arisen and has developed primarily as the theory of random not time-dependent numbers. For this reason the probability theory can be extensively utilized in standardization and normalization work.

A major goal of all Soviet machine building workers at the present time is to improve in all possible ways the quality of produced machines, mechanisms, apparatus, instruments and automation facilities. The problem of increasing their service life and operational reliability, lowering of weight, improving economic indicators and external appearance has been very sharply stated. The solution of the problem of standardiza-

tion of quality indicators can be facilitated and accelerated by mathematical methods, in particular, by the use of correlation calculus, theory of games, etc., which make it possible to find solutions in those cases where up to recently standardization and normalization could not find them.

Two kinds of mathematical relationships are used in standardization. The first is the functional relationship, when a rigorously defined value of one quantity corresponds to a specified value of another quantity. The second kind is the correlational relationship when some mean value of one quantity corresponds to a specified value of another quantity, here actual dimensions of the former can deviate from the mean value.

The utilization of the correlational relationship substantially extends the feasibility of standardization of quality indicators, and also promotes more substantiated establishment of intervals for the quantities being standardized.

Methods of ordinary unification of designs and standard dimensions of products limit the subject field of this work with respect to a narrow nomenclature of the so-called common subassemblies and components of machines, fixtures, diesets and other production tooling. Attempts to substantially extend the subject field and to unify the branch and departmental subject fields into common normal standards have often failed due to the fact that it was impossible to reconcile conflicting desires of different plants. The problem of creating uniform machine building normal standards cannot be fully solved by the use of habitual but outmoded normalization methods. New, more effective and progressive normalization methods, based on mathematics, are necessary. Without this normalization will tread the same ground, and its role will substantially be reduced to the transmission of the same objects from one

variety of documents to another.

Normalization in the field of cutting tools, with rare exceptions, related to the unification of general-purpose tools, but other problems related to the achievement of integrated production automation, must now be faced. Automated plants, shops and sections, equipped by numerous automatic lines, which cannot always use normalized tools, are being created. They require different production tooling (see Chapter 13). The problem of development of the necessary standards and normal standards still awaits its solution. New methods, based on statistical study of the accumulated experience and bolder application of mathematics is needed.

In specifying the values of technical indicators, various parameters, joining and other dimensions, it is necessary to analyze a large amount of practical data, accumulated at different locations, and then to systematize them on the basis of critical observations, measurements, etc. However, it is known that in performing any measurements and comparison it is always necessary to consider certain mistakes and errors which influence the final results of measurements. Measurement errors are systematic and random.

Systematic errors depend for the most part depend on incorrect indications of the instruments and other measurement facilities being used, on incorrect and nonuniform methods of measurement, on a constant but not one-sided external influence. Systematic errors in measurements can be eliminated. This is achieved by thorough study and checking of the measuring facilities used and of introduction, if necessary, of appropriate corrections into the results.

Random errors are mainly a result of that inaccuracy which always exists in observing the indications of instruments and the points of reckoning. These errors do not follow any constant rules, since random

errors tending to increase as well as decrease the measured quantity are equally possible in the making of any given measurement. As a result of this, laws established by the probability theory with respect to multiple appearance of the so-called random events, should be applied to the random errors. Obviously, it is impossible to completely eliminate measurement errors. The probability theory has elaborated mathematical methods which make it possible to lessen the influence of random errors on the final value of the indicator included in the standard. Two cases are here characteristic:

1. Measuring the same unknown quantity of substantial significance to standardization. For example, it is required to determine the stroke of the press slider with the highest degree of accuracy possible. If the stroke is measured several times, and an average of the measurements is obtained, it will be the most probable value.

2. Measuring of any quantity which in itself is subject to statistical variations. For example, it is required to determine the actual rating of standard electric motors of the same series, manufactured at different plants and operating at different enterprises during varous time intervals. This requires measuring the rating, let us say, of 100 electric motors of the same capacity and model (more precisely, version) and from results thus obtained to derive the actual ratings. The value of data thus obtained will depend on the choice of the electric motors (whether new or in operation for some time, whether proper maintenance was provided or not, etc.). Or for example, it is required to determine the volume of noise created by a certain mechanism. For this a large number of measurements is performed, and the most frequently encountered noise indicator is determined on their basis.

We can present an example, showing the feasibility of the use of statistical mathematic methods for establishing a substantiated indica-

tor of the weight of machine tools, subject to inclusion in parametric standards (see Chapter 8). It should be noted that the weight parameter is the cause of most disagreements in approving standard drafts. This indicator is included in state standards in order to guide the work of designers toward lowering the weight of the equipment being elaborated and to effect savings of metal. This norm setting for the weight of newly designed machines and equipment, which takes their strength, overall dimensions, capacity and other parameters into account, is of great practical importance and is one of the major problems of standardization in the foreseeable future.

The geometric similarity principle in design-unified metal-cutting machine-tool series, and also the more or less close to one another schemes of similar machine-tool types, established in the entire world, make it possible, on the basis of a chosen rule for the change of weight of basic load-carrying components as a function of starting parameters, to extend this rule to the change of the weight of the machine-tool as a whole. Statistical analysis of the weights of a sufficiently large number of machine-tool models produced by leading enterprises of different nations of the world makes it possible to establish coefficients or other indicators of economical weight and to take them as standard values. According to data of Reference [16], this methodology, based on statistical analysis, is applicable to metal-cutting machine-tools of any type.

The mathematical statistics method can be widely used in elaborating dimensional series and parametric standards for machines and equipment. Statistical analysis of original data makes it possible to find the function of distribution of parameters, establish their interrelation and to specify substantiated intervals for change of parameters, dimensions or other characteristics, depending on the total volume of

products under investigation. Histograms and cumulative curves are used for acceleration of this analytic work and for simplification of calculations.

The suitability, under practical conditions, of the majority of standardized parameters is subjected to the normal distribution or is close to it. This makes it possible to use special (probability) paper, which has drawn on it an orthogonal coordinate system, on which the normal distribution is laid off on the ordinate axis of this paper and the parameter under investigation or such a function whose distribution is either normal or close to normal is laid off on the abscissa axis. A logarithmic coordinate system is more convenient, since it represents geometric series of preference numbers on an uniform scale.

The use of cumulative curves facilitates the work of distribution analysis for clarifying the relationship between any two parameters. For example, if it is required to expose the statistical relationship between the diameter of the seating hole of a gear and the outside diameter of the rim, then we can only speak about an interval defining the diameter of the seating hold for each value of the outside diameter of the gear rim. This is due to the fact that no single-valued relationship exists between these diameters. No correlational relationship exists either [17].

The exposure of the most needed parameter intervals substantially extends the boundaries of normalization of common subassemblies and components of machines and provides general machine building normalization with the necessary scientific basis.

At the present time the fields of application of mathematical methods to standardization work are thus determined by the following problems:

1. Establishment of indicators characterizing the service life and

reliability of machines, mechanisms, apparatus, instruments and automation facilities in service.

2. Exposure of the optimal precision for the manufacture of machine components and subassemblies and also of other products.

3. Classification of goods and materials used and establishment of the corresponding indicators with respect to geometric, physical, chemical and other properties.

4. Systematization of the choice of specimens for investigating the properties of materials, semifinished products, components, subassemblies, assemblies and finished machine-building and instrument-making objects.

5. Statistical quality control methods and rule for acceptance of goods.

6. Substantiation of the choice of brands, profiles, dimensions and other characteristics of materials.

7. Establishing expedient installation, joining, overall and other dimensions of components, subassemblies, assemblies and other products.

2. ARITHMETIC AND GEOMETRIC PROGRESSIONS

Machine-building historians point out that as late as at the end of the 19th century the common fastening components (nuts, bolts, pins, etc.) were special components, were designed individually in conjunction with machines for which they were used. But the expanding scale of machine building and of the type range of machines and equipment that were ordered, alongside with accentuation of capitalistic competition, have independently required acceleration of the production cycle and lowering the net cost of production. This was achieved by various measures, including standardization of components, profiles and brands of materials being ordered. Individual large plants have created their own assortments of common components which then, as specialized related

production and other plants began to appear, were combined and unified. Two trends are characteristic in this standardization process, performed at the beginning of the 20th century:

1) creation of dimensional series of general machine building components based on one or another qualitative relationship;

2) creating of dimensional series and assortments of common components and also of rolled stock on the basis of combination and unification of individual requirements with gradual approach to series governed by qualitative relationships.

The first trend is most characteristic of fastening components and antifriction bearings. It has resulted in the appearance of standards for types and dimensions of bolts, nuts, pins, screws, etc., and correspondingly also for drills, markers and other hole machining tools. The use of these standards evolved on the basis of arithmetic progressions has become more extensive with the passage of time and they have been extended to an ever increasing number of objects from among common machine subassemblies and components (for example, all forms and types of antifriction bearings).

The second trend has most clearly appeared in standardization of rolled stock profiles, pipes and other metallurgical products. This is due to the fact that a considerable part of rolled stock supplied by the metallurgical plant was reprocessed by hot wirking with substantial change of the shapes and cross sections of the metal. Gradually, the consumers began to make use of standard profiles and material brands, since the cost was lower and they could be obtained faster. Arithmetic progressions, expressed by rounded numbers, have thus come within the range of standardization and have retained their significance up to the present time.

Geometric progression were first used for standardization purposes

about 90 years ago, when making ropes for balloons in Paris besieged by the Germans.

The desirability of more extensive utilization of geometric progressions in domestic and foreign standardization practices is due to the following.

Analytical work performed in a number of countries have shown that assimilation of new equipment is most effective in those cases when the parameters of machines and equipment, dimensions of purchased articles and technical characteristics of various kinds of products are specified not randomly but according to a certain general system, based on geometric progressions. If the choice of productivity, capacity, weight lifting ability, dimensions, rpm, pressures, temperatures, voltages, number of cycles and other parameters is made on the basis of a specified, rigorously substantiated series of preference numbers, then by virtue of the same fact best agreement will be obtained between parameters and dimensions of each individual product or group of products with each type of goods related to them. And, conversely, nonconformance to this conditions results in excessive consumption of materials and power, inefficient utilization of equipment, areas, etc. For example, nonconformance of the assortment of round steel stock to the diameter series in machine building results in overconsumption of metal in the form of chips and additional work for the equipment.

The long years' experience with the use in machine building of preferential numbers series, based on geometric progressions, has exposed their advantages in establishing rational parameters and dimensions of machines. The sizes of many machine-tools are at the present time established by the preference numbers and preference number series. The new GOST 8032-56 establishes preference numbers and their series which should be used as the basis for the choice of gradations of para-

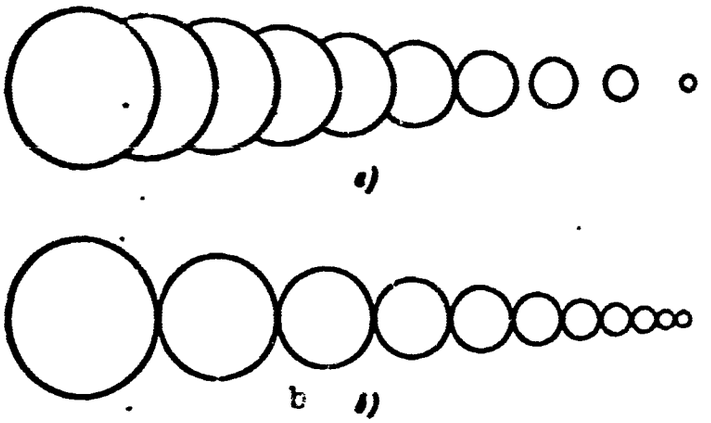


Fig. 1. The relationship between the arithmetic and geometric series. a) Arithmetic series; b) geometric series.

meters and dimensions and also of individual numerical characteristics of products put out by all branches of the national economy.

Both systems of preference dimensions, i.e., based on arithmetic and geometric progressions, have their virtues and shortcomings. The relationship between them is graphically illustrated in Fig. 1.

The shortcoming of the arithmetic series is its relative nonuniformity. For a constant absolute difference, the relative difference between the terms, as the series increases, decreases very sharply. Here the relative difference between lower terms exceeds considerably the difference between the higher terms. Thus, for example, while the difference between terms of the arithmetic series 1, 2, 3, ..., 10 is 100% for numbers 1 and 2, it is only 11% for numbers 9 and 10, which creates certain inconveniences in using these series. However, the arithmetic series also have their advantages. In particular, their use does not require the rounding off of numbers.

Geometric series ensure a uniform relative difference between any adjacent numbers of the series. This important property is determined by the fact that the ratio of any two adjacent numbers of any geometric series is always equal to the common progression ratio, denoted by φ, which is constant for the given series. Number series based on one or

another specific common ratio φ are denoted, for example $\sqrt[5]{10}$, $\sqrt[10]{10}$, etc. The basic shortcoming of geometric series consists in the fact that for an identical ratio of any two adjacent numbers the actual difference in their value is nonuniform and, in the case of small numbers, comprises very small values and for large numbers, conversely, very considerable values. This requires to find one or another solution for elimination of this shortcoming (see below in a number of chapters).

The question can be raised to the effect that the idea of utilizing preference numbers, based not on an arithmetic but on a geometric progression, is farfetched in general, and in particular in its application to equipment and standardization. We can present an example far removed from the machine building field but doubtlessly of general scientific interest. Our solar system, according Academician V. Fesenlov, was created on the basis of geometric progression. The sizes of planetary orbits increase in a geometric progression and each successive planet is located by a factor of 1.5-2 farther away from the sun than the preceding planet. The relative radii of planetary orbits, if we take the radius of the orbit of the earth as a unit, comprise: Mercury 0.39, Venus 0.72, Earth 1, Mars 1.52, Jupiter 5.2, Saturn 9.5, Uranus 19.2, Neptune 30.1 and Pluto 39.5.

The property of geometric progressions to sharply increase the absolute value of each successive term of the series, past the limits of a certain value, fosters the adoption of preference numbers based on geometric progressions into the parametric standardization practice.

The system of normal linear dimensions and the system of preference numbers (see below) have served as a basis for the establishment of many existing machine-building and instrument-making standards. In the prewar years these were standards for components and simple articles, and in the postwar years the system of standard preference numbers had

begun to be ever increasingly used in the elaboration of parametric standards for machine and equipment series. Standardization on the basis of normal linear dimensions series and preference numbers has resulted in the appearance of state standards and machine-building normal standards for various linds of products, which in some part (smaller or greater) have not as yet been assimilated by the production units.

This is due to the fact that in constructing dimensional and parametric series in accordance with the system of normal linear dimensions and preference numbers, a certain orderly series is, as a rule, assumed deletions of individual dimensions or parameters of which is undesirable. This standardization principle, possessing as it does doubtless scientific and methodic advantages, also has disadvantages.

The designer using a standard or a machine-building normal standard, which is based on one or another parametric series does not know and cannot be positive in the fact that the standard dimensions of the standardized (normalized) products chosen by him are actually at the given instant produced by specialized plants and that they can be at any time obtained in the finished form. If these are components or subassemblies the manufacture of which is simple, then the machine-building, instrument-making and repair plants in this case are forced to produce by their own internal resources, and if these are more complex products (for example, clutches, reducers or variable-speed drives), then it becomes necessary to change individual working drawings and adapt the given subassembly of a machine or instrument to those standardized products that can actually be obtained at the given time from specialized plants, already in the production preparation stage.

The given situation, well known to workers of heavy machine building and other production branches, usually results in complaints to standardization and normalization workers, who have as if evolved use-

less norm-setting documents. Actually, however, proper coordination of standards and normal standards with catalogs and handbooks can entirely eliminate these situations.

It is entirely natural that state standards do not provide information about, for example, which antifriction bearings have already been assimilated and when. For this reason the choice of standard antifriction bearings for actual service conditions must be made taking into account their assimilation and of the availability at the given time of production of the given series and dimensions. This purpose should be served by periodic issuance of catalogs, for example, of bearings being produced, and also handbooks, in which it is necessary to give exhaustive information about a given date at which the given bearings should be assimilated by the industry and also other information which is not contained in the standards. Similar handbooks are also needed for all other standardized products.

It follows from the above that standardization of goods on the basis of the normal linear dimensions system and the preference numbers system is characterized by the fact that state standards and machine building normal standards should be related to an appropriate reference literature. Without this working combination of standards and normal standards with references, they can become of little practical importance. Regretfully, this principle is far from being universally observed.

3. THE SYSTEM OF NORMAL LINEAR DIMENSIONS

The normal linear dimensions series given by GOST 6636-60 in the interval of 0.001-20,000 mm are constructed on the basis of GOST 8032-56 titled "Preference numbers and preference numbers series," which contains number series in one-tenth intervals from 1 to 10, with the values for other number intervals obtained by multiplication or division

by 10, 100, etc.

Standard normal linear dimensions series (of diameters, lengths, heights, etc.) given in GOST 6636-60 serve for choosing nominal dimensions of industrial products and primarily of machine-building goods. The limitations imposed on the number of linear dimensions used creates the prerequisite conditions for decreasing the nomenclature of products and for their unification. This also serves to decrease the nomenclature of cutting and measuring tools (drills, reamers, counterbores, gages, fixtures, diesets and other production process tooling equipment, which further results in improving the level of interchangeability, increasing the production scale and simplification of the organization of tool maintenance at enterprises. As a result it is possible to achieve lowering the cost of goods and very considerable savings on the scale of the entire industry.

Linear dimensions series are specified for all decimal intervals from 0.001 to 20,000 mm; here, taking into account the established design practice, certain preference numbers are replaced by their rounded off values. The use of other (rounded off and not rounded off) values is not permitted. Thus, this makes it possible to unambiguously solve the problem of permissible linear dimensions and prevents increasing their nomenclature by using not rounded off as well as rounded off values of the same preference numbers. Construction of normal linear dimensions series on the basis of preference numbers series makes it possible, together with the generally known advantages of the latter, to ensure a proper relationship between the dimensions of products and their other parameters (rating, peripheral speed, [fuel] consumption, productivity, etc.).

Establishment of parameters and numerical characteristics of products which are not linear dimensions is performed directly by prefer-

TABLE 3

Series of Normal Linear Dimensions

a mm										
Ra5	Ra10	Ra20	Ra5	Ra10	Ra20	Ra40	Ra5	Ra10	Ra20	Ra40
0,001			0,010	0,010	0,010		0,100	0,100	0,100	0,100
										0,105
					0,011				0,110	0,110
										0,115
				0,012	0,012	0,012		0,120	0,120	0,120
						0,013				0,130
					0,014	0,014			0,140	0,140
						0,015				0,150
0,002			0,016	0,016	0,016	0,016	0,160	0,160	0,160	0,160
						0,017				0,170
					0,018	0,018			0,180	0,180
						0,019				0,190
				0,020	0,020	0,020		0,200	0,200	0,200
						0,021				0,210
					0,022	0,022			0,220	0,220
						0,024				0,240
0,003			0,025	0,025	0,025	0,025	0,250	0,250	0,250	0,250
						0,026				0,260
					0,028	0,028			0,280	0,280
						0,030				0,300
				0,032	0,032	0,032		0,320	0,320	0,320
						0,034				0,340
					0,036	0,036			0,360	0,360
						0,038				0,380
0,004	0,004		0,040	0,040	0,040	0,040	0,400	0,400	0,400	0,400
						0,042				0,420
					0,045	0,045			0,450	0,450
						0,048				0,480
	0,005			0,050	0,050	0,050		0,500	0,500	0,500
						0,052				0,520

TABLE 3 cont'd.

Ряды a											
Ra5	Ra10	Ra20	Ra40	Ra5	Ra10	Ra20	Ra40	Ra5	Ra10	Ra20	Ra40
0,004	0,005			0,040	0,050	0,055	0,055	0,400	0,500	0,550	0,550
							0,060				0,600
0,006	0,006	0,006		0,060	0,060	0,060	0,063	0,600	0,600	0,600	0,630
							0,065				0,650
		0,007				0,070	0,070			0,700	0,700
							0,075				0,750
	0,008	0,008			0,080	0,080	0,080		0,800	0,800	0,800
							0,085				0,850
		0,009				0,090	0,090			0,900	0,900
							0,095				0,950

Ряды a											
Ra5	Ra10	Ra20	Ra40	Ra5	Ra10	Ra20	Ra40	Ra5	Ra10	Ra20	Ra40
1,0	1,0	1,0	1,0	10	10	10	10	100	100	100	100
			1,05				10,5				105
		1,1	1,1			11	11			110	110
			1,15				11,5				120
	1,2	1,2	1,2		12	12	12		125	125	125
			1,3				13				130
		1,4	1,4			14	14			140	140
			1,5				15				150
1,6	1,6	1,6	1,6	16	16	16	16	160	160	160	160
			1,7				17				170
		1,8	1,8			18	18			180	180
			1,9				19				190
	2,0	2,0	2,0		20	20	20		200	200	200
			2,1				21				210
		2,2	2,2			22	22			220	220
			2,4				24				240
2,5	2,5	2,5	2,5	25	25	25	25	250	250	250	250
			2,6				26				260

TABLE 3 cont'd.

8 Ряди											
Ra5	Ra10	Ra20	Ra10	Ra5	Ra10	Ra20	Ra10	Ra5	Ra10	Ra20	Ra10
2,5	2,5	2,8	2,8	25	25	28	28	250	250	280	280
			3,0				30				300
	3,0	3,0	3,2		32	32	32		320	320	320
			3,4				34				340
		3,5	3,6			36	36			360	360
			3,8				38				380
4,0	4,0	4,0	4,0	40	40	40	40	400	400	400	400
			4,2				42				420
		4,5	4,5			45	45			450	450
			4,8				48				480
	5,0	5,0	5,0		50	50	50		500	500	500
			5,2				52				530
		5,5	5,5			55	55			560	560
			6,0				60				600
6,0	6,0	6,0	6,3	60	60	60	63	630	630	630	630
			6,5				65				670
		7,0	7,0			70	70			710	710
			7,5				75				750
	8,0	8,0	8,0		80	80	80		800	800	800
			8,5				85				850
		9,0	9,0			90	90			900	900
			9,5				95				950

9 Ряди							
Ra5	Ra10	Ra20	Ra10	Ra5	Ra10	Ra20	Ra40
1000	1000	1000	1000	1000	1250	1400	1400
			1060				1500
		1120	1120	1600	1600	1800	1600
			1180				1700
	1250	1250	1250			1800	1900
			1320				1900

TABLE 3 cont'd.

a Ряды

Ra5	Ra10	Ra20	Ra40
1600	2000	2000	2000
			2120
		2240	2240
			2360
2500	2500	2500	2500
			2650
		2800	2800
			3000
	3150	3150	3150
			3350
		3550	3550
			3750
4000	4000	4000	4000
			4250
		4500	4500
			4750
	5000	5000	5000
			5300
		5600	5600
			6000
6300	6300	6300	6300
			6700
		7100	7100
			7500
	8000	8000	8000
			8500
		9000	9000
			9500
10000	10000	10000	10000
			10600
		11200	11200
			11800
	12500	12500	12500
			13200
		14000	14000
			15000
16000	16000	16000	16000
			17000
		18000	18000
			19000
	20000	20000	20000

Примечание. В отдельных технически обоснованных случаях допускаются следующие промежуточные размеры

в интервале	1.2—2.6	мм	кратные 0.05;
»	2.6—5	»	кратные 0.1;
»	5—12	»	с цифрами 2 и 8 после запятой
»	12—26	»	кратные 0.5.
»	26—50	»	выраженные целыми числами;
»	50—120	»	оканчивающиеся на 2 и 8, а также размер 115;
»	120—260	»	кратные 5;
»	260—500	»	кратные 10, затем кратные 5;
»	500—1200	»	оканчивающиеся на 20 и 80, затем кратные 10;
»	1200—2600	»	кратные 50, затем оканчивающиеся на 20 и 80;
»	2600—5000	»	кратные 100, затем кратные 50;
»	5000—12 000	»	оканчивающиеся на 200 и 800, затем кратные 100.
»	12 000—20 000	»	кратные 500, затем оканчивающиеся на 200 и 800.

a) Series; b) Note: the following intermediate dimensions are permitted in cases warranted by technical [engineering] considerations; c) in the interval; d) mm; e) multiples of 0.05; f) multiples of 0.1; g) with numbers 2 and 8 after the decimal point; h) multiples of 0.5; i) expressed by integral numbers; j) ending in 2 and 8 and also the dimension 115; k) multiples of 5; l) multiples of 10 and then multiples of 5; m) ending in 20 and 80 and then multiples of 10; n) multiples of 50 and then ending in 20 and 80; o) multiples of 100, then multiples of 50; p) ending in 200 and 800 and then multiples of 100; multiples of 500 and then ending in 200 and 800.

ence numbers series (GOST 8032-56).

The system of normal linear dimensions presented in Table 3 according to GOST 6636-60 does not extend to derived dimensions depending on starting dimensions and parameters, including production-process interoperational dimensions and also dimensions established by individual standards for specific products.

In choosing the dimensions preference is given to numbers from series with largest gradations. It is permitted to set up series, which in their different ranges do not have a uniform common ratio, from the basic series.

In addition to basic series given in the table it is permitted to use derived series, which are obtained from the basic series by choosing each second, third, etc., term of the same basic series.

4. THE PREFERENCE NUMBERS SYSTEM

The system of preference numbers in force in the Soviet Union is based on the recommendation of the International Standardization Organization (ISO) about preference numbers and series of preference numbers. It is formalized as the GOST 8032-56.

Series of preference numbers established by the above standard (see Table 4), represent decimal geometric progression series with the common ratios:

for series R5 $-\sqrt[5]{10}=1{,}5849\approx1{,}6$;

for series R10 $-\sqrt[10]{10}=1{,}2589\approx1{,}25$;

for series R20 $-\sqrt[20]{10}=1{,}1220\approx1{,}12$;

for series R40 $-\sqrt[40]{10}=1{,}0593\approx1{,}06$.

In individual cases, based on technical [engineering] considerations, the standard permits the use of the supplementary numbers series R80 with the common ratio $\sqrt[80]{10}=1{,}02938\approx1{,}03$. The standard also permits, in accordance with ISO recommendations that in cases when engineering

considerations make it impossible to use preference numbers from basic series, to use derived numbers series, obtained from the basic series and also rounded off numbers.

Terms of preference numbers series are rounded off numbers; here the relative difference between the calculated and rounded off numbers is found between the limits from plus 1.26 to minus 1.01%. The relative difference between adjacent numbers remains constant for the entire series. For series R5 it is 58%, for R10 25%, for R20 12%, for R40 6% and for R80, 3%.

The number of terms in each decimal interval of numbers (1-10, 10-100, 100-1000, etc., and also 1-0.1, 0.1-0.01, 0.01-0.001, etc.) of any series remains constant for the entire series. The amount of numbers in the decimal interval of series R5 is 5, of R10 10, of R20 20, of R40 40 and of R80 80; here each subsequent series includes the numbers of the preceding series: series R10 includes all the numbers of series R5, series R20 contains all the numbers of series R5 and R10, etc. Series of preferential numbers are unlimited in both directions. Numbers above 10 are obtained by multiplication of values in the 1-10 interval by 10, 100, 1000, etc., and numbers below 1 are obtained by multiplication by 0.1, 0.01, 0.001, etc.

The basic series of preference numbers are given in Table 4. An additional series of preference numbers obtained from R80 is given in Table 5.

The basic and supplementary series of preference numbers are designated as follows:

a) designations of series not bounded by limits: R5, R10, R20, R40, R80.

b) designations of series with bounded limits and numbers: R5 (...40..) is the basic R5 series, without upper or lower limits, but with mandatory inclusion of term 40,

TABLE 4

Basic Series of Preference Numbers.

Основные ряды a				Номер предпочтительного числа N	Мантиссы логарифмов	Расчетные величины чисел	Разность между числами основного ряда и расчетными величинами в %
R5	R10	R20	R40	b	c	d	e
1,00	1,00	1,00	1,00	0	000	1,0000	0
			1,06	1	025	1,0593	+0,07
		1,12	1,12	2	050	1,1220	—0,18
			1,18	3	075	1,1885	—0,71
	1,25	1,25	1,25	4	100	1,2589	—0,71
			1,32	5	125	1,3335	—1,01
		1,40	1,40	6	150	1,4125	—0,88
			1,50	7	175	1,4962	+0,25
1,60	1,60	1,60	1,60	8	200	1,5849	+0,95
			1,70	9	225	1,6788	+1,26
		1,80	1,80	10	250	1,7783	+1,22
			1,90	11	275	1,8836	+0,87
	2,00	2,00	2,00	12	300	1,9953	+0,24
			2,12	13	325	2,1135	+0,31
		2,24	2,24	14	350	2,2387	+0,05
			2,36	15	375	2,3714	—0,48
2,50	2,50	2,50	2,50	16	400	2,5119	—0,47
			2,65	17	425	2,6607	—0,49
		2,80	2,80	18	450	2,8184	—0,65
			3,00	19	475	2,9854	+0,49
	3,15	3,15	3,15	20	500	3,1623	—0,39
			3,35	21	525	3,3497	+0,01
		3,55	3,55	22	550	3,5481	+0,05
			3,75	23	575	3,7584	—0,22
4,00	4,00	4,00	4,00	24	600	3,9811	+0,47
			4,25	25	625	4,2170	+0,78
		4,50	4,50	26	650	4,4668	+0,74
			4,75	27	675	4,7315	+0,39
	5,00	5,00	5,00	28	700	5,0119	+0,24
			5,30	29	725	5,3088	—0,17
		5,60	5,60	30	750	5,6234	—0,42
			6,00	31	775	5,9566	+0,73
6,30	6,30	6,30	6,30	32	800	6,3026	—0,15
			6,70	33	825	6,6834	-0,25
		7,10	7,10	34	850	7,0795	+0,29
			7,50	35	875	7,4989	+0,01
	8,00	8,00	8,00	36	900	7,9433	+0,71
			8,50	37	925	8,4140	+1,02
		9,00	9,00	38	950	8,9125	+0,98
			9,50	39	975	9,4406	+0,63
10,00	10,00	10,00	10,00	40	000	10,000	0

Calculated values of numbers given in the table are values calculated with the accuracy of up to the 5th significant figure; here the errors in comparison with theoretical values comprise less than 0.00005.

a) Basic series; b) number of the preferential number, N; c) mantissas of logarithms; d) calculated values of numbers; e) difference between numbers of the basic series and calculated values in %.

R10 (1.25...) is the basic R10 series, limited by the term 1.25 as the lower limit,

R20 (...45) is the basic R20 series with the term 45 as the upper limit,

R40 (75...300) is the basic R40 series with 75 as the lower limit and 300 as the upper limit.

TABLE 5

Supplementary series of preference numbers. Supplementary Series R80

1.00	1.80	3.15	5.60	1.22	2.18	3.87	6.90	1.50	2.65	4.75	8.50
1.03	1.85	3.25	5.80	1.25	2.24	4.00	7.10	1.55	2.72	4.87	8.75
1.06	1.90	3.35	6.00	1.28	2.30	4.12	7.30	1.60	2.80	5.00	9.00
1.09	1.95	3.45	6.15	1.32	2.36	4.25	7.50	1.65	2.90	5.15	9.25
1.12	2.00	3.55	6.30	1.36	2.43	4.37	7.75	1.70	3.00	5.30	9.50
1.15	2.06	3.65	6.50	1.40	2.50	4.50	8.00	1.75	3.07	5.45	9.75
1.18	2.12	3.75	6.70	1.45	2.58	4.62	8.25				

In addition to basic series of preference numbers given in Tables 4 and 5, it is permitted to use derived series which are obtained from the basic or supplementary series by choosing each 2nd, 3rd, 4th or nth term of a basic or supplementary series. Series of derived numbers are used in those cases when gradations are established for parameters, dimensions and other numerical characteristics depending on parameters and dimensions constructed on the basis of basic series.

The designations of derived series should include: the designation of the basic or supplementary series (R5, R10, R20, R40, R80), from which the derived series has been constructed; a slash, a number showing that the derived series has been constructed from the basic series by choosing each 2nd, 3rd, 4th, ..., nth term, and also the limits of the derived series (in parentheses).

Below we present examples of designation of derived series.

R5/2 (1...1,000,000) is a derived series obtained by choosing each 2nd term of the basic series R5 and limited by terms 1 and 1,000,000;

R20/4 (112...) is a derived series obtained by choosing each 4th

term of the basic series R20 with 112 as the lower limit;

R40/5 (...60) is a derived series obtained by choosing each 5th term of the basic series R40 with 60 as the lower limit;

10/3 (...80...) is a derived series obtained by choosing each 3rd term of the basic series R10, including the number 80 and unlimited in both directions.

Examples illustrating the determination of the composition of derived series: a) derived series R10/3(1...) should consist of each 3rd term of the basic series R10 with unity as the lower limit; thus this series will consist of the following terms: 1, 2, 4, 8, 16, 31.5...

b) derived series R80/8(25.8...165) should consist of each 8th term of the supplementary series R80 with 25.8 as the lower limit and 165 as the upper limit; thus, this series should consist of the following terms: 25.8, 32.5, 41.2, 51.5...165. The common ratio of these series is the same as that of R10, but the series starts with a term belonging to series R80.

If establishment of gradations of parameters and dimensions of goods requires to have a nonuniform relative difference between numbers in various ranges, then it is necessary to choose the most suitable basic series for each interval in such a manner that the successions of numerical values should form a combination of series with different common ratios, making possible additional interpolations. In individual cases, warranted by engineering considerations, it is permissible to round off the preference numbers; here use should be made of the rounded off numbers presented in Table 6.

When using rounded off numbers given in Table 6, use should be made of those which make it possible to keep the common ratio of the series most uniform over the entire series. Rounded off numbers should not be used in those series in which additional intermediate values will be included at a later time.

The preference numbers series established by the standard are sim-

TABLE 6

Rounded off Preference Numbers

Предпочтительные a	Округленные b	Предпочтительные a	Округленные b	Предпочтительные a	Округленные b
1,05	1,05	2,24	2,2; 2,25	4,25	4,2
1,12	1,1	2,36	2,35; 2,4	4,75	4,8
1,18	1,15; 1,2	2,65	2,6	5,6	5,5
1,25	1,2	3,15	3,0; 3,2	6,3	6,0
1,32	1,3	3,35	3,4	6,7	6,5
1,6	1,5	3,55	3,5; 3,6	7,1	7,0
2,12	2,1	3,75	3,8		

a) Preference [numbers]; b) rounded off [numbers].

ple and easy to remember, they are unlimited in both directions, included all multiples of ten of any term and also unity, ensure the establishment of rational gradations of parameters, dimensions and individual numerical characteristics of goods. A product or fraction of any two terms of a series is also a term of the series. Integral positive or negative powers of any term of a series are always terms of this series.

If we assume that $\sqrt[10]{10}\approx\sqrt[3]{2}$ (when calculating with accuracy up to 0.001), then the cube of any term of this series will be approximately two-fold greater than the cube of the preceding term; the square of a term of this series will be approximately by a factor of 1.6 greater than the square of the preceding term. Terms of the R20 series are doubled every 6 terms and of the R40 series are doubled every 12 terms. Starting with R10 the numbers in the series include 3.15 which is approximately equal to π. It follows from this that the length of the circumference and area of a circle whose diameters are preference numbers will also be expressed by preference numbers. This is applicable, in particular, to peripheral speeds, cutting speeds, surfaces and volumes of cylinders and spheres.

The preference numbers series R40 includes the numbers 3000-1500-750-375, which are of special significance in electrical engineering

since they express the rpms of asynchronous electric motors operating at no load on 50 cycles AC current.

Chapter 7

THE FOUR-ORDER STANDARDS SYSTEM IN MACHINE BUILDING

The President of the Academy of Sciences of the USSR, Academician M.V. Keldysh in his report to the All-Union Conference of Scientific Workers (12 June 1961) about the rearrangement of the work of scientific institutions has stated that "two main trends exist in machine building. The first is the creation of integrated groups of machines, ensuring flow production and feasibility of automatic control of the processes. Extensive mechanization of labor processes is involved in this trend. The second trend is the creation of assemblies operating under especially intensive conditions."

Standardization is directly related to the practical solution of these major problems of machine building. The successful solution of these problems depends to a large extent on the degree to which the existing system of standards in the USSR corresponds to the feasibility of creation of integrated groups of machines needed by the national economy, taking into account long range development and also the feasibility of establishing progressive quality requirements for machines and assemblies.

1. THE EXISTING SYSTEM OF STANDARDS AND WAYS FOR IMPROVING IT

State machine building standards are subdivided, starting with 1958, into six forms.

1. Standards of parameters and dimensions. Standards of this kind establish series of the most rational types, kinds and brands (assortment) of machine-building products, of dimensions of products and their

elements produced in the Soviet Union, with the purpose of the most complete satisfaction of needs of the various branches of the national economy in conjunction with achievement of maximal unification. These standards provide for basic parameters of products, characterizing its major properties of interest to the consumers, including: productivity, capacity, weight-lifting capacity, efficiency and other operational indicators, and also basic joining, overall and other dimensions of products and their elements.

These standards establish, alongside with types and kinds of products the mass or series production of which has been assimilated, also new, more progressive types and kinds of products the assimilation of whose production will promote the further development of technology and increasing the industrial level. Names and conventional designations are provided for each type, kind of brand of products provided for in the standard.

2. Standards of technical requirements. These standards establish indicators which characterize the products from the point of view of quality, including operational reliability and external appearance. The standards determine, depending on the kind and intended service of the products, the physiomechanical properties (strength, hardness, heat capacity, thermal stability, water and gas permeability, wear resistance, elasticity, precision, etc.); requirement to the surface finish, to the used materials and semifinished goods; requirements for comparison of the standardized goods with a standard specimen; the procedure for approval of standard specimens, the location where they are stored and the procedure for supplying them to interested organizations; special requirements to the quality of products destined for prolonged storage, etc.

3. Standards of testing methods and [quality] control facilities.

These standards provide for unified methods for testing of products based on the achievement of present time science and technology, utilization of new instruments and apparatus ensuring quality control at minimal cost. The field of application of standard testing methods is given depending on the kind and intended service of products. These testing methods are established arbitrarily and are used for obtaining comparable results which are regarded as final.

4. Standards for branding, packing, transportation and storage. Standards of this kind specify: rules for branding of goods and marking of crates, and also designations used for marking by consumers, packing materials, packing methods, kinds and dimensions of containers, requirements put to packing of goods; they also give the contents of technical documentation testifying to the quality of products which should accompany the goods when they are shipped or allotted to the consumer.

5. Standards of complete technical characteristics. These standards contain all that which is peculiar to the above four kinds of standards.

6. General technical standards. They establish general rules and norms, scientific and technological terms, units of measurement, general designations and classifications, systems of tolerances and fits, rules for execution of drawings and other technical documentations, structural elements of machine components, calculation and design norms, etc.

Each of these kinds of standards includes several different characteristics the inclusion of which, in a single standard, is not always possible or expedient. For example, in by far not all cases can dimensional and other requirements put to specific products be concentrated in one general standard. In the majority of cases, the opposite is true; all these requirements and norms are given in several independent stand-

ards, which are elaborated and issued at different times. The expediency of the use of numerous standards of partial characteristics has been proven by long years of practice. Even the so-called complete standards are not complete in the majority of cases, since they either do not at all contain reliability and service life indicators, or give guarantee periods which are commercial indicators and do not reflect the operational virtues of the machines and equipment and of their elements. In addition, the content of standards of the same type is not always unified. All this taken together imparts a peculiar diversity, which is characterized by Table 7.

The differentiation between standards of partial characteristics shown by this table is conventional in character, since actually, standards are used which combine two or more of the given partial characteristics. For example, standards are frequently elaborated which combine SK and SO or ST and SR, of SOP and STT, of ST, SR and STT, etc. The system of partial characteristics standards can, by analogy, be also extended to all kinds of normal standards. In this case their designations, instead of the letter S, will have letters MN, ON or N, depending on the kind of the normal standard.

The following are most characteristic in the above group of standards in force in the machine-building industry:

1) the existing system of standards has an entirely universal character and has been evolved gradually relative to the entire industrial output, including also the output of machine building;

2) this system is based on standards extending to individual groups of similar types of goods, for example: lathes, mining loading machines, self-propelled general-purpose boom cranes, universal single-shovel excavators, etc.; however, standards for individual types of machines, which are called brand standards, are also used;

3) standards for the majority of partial characteristics extend to entire machines, as well as to their subassemblies and components;

4) the existing system does not provide for standards which would unify different kinds of machines and equipment into integrated functional groups.

It is necessary to achieve such an improvement of the standardization system that will stimulate the elaboration of integrated groups of machines and equipment, which would ensure flow production as well as the feasibility of achieving automatic control of production processes.

TABLE 7

Standards of Partial Characteristics.

Standards		Objects of Standardization;
Conventional designation	Name of Standard	
SE	Standard of units of measurement	Systems and units of measurement;
SO	Standard of designations, terminology and definitions;	Uniform designations, terms and their definitions, abbreviations in the field of scientific concepts and technology;
SK	Standards of classifications and nomenclatures of goods	Uniform systematized list of objects making up the nomenclature; Classifications of machine-building products;
SR	Standard of dimensions;	Basic, overall and fabricated dimensions of one or several objects;
SS	Standard of grades and assortment	Characteristics of goods, grouped by common features or sorts
SN	Standard of norms	Tolerances and fits; precision and rigidity norms and also other norms characterizing primarily physical or geometric properties of objects

STT	Standard of technical [engineering] requirements	Physiomechanical properties, chemical composition, operational reliability, life and other qualitative characteristics of products, and also requirements established for semifinished goods and blanks
SOP	Standard of basic parameters, productivity, capacity and parameter scales	Major quantities characterizing the objects from the point of view of one or many technological and production properties, specified or established by various methods
ST	Standard of types, designs or typical arrangements	Ensemble of technological and production properties of objects, which basically determine their designs and their basic indicators
SMI	Standard of testing methods, sampling and analysis	List and characteristic of activities directed toward quality control for the given goods, in particular, checking for conformance with the established technical requirements
SMR	Standard of computational rules and methods	Methods, rules and procedures related to design and calculations of machine-building objects, and also instructions and typical calculations;
SKE	Standard of structural elements and production process requirements	Structural elements of machine and equipment components, including those related to the production processes
SM	Branding Standard	Methods, means and locations for branding of goods, and also requirements put to their descriptiveness and longevity of preservation

SU	Standard of packing, transportation and storing	Means and methods of reliable packing, transportation and storing of goods, directed toward maximal preservation of its properties
SP	Standard of complete characteristic	Complete, all-inclusive characteristic of the objects, showing indicators and characteristics presented in this table.

What should be the standards for integrated groups of machines? What are the basic principles for their development? How should parameters and characteristics of jointly operating but different machines be included in a single standard? Is it necessary or mandatory to include a complex integrated group of machines in a single standard and doesn't another possibility for solving this problem exist?

These are the basic problems, related to the improvement of the present system of machine-building standards. But other problems may arise together with these, including, for example, the elaboration of standards for machines of different functional intent, but which are assembled from common, unified assemblies, and also of standards for machines of common functional intent, but functionally different, this difference including also the operational principles.

2. FIRST INTEGRATED STANDARDIZATION WORK

The problem under consideration, in its theoretical and practical aspects, has arisen long ago, which was illuminated in the author's work [1].

It was found that design organizations and Scientific Research Institutes of the shipbuilding industry were the most prepared for performing first integrated standardization work. The interest expressed by leaders of the shipbuilding industry in standardization as in a base for specialization and extensive coordination of production was also

significant. As early as in the war years, in elaborating the basic trends for development of postwar standardization in the shipbuilding industry, the author of this book has suggested and substantiated the expediency of elaboration of such standards which would in an integrated manner determine not only the type range of freight vessels needed by our country in the restoration period, but also would promote the adoption of more progressive production processes, including flow production methods. After the war ended this suggestion was implemented in the form of two measures.

The first measure was based on the elaboration of an integrated series of standards for river and lake freight vessels and of a series of standards for fishing industry vessels. The second measure was formalized in a work called "Integrated Typification of Technical Internal Water Transportation Facilities." Both these works were of great significance to the national economy and as a result of their adoption had a tremendous economic effect. Of significance also is their methodical significance. They not only have graphically illustrated the expedient trend for further development of Soviet standardization in the machine-building and related fields, but have also pointed to ways for practical solution of that problem which has now been placed before all machine-building workers in the field of creating of integrated groups of machines and equipment.

The idea of creating integrated machine series is based on the "from general to particular" standardization principle. It is based on practical considerations for finding the shortest ways for achieving standardization on the most complete scale.

When performing standardization on the basis of the "from the particular to the general" principle, it would have been necessary to elaborate a tremendous number of standards and normal standards for

various main and auxiliary mechanisms, apparatus, instruments, equipment and other products, including supply items used in all shipbuilding branches.

The internal water transportation [system] was taken as the first priority object of standardization for the reason that the river fleet suffered extensive damage during the war, and the river shipbuilding technology lagged behind seriously in the prewar years.

Vessel types and their mechanisms depend primarily on the fuel used. Their main mechanisms can, without detriment to service, be unified for vessels of various service designations and sizes. This determines the minimal requirement in types of mechanisms for a fleet of a sufficiently extensive composition and at the same time substantially enlarges the run length in manufacture of mechanisms. When the type range of main mechanisms is sharply curtailed it is not difficult to determine the nomenclature, types, parameters and characteristics of hold and deck mechanisms, fittings, devices, etc.

The nomenclature of parameters contained in the standard for tugboat types contains: rating, pulling capacity at 8 kilometers/hour, kind of main mechanisms, kind of motors, number of screws, kind of fuel, fuel capacity and the depth of draw. The type of each tugboat is characterized by these indicators.

For standardization purposes tugboats are subdivided into three characteristic groups. The first group includes ribber [paddle]-wheel steam tugboats standardized on the basis of existing prototypes. The second group includes screw-driven steam tugboats, prototypes of which do not exist, in conjunction with which the standardized parameters were based on entirely new design proposals, not yet implemented at the time when the standard was elaborated. The last group includes all the remaining standard tugboats, for which neither prototypes with analo-

gous characteristics nor finalized designs existed. For this reason their basic parameters were established on the basis of applicable calculations especially performed by the authors of the standard. A detailed description of this entire work, which is of considerable methodological interest to all machine-building branches, is presented in Reference [9].

Standard types of dry cargo and liquid cargo nonself-propelling steel barges are characterized by the cargo capacity and the limiting depth of draw.

The three standards for river and lake tugboats and river dry and liquid cargo nonself-propelling steel barges represent a single integrated group, a single integrated series of cargo vessels for internal waterways, whose parameters and technical characteristics are interrelated, which is illuminated in detail in Reference [9]. Integrated standardization of cargo vessels for internal waterways was achieved on the basis of the major parameter, i.e., the rating of the vessel's motors.

It was assumed in approving these standards that they will retain their timeliness for approximately 4 years and that they will play an important role in the postwar period of restoration of river shipbuilding. However, these standards were in force for about 10 years, although the fact that their revision is necessary was beyond doubt for 6-7 years.

These interrelated standards were a convincing proof of the feasibility and expediency of integrated standardization of objects of production, including also objects of great structural complexity. This is their indisputable fundamental significance. But their methodological value is not determined by this fact only. They have provided an answer to the problem of expedient completeness of standards content.

It was previously assumed that each object should be described in the standard in great detail, without which it would be impossible to ensure strict uniformity of products manufactured at different plants. To counter this point of view, another principle was put forward, according to which it is not the number of standardized parameters which determined uniformity of objects of production manufactured at different plants, but the system for adoption of standards and of performance of planning and design work. It was established that only one design proposal, approved by central authority, can at the given instant be in force with respect to each type of a standard object of production. And this draft should be periodically, at specified intervals, be modernized or replaced by a new one.

Only this system can ensure actual uniformity of machines, diesel locomotives, vessels and other objects and their conformance with the present-time level of science and technology.

This condition has made it possible to sharply limit the number of parameters included in state standards to those absolutely necessary. A bibliography on this problem is presented in Reference [1].

Even at the present time each important principle of construction of parametric series and their implementation is, regretfully, known to only a limited circle of the machine-building industry's workers. But in 1948, it was entirely little known, which resulted in the fact that the former Gostekhnika USSR has rejected drafts of standards for an integrated series of seagoing cargo vessels, despite the high degree of their efficiency, on the basis of the assumption that the basic parameters included in these standard draft proposals do not describe in sufficient detail the type of each seagoing vessel, in particular, with respect to their auxiliary mechanisms. Subsequently, the new standardization ideas have been gradually recognized, which was reflec-

ed in numerous machine building parametric standards.

The economic effectiveness of integrated standardization can be demonstrated through an example of river cargo vessels.

1. The building cost of tugboats is lowered by approximately 30-35% and of barges by 35-40%.

2. The fleet's operational expenses for tugboats and nonself-propelling barges are decreased by 20-25%, and continuous replacement of steam-driven tugboats by diesel units will give an additional saving of 10-20%.

3. The net cost of hauling for standard diesel tugboats of 1200 horsepower capacity is lower by 2.5-11%, which is due to improved pulling qualities of standard tugboats, and in comparison with steam tugboats of the same rating it is lower by 21-24%. The net cost of hauling for 600 horsepower tugboats is lowered by 38%.

As a result of extensive adoption of standardization the river shipbuilding industry was converted from a lagging prewar industry into a leading branch of Soviet shipbuilding.

The "from the general to the particular" standardization principle, popularized by shipbuilding and river transportation workers, has called to life a methodologically interesting and useful work, called "Integrated Typification of Technical Facilities of Internal Water Transportation" [18], performed by the Section for Scientific Elaboration of Transportation Problems of the Academy of Sciences of the USSR and the Technical Council of the Ministry of River Fleet under the direct guidance of Corresponding Member of the Academy of Sciences of the USSR, V.V. Zvonkov. Basic information on this work, which is of interest to machine building, is presented in the first edition of this book [1].

Integrated typification of technical facilities of internal water

transportation has interrelated all its elements by subjecting the typified components to the same idea of harmonious development of internal water transportation. As a result, standardization has directly effected the appearance of a tremendous branch of the national economy.

Work was begun for creating an integrated group of machines and equipment needed for complete mechanization of extensive automation of work for construction of main pipelines. Not less complex work is in process for creating an integrated group of machines and equipment which serves for automating mining and transportation of coal in mines. Research and design work is performed for creating equipment which would replace manual labor in the manufacture of electric motors and generators. And all this creative work for elaboration of integrated groups of new machines and equipment is based on the choice of a single main parameter and on the establishment of numerical series characterizing the values of the main parameter.

3. THE SYSTEM OF MAIN PARAMETERS

It could have been assumed at the initial stage of creating the basis for parametric standardization that the nomenclature of main parameters of machines and equipment is very extensive and of varied character, but investigations in the field have disproved this assumption. Existing parametric standards and also technical characteristics of 27 kinds of metal-cutting machine-tools, 20 kinds of forging press equipment, 9 kinds of tractors and 30 kinds of construction and road-building machines, a total of 86 machines and equipment units of different design and functional designation were analyzed. The work was performed in the VNIIK [All-Union Scientific Research Institute] [of Standards]]. This work resulted in the preparation of methodical materials of practical interest for developing work in the field of elaboration of dimensional series and parametric standards for machines and

equipment.

It was shown by systematization of the above 86 kinds of various machines and equipment that their main parameters can be reduced to the following system.

One of the following should be chosen as the main parameter for metal-cutting machine-tools: a) the dimensions of blanks they handle; b) the displacement of working elements per one operating cycle; c) dimensions of the table's operating surface and d) the force developed by working elements. Important, but not main, parameters are: a) dimensions determining the interchangeability of production equipment; b) the rpm or number of back and fourth motions per minute; c) the design weight of the machine-tool.

The main parameters for forging press equipment can be: a) the force developed by working elements; b) the weight of falling parts; c) the effective kinetic energy. As important, but not main, parameters, we can cite: a) dimensions determining interchangeability of production equipment; b) the rpm or number of back and fourth motions per minute; c) the speed of working elements and d) the design weight of the machine.

The main parameter characteristic of wheel and track tractors of all types and service purposes is the force developed by the working elements; the important parameters include: a) dimensions determining the use of tractors under specific production conditions: gauge, vertical clearance, width reckoned from external edges of tracks, etc.; b) rating; c) speed; d) design weight of the tractor and e) the specific weight.

The main parameters for various construction and road-building machines include: a) rating; b) the force developed by working elements; c) weight of falling parts. The important parameters are dimensions de-

termining interchangeability with replacement equipment, or dimensions determining the utilization of machines under specific production conditions: gauge, vertical clearance, width reckoned from external edges of tracks, etc.

The basic feature of main parameters is their relative stability with respect to time. Standards for main parameters, if properly elaborated, should be capable of remaining current for a long period of time. The auxiliary parameters included in the standard usually are: specific consumption of electricity, fuel and lubricants; stopping length, fuel tank capacity or other fuel capacity indicators; the force required for switching levers and pedals, engine torques; requirements put to materials and physiomechanical properties of the structural elements of machines and equipment; requirements to external appearance and finish; individual operational requirements, pertaining to the climate or other initial conditions, etc.

All these parameters and characteristics depending on the designs of machines and equipment, on the methods by which they are manufactured and also on individual special requirements, should be revised systematically and considerably more often than the main parameters. Revision of auxiliary parameters is primarily related to modernization of the machines and equipment being produced, while revision of main parameters almost always denotes extension of the type range, and also adoption of new, more refined machines, equipment and other products.

It can be seen from the above that, despite the characteristic variety of the aforementioned machines and equipment, their main parameters can be united in a system presented in Table 8.

As it proceeds in embracing machines of other operational designation, the nomenclature of main parameters presented in this table can be supplemented by the given specific parameter.

TABLE 8

Main Standardized Parameters

Groups of Parameters	Characteristics of parameters
Dimensional parameters	Dimensions of blanks handled; displacement of working elements per one operating cycle; dimensions of the operating surface of table; dimensions of working elements determining the main characteristics of machines and equipment Dimensions determining interchangeability: of production equipment; of mounted or attached systems and working equipment replacements Dimensions determining the utilization of machines under specific production conditions: gauge, vertical clearance, width reckoned from external edges of tracks, etc.; dimensions determining the capacity;
Rating of the main engine or the total rating of main engines	Rating in HP, kwt or watts;
Power parameters	Force developed by working elements, weight of falling parts, effective kinetic energy
Parameters characterizing productivity	rpm or number of back and fourth motions per minute, rate of displacement of working elements, speed of the entire machine, output per hour
Weight parameters	Design weight of the machine, specific weight.

TABLE 9

Characteristics of Four-order Standards

Order of Standard	Content of Standards
First	1. Series of main parameters, characterizing integrated groups of machines and equip-

	ment of the same functional purpose, needed by the national economy, taking into account prospects for its development 2. Series of main parameters of integrated groups of transportation facilities needed by the national economy, taking into account prospects for its development; 3. Series of main parameters characterizing basic types of machines, equipment and transportation facilities operating in unison; 4. General technical requirements to the elaboration of integrated groups of machines and equipment, including guarantee periods; 5. General technical requirements to the elaboration of integrated groups of transportation facilities, including guarantee periods
Second	1. Design-unified series of machine and equipment types, including expedient modifications (varieties) needed by the national economy, taking into account prospects for its development 2. Design-unified series of transportation facilities types, including expedient modifications (versions) needed by the national economy, taking into account prospects for its development 3. Design-unified series of machines and equipment of different functional intent, including expedient modifications (versions), assembled from unified assemblies 4. Technical requirements to the manufacture of machines, equipment and transportation facilities based on design-unified series 5. Typical and accelerated testing methods for machines, equipment and transportation facilities 6. Terminology, systems of designation and branding of machines, equipment and tran-

	portation facilities 7. Norms of precision, rigidity, etc. 8. Requirements to packing, transportation and storage
Third	1. Series of types and main parameters of common machine, equipment and transportation facilities assemblies 2. Technical requirements to the creation of common assemblies 3. Technical requirements to the manufacture of common assemblies 4. Typical and accelerated methods for testing of common assemblies 5. Designation and branding systems for common assemblies 6. Subassemblies of production equipment 7. Technical requirement to production equipment subassemblies 8. Terminology, designation and branding systems 9. Requirements to packing, storage, transportation, etc.
Fourth	1. Series of types and dimensions of common machine subassemblies and components 2. Technical requirements to the manufacture of common machine subassemblies and components 3. Typical and accelerated methods for testing of common machine subassemblies and components 4. Series of cutting, auxiliary and measuring tools 5. Components of fixtures, diesets and other production equipment 6. Technical requirements to the manufacture of tools and components of production equipment 7. Designation and branding systems

	8. Terminology 9. Requirements to packing, storage and transportation 10. Tolerances and fits 11. Threads 12. Structural elements and production process requirements, etc.

As it proceeds in embracing machines of other operational designation, the nomenclature of main parameters presented in this table can be supplemented by the given specific parameter.

The main parameters can serve as a basis for an interrelated system of machine-building standards.

4. THE FOUR ORDERS OF STANDARDS

Taking into account the problems facing machine-building workers and the role played by standardization in solving these problems, we can recommend, for the next several years, the following system of machine-building standards (Table 9).

Table 9 enumerates only the more characteristic kinds of standards for each of the four orders.

For example, among first order standards we can also include:

a) general classification and designation system for machine-building products, which should serve as a basis for the development of branch classifications and designation systems;

b) general rules and norms, ensuring uniformity in controlling various machines and equipment, needed for integrated automation, etc.

The correctness of the succession of standards order given in Table 9 is confirmed by the fact that under present conditions, in light of problems raised by the new Program of the CPSU and the Plenary Sessions of the Central Committee of the CPSU, a major standardization problem is the elaboration of machine and equipment series which would

ensure integrated mechanization and automation of production. From this stanard for integrated groups of machines, equipment and transportation facilities needed by the national economy, for progress of the country's production forces are actually first order standards.

It follows from Table 9 that parametric standards for machines and equipment can be both of the first and the second order. What are the features of first order standards and what is their substantial difference from the existing commonly known parametric standards? Primarily, they are distinguished by the inclusion of main parameters (and in individual cases also of several auxiliary) only, which characterize basic types of machines and equipment (their basic models). This makes it possible to more rapidly, more efficiently and boldly solve the problems of establishing type ranges of machines and other products taking into account long range needs, on the scale of the entire country. These standards can be elaborated, agreed upon and submitted for approval considerably faster than the many existing, more detailed parametric standards for machines and equipment. On the basis of first order standards, solving the problems of establishing the basic type range of necessary machines and other articles, it is possible to more rapidly implement the elaboration of second order standards, providing for design-unified series of machines and equipment, including their basic models as well as all expedient special purpose modifications.

The work, which is complex in all respects, is thus divided into two stages, and each of them is completed by establishment of specific standards which can serve as a basis for effective development of standardization and normalization of assemblies, subassemblies and components.

The existing system of standardization of types and basic parameters of machines and equipment makes it necessary to solve simultan-

eously several problems, each being complex and time consuming, namely:

1) the choice and substantiation of the main parameter, characterizing machines or equipment of the given functional purpose;

2) determination of the range of optimal values of the main parameter (within the limits of which standardization is expedient); limiting numerical values of parameters are established taking into account current and long range needs for these machines or equipment;

3) substantiation of the choice of the dimensional characteristic of the series on the basis of the preference numbers system, including the choice and substantiation of the basic or derived series most advantageous for the given kind of machines (or equipment);

4) elaboration of the nomenclature of major dimensional and other parameters, subjected to inclusion in the given parametric standard; this part of the work is tied to the isolation, on one hand, of stable parameters, and on the other, of auxiliary parameters, the inclusion of which in the parametric standard is, in individual cases inexpedient, due to their instability;

5) determination of the numerical values of the entire aforementioned nomenclature of parameters, taking into account current scientific and technological achievements;

6) determination of expedient modifications of special-purpose machines and equipment;

7) determination of the characteristics of common assemblies and design features needed by the machines, i.e., of modifications;

8) formulation of supplementary technical characteristics and explanations, necessary to provide for uniform comprehension of the standard content and of all its requirements;

9) compilation of explanatory notes, technical and economic calculations and other documentation, the preparation of which is included

in the usual volume of work for elaboration of standard drafts.

It follows from the above that the volume of work for elaboration of any standard for types and basic parameters of machines and equipment required by the existing procedures is quite considerable. The volume work and especially its complexity in the case when a standard is elaborated for an integrated group of machines and equipment increase out of proportion. This is the reason why, from the practical point of view, it is so important to so split up the process of standards elaboration, as to make it possible to solve the problems by parts, successively. First order standards satisfy this desire and they will be found expedient not only in the elaboration of integrated standards (standards for integrated machine and equipment groups), but also in the elaboration of common parametric standards.

For example, the greatest difficulties in the elaboration of the integrated series of standards for fishing vessels (see above) were encountered in agreeing upon a new nomenclature of types of vessels, characterized primarily by the ratings of their main engines. Agreeing upon drafts of standards in all their complexity has taken up more than three years, since disagreements arose at the same time with respect to other, less substantial problems of these proposals. The discussion ranged over a large number of problems, while the attention of all interested organizations in the elaboration of the standard of main parameters was concentrated only on one basic problem, i.e., on the composition of the fishing fleet of the USSR. The basic table of this main parameter standard (i.e., of this first order standard) would have had the following form (Table 10).

The first order standard at the same time also gives the character of unification of main engines. A series of first order standards, extending, for example, to cargo vessels for internal waterways, seagoing

TABLE 10

First Order Standard for Fishing Vessels

Тип судна 1	2 Мощность двигателей в л. с.							
	20	40	80	160	200	300	400	800 (1000)
Рыболовные траулеры . . . 3	—	—	—	—	×	—	×	×
Рыболовные сейнеры . . . 4	—	—	×	×	—	×	—	—
Рыболовные боты 5	×	×	×	—	—	—	—	—
Приемно-транспортные суда . . . 6	—	—	×	×	—	×	—	—
Морские буксиры рыболовного флота 7	—	×	×	×	—	×	—	—
Речные буксиры рыболовного флота . 8	×	×	×	—	—	—	—	—

1) Type of vessels; 2) engine ratings in HP; 3) fishing trawlers; 4) fishing seiners; 5) fishing boats; 6) receiving and transporting vessels; 7) seagoing fishing fleet tugboats; 8) river fishing fleet tugboats.

and harbor cargo ships and fishing industry vessels, can serve as a basis for the elaboration of a first order standard for marine diesels. It is beyond doubt that the number of needed standard sizes of marine diesels established by such a standard will be many-fold smaller in comparison with the existing standard for diesels (reference is here made to the existing parametric standard for diesels, i.e., to a second order standard).

Common designs of certain excavators and boom cranes and of the

Many works were published on the problem of elaboration of feasible common designs of certain excavators and boom cranes and of the evolved in practice. The existing dimensional series and parametric standards (second order standards) are based on different main parameters and this does not promote the unification of excavator and boom crane assemblies.

Certain of the existing parametric standards are (by their content) close to first order standards. Thus, for example, standards for milling machines are closer to first order standards. The standard for vertical milling machines provides for the size and travel of the table, the overhang of the spindle over the working part of the table and the

TABLE 11

Second Order Standard for Tractor-Driven Plows.

Параметры A	I Основные плуги B														II. Полуприцепные плуги C	III. Прицепные плуги D				
	E	F			G	H		I	J	K					N	O		P	Q	R
	I-1. общецелевые	I-2. корпусные с предплужниками			I-3. полевые с предплужниками	I-4. с предплужниками для каменистых почв		I-5. с почвоуглубителями для обычных и болотистых почв	I-6. общецелевые	I-7. кукурузные		I-8. с почвоуглубителями для обычных и каменистых почв	I-9. с почвоуглубителями для обычных и болотистых почв	I-10. кукурузные с предплужниками	II. полуприцепные	III-1. окучивающий		III-2. окучивающий	III-3. с почвоуглубителями и корпусами для гребней	III-4. с почвоуглубителями для обычных почв
Удельное сопротивление почвы при пахоте в кГ/см² S	Т До 0,9	До 0,9			До 1,3 Т	До 0,9 Т		До 0,9 Т	Т До 0,9	До 0,9		До 0,9	До 1,3 Т		Т До 1,3	Т До 0,9		До 1,3 Т	До 1,3 Т	До 0,9 Т
Ширина захвата корпуса в см U	30	30	35	40	35	30	35	35	30	30	35	35	30	35	35	40	35	35	35	
Число корпусов V	3—5**	1, 2 и 3 W	3 и 4** W	4**	5**	2	3	3 и 4** W	1 и 2 W	1	1	3 и 4** W	3**	5 и 6** W	5**	5**		5**	5**	5 и 6** W
Максимальная расчетная глубина пахоты в см X	До 22 Т	До 25 Т	До 27 Т	До 25 Т	До 27 Т	До 25 Т	До 27 Т	До 35 с вырезными, 40 с безотвальными (с учетом эксплуатационной) и 27+15 с обычными корпусами и почвоуглубителями Y	До 25 Т	До 25 Т	До 27 Т	До 27+15 Т	До 25+15 Т	До 27 Т	До 27 Т	До 35 Т	До 27 Т	До 35 с вырезными корпусами, 27+15 с обычными + с почвоуглубителями Z	До 40 с учетом всхожести a
Перекрытие между корпусами, не менее в мм b	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Расстояние между корпусами по ходу плуга в мм c	700	700	750	800	700	750	800	800	700	—	—	800	800	750	800	800	800	800	800	
Расстояние от опорной плоскости до рамы плуга в мм d	540	540	540	540	540	705	705	540, 585, 625***	540	540	540	540	565	565	585	640	565	565, 625***	565	
Транспортный просвет в мм, не менее e	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	350	
Ширина захвата предплужника в см f	30	30	33	35	33	30	33	33	30	30	33	33	30	33	33	35	33	33	—	
Максимальная глубина хода предплужника в см g	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	—	
Расстояние от носка корпуса до носка предплужника по ходу плуга в мм, не менее h	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	—	
Вес плуга в кг на 1 м захвата, не более i	—	Одноконный 400, двухконный 300 j		300	440	450	505	475	400	—	—	—	—	—	—	725	720	805	960	860

*For determination of guaranteed strength of the structure.
** Three and four bottom plows have only detachable bottom, five and six bottom plows have two detachable bottoms. Plows with welded frames may not have detachable parts.
*** 665 is the height from the bearing surface to the plow frame for slotted bottoms.

A) Parameters; B) I. tractor-mounted plows; C) II. semi-mounted plows; D) III. pull-type plows; E) I-1, light-duty; F) I-2, standard strength; G) I-3, heavy-duty; H) I-4, with protectors on each bottom for stony soils; I) I-5, with subsoil plows or with slotted and earthboardless bottoms; J) I-6, reversible; K) I-7, oscillating; L) I-8, with subsoil plows for shuttle (standard strength) tractors; M) I-9, with subsoil plows for shuttle (heavy-duty) tractors; N) II, heavy duty; O) III-1, standard strength; P) III-2 heavy dury; Q) III-3, with subsoil plows or with slotted bottoms; R) III-4, with earthboardless bottoms; S) specific resistance of soil to plowing, in kg/cm^2*; T) up to; U) bottom coverage width in cm; V) number of bottoms; W) and; X) maximal design plowing depth in cm; Y) up to 35 with slotted, 40 with earthboardless (taking bulges into account) and 27 + 15 with standard bottoms and subsoil plows; Z) up to 35 with slotted bottoms, 27 + 15 with standard [bottoms] plus subsoil plows; a) up to 40 taking bulges into account; b) nominal overlap between bottoms, in mm; c) distance between bottoms in the direction of plow motion in mm; d) distance between bearing surface to the plow frame, in mm; e) transport clearance in mm, not less than; f) colter coverage width in cm; g) maximal depth of colter penetration in cm; h) distance from bottom forepart to colter forepart along the direction of the plow's motion in mm, not less than; i) weight of plow in kg per 1 meter of coverage, not more than; j) single-bottom 450, two- and three-bottom 360.

gage of the spindle end. The content of the standard for knee-type milling machines is even more brief, giving only the dimensions and travel of the table and also the minimal distance from the spindle axis to the table. Standards for gear-cutting machine-tools, although providing for a certain greater number of parameters, still lack directions with respect to modifications. They are also closer to first order standards.

A characteristic example of a second order standard is the standard for types, basic parameters and basic requirements for tractor-driven, share-type, tractor-mounted, semimounted and pull-type plows. This standard includes the necessary types and versions of plows, which is graphically illustrated by Table 11. Versions of each type of plow, with extensive unification of parameters and design characteristics are given. Basic requirements included in the standard determine additional

requirements put to the unified plow design. This standard can be called a typical second order standard.

The second order parametric standard for tractor-driven cultivators for continuous soil cultivation has been evolved by a similar principle. It provides for tractor-mounted cultivators of high maneuverability and requiring half the amount of metal in comparison with the pull-type cultivators, although the working elements of the latter are more adaptable to the terrain. The parametric standard includes five types of cultivators: I – pull-type for fallow and presowing cultivation of soil; II – the same, but tractor-mounted; III – pull-type for fallow and presowing cultivation of difficult and stony soils; IV – the same, but tractor-mounted; V – pulled, bar-type for fallow cultivation of soil. The cultivators are intended for work on soils with the following design specific resistance per 1 meter of coverage: up to 210 kg for cultivators of types I and II, up to 380 kg for types III and IV and up to 280 kg for type V.

The unification which serves as the basis of this standard for cultivators makes it possible to efficiently utilize normalized common subassemblies and components, as is graphically illustrated by Table 12.

The second order parametric standard for grain seeders also ensures extensive unification, which facilitates simultaneous design of sowing machines and normalization of their common subassemblies and components. Those reaping the advantages of this development of standardization and normalization and of adapting them into the design and manufacturing practice are not only the manufacturing plants, but also those who operate the machines, since the repair of the sowing machines and availability of interchangeable replacement parts is substantially facilitated. But all this can in the fullest extent be achieved only upon ensuring simultaneous designing of the sowing machines, normaliza-

tion of their subassemblies and components and specialization and automation of [their] production at an appropriate scale. Here we can see the direct interrelationship between standardization – normalization – specialization – automation. The unification integrated in the standard is described by Table 13.

TABLE 12.

Unification of Cultivator Parameters

Параметры A	B Тип культиваторов I	II	III	IV	V
Ширина захвата в м C	2–4	2–4	2–4	2–4	3–4
Глубина хода в см: D					
полольных лап E	5–12	5–12	6–12	6–12	—
рыхлящих лап F	До 12	До 12	До 13	До 13	—
вращающейся штанги H	—	— G	— G	— G	7–10
Перекрытие между полольными лапами в см, не менее I	6,0	6,0	6,0	6,0	—
Расстояние между рядами лап по ходу культиватора в мм, не менее J	500	500	500	500	—
Транспортный просвет в мм, не менее K	150	200	150	200	150

A) Parameters; B) type of cultivator; C) coverage width in meters; D) penetration depth in cm of; E) weeding teeth; F) cultivator teeth; G) up to; H) rotating bar; I) overlap between weeding teeth in cm, not less than; J) distance between rows of teeth in the direction of cultivator motion in mm, not less than; K) transport clearance in mm, not less than.

In elaborating the second order parametric standard for turret lathes a provision was made for extensive unification of their assemblies, subassemblies and components. For example, for the total number of 18 versions of these lathes the number of largest blank heights machined on them is 9, which provides the condition necessary for unification of supports. The heights of blanks subject to machining are the same for a pair of adjacent lathes. The dimensions of single- and double-support lathes forming the two extremes of the series are unified with respect to machining diameters and faceplates and this can facilitate product and component specialization of machine-tool building plants.

The ideas for creating the given parametric standard, described

above, are based on the progressive method of simultaneous design of turret lathes. However, it would be incorrect to assume that any design approach will ensure appropriate unification of components and subassemblies. The standard has provided a type range such which makes unification feasible, but it can be fully implemented only upon simultaneously performing the necessary planning and design work and properly developing the branch standardization.

TABLE 13

Unification of Grain Seeder Parameters

Параметры A	Тип сеялок B						
	I	II	III	IV	V	VI	VII
Ширина захвата в *мм* . . . C	3600	3600	3600	3600	3600	1500	1500
Ширина междурядья в *мм* . D	150	100	70—80	100	75	150	125
Количество сошников . . . E	24	36	24	36	48	10	12
Число засевных рядов . . . F	24	36	48	36	48	10	12
Глубина хода в *мм* . . . . G	40—80	40—80	60—110	40—80	40—80	40—70	40—70
Расстояние между сошниками по ходу сеялки в *мм* (не менее): H							
I при двухрядном расположении	135	200	470	—	—	135	300
J при трехрядном расположении	—	—	—	250	300	—	—
Диаметр колес в *мм* K . . .	1220	1220	1220	1220	1220	1220	1220
Транспортный просвет в *мм*, не менее . . . . L	110	110	110	110	110	110	110
Объем семенного ящика в $дм^3$, не менее . . . M	330	300	300	300	300	60	60
Усилия на рукоятке рычага при подъеме сошников в *кГ*, не более . . . . N	—	—	—	22	22	22	22

A) Parameters; B) seeder types; C) coverage width in mm; D) distance between rows in mm; E) number of colters; F) number of rows being sown; G) depth of penetration in mm; H) distance between colters in the direction of seeder motion (not less than):; I) when placed in two rows; J) when placed in three rows; K) wheel diameter in mm; L) transport clearance in mm, not less than; M) seed box capacity in cubic decimeters, not less than; N) force on the lever handle when raising the colters in kg, not more than.

The existing second order parametric standards for compressors form three series: 1) ammonia compressors for refrigerating devices; 2) freon compressors for the same purpose and, 3) general purpose air compressors. Provisions are made for vertical, horizontal and V-arrangement machines of the crosshead as well as the crossheadless version.

They are unified either with respect to basic components or with respect to structural elements. The unification of the driving mechanism components of freon and ammonia compressors has been achieved and the ammonia compressors are unified with air compressors with a delivery of 100 meters^3/min. The angular placement of crosshead compressor cylinders makes it possible to organize the production of special gas compressors and high pressure compressors, i.e., to achieve a number of modifications on the basis of utilization of common subassemblies and components.

The air compressor series has been constructed on the basis of a design feature, which has resulted in division of air compressors into stationary and movable. These two groups of machines differ by their weight, overall dimensions, service life and reliability. In addition, air compressors are subdivided into crosshead and crossheadless, which has determined the direction of unification of their components and subassemblies. Identical frames, housings and driving mechanisms were used. Identical components were also used for the cylinder, piston and other assemblies.

The movable compressors are characterized by their relatively moderate delivery, small overall dimensions and low weight. Consequently, these compressors should be high-speed. The main parameter of the stationary and nonstationary compressor series is their delivery, which makes it possible to develop unification of subassemblies and components. For example, compressors with deliveries of 3 and 6 meters^3/min of the stationary and nonstationary versions can be mutually unified.

Designs of air compressors are not standardized. The choice of a vertical or V version is left to the designer. As a result, the two related standards for compressors (standard for refrigerating devices compressors and the standard for general purpose air compressors) dif-

fer substantially by their structural principles, which points to the fact that the work of standardizing parametric series of compressors is as yet unfinished; it is in its initial state. The absence of a first order standard is being felt.

It should be noted that existing second order standards reflect the results of design and production process inheritance, and compressor series were created on the basis of mandatory utilization of certain common components, i.e., standardization in the given case has developed on the basis of the "from the particular to the general" principle. Second order standards, constructed on the basis of the "from the general to the particular" principle, i.e., on the basis of a first order standard, would have been more effective from the point of view of unification.

The absence of first and second order standards in the automotive industry has resulted in uneffective solutions in the field of establishing basic types of trucks and autobuses and their modifications.

Chapter 8

DIMENSIONAL SERIES AND PARAMETRIC STANDARDS FOR MACHINES AND EQUIPMENT

1. DIMENSIONAL SERIES - PARAMETRIC STANDARDS

The parameters of machines and equipment subject to standardization exert a decisive influence on increasing the productivity of labor and improving the level of technological equipment of the Soviet industry, agriculture, power supply, transportation, construction and communications. For example, the productivity of a tractor can be improved by increasing its operational and road speeds and pulling force and also by decreasing the repair and service time. The adoption of remote control for tractors also contributes to the solution of this problem.

Many from among the parameters, indicators and technical characteristics cited above cannot be referred either to dimensional series of machines and equipment or to parametric standards for these objects of production, since they characterize technical requirements to their manufacture and acceptance, i.e., to technical specifications. It has been shown by the practice acquired in elaboration of dimensional series (not within standardization), as well as parametric standards for machines and equipment that they do not differ by the nomenclature of indicators included in them. As an example, we can refer to the dimensional series of trucks and passenger automobiles and autobuses (Table 14), elaborated by NAMI under the leadership of prof. A.A. Lipgart.

The nomenclature of parameters included in the dimensional series of basic types of automotive vehicles and autobuses corresponds, in

principle, to second order parametric standards, but their substantial difference consists in the absence of all the necessary modification in the dimensional series of automotive vehicles and autobuses. It is doubtful whether it is necessary to standardize the piston diameter and travel, when simultaneous standards exist for the working volume and maximum capacity of engines being used, for a specific rpm and maximal torque.

We can conclude from this example, that in individual cases, the dimensional series can include a large number of indicators in comparison with the second order parametric standard.

TABLE 14

Nomenclature of Parameters Provided for by Dimensional Series for Automotive Vehicles and Autobuses

1 Параметры	2 Автомобили		3 Автобусы
	4 Грузовые	5 Легковые	
6 Тип машины	X	X	X
7 Грузоподъемность по грунтовым дорогам и шоссе	X	—	—
8 Число мест в кузове, включая место водителя	—	X	—
9 Число мест для сидения (не считая мест кондуктора и водителя) и полное число мест	—	—	X
10 Расположение мест	—	X	—
11 Число колес, из них ведущих	X	X	X
12 Размер в дюймах и число шин	X	X	X
13 Собственный вес в снаряженном состоянии со стандартной бортовой платформой, не более	X	—	—
14 Собственный сухой вес, не более	—	X	X
15 Максимальный полный вес	X	—	X
16 Тип двигателя	X	X	X
17 Максимальная мощность двигателя при заданных оборотах в минуту	X	X	X
18 Число цилиндров, диаметр и ход поршня	X	X	X
19 Рабочий объем двигателя	X	X	X
20 Максимальный крутящий момент двигателя	X	X	X
21 Контрольный расход топлива на 100 км пути с полной нагрузкой по шоссе, не более	X	X	X
22 Максимальная скорость с полной нагрузкой по шоссе, не менее	X	X	X
23 Удельная мощность автомобиля в л. с. на 1 т полного веса	X	X	X

Note. In this and subsequent tables the symbol X denotes the machines to which the standardized parameters and characteristics pertain.

1) Parameters; 2) automotive vehicles; 3) autobuses; 4) trucks; 5) passenger cars; 6) type of vehicle; 7) carrying capacity over dirt and paved roads; 8) number of spaces, including the driver's space; 9) number of seating spaces (not including the ticket seller's and driver's spaces) and the total number of spaces; 10) arrangement of seats; 11) number of wheels, of them driving [wheels]; 12) size in inches and the number of tires; 13) net weight including equipment with standard load platform, nor more than; 14) net dry weight; 15) maximum total weight; 16) type of engine; 17) maximal engine output at nominal rpm; 18) number of cylinders, piston diameter and travel; 19) working volume of the engine; 20) maximal engine torque; 21) routine fuel consumption per 100 kilometers traveled with full load over a paved road, not more than; 22) maximal speed at full load traveling over a paved road, not less than; 23) specific rating of vehicle in HP per one ton of total weight.

The basic difference between dimensional series and parametric standards thus consists of not their content and the completeness of the nomenclature of included indicators and other technical characteristics, the basic, principal difference is in the degree to which they are mandatory.

2. THE OPTIMAL CONTENT OF PARAMETRIC STANDARDS FOR MACHINES AND EQUIPMENT

A large number of parametric standards for machines and equipment is in existence at the present time. Their contents differ by the nomenclature of parameters provided in them and the general arrangement, which follows from the following factors; 1) the fact that their elaboration is based on different principles and 2) the influence of the different views of their authors with respect to content, purpose served and stability.

Analysis of many parametric standards makes it possible to make several characteristic conclusions, of general methodological interest.

1. The content of parametric standards can be considered to be optimal if, alongside with the necessary number of stable parameters, they also provide for such parameters and characteristics which directly (or indirectly) reflect contemporary scientific and technological achievements. Nonconformance with this requirement results in the ap-

pearance of standards according to which any machine (or piece of equipment), manufactured in full conformance with this low-quality standard will be either very progressive, average or mediocre.

For example, parametric standards for metal-cutting machine-tools, as a rule, provide for limiting dimensions of machined blanks, diameter of the spindle hole, dimensions of the working surfaces of tables, displacement of working elements, the spindle rpm, faceplate diameter, etc. The weight without electrical equipment and accessories (or with standard accessories) is given for certain types and standard sizes of machine-tools. The driving mechanism rating (for example, of an automatic machine-tool) is provided for only in single cases. With small exceptions, these are very stable parameters, which are revised very infrequently, sometimes every 10-15 years.

The standardization of the weight of the overwhelming majority of machine-tool types has met and is meeting with objections by the Experimental Scientific Research Institute of Machine-Tools (ENIMS), which assumes that this is an unstable parameter depending on the design of the machine-tool. We can note that certain domestically produced machines are on the average 30-40% heavier than similar foreign makes [19].

The weight of machines is greatly increased by the use of a large number of cast components. The consumption of iron, steel and nonferrous castings per ton of rolled stock used comprises: 345 kg at USSR machine-building plants and 207 kg in the USA, or by 40% less. For example, the weight of cast components of the DT-56 tractor was not lowered, although some of them can be fabricated by stamping or from special rolled profiles. The medical equipment plant of the Volgograd Sovnarkhoz has manufactured a lifting table for the seriously ill which is capable of lifting 25-30 tons. A large number of castings used here un-

necessarily. All this shows the expedience of including weight indicators, characterizing the refinement of the design, in the parametric standards.

2. In all cases it is expedient to accompany standards for types and basic parameters of machines and equipment by standards of technical requirements. These can be standards of technical requirements for the creation of integrated groups of jointly operating machines or of machines of different functional intent assembled from common (unified) assemblies. These can also be standards of technical requirements to the manufacture of machines, which give a description of all measures which ensure correspondence of the machine and equipment designs to the present time level of science and technology.

3. The mandatory form of state standards in a number of cases slows down the development of parametric standardization. It does not promote a bolder and more effective development of standardization in the interest of ensuring progress of the domestic industry. In the first postwar years individual standards were approved by a specific period as recommended [rather than mandatory]; but very soon this form was revoked without sufficient grounds. The recommended form of standards not only denotes the fact that they are not mandatory, but also that it is precisely these standards which are recommended for adoption. Upon accumulation of experience these recommended standards can be refined somewhat and become mandatory.

The VNIIK has performed methodological work in the field of establishing the optimal content of parametric standards for machines and equipment, taking the degree to which they are mandatory into account, on the basis of correlation of experience accumulated by a number of machine-building branches.

Tables 15-19 present examples of nomenclatures and dimensions of

TABLE 15

Parameters of Milling Machines and Shapers

Параметры 1	Размерность 2	3 Фрезерные станки		4 Строгальные станки	
		консольно-фрезерные 5	продольно-фрезерные 6	поперечно-строгальные 7	продольно-строгальные 8
Наибольший ход ползуна 9	мм	—	—	×	—
Размеры рабочей поверхности стола: 10	26				
ширина и длина 11	»	×	×	×	×
Ход стола 12					
продольный и поперечный 13	»	×	—	—	—
Наибольшее расстояние от опорной поверхности резца до станины, не менее 14	»	—	—	×	—
Наибольшие размеры устанавливаемой заготовки: 15					
ширина и высота 16	»	—	×	×	×
Наибольшее расстояние между верхней плоскостью стола и ползуном, не менее 17	27 мм	—	—	×	—
Наибольшая подача 18	мм/мин	×	×	—	—
Наибольшее горизонтальное перемещение стола, не менее 19	26 мм	—	—	×	—
Размеры конца шпинделя 20	28 номер	×	×	—	—
Наибольшее сечение резца 21	26 мм	—	—	×	×
Наибольшее число двойных ходов ползуна или стола в минуту, не менее 22	—	—	—	×	×
Наибольшая скорость ползуна (для станков с гидравлическим приводом), не менее 23	27 мм/мин	—	—	×	—
Наибольшее расстояние от плоскости стола до оси шпинделя (для станков горизонтального исполнения) и до торца шпинделя (для станков вертикального исполнения) 24	26 мм	×	—	—	—
Вес станка, не более 25	29 кг	×	×	×	×

1) Parameters; 2) units of measurement; 3) milling machines; 4) shapers; 5) knee-type; 6) plano-milling machines; 7) shapers; 8) planers; 9) maximum ram stroke; 10) dimensions of the table's working surface:; 11) width and length; 12) table traverse; 13) longitudinal and transverse; 14) greatest distance from the bearing surface of the tool to the bed plate, not less than; 15) largest dimensions of blanks taken: 16) width and height; 17) greatest distance between the table's upper surface and the ram, not less than; 18) greatest feed; 19) greatest horizontal displacement of table, not less than; 20) dimensions of the spindle end; 21) greatest tool cross section; 22) largest amount of ram or table strokes per minute, not less than; 23) highest ram speed (for machine-tools with a hydraulic drive), not less than; 24) greatest distance from the surface of the table to the spindle axis (for the horizontal version machine-tools) and to the end of the spindle (for the vertical version machine-tools); 25) weight of machine-tool, not more than; 26) mm; 27) mm/min; 28) gauge; 29) kg.

TABLE 16

Parameters of Turret Lathes.

Параметры 1	Размерность 2	Нормальное исполнение 3	Тяжелое исполнение 4
5 Наибольший диаметр обрабатываемой заготовки (по всей высоте):			
6 при неподвижных или придвинутых к планшайбе стойках	7 мм	×	×
8 при отодвинутой портале	»	—	×
Диаметр планшайбы: 9			
10 одной или наружной (при двух планшайбах)	7 мм	×	×
11 внутренней	»	—	×
12 Наибольшая высота обрабатываемой заготовки над планшайбой	»	×	×
13 Наибольший вес обрабатываемой заготовки (не менее):			
14 суммарный	15 т	×	×
16 в том числе на наружной планшайбе .	»	—	×
17 Наибольшее число оборотов планшайбы в минуту, не менее		×	×
18 Вес станка, не более	19 кг	×	×

1) Parameters; 2) units of measurement; 3) standard version; 4) heavy-duty version; 5) greatest diameter of machined blank (overall height):; 6) with the support either stationary or placed close to the chuck; 7) mm; 8) with the portal drawn back; 9) chuck diameter:; 10) of one or external (in the case of two chucks); 11) internal; 12) greatest height of blanks taken in excess of the chuck height; 13) greatest weight of blanks taken (not less than):; 14) total; 15) tons; 16) including by the external chuck; 17) highest chuck rpm, not less than; 18) weight of machine-tool, not more than; 19) kg.

TABLE 17

Parameters of Surface-Grinding Machines

Параметры 1	2 Размерность	3 Станки с круглым столом		4 Станки с прямоугольным столом	
		5 с горизонтальным шпинделем	6 с вертикальным шпинделем	5 с горизонтальным шпинделем	6 с вертикальным шпинделем
Диаметр стола . . 7 . .	мм	×	×	—	—
Размеры рабочей поверхности стола: 8					
9 ширина и длина 10 . . .	»	—	—	×	×
11 Наибольшая высота устанавливаемой заготовки (при наибольшем диаметре шлифовального круга)	»	×	×	—	—
12 Наибольшие размеры устанавливаемой заготовки . . .	»	—	—	×	×

TABLE 17 CONT'

1	2	3	4	5	6
13 Наибольший диаметр шлифовального круга	мм	×	×	×	×
14 Наибольшее число оборотов шлифовального круга в минуту	—	×	×	×	×
15 Диаметр конца шпинделей для крепления шлифовального круга	16 номер	×	×	×	×
17 Вес станка, не более	кг	×	×	×	×

1) Parameters; 2) units of measurements; 3) machine-tools with a round table; 4) machine-tools with a rectangular table; 5) with a horizontal spindle; 6) with a vertical spindle; 7) table diameter; 8) mm; 9) dimensions of the table's working surface; 10) width and length; 11) greatest height of blank taken (for greatest grinding wheel diameter); 12) greatest dimensions of blank taken; 13) greatest diameter of grinding wheel; 14) highest grinding wheel rpm; 15) diameter of the ends of spindles used for mounting the grinding wheel; 16) gauge; 17) machine-tool weight, not more than; 18) kg.

TABLE 18

Parameters of Gear Cutting Machines

1 Параметры	2 Размерность	3 Станки: 4 для нарезания конических колес	5 зубофрезерные общего назначения	6 зубодолбежные	7 зубошлифовальные
8 Наибольший диаметр нарезаемых колес, не менее	9 мм	×	×	×	×
10 Наибольшая длина зуба нарезаемых колес, не менее	»	×	—	—	—
11 Наибольшая ширина нарезаемых колес	»	—	×	×	×
12 Наибольший модуль, не менее	»	×	×	×	×
13 Номинальный диаметр резцовых головок	»	×	—	—	—
14 Наибольшее число двойных ходов в минуту	—	×	—	—	—
15 Наибольший угол наклона нарезаемых колес	град	—	×	—	—
17 Диаметр отверстия в столе (для хвостовика заготовки), не менее	16 9 мм	—	—	×	—
18 Наибольшее число оборотов фрезы или шлифовального круга в минуту, не менее	19 —	—	×	—	×
Размеры конуса в шпинделе	номер	×	×	×	—
21 Наибольшее число двойных ходов долбяка в минуту, не менее	20 —	—	—	×	—
Размеры конуса центров	22 номер	—	—	—	×
23 Диаметр конца шпинделя для крепления шлифовального круга	20 9 мм	—	—	—	×
Вес станка, не более	кг	×	×	×	×
24	25				

1) Parameters; 2) units of measurement; 3) machine-tools; 4) for cutting of bevel gears; 5) general purpose gear milling; 6) gear shaping; 7) gear grinding; 8) greatest diameter of gears being cut, not less than; 9) mm; 10) greatest tooth height of gears being cut, not less

than; 11) greatest width of gears being cut; 12) greatest module, not less than; 13) nominal diameter of cutting heads; 14) greatest number of complete traverses per minute; 15) greatest pressure angle of gears being cut; 16) degrees; 17) diameter of hole in the table (for the blank tail), not less than; 18) the greatest rpm of the milling cutter or grinding wheel, not less than; 19) dimensions of the spindle taper; 20) gauge; 21) greatest number of gear-wheel cutter strokes per minute, not less than; 22) dimensions of the taper of centers; 23) diameter of the end of the grinding wheel mounting spindle; 24) weight of machine-tool, not more than; 25) kg.

TABLE 19

Parameters of Jig-Boring Machine-Tools.

Параметры 1	Размерность 2	3 Станки: 4 одностоечные	5 двухстоечные
Ширина рабочей поверхности стола . 6.	7 мм	×	×
Длина рабочей поверхности стола . . 8.	»	×	×
Величина поперечного перемещения стола или расточной головки . 9 10	»	×	×
Величина продольного перемещения стола	»	×	×
Наибольшее расстояние от поверхности стола до торца вертикального шпинделя 11	»	×	×
Наибольшая величина перемещения вертикальной расточной головки или траверсы 12	мм	×	×
Наибольшая величина перемещения гильзы шпинделя вертикально- расточной головки 13	»	×	×
Расстояние от оси шпинделя до стойки (вылет) 14	»	×	—
Расстояние между стойками . 15. . .	»	—	×
Наивысшее положение оси шпинделя горизонтальной расточной головки над поверхностью стола 16	»	—	×
Наибольшее число оборотов шпинделя в минуту, не менее 17	—	×	×
Вес станка, не более 18	кг 19	×	×

1) Parameters; 2, units of measurement; 3) machine-tools; 4) single-frame; 5) double-frame; 6) width of working surface of the table; 7) mm; 8) length of the working surface of the table; 9) total transverse travel of the table of boring head; 10) total longitudinal travel of the table; 11) greatest distance from the table surface to the end of the vertical spindle; 12) greatest travel of the vertical boring head or traverse; 13) greatest displacement of the spindle sleeve of the vertical boring head; 14) distance from the spindle axis to the frame (overhang); 15) distance between frames; 16) highest position of the spindle axis of the horizontal boring head over the table surface; 17) highest spindle rpm, not less than; 18) weight of machine-tool, not less than; 19) kg.

parameters describing certain types of metal-cutting machine-tools.

Their main parameters are subdivided into three groups:

1st group - overall dimensions of blanks machined in them;

TABLE 20.

Parameters of Hammers

1 Параметры	2 Размерность	3 Молоты: 4 паро-воздушные штамповочные	5 пневматические ковочные	6 паро-воздушные ковочные двойного действия
7 Номинальный вес падающих частей	8 т или кг	×	×	×
Эффективная кинетическая энергия падающих частей при полных последовательных ударах, не менее 9	кгм	×	—	—
То же при полном единичном ударе, не менее 11	10 »	—	×	×
Наибольший рабочий ход бабы 12	мм	×	—	×
Число ударов бойка в минуту 14	—	—	×	—
Наименьшая высота штампа без хвостовика 15	13 мм	×	—	—
Крепление штампов — группа молотов по ГОСТу 6039—51 16	13 —	×	—	×
Расстояние между стойками в свету 17	мм	×	—	×
Расстояние от зеркала нижнего бойка до нижней кромки буксы бабы 18	13 »	—	×	—
Расстояние от оси бабы до станины 19	»	—	×	—
Расстояние от зеркала нижнего бойка до направляющих 20	»	—	—	×
Размеры зеркала бойка 21	»	—	×	×
Размеры бабы (спереди назад) 22	»	×	—	—
23 Размер штамподержателя (спереди назад)	»	×	—	—
Вес молота без шабота, не более 24	кг	×	×	×
Вес шабота 26	25	×	×	×

1) Parameters; 2) units of measurement; 3) hammers; 4) steam or air die forging; 5) pneumatic forging; 6) steam or air forging, double-action; 7) nominal weight of falling parts; 8) tons or kg; 9) effective kinetic energy of falling parts, for complete successive impacts, not less than; 10) kg-m; 11) same as above, for a complete single impact, not less than; 12) greatest working stroke of head; 13) mm; 14) hammer head impacts per minute; 15) lowest dieset height without tail section; 16) fastening of diesets — hammer group by GOST 6039-51; 17) inside interframe distance; 18) distance from the lower hammer head surface to the lower edge of the head bushing; 19) distance from the head axis to the frame; 20) distance from the lower hammer surface to the guides; 21) dimensions of the hammer head surface; 22) dimensions of the head (from front to back); 23) size of dieset holder (from front to back); 24) weight of hammer without anvil block, not more than; 25) kg; 26) weight of anvil block.

2nd group — structural elements of the machine-tools;

3rd group — specific characteristics peculiar to individual types of machine-tools only.

Standardization of types and dimensions of press forging equipment must be based on the basic features of the production process. The characteristic feature of the majority of types of this equipment is

the obtaining of blanks the shape and dimensions of which differ substantially from the original profile of the material. From this follows that the main parameter for the majority of press forging equipment types can be the power characteristic.

Parameters of various hammers are presented in Table 20. Alongside with the power characteristic, of great significance are linear parameters, established in order to make it possible to obtain components or blanks for subsequent machining or welding with specified overall dimentions. The main parameter for crank presses, irrespective of their design and intended service, is the nominal force developed by the working element. The standards also must give the distance from the slide to its extreme bottom position (slide to table clearance), for which the standardized nominal force is ensured.

The significance of the given parameter is determined by the fact that when this clearance is excessive the design of the driving mechanism becomes complicated and the weight and cost of the press is increased. A smaller than optimal clearance lowers the quality of operational characteristics of the press. The work delivered by the press per one working stroke determines the feasibility of its use.

An overly large safety factor results in excessive use of electricity, increasing the weight of the press and its cost. The shape and size of a blank are changed over a specific length of stroke of the working element, and for this reason crank-type presses must be described by the ram stroke. This parameter determines a dimension of major importance to the designer, i.e., the crank radius. It is also necessary to give the required degree of control over the distance between the table and the ram and of the distance between the table and the ram in its lower position.

The subjects of standardization for single-frame presses and open

end simple-action tilted presses are the dimensions of the holes in the table needed for the passage of the blank. The output of presses is described by the number of ram strokes per minute. The parameter series must be included in the standard in order to ensure placement of die-sets with specific overall dimensions. The progressiveness of hydraulic presses is characterized by the ram speed. The productivity of four-column forging presses is determined by the hammer head strokes per minute. All these and other necessary parameters are given in Table 21, which gives a summary of the nomenclature of parameters for 12 different types of presses.

The nomenclature of parameters of horizontal forging machines is given in Table 22 and of cold upsetting and trimming automatic machines in Table 23.

The nomenclature of tractor parameters included in the parametric standard is based on requirements put to their operation under various soil and climatic conditions, and also on ensuring the feasibility of aggregating with drawn and tractor-mounted agricultural machines and implements of various types. Taking into account these requirements, we must admit that the pulling force delivered to the hook is the main parameter. The pulling force at the hook determines the interrelationship between the above operational requirements and the design execution of the tractor, its assemblies, subassemblies and components, and also of the mounted and drawn agricultural machines and implements used with it.

The capacity of a tractor actually utilized in the performance of various operations is estimated in units of the so-called accounting pulling capacity. This indicator is officially established for accounting and planning purposes.

The formula for accounting pulling capacity suggested by I.I. Trepenkov:

TABLE 21

Parameters of Presses

Параметры (1)	Размерность (2)	3 Прессы: 4 Кривошипные горячештамповочные	5 Винтовые фрикционные	6 Кривошипные чеканочные	7 Однокривошипные: 12 одностоечные	13 открытые простого действия	14 закрытые простого действия	15 двойного действия	8 Двухкривошипные: 16 простого действия	17 двойного действия	9 Гидравлические	10 Гидравлические ковочные четырехколонные	11 Автоматы кривошипные многопозиционные
Номинальное усилие: 18 пресса . . . . . 19 . .	т	×	×	×	×	×	×	—	×	—	×	×	×
внутреннего ползуна . 21	20	—	—	—	—	—	—	×	—	×	—	—	—
наружного ползуна . 22		—	—	—	—	—	—	×	—	×	—	—	—
Расстояние от ползуна до его нижнего крайнего положения (недоход ползуна), при котором обеспечивается 23	24												
номинальное усилие пресса	мм.	×	—	×	×	×	×	×	×	×	—	—	×
Работа пресса за один рабочий ход . . 25	кГм	×	—	×	×	×	×	×	×	×	—	—	×
Эффективная кинетическая энергия движущихся частей при наибольшем ходе, не менее 27	26 »	—	×	—	—	—	—	—	—	—	—	—	—
Ход ползуна . . 28	мм	×	×	×	×	×	×	—	×	—	×	—	×
Ход: 29	24												
30 внутреннего ползуна . .	»	—	—	—	—	—	—	×	—	×	—	—	—
31 наружного ползуна . . .	»	—	—	—	—	—	—	×	—	×	—	—	—
Число ходов ползуна в минуту, не менее . 32	—34	×	×	×	×	×	×	×	×	×	—	—	×
Скорость ползуна не менее 33	мм/сек												
при холостом ходе . 35		—	—	—	—	—	—	—	—	×	—	—	—
при рабочем ходе 36 . .		—	—	—	—	—	—	—	—	×	—	—	—
при возвратном ходе 37 .		—	—	—	—	—	—	—	—	×	—	—	—
Число ходов бойка в минуту 38 (при ходе поперечины в мм)	—	—	—	—	—	—	—	—	—	—	—	×	—
Наибольшее расстояние между столом и ползуном в его нижнем или верхнем положении (при верхнем положении регулировки или при наибольшем ходе)	24 мм	×	×	×	×	×	×	×	×	×	×	—	—
Регулирование расстояния 40 между столом и ползуном	»	×	—	×	×	×	×	×	×	×	—	—	—
Наибольшее расстояние от стола до подвижной поперечины в ее верхнем положении . . 41	»	—	—	—	—	—	—	—	—	—	—	×	—
Размеры стола . . 42	»	×	×	×	×	×	×	×	×	×	×	×	—
Размеры ползуна (или ползунов) . 43	»	×	×	×	×	×	×	×	×	×	—	—	—
Расстояние между стойками станины или между колоннами в свету . 44 . . .	24 мм	×	×	×	—	×	×	×	×	×	×	×	—
Размеры пазов в ползуне для крепления штампов 45 .	»	—	—	×	—	—	—	—	—	—	—	—	—
Толщина подштамповой плиты . . 46	»	—	—	×	×	×	×	×	×	×	×	—	×
Размеры отверстия в столе 47	»	—	—	—	×	×	×	×	—	—	—	—	—
Расстояние от оси ползуна до станины (вылет) 48 .	»	—	—	—	×	×	—	—	—	—	—	—	—
То же до плоскости крепления стола к станине . 49 .	»	—	—	—	×	—	—	—	—	—	—	—	—
Наибольшее расстояние между осью отверстия для рога и ползуном в его нижнем положении при наибольшем ходе 52	»	—	—	—	×	—	—	—	—	—	—	—	—
Угол наклона станины . 51 .	град	—	—	—	—	×	—	—	—	—	—	—	—
Усилие выталкивателя . 53 .	т 20	—	—	—	—	—	—	—	—	—	×	—	—
Ход выталкивателя . . . 54 .	мм	—	—	—	—	—	—	—	—	—	×	—	—
Наибольший ход подвижной поперечины . . . . 55 .	24 »	—	—	—	—	—	—	—	—	—	—	×	—
Ход стола, не менее 56 . .	»	—	—	—	—	—	—	—	—	—	—	×	—
Наибольшее расстояние между столом и нижней кромкой пуансонодержателя при нижнем положении ползуна и верхнем положении регулировки . 57	»	—	—	—	—	—	—	—	—	—	—	—	×
Регулирование расстояний между столом и пуансонодержателем . . 58	»	—	—	—	—	—	—	—	—	—	—	—	×
Расстояние между осями пуансонодержателей . 59 .	»	—	—	—	—	—	—	—	—	—	—	—	×
Число позиций . . . 60 . . .	—	—	—	—	—	—	—	—	—	—	—	—	×
Вес пресса без электрооборудования, не более . 61 .	т 20	×	×	×	×	×	×	×	×	×	×	×	×

1) Parameters; 2) units of measurement; 3) presses; 4) crank-driven die forging; 5) roll-driven friction presses; 6) coining crank-driven; 7) single-crank; 8) double-crank; 9) hydraulic; 10) hydraulic, four-column, forging; 11) multiposition, crank-driven automatic; 12) single-frame; 13) simple-action open end; 14) simple-action closed end; 15) double-action; 16) simple-action; 17) double action; 18) nominal force:; 19) of the press; 20) tons; 21) of internal slider; 22) of external slider; 23) distance from slider to its lowest limiting position (slider to table clearance) for which the nominal force delivery is ensured; 24) mm; 25) work delivered by the press per one working stroke; 26) kg-m; 27) effective kinetic energy of moving parts for the longest stroke, not less than; 28) slider stroke; 29) stroke of the:; 30) internal slider; 31) external slider; 32) slider strokes per minute, not less than; 33) slider speed not lower than; 34) mm/sec; 35) on idle stroke; 36) on working stroke; 37) on return stroke; 38) hammer head strokes per minute (on transverse motion, in mm); 39) greatest distance between the table and the slider in lower or upper position (when it is adjusted upward and on longest stroke); 40) adjustment of the distance between the table and the slider; 41) greatest distance between the table and the moving crosshead in its upper position; 42) dimensions of table; 43) dimension of slider (or sliders); 44) distance between frame beams or columns, in the clear; 45) dimensions of slots in the slider for fastening of diesets; 46) thickness of die cushion platen; 47) dimensions of the hole in the table; 48) distance from the slider axis to the press frame (overhang); 49) the same as above to the plane of fastening of the table to the frame; 50) greatest distance between the anvil beak hole axis and the slider in its lower position for the longest travel; 51) angle of inclination of the press frame; 52) degrees; 53) ejector force; 54) ejector stroke; 55) longest stroke of moving cross head; 56) table travel, not less than; 57) greatest distance between the table and the lowest edge of the male-die holder for the lowest slider position and on upward adjustment; 58) adjustment of the distance between the table and male-die holder; 59) distance between axes of male-die holders; 61) weight of press without electrical equipment, not more than.

$$N_p = C[aN_a + (1-a)N_b].$$

where C is the pulling load coefficient, equal to 0.85 for wheel and 0.9 for crawler tractors; a is the tractor time utilization coefficient when working on a stubble field, equal to 0.4 for wheel and 0.6 for crawler tractors; (1 - a) is the tractor time utilization coefficient when working on loose soil; N_a is the maximal pulling capacity obtained in tests on a stubble field, N_b is the same as above for loose soil.

The productivity of a tractor depends on its speed and the width of coverage of machines assigned to it. For this reason great signifi-

TABLE 22

Parameters of Horizontal Forging Machines

Параметры 1	Размерность 2
Номинальное усилие 3	4 *т*
Ход подвижной матрицы 5	6 *мм*
Ход высадочного ползуна 7	»
Ход высадочного ползуна после закрытия матриц . 8 .	»
Обратный ход высадочного ползуна при закрытых матрицах 9	»
Наибольшие размеры матриц (длина, высота, ширина) 10 .	»
Расстояние между высадочным ползуном в его крайнем положении и матрицами, не менее . 11	»
Размеры зева 12	»
Число ходов ползуна в минуту, не менее . . 13 . . .	—
Наибольшее расстояние между плитой станины в ее нижнем 14 положении при переднем положении высадочного ползуна .	»
Размеры мест крепления блоков матриц . 15	»
Размеры мест крепления блоков пуансонодержателей 16 .	»
Вес, не более . . . . . 17 . . .	18 *кг*

1) Parameters; 2) units of measurements; 3) nominal force; 4) tons; 5) stroke of movable dieset; 6) mm; 7) stroke of ejector slider; 8) stroke of ejector slider after dies are closed; 9) return stroke of ejector slider with the dies closed; 10) greatest dimensions of dies (length, height, width); 11) distance between ejector slide in its extreme position and the dies, not less than; 12) dimensions of the gap; 13) slider strokes per minute, not less than; 14) greatest distance between the frame platen in its lower position when the ejector slider is located at the front; 15) dimensions of spaces provided for fastening of die blocks; 16) dimensions of spaces provided for fastening of male die holders; 17) weight, not more than; 18) kg.

TABLE 23

Parameters of Automatic Cold Upsetting and Trimming Machines

Параметры 1	Размерность 2	3 Автоматы: Холодно-высадочные 4	3 Автоматы: Обрезные 5
Диаметр стержня изделия наибольший и наименьший . 6	7 *мм*	×	×
Длина стержня изделия наибольшая и наименьшая . . . 8	»	×	—
Наибольшая длина утоненной части стержня под накатывание резьбы . 9 . .	»	—	×
Номинальное усилие ползуна . . 10 . .	11 *кГ*	×	×
Расстояние от ползуна до его крайнего положения (недоход ползуна), при котором обеспечивается номинальное усилие .	12 14 »	×	×
Работа автомата за один рабочий ход 13 .	*кГм*	×	×
Число ходов ползуна в минуту, не менее .	15 —	×	×
Размеры присоединительных элементов для крепления инструмента . . 16 . .	*мм* 17	×	×
Вес автомата, не более . . 17 . .	*т* 18	×	×

1) Parameters; 2) units of measurements; 3) automatic; 4) cold upsetting; 5) trimming; 6) largest and smallest bar stock diameter; 7) mm; 8) longest and shortest product bar length; 9) longest length of thinned out part of bar for thread generation; 10) nominal slider force;

11) kg; 12) distance from slider to its limiting position (table to slider clearance), for which the nominal force is ensured; 13) work delivered by the machine per one working stroke; 14) kg-m; 15) slider strokes per minute, not less than; 16) dimensions of joining elements for fastening of tools; 17) weight of machine, not more than; 18) tons.

ficance is acquired by indicators characterizing the range of working speeds, highest road speed and the number of speeds. Loss of self-propelling capacity by the tractor increases as the wheel or crawler track sinks deeper into the soil. In order to lower these losses and to increase the passability of the tractor, the area of contact between the wheel or crawler track and the soil is increased. Standardization of the indicator characterizing the mean specific pressure of the wheel or crawler track on the soil is expedient from the operational point of view. Specific vertical clearance and the gauge should be ensured for a number of tractor executed operations. These dimensions determine the feasibility of utilization of the tractor under specific operational conditions.

Specific operational conditions for tractors with mounted agricultural machines are a factir in the desire to lower the design weight. Limiting the weight has as its purpose not only decreasing the metal consumption, but also ensuring the necessary interrelationship between the weight parameters and the tractor speed parameters. The weight indicator of a tractor, alongside with the design weight is characterized by the specific metal consumption. The pulling capacity specific weight, i.e., the ratio of the design weight of the tractor to its pulling acpacity (delivered to the hook), makes it possible to compare wheel and crawler-mounted tractors. The purpose of standardization of weight parameters is to ensure the manufacture of each tractor with the lowest weight permissible from the engineering point of view. The specific weight of tractors can be lowered by increasing the engine rating and decreasing the design weight of the tractor up to specified expedient

limits. Standardization of the gauge is expedient for orchard and garden, cotton growing and furrow plowing tractors. The width reckoned from external track edges (nor more than) must be given for general purpose and vineyard tractors. Maximal and minimal gauge width are established for tractors with changeable gauges. An expedient nomenclature of various purpose tractor parameters is presented in Table 24.

The nomenclature of construction and road-building machines is chosen taking into account the necessity for ensuring the needed productivity and of the feasibility of operating these machines under specific conditions. The tremendous variety of machines makes it impossible to establish a single parameter nomenclature for them.

The nomenclature of parameters for excavators used for digging or earth moving should determine their output. This condition is satisfied by the rating and capacity of the bucket. The bucket capacity is determined by the moment capable of overturning the excavator. Its weight is found as a certain function of the engine rating. Together with this, the engine rating is related to the lifting effort delivered to the bucket unit. For a trench hoe and drag line working in open pit mines, located below the horizontal displacement path of the excavator, it is necessary to know the limiting depth of the face which is characterized by a) the ditch and pit depths for the trench and b) by digging depth on side passes and digging depth on end passes for the drag line. Standardization of excavator parameters, regardless of the type of working equipment, includes parameters determining the feasibility of utilizing the excavators under different operational conditions: dumping height and radius, clearance below the rotating platform, road grade that can be overcome when traveling on hard soil, specific pressure of wheels or tracks during the excavator's motion. etc. When a trench hoe is used it is necessary to give the speed with which the excavator moves in the

pit. The road speed is, in addition, specified for wheel excavators.

TABLE 24

Parameters of Tractors

1 Параметры	2 Размерность	3 Назначение тракторов: Общего назначения	Садово-огородный	Садово-виноградниковый	Хлопководческий	Пропашной	Лесохозяйственный	Болотный	Трелевочный	Промышленный
13 Номинальное тяговое усилие	14 кГ	+	+	+	+	+	+	+	+	+
15 Учетная тяговая мощность	16 л. с.	+	+	+	+	+	+	+	+	+
17 Рабочий объем двигателя	18 л	+	+	+	+	+	+	+	+	+
19 20 Диапазон рабочих скоростей (от до)	км/ч	+	+	+	+	+	+	+	+	+
21 Наибольшая транспортная скорость, не менее	»	+	+	+	+	+	+	+	+	+
22 Число скоростей (рабочих и транспортных, кроме особо низких), не менее	—	+	+	+	+	+	+	+	+	+
23 Число скоростей заднего хода, не менее	—	+	+	+	+	+	+	+	+	+
24 25 Среднее удельное давление движителей на почву, не более	кГ/см²	+	+	+	+	+	+	+	+	+
26 Колея	27 мм	—	+	—	+	+	—	—	—	—
28 Ширина по наружным кромкам гусениц не более	27 мм	+	—	+	—	—	—	—	—	—
29 Вертикальный просвет, не менее	»	+	+	+	+	+	+	+	+	+
30 31 Вес трактора конструктивный, не более	кг	+	+	+	+	+	+	+	+	+
32 Тяговый удельный вес (конструктивный вес трактора, отнесенный к тяговой мощности), не более	33 кг/л. с.	+	+	+	+	+	+	+	+	+

Notes: 1. For tractors with changeable gauge dimensions minimal and maximal gauges are specified. 2) The term vertical clearance for orchard and garden, cotton growing and furrow plowing tractors is meant to denote the clearance over the row over a strip of specified width. For the other tractors the vertical clearance is defined as the smallest distance between the lowest point of the tractor's chassis when carrying its maximal operation weight to the horizontal surface of the road.

1) Parameters; 2) units of measurements; 3) service designation of tractors; 4) general purpose; 5) orchard and garden; 6) vineyard; 7) cotton growing; 8) furrow plowing; 9) forestry; 10) swamp; 11) hauling; 12) industrial; 13) nominal pulling force; 14) kg; 15) accounting pulling capacity; 16) HP; 17) working volume of engine; 18) liters; 19) range of working speeds (from to); 20) kilometers/hour; 21) highest road speed, not less than; 22) number of speeds (working and road, not including very low [speeds]), not less than; 23) number of reverse speeds, not less than; 24) mean specific pressure of wheels or tracks on the soil, not more than; 25) kg/cm^2; 26) gauge; 27) mm; 28) width reckoned from external track edges, not more than; 29) vertical clearance, not more than; 30) design weight of the tractor, not more than; 31) kg; 32) pulling specific weight (design weight referred to the tractor's pulling capacity), not more than; 33) kg/HP.

The main parameter of a quarry-type multibucket crossbite, rail excavator is the digging depth and height. When the soil is dumped in a

heap the overhang of the dumping train from the railroad bed axis must be given. When loading onto transportation facilities it is necessary to fix the hopper capacity which determines the efficiency with which the transportation facilities are utilized. The feasibility of utilizing quarry-type excavators under various conditions is determined from the unloading height.

Here we present only brief considerations of parameters included in standards and describing the design features and operational capabilities of excavators. Tables 25-27 include parameter nomenclatures which completely describe the excavators.

Parameters of graders are presented in Table 28. The most characteristic feature of trailing graders is the length and height of the moldboard and for elevator graders it is the output in meters^3/hour, and for self-propelling graders it is the engine rating. The greatest required pulling force should be specified for trailing graders, which determines the tractor type and also the dimensions of the grader's subassemblies and components. The establishing of recommended tractor types has as its purpose their most efficient aggregating. The vertical clearance under the moldboard is specified to ensure free passage of the grader over the locale when in its hauling position. The vertical clearance under front and back bridges should in addition be specified for self-propelled graders. To ensure turning ability of self-propelled graders under working conditions the parameter nomenclature also includes the turning radius of the external front wheel. The unloading height and also the elevator overhang from the external edge of wheels (this is instrumental in increasing the operating front width when moving soil into heaps) should be given for elevator graders loading onto transportation facilities. Characteristic parameters for self-propelled graders are those determining the speed; pressure per unit knife length,

TABLE 25.

Parameters of Single-Bucket General-Purpose Excavators

1 Параметры	2 Размер	3 Прямая лопата	4 Обратная лопата	5 Драглайн	6 Грейфер
7 Мощность	8 л. с.	×	×	×	×
9 Емкость ковша, не менее	10 м³	×	×	×	×
11 Подъемное усилие на блоке ковша, не менее	12 т	×	×	×	×
13 Длина:					
14 стрелы основной (номинальная)	15 мм	—	—	×	×
16 стрелы со вставками	»	—	—	—	×
17 Ширина ковша, не менее	»	—	×	—	—
18 Наибольшая глубина копания (не менее)	»	—	—	×	—
19 То же, траншеи	»	—	×	—	—
20 То же, котлована	»	—	×	—	—
21 Наибольшая высота (не менее):					
22 выгрузки	»	×	×	×	×
23 копания	»	×	—	—	—
24 Наибольший радиус (не менее):					
25 копания	»	×	—	—	—
26 выгрузки	»	×	×	×	×
27 Высота (по блоку двуногой стойки или кузова), не более	»	×	×	×	—
28 Вылет стрелы от оси вращения платформы	»	—	—	—	×
29 Радиус вращения хвостовой части, не более	»	×	×	×	×
30 Производительность	31 м³/ч	×	×	×	—
32 Просвет под поворотной платформой	15 мм	×	×	×	×
33 Скорость подъема наибольшего груза, не менее	34 м/мин	—	—	—	×
35 Преодолеваемый подъем пути при твердом грунте, не менее	36 град	×	×	×	×
37 Скорость передвижения в забое в пределах	38 км/ч	×	×	×	—
39 Транспортная скорость, не менее	»	×	×	×	×
40 Вес в т (не более):					
41 экскаватора с рабочим оборудованием	42 т	×	×	×	×
43 грейфера с материалом	»	—	—	—	×
44 Удельный вес (вес, отнесенный к единице производительности), не более	45 кг/м³/ч	×	×	×	×
46 Среднее удельное давление движителей на грунт при передвижении экскаватора, не более	47 кГ/см²	×	×	×	×

1) parameters; 2) unit of measurement; 3) power shovel; 4) trench hoe; 5) drag line; 6) grader; 7) rating; 8) HP; 9) shovel capacity, not less than; 12) tons; 13) length of; 14) main boom (nominal); 15) mm; 16) boom with extensions; 17) shovel width, not less than; 18) greatest digging depth (not less than); 19) the same as above, of the ditch; 20) the same as above, of the pit; 21) greatest height (not less than) of:; 22) unloading; 23) digging; 24) greatest radius (not less than) of:; 25) digging; 26) unloading; 27) height (of the two-support frame or cab body), not more than; 28) overhang of boom from the platform rotation axis; 29) radius of rotation of the tail part, not more than; 30) output; 31) meters^3/hour; 32) clearance under the rotating platform; 33) rate at which the greatest load is lifted, not lower than; 34) meters/min; 35) road grade overcome over hard soil, not less than; 36) degrees; 37) digging speed within limits [of]; 38) kilometers/hour; 39) road speed, not less than; 40) weight in tons, (not more than) for:; 41) and excavator with working equipment; 42) tons; 43) of grader [sic] with material; 44) specific weight (referred to unit output), not more than; 45) kg/meter^3/hour; 46) mean specific pressure of wheels or tracks on the soil when the excavator in moving, not more than; 47) kg/cm^2.

TABLE 26

Excavator Parameters

1 Параметры	2 Размерность	3 Экскаваторы: 4 Шагающие	5 С электрическим многомоторным приводом	6 Карьерные многоковшовые поперечного копания на рельсовом ходу
Подъемное усилие на блоке ковша . .	8 *т*	—	×	—
9 Произведение подъемного усилия на максимальный радиус копания . . .	10 *т·м*	×	×	—
11 Емкость ковша, не менее	*м*³ 12	×	×	—
13 Длина стрелы номинальная	14 *мм*	×	—	—
15 Наибольший радиус (не менее):	16 *мм*			
17 копания		×	×	—
18 выгрузки		×	×	—
19 Наибольшая высота (не менее):	16 *мм*			
20 копания		—	×	—
21 выгрузки		×	×	×
22 Высота копания при угле откоса забоя 45°, не менее	16 *мм*	—	—	×
23 Глубина копания (не менее):	16 *мм*			
24 при боковом проходе		×	—	—
25 при концевом проходе		×	—	—
26 при угле откоса 45°		—	—	×
27 Радиус вращения хвостовой части (не более)	16 *мм*	×	×	—
28 Просвет под поворотной платформой .	16 *мм*	×	×	—
29 Преодолеваемый подъем пути при твердом грунте (не менее)	30 *град*	×	×	—
31 Скорость передвижения в забое, не менее	32 *км/ч*	×	×	—
33 Емкость бункера, не менее	*м*³ 12	—	—	×
34 Производительность (не менее):	35 *м*³/*ч*			
36 при работе в отвал с поворотом платформы	39	×	×	—
37 проектная (в плотном теле) . . .		—	—	×
38 Среднее удельное давление (не более):	*кГ/см*²			
40 на грунт для базовой опоры . . .		×	—	—
41 движителей или лыж на грунт . .		×	×	—
42 Вес экскаватора (не более):	8 *т*	×	×	—
43 с рабочим оборудованием, не более без противовеса с бункером . .		—	—	×
44 то же с транспортером		—	—	×
45 Удельный вес (вес, отнесенный к единице производительности), не более .	46 *кг/м*³/*ч*	×	×	×
47 Вылет транспорта от оси железнодорожного пути при горизонтальном положении транспортера, не менее . . .	48 *м*	—	—	×
49 Номинальная ширина рельсового пути	16 *мм*	—	—	×

1) Parameters; 2) units of measurements; 3) excavators; 4) stepping; 5) with electric multimotor drive; 6) quarry-type multibucket crossbite rail; 7) lifting force at the bucket unit; 8) tons; 9) product of lifting force and the maximum digging radius; 10) ton·meters; 11) bucket capacity, not less than; 12) meters^3; 13) boom length, nominal; 14) mm; 15) greatest radius (not less than) of; 16) mm; 17) digging; 18) unloading; 19) greatest height (not less than) of:; 20) digging; 21) unloading; 22) digging height with the quarried bank sloping at 45°, not less than; 23) digging depth (not less than):; 24) on side digging; 25) on end digging; 26) for a bank inclination of 45°; 27) radius of rotation of the tail section; 28) clearance under rotating platform; 29) road grade overcome on hard soil (not less than); 30) degrees; 31) speed when digging, not less than; 32) kilometers/hour; 33) hopper capacity, not less than; 34) output (not less than):; 35) meters^3/hour;

36) when heaping with platform rotation; 37) design (in a solid body; 38) mean specific pressure (not more than):; 39) kg/cm^2; 40) on the soil when supported on the frame; 41) of wheels, tracks or skis on the soil; 42) excavator weight (not more than):; 43) with working equipment, not more than without counterweight with hopper; 44) the same with unloading belt; 45) specific weight (weight referred to unit output), not more than; 46) kg/meter^3/hour; 47) overhang of unloading belt from the axis of the railroad bet with the belt in horizontal position, not less than; 48) meters; 49) nominal width of railroad tracks.

TABLE 27.

Parameters of Multi-Bucket Ditching Excavators

1 Параметры	2 Размерность
3 Мощность двигателя	4 л. с.
5 Глубина траншеи	6 м
7 Ширина траншеи	
8 Рабочая скорость движения наименьшая и наибольшая	м/с 9
Транспортная скорость наименьшая и наибольшая 10	км/ч 11
Число скоростей: 12	
13 ковшовой цепи (ротора), отвального устройства, рабочего хода, транспортного хода	—
Удельное давление движителей на грунт в рабочем положении 14	кГ/см^2 15
Преодолеваемый подъем пути в работе на подъемах и косогорах 16	град 17
Преодолеваемый подъем пути на транспортном ходу на подъемах 18 и косогорах	
Габариты в транспортном положении (длина, ширина, высота) 19	мм 20
Вес, не более 21	т 22

1) Parameters; 2) units of measurement; 3) engine rating; 4) HP; 5) ditch depth; 6) meters; 7) ditch width; 8) moving speed while working lowest and highest; 9) meters/hour; 10) road speed lowest and highest; 11) kilometers/hour; 12) number of speeds of the:; 13) bucket chain (rotor), unloading device, working speed, road speed; 14) specific pressure of wheels or tracks on the soil in operating position; 15) kg/cm^2; 16) road grade overcome when working on slopes and inclines; 17) degrees; 18) road grade overcome when transporting itself on slopes and inclines; 19) overall dimensions in traveling position (length, width, height); 20) mm; 21) weight, not more than; 22) tons.

axle arrangement, etc.

The parametric series for bulldozers (Table 29) has its peculiarities: these are mounted-type machines, aggregated with wheel or track tractors. For this reason the parameters of the mounted units are determined from relationship with the tractor engine capacity, which is the main parameter of a bulldozer.

The required productivity of a bulldozer is characterized by the amount of soil or other materials it displaces per unit time, which is

determined by the length and height of the scoop and its penetration below the level of the bearing surface of the tracks. The height to which the scoop can be lifted determines conditions necessary for felling of trees by the bulldozer.

The choice of the main parameters of road surfacing rollers is predetermined by the method by which they are moved (Table 30). The roll dimensions are characteristic for trailing rollers and the engine rating is the characteristic for self-propelled rollers. For a given operational speed these parameters determine the productivity of the rollers. A second parameter is the weight of the rollers, which is determined on the basis of the required packing of road foundations and surfaces. The roll weight is also related to the linear specific pressure per 1 cm of its width. For pneumatic semitrailing rollers, aggregated with tractors, the highest load on roller axle is specified alongside with the roll weight. To ensure design refinement of the standardized rollers their weight is given with and without ballast. The productivity of self-propelled rollers determines their working and road speeds. The operational conditions are determined by the turning radius, overlapping of the roll trail on each side and other indicators.

Parameters of gravel washers and gravel washer-sorters are given in Table 31. Their parameter nomenclature takes into account their design features and productivity. The parameter nomenclature for piston-type cement pumps is constructed in a similar manner (Table 32).

The tables which we presented characterize the optimal content of parametric standards for many kinds of machines of various character, differing by their design and utilization conditions. But all of them are constructed on the basis of certain main parameters and include that minimum of technical indicators which is necessary and at the same time sufficient for determining the characteristic of the machine or

TABLE 28

Parameters of Graders

1 Параметры	2 Размерность	3 Грейдеры: 4 Самоходные	5 Прицепные	6 Грейдер-элеваторы прицепные
Мощность двигателя 7	8 л. с.	×	—	×
Давление на единицу длины ножа, не менее 9	10 кг/м	×	—	—
Длина отвала с удлинителем и без удлинителя 11	12 мм	×	×	—
Высота отвала (с ножами), не менее 13	12 »	×	×	—
Производительность при непрерывной работе, не менее 14	15 м³/ч	—	×	—
Пределы изменения угла ножа отвала 16	17 град	×	—	—
Угол наклона ножа к горизонту при планировке откосов и срезке косогоров 18	»	×	×	—
Номинальный угол захвата при работе правым и левым концом ножа 19	»	—	×	—
Опускание ножа ниже уровня, не менее 20	мм 12	×	—	—
Дальность отброса от режущей кромки ножа 21	22 м	—	—	×
Наибольшая высота выгрузки 23	»	—	—	×
Вылет элеватора от наружной кромки колеса при небольшом подъеме, не менее 24	»	—	—	×
Ширина ленты элеватора 25	мм 12	—	—	×
Скорость ленты элеватора 26	м/сек 27	—	—	×
Наибольшее потребное тяговое усилие 28	кг 29	—	×	×
Диаметр диска плуга 30	мм 12	—	—	×
Вертикальный просвет 31	»	×	×	×
Скорости движения 32	км/ч	×	—	—
Колесная формула 34	33	×	—	—
Радиус поворота по внешнему переднему колесу, не более	12 мм	×	—	—
Рекомендуемые типы тягачей (трактор-)	—	—	×	—
Давление на единицу длины ножа	38 т/м	—	×	—
Вес (конструктивный) с рабочим оборудованием, не более	40 кг	×	×	×
Удельный вес, отнесенный к единице оборудования	кг/м²/ч 42	—	—	×

1) Parameters; 2) units of measurement; 3) graders; 4) self-propelling; 5) trailing; 6) trailing elevator graders; 7) engine rating; 8) HP; 9) pressure per unit knife length, not less than; 10) kg/meter; 11) length of moldboard with and without extension; 12) mm; 13) moldboard height (with knives), not less than; 14) output on continuous operation, not less than; 15) meters^3/hour; 16) limits within which the angle of the moldboard knife can be varied; 17) degrees; 18) angle the knife makes with the horizontal when leveling slopes and cutting off inclines; 19) nominal coverage angle when working with the right and left knife edge; 20) lowering of knife below the level, not less than; 21) distance of throw from the knife's cutting edge; 22) meters; 23) greatest unloading height; 24) elevator from the external edge of wheel on a moderate grade, not less than; 25) width of elevator belt; 26) elevator belt speed; 27) meters/sec; 28) greatest pulling force required; 29) kg; 30) diameter of plow disk; 31) vertical clearance; 32) moving speed; 33) kilometers/hour; 34) axle arrangement; 35) radius of rotation of the external front wheel, not more than; 36) recommended tractor types; 37) pressure per unit knife length; 38) tons/meter; 39) weight (design)

with working equipment, not more than; 40) kg; 41) specific weight, referred to unit equipment; 42) kg/meter^2/hour.

TABLE 29

Bulldozer Parameters

1 Параметры	2 Размерность
Мощность двигателя	4 л. с.
Тип трактора	—
Скорости движения (от до)	7 км/ч
Длина отвала без удлинителя и с удлинителем	9 мм
Высота отвала без козырька и с козырьком	•
Высота подъема отвала над опорной поверхностью гусениц	•
Величина заглубления отвала ниже опорной поверхности гусениц	•
Угол поворота отвала в горизонтальной плоскости	14 град
Угол перекоса отвала в вертикальной плоскости	•
Вес бульдозерного оборудования с трактором, не более	17 т

1) Parameters; 2) unit of measurements; 3) engine rating; 4) HP: 5) tractor type; 6) moving speed; 7) kilometers/hour; 8) scoop length with and without extension; 9) mm; 10) scoop height with and without lip; 11) height to which the scoop can be raised over the bearing surface of the tracks; 12) penetration depth of scoop below the bearing surface of the tracks; 13) angle of rotation of the scoop in the horizontal plane; 14) degrees; 15) angle of inclination of the scoop in the vertical plane; 16) weight of the bulldozer equipment with tractor, not more than; 17) tons.

equipment type. In the majority of cases these are stable indicators which are rationally placed together with indicators requiring peiodic revision, since they influence the progressiveness of machines produced according to these standards and their quality.

The parameter nomenclature and parametric standards constructed on their basis should be revised in accordance with prescribed procedures every five years. Then the USSR state standards will always conform to the existing level of world science and technology.

TABLE 30

Parameters of Road Surfacing Rollers

Параметры 1	Размерность 2	3 Катки: Самоходные вибрационные с гладкими жесткими вальцами 4	Самоходные статического действия с гладкими жесткими вальцами 5	Прицепные гладкие и кулачковые 6
Мощность двигателя 7	л. с. 8	×	×	—
Конструктивный вес катка: 9				
10 с балластом	т	×	×	×
без балласта 12	11 »	×	×	×
Число осей 13	—	×	×	—
Общее количество вальцов 14	—	×	×	—
ведущих 15	—	×	×	—
направляющих 16	—	×	—	—
вибрационных 17	—	×	—	—
ведомых 18	—	—	×	—
Диаметр вальцов 19	мм			
ведущих 15	20 »	×	×	—
направляющих 16	»	×	—	—
вибрационных 17	»	×	—	—
ведомых 18	»	—	×	—
без кулачка 21	»	—	—	×
с кулачком 22	»	—	—	×
Ширина вальцов 23	»	×	×	×
Перекрытие следа вальцов с каждой стороны, не менее 24	27 »	×	×	—
Ширина уката 25	»	×	×	—
26 Удельное линейное давление ведущих вальцов	кг/см	×	×	—
То же без балласта и с балластом 28	»	—	—	×
Скорости движения: 29	31			
рабочие 30	км/ч	×	×	—
транспортные 32	»	×	×	—
Радиус поворота по внутреннему следу, не более 33	20 мм	×	×	—
Число колебаний вибратора в минуту 34	36	×	—	—
Наибольшее потребное тяговое усилие (для одного и нескольких сцепленных катков) 35	кг	—	—	×
Рекомендуемые типы тягачей (тракторов) 37	—	—	—	×

1) Parameters; 2) units of measurements; 3) rollers; 4) self-propelling vibrating with smooth rigid rolls; 5) self-propelling static action with smooth rigid rolls; 6) trailing smooth and cam-type; 7) engine rating; 8) HP; 9) design weight of roller; 10) with ballast; 11) tons; 12) without ballast; 13) number of axles; 14) total number of rolls; 15) driving; 16) guiding; 17) vibrating; 18) driven; 19) roll diameter; 20) mm; 21) without cam; 22) with cam; 23) roll width; 24) overlapping of roll trace from each side, not less than; 25) packed width; 26) specific linear pressure of driving rolls; 27) kg/cm; 28) the same as above without and with ballast; 29) moving speeds; 30) working; 31) kilometers/hour; 32) road; 33) turning radius for the internal trace, not more than; 34) vibrator vibrations per minute; 35) greatest pulling force required (for one and several collected rollers); 36) kg; 37) recommended tractor types.

TABLE 31

Parameters of Cylindrical Gravel Washers and Gravel Washer-Sorters

1 Параметры	2 Размерность	3 Гравемойки	4 Гравемойки-сортировки
5 Производительность, не менее	м³/ч 6	×	×
7 Размеры внутреннего цилиндра (диаметр и длина)	мм 8	×	×
9 Диаметр отверстий сортировочных секций внутреннего и внешнего цилиндра	»	—	×
10 Максимальный размер кусков исходного материала в наибольшем измерении	»	×	×
Объемный вес исходного материала 11	т/м³ 12	×	×
Мощность электродвигателя, не более 13	квт 14	×	×
Удельный вес (вес, отнесенный к единице производительности) 15	16 кг/м³/ч	×	+
Вес без электрооборудования, не более 17	кг 18	×	×

1) Parameters; 2) units of measurement; 3) gravel washers; 4) gravel washer-sorters; 5) output, not less than; 6) meters^3/hour; 7) dimensions of the internal cylinder (diameter and length); 8) mm; 9) diameters of sorting section holes of the internal and external cylinder; 10) maximal largest dimension of starting material pieces; 11) specific gravity of starting material; 12) tons/meter^3; 13) rating of electric motor, not more than; 14) kwt; 15) specific weight (weight referred to unit output); 16) kg/meters^3/hour; 17) weight without electrical equipment, not more than; 18) kg.

TABLE 32

Parameters of Reciprocating Cement Pumps

Параметры 1	2 Размерность
Производительность, не менее 3	4 м³/ч
5 Наибольшая дальность подачи по горизонтали (при прямолинейном бетоноводе) по вертикали	м 6
7 Наибольший размер кусков гравия в бетонной смеси	8 мм
Емкость бункера смесителя 9	м³ 10
Диаметр цилиндра, не менее 11	8 мм
12 Мощности электродвигателей главного привода, привода смесителя и привода побудителя	13 квт
14 Вес бетононасоса без электродвигателя и без комплектующего оборудования, не более	15 кг
Трубы бетоновода: 16	
наружный диаметр, не более 17	8 мм
18 толщина стенки, не более	»
Удельный вес (вес, отнесенный к единице производительности), не более 19	кг/м³/ч 20

1) Parameters; 2) units of measurement; 3) output, not less than; 4) meters^3/hour; 5) greatest horizontal delivery distance (for a rectilinear cement pipeline), vertical; 6) meters; 7) greatest dimension of gravel pieces in the cement mix; 8) mm; 9) capacity of mixing hopper; 10) meters^3; 11) cylinder diameter, not less than; 12) rating of the main drive motor; mixer motor and exciter motor; 13) kwt; 14) cement pump weight without the electric motor and without supplementary equipment, not more than; 15) kg; 16) cement pipeline pipes; 17) outside diameter, not more than; 18) wall width, not more than; 19) specific weight (weight referred to unit output), not more than; 20) kg/meter^3/hour.

3. USE OF PREFERENCE NUMBERS IN PARAMETRIC STANDARDS

The nomenclature of parameters included in a standard determines its content, so to speak, in the vertical direction. In the horizontal direction tables of dimensional series and parametric standards contain numerical values of each parameter thus creating specific series. The setting up of these series is substantially facilitated by the use of the preference numbers system. Despite the fact that the preference numbers exist for a long time, they are not as yet used on a sufficient scale in machine design. A certain even negative attitude toward preference numbers is making itself felt, which can be due to a number of factors, namely:

1. The scientific and technological propaganda of the experience of more extensive utilization of preference numbers based on geometric progression is very weak.

2. Geometric series in their classical ("pure") form do not always give the desired distribution of parameter values over the entire series (small discontinuities between adjacent terms at the beginning of the parametric series and very large discontinuities at the end of the same series).

3. The actual values of preference numbers in a number of cases are different than usual rounded off numbers. For example: electric motor rating 71, rather than 70 kwt; lifting capacity of crane 16, rather than 15 tons; load carrying capacity of truck 6.3, rather than 7 tons; automobile motor rating 63, rather than 60 HP; road clearance 355 rather than 350 mm, etc.

4. The true relationship of numerical values of a series for a specific main parameter, expressed in terms of preference numbers, with other major or auxiliary parameters included in the same parametric standard, has not as yet been studied.

5. Economic substantiation of the advantages of one geometric series as compared with another creates difficulties for the designers, due to the absence of a reliable and convenient methodology of technico-economic calculations which do not require collection of a large amount of starting data or the setting up of preliminary net cost calculations.

6. Undervaluation of the role played by mathematics in standardization processes; insufficient participation of mathematicians (with university-level education) in standardization work; absence of investigation of the field of mathematically substantiated various derived and mixed series.

7. Absence, in standardization plans, of any research efforts for the creation of a more refined preference numbers system, free of the basic shortcoming of geometric series (this work was already begun in England).

All the above factors influence the scale on which the existing system of geometric series of preference numbers is utilized, despite its international acclaim. Successful utilization of this system requires finding and substantiation of derived and mixed series, eliminating to a certain degree, and in certain cases also entirely, the organic shortcoming of the classical geometric series.

Below we present short remarks on the manner in which the problems of the use of preference numbers were solved in the elaboration of individual existing parametric standards for machines and equipment.

In standardizing parameters of stationary and marine diesel engines use was made of series of nominal ratings of one cylinder, which are different for two-cycle and four-cycle engines. These series are presented in Table 33. They are based on numbers included in the R10 series, but ratings of 60, 300, 450 and 600 brake horsepower are based

on the R10 series. Of the 38 standardized ratings of the general series for two-cycle and four-cycle diesels 16 values pertain to series R10,

TABLE 33

Series of Nominal Ratings for one Cylinder

1 Тип дизеля	2 Мощность дизеля в одном цилиндре в э. л. с.													
	5	20	25	40	50	60	100	125	200	250	300	400	450	600
3 Двухтактный	—	×	—	×	—	×	—	×	—	×	—	×	—	×
4 Четырехтактный	×	—	×	—	×	—	×	×	×	—	×	—	×	×

1) Type of diesel; 2) diesel rating for one cylinder in brake horsepower; 3) two-cycle; 4) four-cycle.

12 values correspond to series R40, four values are taken from the supplementary R80 series and the remaining six values are not included in the preference numbers system. The picture is the same for individual (not general) series of two-cycle and four-cycle diesel ratings, except that about half of the values in each of them corresponds to the R10 series. This is primarily due to the additional inclusion in the standard, during approval, of several types of actually produced absolescent design diesel. This [design] inheritance could not but have its effect on the orderliness of the parametric series.

Insignificant divergences of the ratings established by the standard with the closest values of preference numbers (300 and 315, 360 and 355, 3200 and 3150, 1200 and 1250, 4800 and 4750 BHP) show that the utilization of preference numbers is feasible. However, these individual corrections do not eliminate the basic shortcoming of the parametric series for diesels. The rating series of the standard can be revised advantageously and brought into conformance with the R10 series.

The expedience and feasibility of a certain compression of the parametric series for diesels can be proven in the following manner. The parametric standard pertains to low-speed and high-speed four and two-cycle diesels; here the low-speed category pertains to engines with

average piston speeds up to 6.5 meters/sec, and the high-speed category – to engines with average piston velocity of 6.5 meters/second and higher. Parameters of diesels are presented in Table 34.

TABLE 34

Parameters of Diesels

Параметры 1	Размерность 2	3 Быстроходные		4 Тихоходные	
		Двухтактные 5	Четырехтактные	Двухтактные 5	Четырехтактные 6
7 Средняя скорость поршня не менее	м/сек 8	4,25	5.0	6,5	6,5
9 Среднее эффективное давление не ниже	кГ/см² 10	4,2	5,2 С наддувом 7,0	4,5	5,5 С наддувом 7,0
13 Удельный вес дизелей . . . (не более): 12	кг/э. л. с.	—	40	—	11—
14 тронковых		35	—	—	—
15 крейцкопфных		55	—	—	—
16 с числом оборотов до 1000 об/мин		—	—	15	
17 то же, свыше 1000 об/мин		—	—	12	

1) Parameters; 2) units of measurement; 3) high-speed; 4) low-speed; 5) two-cycle; 6) four-cycle; 7) average piston speed, not less than; 8) meters/sec; 9) mean effective pressure, not lower than; 10) kg/cm^2; 11) with supercharging 7.0; 12) specific weight of diesels (not more than):; 13) kg/BHP; 14) trunk; 15) crosshead; 16) up to 1000 rpm; 17) over 1000 rpm.

The general parameters for all diesels independent of their speed and the number of cycles, are the specific fuel consumption and also the cylinder diameters. The specific fuel consumption is established for diesels with up to 750 rpm as not more than 185 grams/BHP-hour; with 750-1500 as not more than 200 grams/BHP-hour and with 1500 and more rpm as not more than 220 grams/BHP-hour. Cylinder diameters are specified for all diesel types: 60, 65, 85, 100, 105, 110, 130, 140, 150, 160, 165, 170, 180, 190, 220, 230, 240, 250, 280, 300, 320, 340, 360, 400, 430, 470, 500,530, 560, 600, 650, and 700 mm. The standard diesel ratings are increased by increasing the mean effective pressure by supercharging or by increasing the standard rpm by 15% or by decreasing them by 40% or even more upon agreement between the consumer and manufacturer.

In addition to the above parameters and characteristics the standard permits a number of agreements and additions which effect the standard parameters. Thus, for example, the mean effective pressure for two-cycle diesels with crankcase ventilation should not be less than 2.7 kg/cm^2 and the specific weight not higher than 45 kg/BHP. Upon obtaining the consent of the consumer a number of diesel types can be made as four-cycle, and certain four-cycle diesels can be produced with five, seven or nine cylinders. The average pistor. speed for diesels (high-speed) with opposed pistons should not be less than 5.5 meters/sec. Lowering of the mean effective pressure by 15% is permitted for a number of diesel types. The specific weight for high-speed one and two cylinder diesels is taken as not more than 18 kg/BHP. It is permitted to increase the specific fuel consumption for one and two cylinder diesels by 10% and for diesels with prechamber carburation – by 5%.

The principal shortcoming of the above parametric standard is the fact that the number of diesel types and their standard sizes provided for in it is excessively large. The standard does not conform with the actual capacity of the diesel industry and does not promote concentration of diesel manufacture and more profound specialization of diesel-producing plants of the USSR. The parametric series as a whole includes only 22 diesel types, but this is only formal. Practically, many more types exist since all the high-speed diesels can be four as well as two-cycle. In addition, certain portions of diesels can be manufactured as reversible and nonreversible. Taking into account the number of cylinders the reversibility and cycle option, etc., the actual number of standard sizes of standardized diesels can comprise 189, and taking into account production of diesels with lowered mean effective pressure this number can be about 200.

The question can be raised: is it necessary for our country, even

taking into account future prospects, to have such a number of standard diesel sized and is it possible to efficiently produce them at specialized plants, using the present-time equipment? The answer to this question must be negative.

In order for the parametric standard for diesels to stimulate, to the highest degree, the creation of well equipped high-productivity diesel-producing plants, specializing in the output of certain families (modifications) of diesels, it is necessary to elaborate a new parametric standard, taking into account the actual need for diesel types for the coming 15-20 years and the feasibility of deeper unification of structural elements of these engines on the basis of the R10 series of preference numbers.

If we turn to the machine-tool building field, then here we have a considerable number of parametric standards based on the preference numbers system.

The parametric series for multispindle bar stock horizontal automatic lathes includes eight standard sizes.

The series has been constructed for the following largest diameters of machined bar stock: 25, 32, 40, 50, 65, 80, 100 and 125 mm, i.e., on the basis of the R10 series with dimensions 31.5 and 63 rounded off to 32, and 6 . It is characteristic that the system for the unification of subassemblies and components used here provides for increasing the bar stock diameter by one degree for four-spindle lathes in comparison with the basic six-spindle lathes for which the dimensional series of 25, 40, and 65 mm has been assumed, while the dimensional series 32, 50 and 80 has been assumed for four-spindle automatic lathes unified with them, which increases the operational capabilities of the latter (for the same weight and cost).

The goal put forward in creating the parametric series of horizon-

tal boring machines was to ensure optimal satisfaction of the needs of all machine building branches for general purpose machine-tools of the same type, created on the basis of six basic types of machine tools of the given parametric series by virtue of extensive unification of their subassemblies and components.

The main parameter series for horizontal boring machines (diameter of standard movable spindle 65, 90, 125, 160, 220 and 320 mm) is constructed on the basis of the nonstandard common ratio of the geometric pressure 1, 41, i.e., intermediate for R5 and R10 series. However, the values of main parameters are relatively close to preference numbers provided for by the R10 series. The overwhelming number of machined components has smaller overall dimensions and these components are placed in the boring machine depending on the diameter of its spindle, i.e., on the vibration resistance ensured for the given overhang and hole diameters being bored. This also accounts for the fact that the basic parameter for boring machines is the spindle diameter. The weight of boring machines can be substantially lowered by adapting reinforced spindles; this, for example, enables the consumer to replace a part of boring machines with spindle diameter of 90 mm and weihing 12-13 tons by boring machines with a reinforced 80 mm spindle (on the basis of machines with a 65 mm standard spindle) weighing 6-6.5 tons, and to replace a part of machines with a 220 mm spindle, weighing about 100 tons by machines with a reinforced spindle on the basis of 160 mm machines weighing 30-40 tons.

The main parameter describing the type range of boring machines and enabling the consumer to judge their production process capabilities is the diameter of the movable spindle. The spindle diameter series according to DIN 63, 80, 100 and 125 mm corresponds to R10; the series 50, 63, 80, 100, 125, 160, 200, 250 and 320 mm given by Czech-

Czechoslovakian and English standards correspond to the same R10, but with deviations (5.3 instead of 5.15 mm). The same series is given in the encyclopedic handbook "Machine Building." The basic parameters are dimensions of components which are classified as functions in the machine tool. These dimensions are usually related to displacements of the tables, supports and the spindle ram. They were chosen from among preference numbers, provided for, the R0 series.

The axial displacement of the spindle was based on the R10 series. The vertical stroke of the spindle ram, as far as possible, selected from standard numbers. The working surface of the lower tables (with a stationary tool support) in relation with the smallest and largest sides of basic tables is described by the R10 series.

The parameters of turret lathes were selected in accordance with the R10 series and include the following standard dimensions for the greatest [illegible] 1000, 1250, 1600, 2000, 2500, 3200, 4000, 5000, 6300, 8000, 10,000 and 20,000 mm. Only one dimension (6300 mm) does not correspond to the R10 series, where the closest preference number is 6300. By the completeness with which the standard covers turret lather, the parametric series adopted in USSR is without precedent in foreign standardization. This parametric series provides the necessary prerequisites for extensive unification of subassemblies and components. For example, with the total number of 16 versions of the lathes, the series of highest blanks machined comprises 4 (making possible unification of supports), the number of gradations of greatest machined components weights is 14 (making possible unification of foundations), etc.

The basic parameter characterizing production capabilities of turret lathes (by analogy with other similar standards) are the greatest dimensions of components machined in the lathe, the greatest diameter of

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machined workpiece and its height). These limiting dimensions to a certain extent determine the overall dimensions of the lathes (distance between supports and support height for two-support and the support height for single-support lathes). The basic parameters also include the chuck diameter which for the most part corresponds to the R10 series. The height machined workpieces are also established according to the R10 series. With the purpose of making possible unification, the height of workpieces has been set identical for a pair of adjacent lathes.

TABLE 35

Parametric Series of Forging Hammers

1													
Номинальный вес падающих частей, в т	0,63	1,0	1,6	2,0	2,5	3,15	4,0	5,0	6,3	8,0	10,0	12,5	16,0
2 Эффективная кинетическая энергия падающих частей при полных последовательных ударах в кгм, не менее	1550	2500	4000	5000	6200	7800	10 000	12 500	15 500	20 000	25 000	31 200	40 000

1) Nominal weight of falling parts in tons; 2) effective kinetic energy of falling parts for complete successive impacts in kg-meters, not less than.

The parametric series of forging steam and air hammers established by the existing standard can also be of some interest. The derived series of nominal weights of falling parts was constructed on the basis of the R10 series with selection of each second term in its beginning portion (i.e., omitting values 0.8 and 1.25).

The parametric series of horizontal forging machines provides for the following nominal forces: 100, 160, 250, 400, 630, 800, 1000, 1250, 1600, 2000, 2500, and 3150 tons. This corresponds to the derived R10 series with each second term selected in the initial portion of the parametric series. The dimensional series determining the stroke of the moving die is characterized by a nonordered series, close to R10, but

including several terms which do not at all correspond to preference numbers.

The picture for the several standards for presses which we have analyzed is similar.

The parametric series of twin-crank closed double-action presses includes the following nominal forces of the internal and external sliders: 100, 160, 200, 250, 315, 400, 500 and 630 tons; this is the R10 with the 125 term missing. The parametric series of twin-crank open direct-action presses is 40, 63, 100, 160, 200, 250, 315, 400 and 500 tons; this is the derived R10 series with each second term selected in its initial portion.

The parametric series of sheet-metal stamping direct action hydraulic presses with an individual drive includes 100, 160, 250, 400, 630, 1000, 1600 and 2000 tons; this is a mixed series, where the first six terms correspond to the R5 series and the last two are from the R10 series. The nominal forces of sheet-metal bending presses with a horizontal crank form the series 25, 40, 63, 100, 160, 250, 315, 400 and 500 tons, i.e., this is also a mixed series having at the beginning six terms from the R5 series and at the end three terms from the R10 series.

The parametric series of straightening direct action hydraulic single-frame presses with an individual drive includes the nominal forces 10, 16, 25, 40, 63, 100, 160 and 250 tons; this is the R5 series. Finally, the nominal forces of coining crank-type presses form the parametric series 63, 100, 160, 250, 400, 630, 800, 1000, 1250, 1600, 2000, 2500 and 3150 tons, where the first four terms are characteristic of the R5 series and the remaining seven terms come from the R10 series, i.e., in the given case a mixed series with preponderance of dimensions from the R10 series has been standardized.

The main parameter (nominal force for any crank position) of closed

shears for cutting of blanks comprises the series 40, 63, 100, 160, 250, 400, 630, 1000, and 1600 tons, which corresponds to the R5 series. The series of greatest dimensions of blanks being cut (diameter of circle) includes: 40, 50, 63, 80, 100, 125, 160, 200 and 250 mm; this fully corresponds to the R10 series.

The parametric series of twin-disk single-frame shears with inclined blades is constructed on the basis of the thickness of the sheet being cut or flanging and bending (Table 36). Here, the last three terms for the parameter describing cutting pertain to the R10 series and the first five terms belong to the R5 series; this entire series has been derived from the R10 series by choosing each second term at the beginning of the series. The parameter pertaining to flanging and bending has also been based on the derived R10 series, whose first half was obtained by selecting each second term. The values 1.3, 3 and 12 which were also included to not correspond to preference numbers.

The greatest diameters of wire processes by universal bending automatic machines form the series: 0.8, 1.2, 3.2, 5, 6.3, 8. 10, 12.5, and 16 mm. This is a derived R10 series.

TABLE 36

Parametric Series of Shears

1 Толщина листа в мм	2 Резка	1,6	2,5	4,0	6,3	10	16	20	25
	3 Отбортовка и гибка	1,3	2	3	5	8	10	12	16

1) Sheet thickness in mm; 2) cutting; 3)flanging and bending.

Thread generating automatic lathes with plane taps are described by parametric series for the largest and smallest diameters of thread they generate (Table 37). These series correspond to the nonordered derived R10 series. The parametric series for nut cold upsetting automatic machines (greatest nut thread diameters 8, 12, 16, 20 and 27 mm)

has been constructed in an analogous manner.

TABLE 37

Parametric Series of Thread-Generating Automatic Lathes

1 Диаметр резьбы	2 Наибольший	2,6	4	6	10	12	16	20	25
	3 Наименьший	2	2,6	4	6	8	10	12	16

1) Thread diameter; 2) largest, smallest.

TABLE 38

Parametric Series of Cold Upsetting Automatic Machines

1 Автоматы	2 Наибольший диаметр стержня в мм								
	2.6	4	6	8	10	12	16	20	25
Одноударные:									
с цельной матрицей	×	×	×	×	×	×	×	×	—
с разъемной матрицей	×	×	×	×	×	×	×	×	—
Двухударные:									
с цельной матрицей	—	×	×	×	×	×	×	×	×
с разъемной матрицей	—	×	×	×	×	×	×	×	×
Обрезные	—	—	×	—	×	—	×	—	×

3 4 5 6 7

1) Automatic upsetters; 2) largest bar stock diameter in mm; 3) single-impact; 4) with a solid die; 5) with a split die; 6) double-impact; 7) trimming.

Spring winding automatic machines are described by the diameters of wire they wind: 0.8, 1.6, 2.5, 4, 6.3, 10 and 16 mm; this is the R10 derived series.

Parametric series of automatic cold upsetters are given in Table 38. All of them correspond to derived series with deviations from the standard values of preference numbers (2.6, 6 and 12 mm). The largest diameters of nail bar stock for automatic wire nail machines form the series 1.2, 2, 3, 4, 5, 6, and 8 mm, which corresponds to the R10 derived series, a portion of whose terms does not correspond to the values of preference numbers.

4. GENERAL RECOMMENDATIONS ON THE CHOICE OF THE R10 SERIES OF PREFERENCE NUMBERS

The choice and substantiation of the expedient preference number series R5, R10, R20 or R40 for constructing a parametric standard for the given machines or equipment involves at the present time substantial difficulties since it requires complex and labor consuming economic substantiations.

Above, as examples of the use of preference numbers series, we have considered certain existing parametric standards for various machines and equipment. By their designs, functional intent, production scales and operational conditions these are different objects of machine building, but almost in all cases their parametric series have been constructed either on the basis of the R10 series or its derivative series, or on nonordered series, but closest to values of preference numbers contained in the R10 series. This creates a basis for the assumption that the R10 series (and its derivatives) is at the present time the most widely used and expedient for constructing dimensional series and parametric standards for machines and equipment needed by the national economy, taking into account its development prospects.

But questions may be raised. Would not the basing of dimensional series and parametric standards on the R10 series and its derivatives result in a rapid loss of their perspectiveness? Should we not, in order to ensure considerably greater perspectiveness of dimensional series and parametric standards, already begin the use of the R20 series (and its derivatives), as giving twice the number of standard dimensions for the range of end values of the series? The answer to these questions must be negative for the following reason.

The experience acquired in the use of parametric standards shows that the almost exclusive reason for their revision was the necessity

of extending the limits (range) of the parametric series. The gigantic development of production forces requires the adoption of increasingly more powerful and more productive machines, and this effects the necessity for extending these series in the direction of increasing parameter values. At the same time the instrument-making and precision mechanics field, which requires small-size equipment, is also expanded, and this requires a corresponding expansion of series in the direction of decreasing values of main parameters.

The parametric series thus spread out their boundaries either in one or in both directions, but the number of the series will remain the same. This trait is characteristic for practically all branches of the machine building and can be verified by the following examples. The extreme limits of tractor ratings are modified in both directions, since the need arises for high-power tractors for the steppe regions as well as for low-power tractors for orchards and vineyards. In exactly the same manner there is a need for small trucks and giant dump trucks. Increasingly higher outputs are required ofearthdigging machine , alongside with small machines for city maintenance work, etc.

However, cases are known when parametric standards have been recalled for another reason, i.e., due to an insufficiently developed type range of objects within the limits of the end values of the main parameter. These standards only provided for basic (general purpose) types of objects and did not provide expedient solutions with respect to the development of the type range of modifications (versions).

Alongside with the increasing need for machines and equipment with very small and very large typical sizes, an even greater need exists for special purpose modifications, and this need increases continuously as integrated mechanization and automation of production is achieved.

The use of special purpose machines and equipment is more effec-

tive for ensuring a substantial increase in the productivity of labor than the use of intermediate standard dizes of general-purpose machines and equipment. For this reason it is more expedient to develop the type range of special purpose machines and equipment on the basis of design-unified series based on the R10 series, and not be creating intermediate standard sizes of general purpose machines on the basis of the R20 series.

Subsequent work for creation of dimensional series for machines and equipment and also of parametric standards for many objects of machine building not yet subjected to standardization will make it possible to accumulate a large volume of material on the actual use of preference numbers series. But at the present time it is expedient to be guided by the R10 series and its derivatives. This will make it possible to considerably accelerate the work of design and scientific research organizations in creating new equipment for all branches of the national economy.

Chapter 9

STANDARDIZATION OF QUALITY REQUIREMENTS PUT TO MACHINE-BUILDING PRODUCTS

The establishment of requirements with respect to the quality of machine-building products is one of the basic and most complex standardization problems. Despite the obvious differences in the purposes served by individual varieties of standards, all of them are related to the establishment of some quality characteristics, parameters and other requirements.

Actually, parametric standards for a number of types of machines and other products needed by the national economy include indicators which directly define the operational qualities of the produced machines, mechanisms, equipment and their conformance with the present day level of world technology.

Standards of technical requirements are devoted entirely to the problem of ensuring the output of high-quality goods. For this purpose they establish various requirements with respect to the materials used, heat treatment and casehardening, surface finish quality, hardness and other properties of components, the necessary plating, requirements to final adjustments, painting, etc. These standards also establish requirements to assembly, preservation, packing, transportation and storage. Many of these requirements and indicators are very specific, but some of them are conventional. The latter include, for example, indicators establishing the guarantee periods.

Interchangeability standards, establishing general norms for ensuring proper mating of parts without additional manual adjustments, also contain requirements for quality conformance.

The concept "quality", as well as certain other standardization concepts, has not as yet been established.

1. GENERAL PRINCIPLES FOR ESTABLISHMENT OF QUALITY INDICATORS

Several basic indicators, which to the most important extent influence the quality and external appearance, the productivity of labor in producing the given type of goods and the effectiveness with which the equipment is used, can be established for each kind of products. Very serious problems face the field of systematic improvement of quality of the machines which in the general form is characterized by the necessity of increasing their service life and operational reliability. The requirements with respect to ensuring equal strength are controversial, although this is a problem of great practical importance, since a not sufficiently long service life of some minor component requires partial dismantling of the machine, thus idling it. For example, it is frequently necessary to dismantle tractor engines in order to replace the rapidly wearing piston rings, while all other components are still in good operating condition.

It is assumed that of special significance in the task of increasing quality of machines are the problems of improving the precision of component fabrication and assembly. However, it is not always possible to improve the quality of machines by increasing the precision of fabrication of individual components only. Each step in this direction should be thoroughly studied and justified in the economic respect. Increasing the precision of components, as a rule, involves increasing labor input for their fabrication and increased production expenses. In each case, it is necessary to make an objective

economic estimate of the rationality of proposed solutions before they are made into law by technical documentation.

For example, precision norms for metal-cutting machine-tools are established by state standards, but these standards may not contain rigidity norms. As a result, very precise and, therefore, very labor consuming machine-tools may not ensure the required precision of work-pieces machined on them. For this reason, standards should establish interrelated precision and rigidity norms.

Products quality indicators are included in state standards and in certain normal standards and also in branch, plant and other technical specifications. However, the methodology of standardization of quality requirements that has been evolved has substantial shortcomings. For example, the question of choice of choice of limiting norms and of the range of technical characteristics and paramete.s is, sometimes, solved without sufficient substantiation and without use of mathematical methods; a disparity is observed between the indicators specified in standards and those properties which the products for which the standards are promulgated actually possess. The standards and normal standards do not, as yet, employ to a sufficient degree scientifically substantiated testing methods and also do not use analysis of numerical characteristics obtained by them. In a number of cases, drafts of new standards are examined and agreed upon on an improper basis.

The system that has been evolved provides for the inclusion in standards of a section "Technical Requirements" (in a number of cases, this section is formulated as a separate standard), which lists the technical characteristics of products being standardized and their numerical values pertaining to different product brands or materials grades. Here, it is usually pointed out that the numerical value of

the standardized characteristic must be a) not higher than a specified value b) not lower than this value and c) in the specified interval of values. Formulated in this manner, tables of technical characteristics make the stabilization and differentiation of products by groups of properties entirely impossible in a number of cases.

Production of goods with unstable, varying properties, lowers to a considerable extent the effectiveness of flow production and interferes with the normal operation of automatic lines. The instability of materials properties in many cases prevents automation of the production process and adaption of progressive production processes in machine-building and instrument-making. Such shortcomings arise as a result of underestimating the fact that the property of goods established by the standards is determined by the technical characteristic related to this property, which must also be quantitatively estimated. However, this necessary specification is frequently found unachievable. This is due to the fact that quantitative estimates of indicators are characterized, as a rule, by distribution curves, which circumstance is not always taken into account. Consequently, in order to more correctly reflect the properties of mass production in the state standard, it is necessary to more extensively utilize mathematical statistics methods.

Under particular, specific, conditions it is possible to arrive at various solutions, since it is necessary to take into account:

a) the technological level achieved by the industry;

b) the degree to which the relationships between technical characteristics of goods introduced into the standard draft and their actual properties has been investigated;

c) methods for determining the total assemblage of characteristics;

d) availability of facilities and feasibility of subdivision of these ensemblages into parts, etc.

It is in comparatively rare cases that the above ensemblage of problems and their interrelation is statistically investigated in elaboration of product quality standards. As a result, indicators are sometimes established by standards without being substantiated by techno-economic considerations. Stability of standards and the length of time during which they are in force depends, to a large extent on the proper choice and interrelation between parameters included in the standard. All this applies to normal standards as well.

The significance, on principle, of statistical methods is not limited to their utilization in elaboration of standard and normal standard drafts. They also play an important role in solving problems of stabilization of the progress of production processes in putting out standardized or normalized goods, increasing the degree of uniformity of these goods and elimination of chance estimates of their quality.

When estimating products quality, the applicable technical documentation is frequently based not on properties of the basic bulk of the given products, but on individual, sometimes rarely encountered indicators. Practically this means that technical documentation directs the production processes toward achievement of indicators located on those parts of distribution curves which are characterized by low frequency and which are, more or less, removed from the basic parameter of the distribution. This method for establishing parameters inevitably results in protests against standards and is the cause of frequent changes and revisions.

The utilization of the statistical-mathematical method can promote the solution of such problems as, for example, the change of pro-

duct quality with time, consistent change of product properties in a given direction, etc.

Accumulation of experience can result in formation of a scientifically substantiated mathematical standardization system.

2. PROBLEMS OF STANDARDIZATION OF MATERIALS AND BLANKS QUALITY

State standards provide for quality estimating methods according to which it is necessary to perform a large number of mechanical tests on a batch of metal and which, in certain cases, require individual testing of each sheet, which retards the output of goods and requires construction of large warehouses and increases expenses. Cutting the number of tests in half will save tremendous sums of money to the USSR machine-building industry. In addition, irretrievable losses of material in cutting out specimen for mechanical tests are very great.

According to Academicians A.A. Blagonravov, I.I. Artobolevskiy, V.I. Dikushin and V.S. Kulebakin, the various machine-building branches employ over one million OTK/Quality Control Department/workers, whose annual wages exceed 600 million rubles. Testing methods are in the majority of cases established by standards, normal standards and technical specifications, hence the task of lowering the labor cost of quality control pertains directly to standardization. To this, we should add the fact that technical specifications at the present time are the most numerous, varied and not always coordinated group of technical documentation. Much depends on the content of all these technical specifications and requirements, considerably more than is usually assumed. Technical specifications may be the guides toward the most progressive measures and, conversely, carriers of inertia and stagnation.

The high rates at which the production of low-alloy steel is increasing are due to its substantial advantages in comparison with ordinary brancs of carbon steel (higher mechanical properties, good weldability, easily worked by pressure, less corrosion prone[illegible]he use of

low-alloy steel results in considerable economy of metal. Components fabricated from it have a higher stability and operational reliability and, which is most important, they weigh less, which is of substantial significance for many types of machines. However, this kind of steel is adapted slowly and this measure can be greatly helped by standardization providing for mandatory use of low-alloy steel in the appropriate standards and normal standards.

Extensive adaption of special rolled shapes in machine-building is one of the effective means of technological progress. The use of special profiles in machine-building makes it possible to:

a) more successfully assimilate many new types of machines and designs, lower the labor time used in their fabrication, increase the productivity of labor, accelerate the production preparation cycle, more efficiently utilize plant equipment and to lower the net cost of goods;

b) increase the strength, reliability and service life of machines and equipment by decreasing the number of joints;

c) considerable lower the weight of machines and sharply decrease metal consumption by eliminating nonproductive losses in the form of chips, waste and scale;

d) decreasing the consumption of tools, diesets, fixtures, etc.

The domestic machine-building industry already utilizes hundreds of special and periodic rolled profiles [20], certain of which are standardized. Further development of technology and organization of production in machine-building is related to extending the application of special and periodic metal shapes. Specialization of plants and increasing the output of machines, makes it necessary to more deeply treat the problem of utilization of special rolled profiles, including profiles, high-precision rolled stock and rolled shapes with built-in final adjustments.

The effectiveness of this type of work in the standardization field can be described by the following examples. The center sill of a freight car was previously made from a No. 30 H-beam and universal plate steel. Now it is produced from a special Z-profile made of steel which has sharply decreased the labor input for the fabrication of the center sill with 30 kgs of steel saved per each car. A considerable effect was given by adapting a new profile for the top beam of a box-car which replaced the previously used welded profile made from two equilateral triangles. The metal saving effected by this replacement comprised 6 kgs per car. The labor put in for component fabrication was lowered by 83%. The use of a continuous rolled profile for the gondola hatch collar instead of components previously produced by welding, has given savings of 37.8 kgs of metal per each car.

In the automobile industry, the fabrication of automobile door hinges from a special profile has lowered the metal consumption by 40% tne the labor input by 30%, since the heating and stamping operations and trimming of the blank fins have been eliminated.

The adaption of a special rolled profile from high-speed steel for attachable milling teeth, makes it possible to save up to 40% of metal previously wasted in chips; as a result of lowering the labor input for fabrication and of the metal saving, the total effectiveness of adapting this profile comprises more than 250,000 rubles annually. Great savings can be obtained by adapting special profiles for fabrication of components of plows, cultivators and other agricultural machines.

The task of standardization workers is to critically study the available standard and non-standard rolled stock and to elaborate, on the basis of this study, together with designers and production engineers, new standard assortments of rolled stock for mass uses.

The industry has assimilated the process for obtaining modified cast-iron castings. This grade of cast-iron is intermediate between gray iron and steel and by a number of properties is better than wrought iron; its use decreases capital expenditures for new capacities, saves metal and decreases the weight of the machine. The main use for this kind of iron is replacement of steel castings and also, sometimes, steel forgings. Castings from modified cast-iron are cheaper than steel castings; it can be used for the fabrication of crankshafts, levers, gears, supporting brackets, reduction unit housings for rolling mills, etc. The high wear resistance of modified cast-iron makes feasible its use in the production of various components which have to withstand wear. At the present time, it is possible to classify this cast-iron by brands and to regulate the basic indicators of mechanical properties of each of the brands. But extensive use of modified cast-iron in the industry depends on standards and normal standards for machine components.

Of great technical and economic significance is the standardization of allowances. But the adaption of these standards is not always effe tive as a result of the fact that the standards lack practical instructions relative to the use of the various precision groups. For example, the standard for tolerances, allowances and forging allowances for stampings provides for three basic precision groups: low, average and high. However, the standard has no instructions on the manner in which they are chosen and on the conditions under which they should be used. As a result, the plants frequently use excessive allowances in cases when more precise work is possible.

The methodology presented in Reference [21] is based on the assumption that the scattering of stamping errors is very close to Gauss' normal distribution. The substance of this assumption consists

in the fact that stamping defects which result in formation of black spots are exposed first. Then, their root mean square deviation is determined and the machining errors are clarified. The sums thus obtained are added up on the basis of the probability theory and their sum is rounded off to the next standard tolerance. The values of errors taken into account can be obtained by actual measurement of not less than 100 forgings received by the OTK for transmission to the machine shop. 50 of them should be produced by one dieset in the beginning of the stamping operations and the remaining 50 when the monthly batch has been forged. Defects due to deformation of the stamping space of horizontal-forging machines and stamping presses are also determined by measurements taking into account the heating up of the diesets.

According to Reference [21], the feasibility of work with minimal tolerances has been checked by experiment. Therefore, transition to a higher precision group in stamping of many blanks is fully practicable. The absence of methodical instructions on the methods of adaption of a given standard, not only does not promote its complete adaption but is also detrimental to the industry. The inclusion in these standards of supplements with instructions as to the feasible regions of application of individual precision groups and methods of conducting of the necessary preparatory operations is not only desirable, but absolutely necessary.

3. PROBLEMS OF STANDARDIZATION OF THE QUALITY OF MACHINE COMPONENTS AND SUBASSEMBLIES

The goal of standardization and normalization of production processes is stimulating the adaption of more progressive industrial processes and new methods of production organization, in particular, adaption of welding where it has not been used before, or where it is used on an unsufficient scale; more extensive use of die-forging and

cold pressing; adaption of precision casting; replacement of steel castings by cast-iron; adaption of various kinds of chemically assisted heat treatment, surface strengthening of components, etc.

As an example of this standardization, we can point to the adaption of seam welding for rolling mill, high power press and forging machine beds, adaption of high-strength modified cast-iron for critical machine components and also use of sheet metal constructions instead of castings, steel plates instead of cast beds, etc. All this can and should be reflected in standards and normal standards for machine components and subassemblies.

Of great practical importance is standardization of testing methods for components and subassemblies, including accelerated industrial testing methods which are a part of the production process. It was established, for example, that the most precise finishing of mating surfaces does not always result in their increased wear resistance. Depending on the conditions under which they operate, each pair separately taken has a corresponding specified optimal surface roughness which changes in the process of standard operation of the machine. The optimal roughness can be provided for in standards and normal standards.

Standardization and normalization of technical requirements put to machine components and subassemblies is of tremendous importance. As an example of this, we can cite the series of standards for frequently replaced components of automobiles, trucks, tractors and their engines. Included among these standards, were first OSTs and now GOSTs for crankshafts and control shafts, connecting rods, pistons, piston rings, piston pins, cylinder sleeves, valves, valve guide collars, pushrods. [illegible]-ts, connecting rod bolts and nuts, cylinder heads, gears, [illegible] shafts, split axles, etc.

The purpose for which these standards are issued is ensuring the necessary stable quality in mass producing interchangeable spare parts at specialized enterprises, as well as on centralized orders from different machine-building plants. The standards for spare parts also include requirements put to the production process. These standards give a positive answer to the question whether it is necessary, in individual cases, to standardize requirements put to the production process.

The existing widespread opinion to the effect that standardization (normalization) of the production process can retard its refinement by plants, is not substantiated by facts. Conversely, inclusion in standards and normal standards of requirements to the production process obligates the plants to use progressive production processes which ensure the required quality.

For example, cast crankshafts for automotive and tractor engines are used for quite a long time; standards and normal standards can stimulate their adaption. The cast crankshaft is hollow and is cast from high-strength cast-iron, which should always be pointed out in the standard or normal standard. The cast hollow shaft, in comparison with the ordinary streel shaft, weighs 20-27% less. Here, the centrifugal forces arising during rotation are decreased considerably and the load on bearings is perceptibly lowered. All this shows the desirability of use of cast shafts. Should we not forego the veiled form of standardization and normalization of production methods and use standards and normal standards to stimulate the adaption of more advanced production processes?

Changing the historically evolved principle of standardization of quality indicators of machine components and an explicit, rather than veiled, standardization of production methods can give a considerable economic effect and make standardization (normalization) more

active, stimulating adaption of progressive production processes.

A sharp increase in the rate of operation of all types of machines has resulted in systematic increase of requirements put to the precision of manufacture of gear transmissions, especially in follower systems and calculating mechanisms. The degree of precision achieved in the last 15 years exceeds several-fold the requirements put only recently to machines and instruments. This also should be reflected in standards and normal standards. We must point out that of very great significance to the precision with which machine and instrument components are produced, is the fabrication, precision and stability of cutting tools. But these problems are not always given the merited attention by standardization organs of the tool-building industry. In the meantime, standardization or normalization of the appropriate parameters could have fundamentally moved ahead the practical solution of the problem of increasing the fabrication precision, sturdiness and stability of cutting-tool quality.

Assembly of components exerts an influence on the quality of subassemblies and mating of subassemblies and assemblies influences the quality of machines put out by the industry. Assembly of machines and especially of large and complex ones, is a very critical process which can be successfully performed only by experienced foremen and workers. This is due to the fact that assembly still frequently involves work-consuming and complex adjustments of components and subassemblies on being placed in position. At the present time, technology increasingly attempts to eliminate this expensive and work-consuming adjustment work by adapting interchangeability.

The quality of machines being produced can be increased substantially by adaption of selective assembly. Standardization has touched upon methodological bases of selective assembly and the only recommend-

ed standard in this field was approved in 1942. The process of selective machine assembly can touch upon not only the dimensions of mating components, but also their weight, for example, the weight of the piston assembly components of auto-tractor and other engines. The achievement of selective assembly, in conjunction with manual labor is very labor-consuming and its automation is of tremendous technological and economic significance.

4. PROBLEMATIC QUESTIONS IN STANDARDIZING THE QUALITY OF PRODUCED MACHINES AND EQUIPMENT

A tremendous number of different machines and equipment operates in each of the branches of our national economy. Their number and type range increase continuously. This situation faces us with the immediate problem of finding indicators which would objectively estimate the quality of machines, mechanisms, apparatus and other equipment being produced. Their productivity and economy are of decisive significance in increasing the productivity of labor.

Longevity and reliability of any machine can be estimated by the length of time it is operated without any repairs of, for example, with only current repairs.

Repair of machines and industrial equipment comprises at the present time, a considerable portion of the net cost of unit work. From this, the tendency to provide for the feasibility of performing repair operations in the technically possible shortest amount of time by aggregation and interchangeability of components and subassemblies.

Convenience in operation of machines and equipment is estimated by the conditions under which the personnel must work and convenience in servicing and repairs is estimated by the necessary time expenditures.

The degree of unification of subassemblies and components of the

given machine with machines related to it, is also an important indicator of the quality of the design accepted for production. This indicator characterizes the practical feasibility of producing a series of different machines, or their modifications, with maximal use of identical subassemblies and also of subassemblies of previously assimilated designs which is of considerable convenience to the consumers, i.e. it expands the type range of machines and equipment, lowers their cost and facilitates repairs and also improves their operational reliability.

The long-range features of a machine design are determined by the feasibility for its further refinement without substantially changing the production process.

The labor time going into and the net cost of production belong among the major objective quality indicators of machine design. It is, for example, possible to assume a coefficient which shows the relationship between the wages paid by the plant to all its workers when producing the machine and the wages paid of personnel operating the machine.

We can conclude from the above short list of indicators, which can be used for describing and evaluating the distinguishing features of machines and equipment being produced, that some of them are useful for standardization purposes. Individual indicators can not only give an answer to the problem whether the equipment already produced can be evaluated, but in a number of cases can be used as a specific assignment for the elaboration of new designs of machines, mechanisms, apparatus and other equipment. A part of these indicators is already used in elaborating standard drafts for parameter series of machines and equipment and another part still awaits its utilization in the elaboration of standard drafts establishing quality requirements put

to new prospective kinds of machines and equipment.

This is due to a number of causes and primarily due to the fact that the quality of a machine depends not only on its design, but also on the quality of its manufacture and on its conformance with operational conditions. However, the decisive quality indicators for machines and equipment - service life and operational reliability - still present a problem. Their adaption by the standardization practice depends, to a large extent, on the degree to which the industry will recognize it as necessary. We should also add that problems of standardization of service life and reliability indicators have not, as yet, been elaborated with respect to methodology.

The complexity of the above problem is due to the large variety of machines and other equipment, to the difference in their design solutions and to operational preculiarities. The difference in the life of components and subassemblies, instability in the as-supplied state of materials being used and the methods by which they have been processed is also felt. The service life of machines and equipment is influenced by mating defects and carelesness in assemblying, adjustment precision, lubricating conditions, servicing shortcomings, climate, etc. But the complexity of the above problem must not serve as a basis for avoiding its consideration, as well as for avoiding attempts to find solutions which could give practically acceptable results.

The situation evolved in standardization work can be characterized as follows. State standards of technical requirements put to the production of individual machine components in the overwhelming number of cases are in total accord with their purposes; they include sufficient technical data describing the quality of component fabrication. In contrast to this, standards for machines as a whole are not, as yet, that specific; here, indicators characterizing the reliability and

service life of machines are either entirely not included in standards or are represented by guarantee times only.

It has been shown by analysis of the 92 state standards for technical requirements put to different machines, which were considered above, that they predominantly include characteristics of materials used and of mechanical properties of individual components and also requirements put to paints, etc. Individual standards, in addition, provide for guarantee times, operational safety requirements and other indicators. All this applies to the same degree to agricultural machines [22], as well as to other mass, large and medium series produced machines.

Certain preliminary work in establishing expedient contents of state standards of technical requirements put to machines, which is in the form of a research paper, was performed by the author of this book with active participation of Candidate of Technical Sciences R.V. Kugel. The work has shown that most complex at the present time is the choice and substantiation of criteria for estimating machine quality which are suitable to standardization. This is due to the lack of generally approved solutions, or recommendations, which would satisfy the interests of our entire national economy as a whole and not only production interests. In the process of the above work, we have considered a number of problems, some of which are illuminated below.

The techno-economic substance of standardization of machine and equipment quality criteria consists in the following. The total expenditures for capital and current repairs of production facilities of the national economy of the USSR in 1959 comprised not less than 13.5 milliard rubles. In addition, considerable indirect losses are caused by lowering the effectiveness with which machines and equipment are operated due to wear and repair-induced idleness and also due to the

use of industrial production facilities for the manufacture of the necessary spare parts. A part of these expenses and losses could be significantly decreased by ensuring longer service life of machines and equipment, primarily of objects of large-series and mass production.

Technical characteristics of machines and equipment being produced usually contain various indicators in addition to the service life. In those rare cases when the state standards or technical specifications give the guaranteed service life, it, with small exceptions, represents the convential limit of the financial responsibility of the plant to the consumer for defects overlooked by the quality control department and do not at all characterize the actual reliability and service life of the machines.

The practice by which the economic effect of a machine design is determined by the production expenses only, without taking into account subsequent operating costs, creates conditions prerequisite to unreliable solutions. As a result, machine and equipment designs, as has been frequently pointed out in the press, which are accepted for production, result in saving for the producing plant but sharply increase the repair costs of consumers. As a result, thousands of plants, hundreds of thousands of workers and specialists are occupied by scheduled and nonscheduled repairs of machines with insufficient service life, which also results in annual consumption of a tremendous amount of various materials.

It is desirable to make the service lives of the machines proper into objects of planning, by including them in state standards as basic indicators of technical characterization of each new machines and by providing for their proper systematic revision. But the choice and substantiation of a rational service life of a machine is an extremely complex question which involves a number of techno-economic problems.

The majority of these problems can be solved with respect to specific machines of individual kinds of equipment, taking into account their purpose and peculiarities. It is, however, still possible to establish a number of general principal propositions as a basis for standardizing the service life of machines.

It is generally known that the design of any machine is a compromise between the designer's desire to ensure high operational qualities and the necessity to cut production costs, taking into account the actual capabilities of machine-building at the given stage of its development. This compromise, on which depend the techno-economical indicators of the future machine during the many years of its use, should be comprehensively considered as early as the earliest stage of elaboration of the new machine, i.e. in elaborating the draft of the state standard for the parametric series of the given machines and then of the engineering assignment for their simultaneous design.

One of the basic quality indicators for the future machine is its service life up to the first capital repair and the total life up to scraping (taking into account the number of necessary capital repairs).

A number of considerations must be taken into account in choosing the service life of a machine.

The service life of a machine until its first capital repair is determined by the service life of assemblies and components. The chosen service life influences, in the designing stage, the dimensions of many of the machine's components, the materials used and the fabrication processes. The service life also affects the production costs which, unlike operational costs of the future machine, can be calculated precisely.

The operational service life of a machine, however, is not infre-

quently not sufficiently considered due to the desire to lower the production net cost. When creating new machines, the problem of restoring them in the future is far removed in time, for which reason it actually arises only after several years have passed since the machine was first built and is, in general, frequently underestimated. As a result, nonproductive expenses, increasing every year, become necessary.

Repair of machines burdens heavily their users and the state is forced to create a network of repair enterprises and bases. Here, direct and indirect losses attributed to insufficient service life of the machine frequently exceed many-fold the savings in production costs effected by building the shscrter-lived variation of a machine. For example, the experience acquired in many years of operation of "Pobeda" automobiles shows that the ratio of the cost of a new automobile to the cost of its capital repair by a well-equipped specialized plant, capable only of performance of mass capital repair of the given model of automobiles, comprised 1:1.56. The capital repair of an automobile performed by a specialized plant thus exceeds by a factor of 1.5 the cost of a new automobile. Taking this into account, the economy of a machine design should have been estimated by the total cost of production and operation. Additional cost of production of components and subassemblies with a longer service life, as a rule, is many-fold lower than the cost of their subsequent restoration or of replacement of components under operating conditions.

The optimal service life of a machine which should be included in a standard draft can be determined on the basis of a number of considerations. First of all, it is desirable to establish the operating conditions under which the chosen or specified service life should be realized. If the machine operates under variable operating conditions

which is, for example, characteristic of automotive vehicles, tractors, agricultural and other machines, then it is necessary to use mathematical statistics to determine their typical operational conditions. The service life which is chosen should be ensured precisely under those conditions which can be characterized and included in the engineering assignment for design which is achieved on the basis of the parametric standard. Further, it is necessary to point out the desirable service life on the basis of consumer desires as well as of the experience acquired in operation of other machines of the same intended purpose in the USSR and in foreign countries.

The distinguishing feature of operation of machines produced by large series and mass production plants, is the fact that they are distributed in comparatively small numbers among a very large number of consumers. Repairs, which due to the above, are performed by thousands of enterprises all over the country, usually results in a general lowering of the quality of the repaired machines. Their service life until a new repair operation is sometimes substantially decreased in comparison with the service life before the first repair. For example, the existing norms provide for lowering the mileage of automobile assemblies subjected to capital repairs by 20-45%. Even in those cases when repairs are performed by specialized enterprises, the average mileage of automobiles with engines subjected to capital repairs is found to be by a factor of 1.5-2.5 lower than the mileage of automobiles with new engines. Since under these conditions the repair costs comparatively rapidly exceed the cost of a new automobile, suggestions were made that it may be to an advantage to accelerate the rejection of automobiles and to decrease the time they are in use before scraping.

Modern repair methods are based on interchangeable spare parts

and assemblies. For this reason, the nomenclature and number of spare parts needed for restoring a machine after a specified period in operation, is one of the criteria of the design and production quality. As the stock of machines increases, the efforts of the industry will be increasingly directed not toward increasing the number of machines but toward their restoration. If spare parts are produced at the expense of basic capacities of the industry, then after several years pass from the time a new model was first produced, the further growth of the machine stock is slowed down. Since the need for various spare does not increase uniformly, then, as time passes, an inevitable disproportion is created in the production capacities of individual sections of machine-building enterprises and it becomes necessary to change their structure.

The above leads to the following conclusions. The necessity of the first repair of a machine should arise as late as possible and the number of restoring repairs during the entire service life must be limited. The design of machine assemblies should provide for their restoration by the simplest means, without the use of complex assembly operations. Here the consumption of spare parts should be minimal.

The cost of machine repair and servicing are minimal when the machine is still new and the wear of components does not affect its reliability and the volume of current repairs. Frequently the reliability of a machine is lowered as the parts wear out, since the adjustments are disturbed and the volume of maintenance repairs and the labor time going into servicing are increased. The higher the reliability and the longer the service life of a machine, the slower does this process take place and the slower do the operational costs increase.

One of the factors which depend on a long service life is thus

not only the value of repair costs, but also the rate at which they increase as the time during which the machine is on operation increases.

In designing a machine it is, consequently, necessary to take actual steps toward ensuring prolonged preservation of its initial properties which can be subjected to specific regulation in standards including standards of testing methods at specified time intervals.

By Karl Marx's definition, obsolescence of a machine can be of two kinds. One of them is due to the appearance of machines serving the same purpose, but costing less, which results in lowering the book value of the previously acquired machine and is responsible for its earlier replacement. The second kind of obsolescence is due to the appearance of new, more refined machines, in connection with which the previously produced machine becomes obsolete.

Obsolescence of the first kind is conjunctive in character, but it still should be taken into account in the approximate estimate of rational times for replacement of the given machines. The second kind of obsolescence (aging) takes place for any machine. In conjunction with this, an opinion is frequently expressed to the effect that it is not desirable to produce machines with long service lives, since anyway, they will soon be replaced by more refined versions. Most frequently, this opinion only covers up insufficient activity of industrial workers in the field of increasing the service life of machines.

The literature gives a number of formulas which are attempts to mathematically express the relationship between a number of factors responsible for obsolescence. These formulas cannot, as yet, be used for practical standardization purposes. Analysis of the evolution of machines of the specific type under consideration in the USSR and in foreign countries is, if you like, the most expedient method. It has been shown by experience that aging for the majority of machines takes

place after a large number of years, during which the machine is repaired a number of times. Aging, consequently, can be taken into account when establishing the expedient total service life of a machine before it is scraped. This service life can be established in the basis of the service life of the machine up to the first restoration repair and of a certain rational number of such repairs during the entire time it is in operation.

The number of repairs being performed can be limited by taking into account their cost, labor input and material consumption and also the cost of a new machine. The greater the cost of restoration repairs in comparison with the cost of a new machine, the smaller should be the number of repairs.

5. MACHINE RELIABILITY AND SERVICE LIFE INDICATORS

The service life of a machine is directly characterized by the length of time during which it operates before the restoring repair and until it is written off (scrapped). Service life can in more detail be characterized by an integrated group of indicators including: repair costs and their volume, consumption of spare parts and also a number of specific indicators (for example, repair costs per unit of work performed). The system of these indicators can be further developed for each type of standardized machines, taking into account their purposes and specific peculiarities. At the given stage of solution of the problem, we should still not make the question of standardization of machine service life more complex.

At the present time, it is expedient to limit the problems of standardization to the establishing of a machine and equipment service life indicator in units most convenient for the given type. For a tractor these can be, for example, hectares of conventional plowing, for an automotive vehicle - the number of kilometers traveled, for a

stationary engine - the number of hours in operation, for a crane - the number of years in operation, for a relay or another automatic mechanism - the number of operations, etc. The service life of machines can also be estimated by complex integrated indicators, for example, the service life of a machine is estimated by the value of the average service lives of its components.

Reliability and service life of a machine are different concepts. The first is characterized by the ability of a machine to operate for a long period of time without forced stops and downtime. The second concept, characterizes the length of time in operation without repairs. But a machine with satisfactory service life can be unreliable, if it frequently goes out of order due to different troubles, for example, plugging up of fuel and lubricating systems, contamination of filters, nonhermeticity of packings, disturbance of adjustments, etc. If this results in breaking or wear of components, then the machine is no longer only unreliable, it also has a short service life.

A problem of not less importance to standardization is the methodology used in checking for actual service life. Undoubtedly, the results of operation of the machines by the consumer, or of its tests under operational conditions should be assumed to be most reliable. However, obtaining operational data in many cases requires long periods of time measured in years, which makes waiting for results of operational tests in a volume sufficient for making a solution about starting serial production of a new model impossible. This solution should be based on the results of standard accelerated tests of experimental specimens of the machines on the testing stand, or proving grounds, under conditions ensuring relatively rapid results.

The standard method and regime of accelerated tests should be based on information about the operational regime of the machine; exces-

sive amplification of the testing regime should be avoided due to considerations presented in Reference [23]. The necessity, in the majority of cases, of using accelerated stand and testing grounds tests makes it necessary to use appropriate units for measuring the service lives of machines (assemblies, components). The most convenient unit of measurement is the number of hours in operation under a specified regime or the number of load cycles of a specified intensity. After operational experience has been accumulated and the statistical character of operational loads has been refined, it is possible to obtain coefficients for conversion from the service life achieved in accelerated tests and the operational service life.

The reliability of a machine is determined in the process of service life tests using the same data, but performing separate estimates by recording forced stoppages and their causes. Here, we can use the spot-checking method which is one of the methods of mathematical statistics.

The operational service life of a machine is a function of a considerably larger number of variable factors than the service life of the same machine under laboratory testing conditions. The load regime and the service quality in actual operation varies within wide limits; properties of materials used during actual service (lubricants, fuels, etc.) are also unstable. The quality of workpiece machining, their assembly and adjustment are also not constant. For example, a case is known whereby two plants have produced gear boxes from the same working drawings. On stand tests, the gear boxes of one plant operated until destruction five times as long as the boxes of the other plant. According to R.V. Kugel, the cause which has been found with difficulty consisted in different surface finish of gear teeth.

Data about the range of service lives of components, assemblies

and machines, about the distribution of their service life and also certain practical conclusions are presented in a number of works of R.V. Kugel. In the majority of cases, it is practically impossible to preestablish the time which elapses before destruction of the units and to plan for precise replacement intervals. The basic problem therefore, reduces to ensuring a) high guaranteed service life of each produced machine operating under specified conditions b) high average service life of all machines c) high minimal service life, guaranteed by the producing plant, for example, 90% or 95% of machines produced d) feasibility of rapid and easy replacement of components and assemblies which went out of order using a revolving stock of interchangeable replacement parts.

The long guaranteed service life indicator determines and limits the responsibility of the producing plant to each consumer. The average service life indicator, as a rule, is higher (sometimes manyfold than the preceding indicator and determines the responsibility of the plant to the state and control organizations. A major feature of this indicator is the fact that it is established statistically, on the basis of a sufficient amount of data analyzed by mathematical statistics methods. The difference in operational conditions can result in conflicting situations. In such cases, it is possible to use the mathematical method of the theory of games and to find a substantiated solution in this manner.

6. ESTABLISHING THE SERVICE LIFE OF MACHINES AND ASSEMBLIES

At the present time, we cannot consider normal a process creating a machine, assembly, subassembly or instrument independent of specified requirements put to their service life. The so-called "resource" of an engine is already for a long time a major, sometimes decisive indicator of its quality. The quality of an electric bulb, or an elec-

tron tube is characterized by the number of hours of operation which are provided by the norms. The minimal service life of 90% of a given batch of antifriction bearings, expressed by number of revolutions before fatigue failure at a specified load, is guaranteed by the producing plant. Numerous instruments and mechanisms are frequently valued by the number of hours in operation. The service life of automotive, tractor and aircraft electrical equipment elements is for a long time already characterized by the number of hours in operation, the number of starts, or mileage, provided for by norms. Intra-plant service life norms (expressed in terms of the minimal number of hours in operation or load cycles in stand tests), are used for already 20-25 years for automotive gear transmissions, split axles, coulings, brakes and other assemblies.

Alongside with establishing service lifes of machines in an explicit form, extensive use is also made of implicit norm setting for the service lives of machines and other products. For example, the designs of many foreign machines are brought into accordance with previously specified service life for specified operational conditions. Materials, production processes and the precision with which components are fabricated and assembled are limited, on one side, by the desire to lower the net cost and, on the other hand, by the necessity to ensure satisfactory quality of the machine, including acceptable service life. However, this should not be taken to mean that specific service life norms, known to consumers, already exist in the capitalist countries for all types of machines. They are only sometimes established in the form of guarantee obligations, but more frequently they exist in the form of an unwritten service life level to which the firms must adhere in order to sell the necessary amount of goods under competitive conditions.

The difficulties of practical achievement of standardization of service life indicators are due to the following 1) the machines operate under varied and variable conditions 2) rules for servicing and operating the machines are frequently disregarded 3) even under identical operational conditions, the service life of components and assemblies of machines fluctuates within wide limits.

The first cause can be eliminated by standardization of the service lives for chosen typical operational conditions of a given machine. Here, the machine is considered as an ensemble of varied assemblies. Specified typical cycles for loading each of the assemblies correspond to typical operational conditions of the machine. These cycles are reproduced in tests on stands and testing grounds with the experimental results then compared with operational results. Settin service life norms is reduced, consequently, to ensuring a sensibly chosen service life of machine assemblies under specified typical operational conditions. Systematization of materials can be performed by standing technical commissions for standardization of machines and equipment.

The second cause requires careful scrutiny. Actually, if, for example, the machine is not lubricated in time or filled up with contaminated lubricants and fuel not up to the proper condition, if it is not subjected to scheduled preventive inspections and industrial care, then even the most progressive measures taken for increasing its service life will not give positive results and the high potential service life of the machine, as produced by the plant, will not be realized in operation. This cannot be used as a basis for the conclusion that standardization and the corresponding measures taken by the plant are useless. Conversely, the production of machines with a service life established by the standard for specified operational conditions will force the consumers to improve the requirements put to the ser-

vice quality. Breakdown of units before a specified time should be considered as proof of careless maintenance. Systematic work in this direction can be performed by the same technical commissions.

Relative to the third cause, we should point out that the scattering of service lives of components and subassemblies in tests and in normal operation does not, in any measure, prevent standardization of service lives, on the condition that these will be evaluated statistically. The character of the scattering curve and the range within which the results fluctuate are a convincing criterion of uniformity, i.e. of one of the major quality indicators for serial production. It is desirable to systematize this data in the same technical commissions.

Despite the complexity of the given problem, the desirability and timeliness of standardization of machine and equipment service life indicators is beyond doubt.

Choice of the most rational indicator characterizing the optimal service life of a machine, with the purpose of including it in a state standard should be accompanied by formulation of typical operational conditions for the given machine or equipment. In this case, i.e. when standardizing such a service life indicator, all work for elaboration of the new machine (equipment), including, design, calculations, making of specimens, their testing and refinement of the design will be subordinated to solving a problem, expressed by the standard by a specific numerical value of the service life indicator.

The optimal service life of a machine until the first capital repair established in standardizing the service life indicator, must be based on:

1) systematized information about service lives of similar machines or equipment in the USSR and abroad under different operational

conditions and also on desires of consumers

2) data about the expected labor input, material consumption and cost of repairs and also considerations about the desired total service life of the machine (equipment) up to failure and writing off for scrap

3) considerations of service life scattering

The problem of feasibility of standardization in precisely this direction was put to many organizations. Most of them answered it positively. The desirability of achieving this standardization is maintained by prominent scientists of our country (Academician V.I. Dikushin, Doctor of Technical Sciences, Professor M.M. Khrushchov, Director of Technical Sciences, Professor D. N. Reshetov and others).

In the most compressed form, the opinion of industrial workers can be formulated as follows.

1. The presentation of the problem of establishing service life and reliability criteria for machines is correct, timely and necessary. At the present time, it is entirely possible to establish substantiated values of indicators characterizing the service life and reliability of machines and their elements. Inclusion of these indicators in state standards will, inevitably, result in improving the quality of produced machines and will make possible to more correctly solve problems of modernization and replacement of equipment and to improve its operational level. Service life and reliability criteria should also be included in technical specifications if no state standards have been established for the goods being produced.

2. According to the opinion of many organizations, the utilization of service life and reliability criteria should be limited to mass produced items. For rolling mills, presses, etc., this is premature. Other organizations, conversely, think it desidrable to extend

them to objects of small series and unit production.

In conjunction with this, it becomes possible to extend the use of service life indicators to the following machine building branches:

1) automotive industry and related production units;
2) tractor industry;
3) machine-tool building;
4) agricultural machine building;
5) construction and road building machine building;
6) forging press building;
7) motorcycle and bicycle industry:
8) food machine building;
9) printing machine building;
10) machines and equipment for the chemical and light industries;
11) power-production machine building (equipment for thermal and hydroelectric power stations);
12) mining, ore-processing and coal-mining machine building;
13) crane building of all kinds;
14) transportation machine building (locomotives, [railroad] cars, etc.
15) electrical machine building;
16) casting equipment;
17) internal combustion engines;
18) typewriters and sewing machines;
19) ship mechanisms and equipment;
20) instrument making;

It is impossible to give uniform guarantee times and service life indicators for all these machine building branches and their objects. These indicators can be:

a) range of vehicles in kilometers depending on the road quality

and features, till the first capital repair;

b) number of hours of machine or equipment operation till the first capital repaid;

c) the volume of work performed by the machine or equipment if their output is measured in physical volumes;

d) the number of hours in operation, for which it is possible to obtain products with the specified precision and surface finish for the given productivity under normal operating conditions and normal operational regimes;

e) the same as above, till the first capital repair;

f) the same as above, until breakdown and scrapping;

g) minimal guaranteed service life until the first capital repair, expressed, corresponding to the machine's purpose, in kilometers traveled, hours of operation, etc.;

h) the number of operations performed for relays and other instruments and devices used for automation purposes;

i) the number of hours burned - for lamps, etc.

Possible service life indicators for individual kinds of machines and equipment are given in Table 39.

TABLE 39

Possible Service Life Indicators for Various Kinds of Machines and Equipment.

Service Life Indicator	Machines and Equipment
Distance traveled in kilometers on the typeof roads	Trucks and passenger cars; city and intercity autobuses, etc.; passenger and freight trolley-buses; trailers and simitrailers; motorcycles and motor scooters.
Distance traveled in kilometers depending on the railroad profile;	All kinds of diesel locomotives and gas-turbine locomotives; passenger and freight cars and the like; electric train cars, trolley cars

Volume of work performed	Construction and road-building equipment whose output is calculated in physical volumes
Time of operation in hours	Hydroelectric and thermal power station equipment; equipment for extraction of non-ore materials in quarries; construction tractors; construction and road-building machines whose output is not recorded; overhead cranes; molding machines; electric motors; crank-operated presses; stationary and marine internal combustion engines; ship mechanisms
Number of hours in operation during which it is possible to obtain products with specified precision and surface finish for the given productivity	Metal-cutting machine tools and other kinds of production equipment

7. AN EXAMPLE OF DETERMINING THE SERVICE LIFE INDICATOR OF AN AUTOMOTIVE VEHICLE

The choice of a service life and of a service life indicator for an automotive vehicle as a whole, can be of certain practical interest from the methodological point of view.

The assumption on which the choice of a service life for an automobile, in terms of kilometers traveled before the first capital repaid, is based, must be the fact that the engine is the automobile assembly with the shortest life. This is affirmed by almost the entire history of automobile production. The cost of the engine comprises 20-32% of the total cost of an automobile. For this reason, increasing the service life of the engine has a direct effect on the value of the service life indicator for the automobile as a whole.

The general problem for increasing the quality of automobiles being produced is bringing the engines to such a state in which the need for capital repairs should not arise before the need for capital repairs of the automobile as a whole.

The service life of an engine is characterized by the rate of wear of its cylinders. For engines of various automobiles, according to R.V. Kugel, this wear comprises from 1.2 to 2.8 microns per 1000 kilometers traveled. From this, we can determine the possible length of the service life before the first capital repair. Other engine elements have their service lives and they can be substantially changed by measures predominantly concerning the production process. In the case of automotive engines, these elements are components of the piston and connecting rod assembly, packing components, the lubricating system, electrical equipment, air cleaning and fuel supply systems. Each of these elements can be analyzed from the point of view of its operating conditions, after which it is possible to find ways for increasing the service lives. It is not necessary to enumerate them here.

Frequently replaced automotive engine parts are standardized with respect to technical requirements put to them. The components of tractor engines are similarly standardized. It follows from this that the problem of choice and substantiation of a service life indicator for an automotive engine is completely tied up with maintenance of standards for engine parts at the proper level. This integrality of standardization is very expedient, if only for the reason that it makes state standards into active means for influencing the technological progress of an entire branch of the national economy.

This is the basis for establishing service lives of future automotive engines until the first repair, measured in terms of thousands of kilometers traveled and in years. It is also possible to establish an expedient number of capital repairs before the engine is scrapped. The engines were here called by the name future, since their service lives take into account all these design and technological improvements which should be achieved in order to ensure improve service life

indicators. Table 40 presents the above information (due to R.V. Kugel).

TABLE 40

Possible Service Lives of Automotive Engines

Автомобиль 1	Характеристика автомобиля 2	Срок службы двигателя до первого капитального ремонта 3		4 Число целесообразных капитальных ремонтов
		5 Пробег автомобиля в тыс. км	6 в годах	
Грузовой	Грузоподъемность в т:			
	0,25	100—110	5	1
7	8 0,8	160—170	8	1
	1,5—2,5	180—200	7—8	1
	4,0	210—220	7	1
	7,5	200—220	3—4	2
	12—14	150—200	3—4	3
Легковой	Микролитражный 10	70—80	5—6	1
	Малолитражный 11	100—110	7	1
9	Среднелитражный 12	140—150	9—10	1
	Большого литража 13	240—250	7—8	2
Автобус	Служебный 15	250—260	10	1
	Городской 16	300—310	5—6	3
14	Междугородный 17	350—400	3	3

1) Vehicle; 2) vehicle characteristic; 3) service life of engine before first capital repair; 4) number of expedient capital repairs; 5) distance traveled in thousands of kilometers; 6) in years; 7) truck; 8) weight carrying capacity in tons; 9) passenger car; 10) micro-displacement; 11) small-displacement; 12) average-displacement; 13) large-displacement; 14) autobus; 15) service; 16) city; 17) intercity.

Standardization of automotive and tractor assemblies has extensively embraced only technical requirements put to individual parts of their engines. Components of their remaining assemblies are standardized to a much lesser extent. As to the entire tremendous variety of machines and equipment used by the national economy, then their components are standardized or normalized to a negligible extent. But this situation cannot serve as a basis for refusing to standardize service life indicators for machines and equipment. These indicators should be established using the same methods as were used for automotive engines.

First, it is necessary to determine that actual service life of

the given machine, which is in accordance with the present-day state of equipment and technology in the given machine-building branch. Then an analysis is made of the so-called "tight spots" which make performance of the capital repair necessary. And then, work must be done with respect to each of these "tight spots" for improving the design and quality of manufacture.

The actual service life is determined by mathematical statistics methods. And, on the basis of this actual service life, taking into account measures planned for elimination of the "tight spots," that service life indicator is established for inclusion in the state standard which will stimulate purposeful actions of designers and production engineers to ensure technological progress in machine building.

8. SPECIFYING RELIABILITIES OF MACHINES

It follows from the above data, that the development of methodological standardization work makes it possible to establish criteria for the service life of machines and equipment and it is also possible to use methods of mathematical statistics to determine numerical values of service life indicators. A problem more complex is that of establishing indicators characterizing the reliability of machines and other objects of production. The reliability of machines can be described by the following indicators:

a) the guaranteed coefficient of machine or equipment utilization (suggested by the Rostov Sovnarkhoz);

b) the time during which the machine or equipment operate without any breakdowns (suggested by the V.A. Malyshev Khar'kov Transportation Machine Building Plant);

c) the time during which constancy of basic characteristics of machines and equipment is retained (suggested by the same plant);

d) feasibility of normal operation of the machine or equipment

(for example, a metal-cutting machine-tool) without forced stoppages and down time during a specified period (in hours), under the condition that work with specified precision and productivity is ensured (suggested by the Odessa Radial Drilling Press Plant).

All these reliability criteria serve the stated purpose and can be used under practical conditions for achieving standardization of the quality of machines, mechanisms, apparatus, instruments and various automation facilities; each of them has its peculiarities and its fields of application. But the most important problem consists in practically commencing achievement of standardization of service life and reliability indicators for the machines and equipment being produced. For this, it is necessary to clearly describe the significance of reliability and of the role its plays in the progress of production forces of our country.

The problems of reliability of machines and equipment being produced were called the "problem No. 1" by Academician A.I. Berg in a number of articles. This, actually, is a very complex problem and, together with this, of tremendous technical and economic importance. In clarifying its substance, A.I. Berg calls ones attention to the evolved opinion to the effect that the more complex the product, the less reliable must it be. Disputing this view with respect to reliability of machines and equipment, A.I. Berg presents the following proof [24]. Let us assume that the guarantee of faultless operation of one machine component is equal to 0.95 (95%). But is a certain assembly of a given machine contains 10 such components, then according to the probability theory, the reliability of the assembly as a whole will be equal to the above coefficient multiplied by itself 10 times, that is $0.95^{10} = 0.6$. And if the assembly has 100 components and the machine 1000? What then? It is, of course, possible to calculate what

should be the number of components in a product in order for its reliability to comprise only 1%. This will mean that in this case, one person out of a hundred has a chance to purchase, for example, a motorcycle or television set, or another product in good operating condition and the other 99 persons will obtain motorcycles or television sets (or other products) which will not operate. According to this "theory", the more complex the design of a product, the less reliable it is. Actually, however, this obviously is not so [24].

In our opinion, reliability is a statistical indicator of product quality, expressed by a specific numerical characteristic or coefficient. Such an objective indicator is the reliability coefficient the value of which, with rare exceptions, is always less than unity. It expresses the probability of proper operation of the given machine during a specified time under specified conditions.

Let us assume that it is necessary to perform 100 kilowatt hours of work in 20 hours. If we use an entirely reliable machine of 5 kwt capacity, then it will perform the given work in exactly 20 hours. But if the reliability coefficient of available machines of 5 kwt capacity is 0.5, then one such machine, probably, operates properly only for 10 hours and will perform during 20 hours useful work of only 50 kilowatt hours instead of the required 100. For this reason, one machine will perform the entire work in 40 hours, or two machines will be needed to perform it in 20 hours. From this, it is possible to establish a machine utilization coefficient which, to a certain extent, describes the probability that the machine is ready to operate at any time instant.

This practically results in the fact that plans of industrial enterprises provide, in individual cases, for a certain equipment surplus which is put into operation in order to compensate for breakdowns

in the basic (calculated) stock of equipment. However, this is not always possible and not always desirable. Present-time machine building plants use, in addition to general-purpose equipment, also automatic lines and unique machine-tools, presses, etc. It is not permissible to install duplicated equipment in all cases for over-insurance purposes. This is expensive and inefficient. This is the reason why the problems of standardization of reliability indicators are of such exclusive importance.

But problems of reliability of machines, mechanisms, instruments and other products are even more important in those numerous cases when they are used individually, which includes automobiles, motorcycles, scooters, bicycles, washing and other consumer machines, radio sets, television sets, etc. We see in the press persistent requests by consumers to increase the reliability of all these products. Guarantee periods given by selling organizations are not convenient to consumers, since such a guarantee actually charges the consumers with setting up and adjustment and deprives them of use during repairs. Moreover, the selling price sometimes includes a certain sum which is transmitted by the producing plant to the repair shop for covering expenses of service during the guarantee period.

The problem of reliability must be solved using all means available to designers, production engineers and testing personnel. But the organizational and methodological work doubtlessly belongs to standardization.

The question arises: how should the work for standardization of service life and reliability indicators for machines, mechanisms, apparatus, instruments and automation facilities be organized in practice? Two ways are available:

1) to include these indicators in separate standards of technical

requirements, extending to certain types, kinds or groups of machine-building and instrument-making objects as the above standards are elaborated;

2) to solve this problem once and for ever, by creating a series of first-order standards establishing service life and reliability indicators and, also, expedient guarantee periods (commercial obligations of producing plants), by kinds or groups of machine-building and instrument-making objects.

In both cases, it is necessary to formulate for inclusion in standards requirements put to operating conditions and regimes of the machines, instruments and other objects, without which establishing of quality indicators will be one-sided and will not serve its purpose.

The second way seems more advantageous, since it makes it possible to considerably accelerate the solution of the stated problem and to create a more reasoned and substantiated system of standardized indicators. Provided with appropriate orders by State Commitees for branches of technology and directions by base standardization and normalization bases, the corresponding scientific research institutes, design organizations and consumer representatives can achieve all this work simultaneously in compressed periods of time.

During the initial period standards of quality indicators for machines, instruments and other products can be approved as recommended versions and then reworked to give them mandatory status.

Chapter 10

STANDARDIZATION OF COMMON MACHINE COMPONENTS AND SUBASSEMBLIES

Despite the long years of practice acquired in standardization and normalization of common subassemblies and components of machines by various machine-building branches, a common, universal methodology, which would satisfy the variegated conditions under which standard and normal standard proposals are elaborated, has not as yet been evolved.

In this Chapter, we illuminate a number of problems which comprise the methodology of standardization of common machine subassemblies and components. It may be found useful, also, in the elaboration of machine-building normal standards, branch and plant normal standards. In elaborating this methodology, we have partially taken into account suggestions by A.Ya. Gurevich (VNIIStroydormash) and Ya.V. Shuliko (NIIKhIMMASH) and also certain foreign materials.

1. GENERAL SCHEME FOR CONDUCTING STANDARDIZATION WORK

The general procedure for constructing and presenting drafts of state standards is briefly illuminated in methodclogical instructions 1-60 of the Commitee of Standards, Measures and Measuring Instruments at the Council of Ministers of the USSR, presentation of whose contents is unnecessary, since the sequence of operations of achieving standardization is discussed in it only in a general form.

The standardization work on any theme should be started with construction of a graph, clarification of the best procedure for elaborating the standard draft and of the expedient level (scale) of stand-

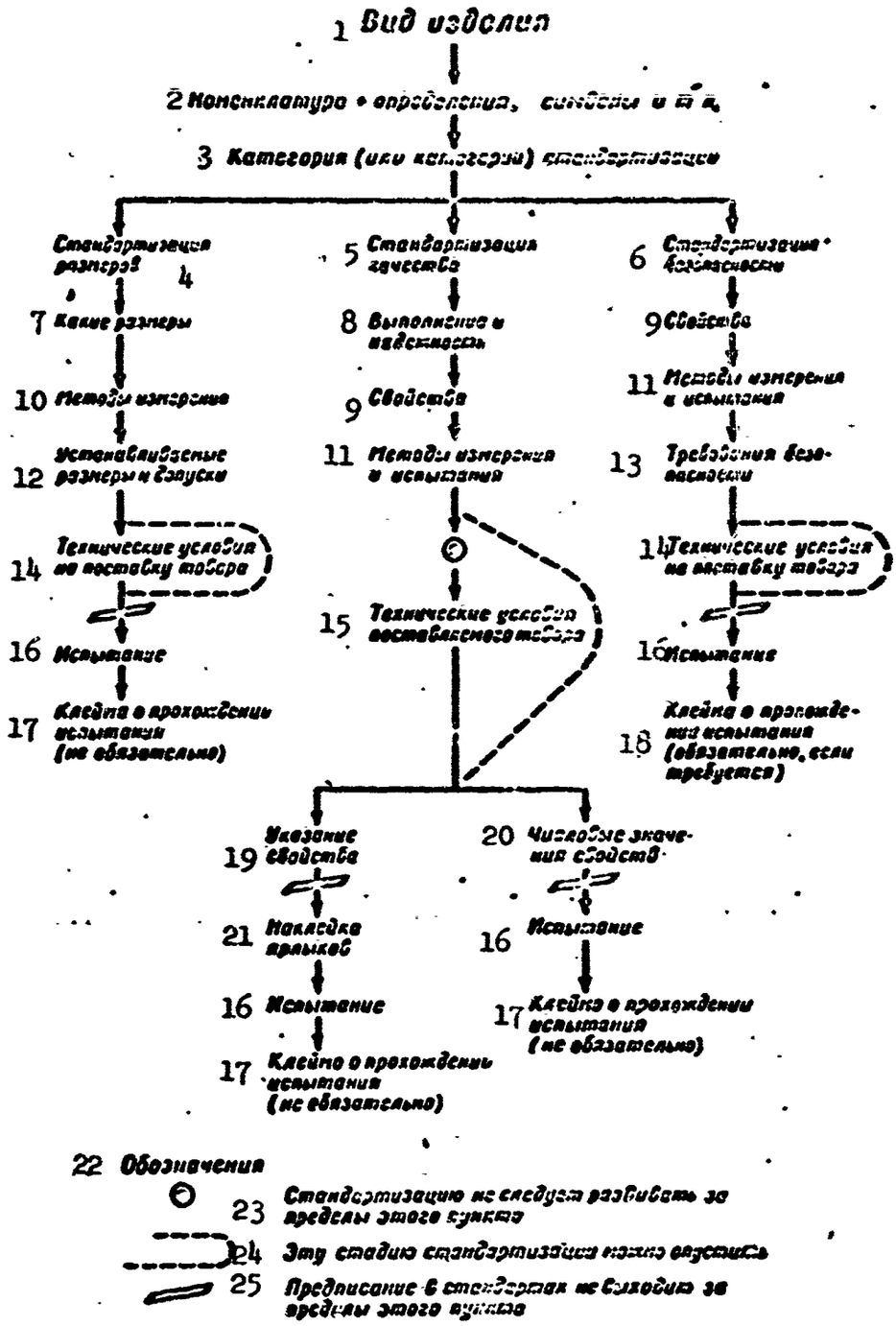


Fig. 2. Scheme of product standardization. 1) Kind of products; 2)nomenclature + definitions, symbols, etc.; 3) category (or categories of standardization; 4) standardization of dimensions; 5) standardization of quality; 6) standardization of safety; 7) what dimensions; 8) execution and reliability; 9) properties; 10) measuring methods; 11) measurement and testing methods; 12) established dimensions and tolerances; 13) safety requirements; 14) technical specification for delivery of commodity; 15) technical specifica-

tions for commodities being delivered; 16) testing; 17) markers showing passing of test (not mandatory); 18) markers showing passing of tests (mandatory, if required); 19) statement of properties; 20) numerical values of properties; 21) labeling; 22) legend; 23) standardization should not be developed past this point; 24) this standardization stage can be dropped; 25) instructions in standards should not go past this point.

ardization and, also, by establishing that expedient degree of detail to which standardization at the given time and on the given theme should be brought up.

Of interest from the methodological point of view, is the arrangement for conducting standardization work suggested by the Standardization Committee of the Netherlands (Fig. 2). It shows how the standardization process can be subdivided into a number of sections and working stages. The given arrangement shows only the more important standardization aspects and it, therefore, should be regarded as a scheme subjected to refinement, as it is utilized in practical work.

In starting standardization work, it is first necessary to consider the kinds of products subjected to standardization and to decide: whether this series of products is limited to one type or to several similar types. In standardizing machine components and subassemblies, it becomes necessary to use specified designations and terms. In those cases when individual designations are rarely used or are not clear, it is necessary to choose own designations and to define their specific meanings. To avoid undefiniteness, only one term should be used. In addition, it is frequently necessary to establish, in the first standardization stage, rules for using uniform symbols, signs, designations, abbreviations, etc., in order to make possible their use in all corresponding standards.

According to the above scheme, standardization is divided into

three trends (categories): 1) standardization of quality; 2) standardization of sizes and 3) standardization for safety purposes, which in the given case is considered as elimination of risks.

The concept "quality" is an integrated one and actually embraces many different conteps. "Quality" can, for example, be understood as the conformance of a product to the specified technical specifications. In standardization, with rare exceptions, "quality" pertains to properties and features of the product from the consumers point of view. For this reason, it can be called "consumer quality." In principle, this concept embraces not only the fabrication of the product and its reliability, but also safety in the sense of guarantee obligations and the precision with which the dimensions are rendered, which touches upon the problem of fits and tolerances.

In individual cases, it may be advantageous to limit standardization to dimensions only; here, this kind of standardization is subjected in many respects to production conditions (production process dependence) and the available measuring equipment. In all cases, independent of the product type, it is first of all necessary to decide which standardization category is expedient and necessary at the given time.

In the schematic (Fig. 2) the symbol 0 denotes the fact that further standardization is not expedient.

The relations between the producer and consumer of goods make it mandatory to perform tests in order to establish conformance with requirements agreed upon. It is, therefore, desirable to formulate rules pertaining to convenient and rapid selection of specimen, investigations and evaluations. The necessity for including this entire procedure in standards depends on a number of factors, including also the kind and peculiarities of the product.

All these cases should be considered individually in elaboration of each standard and this is a part of the task of the standardization organ. Such a problem is made easier by preliminary standardization of general instructions for product groups with respect to selection of specimens and the procedures for analyzing test results. Development of standardization of common subassemblies and components of machines in this direction makes it necessary to elaborate a number of guiding technical materials or instructions pertaining to the procedure and methodology of evaluation of the supplied product batches. On the scheme, these are called technical specifications for commodity delivery. Independent of whether or not elaboration of technical specifications is planned, it is possible to make a further step for developing standardization in one of two possible directions, namely, to establish numerical values of properties being standardized, or only to point out the methods by which the producer should establish their values.

In standardizing machine subassemblies and components, both the producer and consumer are free to decide whether to perform testing by themselves, or whether to assign this work to a special organization. This should not be stated in the standard. It is also not necessary to establish that the product is provided by a marker stating that it has passed the test established by the standard. The use of a marker confirming the fact that the product was tested in accordance with the indicators of the standard, does not belong to standardization problems. This is such a detail which does not have to be included in standards on all cases. The same is true of the question of putting a label on the product.

The basic problems in standardization of components and subassemblies is interchangeability and limiting the number of standard sizes.

Both these problems require thorough study relative to the question which of the product's dimensions are in need of standardization and which are not and also which tolerances and fits must be provided for. In individual cases, it becomes necessary to choose methods of measurement so as to enable the producer and consumer to uniquely and rapidly perform the necessary inspections.

The adoption of a given scheme for performance of standardization work is of important methodological significance, since it determines the planned direction for developing standardization of machine components and subassemblies and which expedient boundaries of achievement should be specified for the given time period. Having chosen a given scheme for achieving standardization, it is possible to start choosing objects of standardization from among the existing tremendous nomenclature of machine subassemblies and components.

2. CHOICE OF OBJECTS OF STANDARDIZATION FROM AMONG COMMON MACHINE SUBASSEMBLIES AND COMPONENTS

The choice and substantiation of standardization of objects from among common machine subassemblies and components, cannot be performed separately. The choice of an object must be substantiated and the degree to which the substantiation is convincing, characterizes the correctness of the choice. The rationality of the choice is based on the results of techno-economic calculations and investigations the performance of which should be considered as absolutely mandatory. This will also reduce to a minimum, cases of nonproductive standardization expenditures.

A standardization object is chosen, taking into account a number of features. Is the given subassembly or component used on a mass scale? Here, the main indicator is the scale on which the standardized components, or subassemblies, are used. If we take as an example re-

presentatives of this category which have become classical - springs, shafts, gears, clutches, packing glands etc., - then doubts about the desirability of standardization cannot arise, even in the case when a quantitative estimate of their need has not been made. But, in addition to these generally known objects of standardization, it is necessary to seek and find other objects, which are used on a smaller scale, including subassemblies and components which require a specific production process for their manufacture.

Objects whose standardization is desirable can be sought along many lines, basing oneself on various technical and especially statistical sources. If it has been established that the object is not utilized on a mass interbranch scale, then it should be analyzed from the point of view of its distribution in several machine-building branches. Thus, for example, components and subassemblies of automotive and tractor engines, compressors, pumps, chemical apparatus and also reducer housings, gears and the like, are at the present time used by individual branches, but they can also be put to use on an interbranch scale with the proper organization of specialized plants and development of coordination.

The stability of functional designations and also continuous varying of their designs, serve as a trusty sign that it is advantageous to subject these subassemblies and components to standardization. In this case, when the scale or other indicators with respect to these features are insufficient to warrant elaboration of a standard, it is possible to recommend achievement of branch normalization.

The guiding technical materials (RTM) usually include a subject field dealing predominantly with methodological problems, for example, methods and rules for calculations, design methods, etc., and also rational fits and clearances in joints. In the majority of cases, these

objects of RTM arise simultaneously with the choice and substantiation of standardization and normalization themes and they should not be disregarded.

The choice of standardization and normalization objects can, in all cases, be characterized by the following three features:

1) mass utilization of subassemblies and components by all or by the majority of machine-building branches;

2) more restricted interbranch utilization;

the necessity of creating conditions for ensuring stable qua li and to guarantee interchangeability.

When a standardization, or normalization, object is chosen by the first and second features, it is advantageous to provide for two successive stages, namely:

a) elaboration of the standard on the basis of products already in use, providing for uniformity of design and also establishment of parametric and dimensional series, decreasing the number of profiles and brands of metal and nonmetal materials being used, etc.;

b) elaborating a standard for new more progressive kinds of products, which refines the computation methods, using design analysis, replacing scarce and expensive materials by those less scarce and more economical, on the basis of results of scientific research and experimental work.

An important role in standardization of mass produced objects used by the entire machine building industry is played by the time factor. For this reason, at the first standardization stage it is sometimes necessary to provide for only the more accessible and less work consuming operations, in order to more rapidly ensure the possibility of centralizing the production of common machine subassemblies and components. This considerably expands the nomenclature of products being

standardized and creates more extensive possibilities for specialization and automation of production. Together with this, the first stage will directly or indirectly but inevitably, serve as a basis for the second stage of standardization of the chosen object.

The standardization practice has accumulated a sufficient number of examples, which affirm the desirability of the above successive evolution of standardization with respect to details. It is known that the elaboration of a standard proposal including choice and analysis of the existing technical documentation, performance of calculations, fabrication and testing of test specimens, adaption of new materials brands and new production processes takes a lot of time. If we limit ourselves at the beginning to only the first standardization stage, then such a standard in the majority of cases can be issued to the industry for adaption within a year.

The acceleration which is thus achieved has a double meaning: firstly, the techno-economic effectiveness of the given standard will be apparent much earlier; secondly, it will become possible to obtain and use objective data pertaining to the practical application of a specific standard for more confident continuation of work on the second more profound and work consuming standardization stage.

Exposure in the machine-building industry of similar subassemblies and components in the absence of a uniform classification and designation system, for standardization purposes, can proceed along several lines. Two of the methods are most characteristic.

In the first method, the standardization object (subassembly or component) is considered independently of its position in the machine. Uniformity is established only on the basis of designations and functional intent and not on the basis of the subassembly's or compoment's design. Thus, for example, the lock and positioner category can include

various products, including locks and positioners of: a) tool box covers; b) mechanisms, positioned in extreme positions; c) electric bulb socket connections; d) devices for switching automotive and tractor gears, etc.

Exposure of similar subassemblies and components by these features will almost always present the producer with a difficult problem, since it will be necessary to look over the designs of all generally known machines, to choose the locks and positioners which they have and to attempt to evolve unified or standard-size series of their basis.

In the second method, it is first possible to establish a certain generality of basic elements of the most different kinds of machines, based not on design similarity, but also on functional features. Thus, for example, almost every machine has a frame, housing or bed on which all the remaining parts are mounted. Many machines move or have moving parts as a part of their design. The majority of machines have power units and mechanisms for working element drives. Each machine has control elements or components. In addition, there exist common components, such as lubricating devices, etc.

Taking this into account, we can subdivide all subassemblies and components into groups by features of component parts of machines. Here, subassemblies and components which are identical by purpose and principle of operation, but differ by designation, will be automatically separated.

Thus, for example, the same lock and positioner is in one case an accessory of a tool box, in the second of lighting fixtures and in the third of a gear box, etc. Naturally, their designs will vary and they will be classified separately which will show that it is impossible to unify them. Another example are gears. If we are guided by the first

method, then all gears used in large, medium and small machines, including clocks and instruments will be included in one group. However, it is evident that their designs, tolerances, materials, specific loads and processes of manufacture have nothing in common. In the second method, gears will be subdivided, for example, into transmission components and instrument components which will always be produced by a different manufacturing process in the appropriate machine-building or instrument-making branch. It follows from this that the second method for choosing standardization objects has certain advantages over the first.

In keeping with the enumerated considerations, A.Ya. Gurevich (VNIIStroydormash) has suggested the following methodology for setting up the nomenclature of machine subassemblies and components, based on first classifying them by the decimal system with increasing the number of classification designation decimals, until precise definition of the kind and type is achieved. It is assumed, in this case, that any machine consists of the following basic parts (groups):

1) Frame, bed, housing or volume.

2) Drivetrain.

3) Transmission

4) Power unit

5) Working mechanism (device for placement or displacement of the working element or for performance of auxiliary operations).

6) Working element (that which touches the material being processed, changing its shape or quality).

7) Work station and control elements.

8) Common subassemblies and components (lubricating devices, fastening components, etc.).

9) Tools and accessories.

Group 10 in this system is kept in reserve.

The following stage in setting up the nomenclature according to this methodology, is subdivision of each group into ten subgroups, which accordingly refine the kind of component parts and which are then subdivided into subspecies and specific types. Thus, for example, transmissions are subdivided into ten subgroups, one of which comprised of reducers. The latter, in their turn, are subdivided into various kinds of reducers, gear, worm, chain, friction, etc. Subspecies will be single shaft, twin-shaft reducers, with parallel shafts, with intersecting shafts, etc. Each of them is then subdivided into types: foundation, shaft suspended, flange, etc.

The more varied the design execution of the given product designation, the more subdivisions will be necessary to classify it and the greater number of classification signs will be used to denote it (index it). But not all groups and subgroups in this classification require detalization in solving the problem under consideration, i.e. the choice of standardization objects. Even without this subdivision, it is possible in a number of cases to expose products which are of no interest to unification and the subsequent interbranch standardization or general machine building normalization. These products, for example, include those classified in groups 1, 5 and 6. They are basically of interest to branch normalization. The same can be said relative to little used types of products. For example, among hydraulic drive pumps with adjustable output which are extensively used and which, as a whole, are of substantial interest to standardization, we can still find types which are not produced in series. Temporarily, they are of no interest to interbranch normalization.

Thus, on the basis of the enumerated considerations it is possible to establish an extensive nomenclature of subassemblies and components

which should serve as a base for subsequent selection of objects for standardization and general machine building and branch normalization.

The feasibility of substantially increasing the run length in producing subassemblies and components is one of decisive factors in the selection of a standardization and normalization object.

The run length characteristic is established successively. The nomenclature and number of machines in which the selected standardization and normalization objects are used are first exposed and the number of identical objects in each machine and the total demand for the machines, both present and future, is then determined. The above data serve as a basis for compiling an approximate list of needs, including: 1) the designation of the object of standardization or normalization; 2) a list of machines in which this object is used; 3) the number of object per machine; 4) the demand in pieces per years of the planned period.

As a result of clarification of the approximate demand, it may be found that the demand for certain products can diminish toward the end of the planned period, in which case standardization or normalization of the corresponding objects can cease to be necessary. The demand for other products can be found to be so small that the cost of standardization or normalization and the possible subsequent organization of specialized production can be found to be undesirable. These successive eliminations can be used to eliminate from the nomenclature being prepared, all or almost all objects which are either not timely, or without a future.

On the other hand, totalling the demand for the given subassemblies and components for different kinds of machines and equipment, which were previously considered not to be substantial enough for standardization (due to the fact that they were produced in a scatter-

ed manner, at many plants and at great cost) can, conversely, be found to be timely and even urgent. Here, still another quite positive factor is determined, i.e. the feasibility of producing standardized or normalized components and subassemblies, according to unclassified centralized orders "for the warehouse," and not for the individual machines for which they are intended, i.e. in one series for a certain planned time interval. As a result of standardization and centralization of orders, the machine-building plants are relieved from continuous small individual orders.

In elaborating standards and normal standards for common subassemblies and machine components, a great amount of attention is paid to the selection of expedient materials. This is the most favorable instant for extensive adaption of plastics.

Substantial preliminary work was performed by the VNIIPTUglemash Institute in 1959-60 relative to 1660 different kinds of machines and equipment produced by coal, peat, lifting and road construction machine building plants and also for [railroad] cars, diesels, turbines and other objects of heavy machine building. This work has shown that about 6400 designations of subassemblies and components of the enumerated machines and equipment can be produced from plastics, but the industry is not, as yet, ready for it.

Adaption of plastics is of great significance, also due to the fact that it promotes lowering the total weight of equipment. For example, use is made in coal shafts of the type KS-9 scraper conveyor which weighs 22 tons. The miners must move from one place to another and are justified in asking why the previously produced type SKR-20 conveyor weighed 17 tons and the more modern KS-9 weighs 5 tons more?

3. COMPILATION OF THE ENGINEERING ASSIGNMENT AND WORK PROGRAM OF STANDARD ELABORATION

The engineering assignment for elaboration of each standard must be counted as a document of first order of importance. Simultaneous with requirements put to the future standard with respect to its content and volume, the engineering assignment must also present basic requirements to the performance of the work.

The standardization practice knows many cases when the absence of the engineering assignment (or when it does exist, but has not been compiled in a sufficiently specific manner), has caused great difficulties in elaborating standards. The desirability of inclusion in the standard of individual sections and indicators, the necessity to analyze and substantiate individual points, etc., have resulted in a large number of discussions. Cases are known when, after the first draft of the standard proposal has been elaborated, trends in the compilation and interpretation of the topic were found which contracdicted the initial intent and idea on which the planning organization has based the future standard. The quality of the standard being elaborated depends directly on the quality of preparation and substantiation of the engineering assignment.

As an example of undervaluation of the engineering assignment, we can present a charactdristic case (according to Ya.V. Shuliko, NIIKhIEMASh). In elaborating normal standards for lubricators, which in this case where classified in the category of lubrication system subassemblies for high-pressure compressors (above 100 kg/cm^2), it was necessary to include a reducer in the normalized lubricator unit. Those implementing the normal standard draft, have chosen a planetary reducer with gear meshing which has been assimilated by the industry. It was found, upon detailed analysis of the elaborated normal standard

draft, that the reducer chosen is not suitable for the given case, since it is intended only for intermittent operation involving short runs and not for continuous operation which is peculiar to the lubricators which were normalized. It was necessary to return the normal standard draft to its authors for revision, which could have been avoided if the engineering assignment would have specified the specific requirements put to the reducer relative to its operational regime or, in any case, if it had called the attention of the authors of the normal standard proposal to the necessity of considering the operational peculiarities of the normalized lubricator.

The engineering assignment for the elaboration of a standard or normal standard draft should originate in that organization which has been entrusted, according to the approved plan, with heading the work on the given topic. Then, this assignment is refined together with the base organization. The task of the latter includes determination of the completeness of the engineering assignment and of its conformance to requirements put to the future standard or normal standard. The base organization edits points of the engineering assignment and supplements it by specific considerations and requirements pertinent to each specific case.

Engineering assignments for elaboration of standards and normal standards are sent out by request to interested plants, design and other organizations, including certain consumers. However, since the object of standardization is a component or subassembly, which is a part of a machine, mechanism, apparatus, etc., it is still more natural that the consumer should judge the quality of the subassembly or component.

The producer can judge the rationality of the proposed dimension series and of attempts to find a more refined design for the standard-

ized or normalized components and subassemblies presented in the engineering assignment, only after appearance of specific suggestions. For this reason, engineering assignments should not be sent on request to all plants interested in the given subassemblies or components. After the engineering assignments are refined, they are approved and sent to the producing plants already in the capacity of directives for achieving the planned standardization and normalization work.

In individual cases, when the objects of standardization or normalization are complex products of various types, it is expedient to subject the engineering assignment draft to consideration and deliberation at a meeting of the scientific and technological council, or at a technical conference with participation of competent specialists. The desirability of this consideration and deliberation depends on the complexity of the work, the significance of the standardized object (the scale on which it is used, the degree to which its position and function in the machine, or mechanism, is critical, etc.). Consideration of the engineering assignment is expedient also in those cases when standardization of the product designs is combined with replacement of materials being used, adaption of new production processes, etc. Thereupon, the draft of such an engineering assignment is sent for agreement and approval. The minutes of deliberations are, in many cases, a mandatory supplement to the engineering assignment which should be pointed out in the text of the latter.

The engineering assignment should provide for the implementation of the following basic points:

1) determination of the production, economic desirability and of the advantages accruing to the national economy by the elaboration of the given standard or normal standard;

2) determination of the character and amount of participation of

various implementing organizations in the elaboration of the draft: if it is elaborated by only one organization, then the participation in this work of its individual laboratories, offices, departments, etc., is specified;

3) compilation of a summary and evaluation of the available original data which include the technical literature, existing standards and normal standards, including also international and foreign standards, various catalogs, handbooks, drawing, etc.; the present time level of development of science and technology in the given field is also described;

4) a list of planned scientific research and investigative work, their content and purpose;

5) determination of the purpose of the standard or normal standard draft whose elaboration is contemplated, namely: specialization or centralization of production, increasing the economic level of the design or the level of interchangeability, introducing uniformity, etc.;

6) substantiation of qualitative and quantitative indicators (elements) of the standardized product, here a list of elements the inclusion of which in the given standard or normal standard is mandatory, is given in the engineering assignment;

7) a list of basic problems which are peculiar of the standardized or normalized objects and which, therefore, require an especially thorough study and substantiation:

8) ensuring proper relationship between the elaborated standard or normal standard and the existing state standards, or machine building normal standards, in order to avoid contradictions and also in order to make possible the use of tested, extensively used data, for example, testing methods, permissible deviations, calculated [design]

coefficients, etc.;

9) determination of the techno-economical effectiveness of the standard or normal standard with most complete consideration of their purpose.

In appropriate cases, the engineering assignment additionally specifies:

a) the need to study the shortcomings of existing designs which are similar to those standardized or normalized, in order to eliminate these shortcomings in the elaboration of revision of the standard (or normal standard);

b) procedure and time periods for performing scientific research work;

c) imperativeness to produce and test specimens and test batches of the standardized and normalized products;

d) the necessity for performing strength, rigidity and operational stability calculations and the like;

e) the necessity for satisfying special requirements put to packing, storage and transportation;

f) the desirability of additional concurrences, etc.

On the basis of the engineering assignment which has been elaborated and approved in the prescribed fashion, the person charged with elaboration of the standard or normal standard draft compiles an operational plan which successively lists working stages, giving their basic content, composition and qualifications of those responsible for implementation, the required experimental work, necessary equipment, instruments and materials, the time schedules and the necessary financial means.

In its final form, the working plan, upon being agreed upon, is approved by the leadership of that organization which is charged with

the implementation of the given standard or normal standard and is then included in the subject field plan and the appropriate financing document.

The engineering assignment, together with the operational plan thus, on one hand, represents a detailed methodological guide for the elaboration of the given specific standard or normal standard and, on the other hand, both these documents serve as a basis for checking the progress of their elaboration at any stage. Finally, after the elaboration of the standard or normal standard draft has been completed, it is possible to judge its quality and completeness on the basis of comparison with the engineering assignment and the operational plan.

In individual cases, it is desirable to compile a preliminary engineering assignment in order to use opinions expressed about it by interested organizations and refinements of technical requirements as a basis of elaborating a better substantiated engineering assignment. The preliminary engineering assignment should include the following information:

1) full designation of the standard or normal standard draft subject to elaboration;

2) the author of the draft and the implementation schedule;

3) the purpose served by the standard of normal standard;

4) list of organization from which original data should be obtained;

5) determination of the demand for the standardized or normalized products;

6) original data which should serve as the basis for elaboration of the standard or normal standard proposal;

7) the degree to which mass production is possible;

8) the most prevalent parameters (a series, or series, of para-

meters);

9) basic engineering data on the standardized or normalized products;

10) the procedure for considering materials collected according to the preliminary engineering assignment and the procedure for elaboration and approval of the final engineering assignment;

11) additional information and instructions pertaining to refinement of the engineering assignment.

A certain part of existing normal standards, especially of branch and local normal standards, was elaborated without sufficiently clearly defined engineering assignment. For this reason, mandatory adaption of engineering assignments by the standardization and normalization practice should be considered as one of the first priority methodological tasks of base organizations.

4. CLARIFICATION OF THE APPLICABILITY OF STANDARDIZED COMPONENTS AND SUBASSEMBLIES BY THEIR BASIC PARAMETERS

In establishing the total demand for standardized or normalized components and subassemblies, it is necessary to clarify boundaries of their application. In elaborating normal standards, it is important to know not only specific standard sizes of components or subassemblies, but also the specific machines in whose assembly they can be used. This question can be clarified by using the statistical method and the structural analysis method.

The statistical method is used in those cases when the dimensions, parameters and design formulation of the standardized or normalized products depend entirely on that joint, subassembly or machine for which these products are used.

For example, the piston pin does not influence the dimension of the piston or connecting rod; conversely, all dimensions and technical

characteristics of the piston pin depend on these components and their elements. Standardization of these components is in the majority of cases, limited to elimination of inefficient fractionality in dimensions, unification of technical requirements, etc. The applicability in these cases, is determined primarily by statistical methods. Certain reworking of designs with the purpose of unification of component dimensions, tolerances and fits, dimensions of chamfers, fillets and other structural elements, is done with mandatory consideration of the specific use to which they are put in the different subassemblies and machines.

The parameter and dimension series used in the standard or normal standard draft being elaborated are, if necessary, subdivided into groups, each of which is referred to specified kinds of machines possessing specific properties. Thus, for example, the piston pin may have different tolerances and fits for cast-iron and aluminum pistons with the same dimensions, or it can be fabricated from different materials, depending on the operating temperatures (for a diesel, for a compressor, etc.). It follows from this that, in the first method used for clarifying the demand for components, their design analysis is an auxiliary concurrent factor.

The design analysis method is more complex, but together with this also more effective. This method is based on a detailed analysis of the designs of the standardized or normalized articles. In the majority of cases, it must involve scientific research or experimental work.

The initial stage of design analysis is based on the choice of assemblies or components, either with the same designation or similar to one another, with idential or similar functional purpose. Then, these subassemblies or components are grouped by their parameters and

dimensions, as a result of which some non-ordered series or actual utilization are formed. It is here made apparent that several components and subassemblies with idential operational functions, but with different design formulation are devolved upon identical or, in any case, close parameters and basic dimensions. This is a result of the unlimited design inheritance as a result of which components and subassemblies of many machines, mechanisms and apparatus being produced have for a long time retained all those features which were peculiar to their prototypes purchased at different times, including those obtained from many foreign firms in the years of the first five-year plans.

As we know, patent limitations and competitive considerations of capitalist enterprises create an infinite number of individual designs of all kinds of products and their component parts which do not give any substantial functional advantages. The indiscriminate design inheritance makes standardization and normalization extremely difficult. An example of this is the unification of fractionating columns, the basic working components of which are the so-called bubble caps. A considerable amount of columns was brought into the USSR from different countries, prior to the Great Fatherland War [World War II]. For this reason, when work for normalization of the bubble caps started, 30 designs of these caps were found which performed identical functions. Naturally, inclusion of all or many cap types in the normal standard draft was found to be irrational. It was necessary to include those which present advantages in their manufacture and provide for efficient operation. Scientific research and experimental work, some of it directly at chemical plants, was performed for several years. Three cap types were determined as a result, the production adaptability of whose design satisfied manufacture and installation requirements. They

also satisfied the stringent requirements of the fractionating process. The specific suitability of each of the three types of caps was also determined and properly substantiated. Prerequisite conditions were created for organizing their production at specialized plants, since the total demand for them is counted in tens of thousands of pieces.

In choosing materials for standardizing structural elements of components, it is also necessary to select data about the suitability of the cutting and measuring tools, which is used for shaping and inspection, respectively, of the normalized structural elements.

If the starting material are working drawings, then they should be used for compiling summary tables of applicability, showing the annual demand for the corresponding subassemblies and components. These summary tables can contain the following information:

1) designation of the component or subassembly;

2) name of the component or subassembly;

3) name of machine for which the component or subassembly are used;

4) number of components or subassemblies per machine;

5) annual output of machines;

6) annual output of components or subassemblies.

For production process analysis purposes and for determination of the optimal design of the normalized components or subassemblies, use is made of cards or tables which show sketches of these components or subassemblies, giving their basic dimensions and other information. These cards, or tables, can serve as a basis for determining the efficiency and production adaptability of the component or subassembly, the labor time required for manufacture, materials used, etc.

5. COMPILATION OF DIMENSIONAL AND PARAMETRIC SERIES OF COMPONENTS AND SUBASSEMBLIES BEING STANDARDIZED

Subassemblies and components the standardization of which is contemplated can differ substantially by their functional designation, basic parameters and dimensions. Thus, for example, basic characteristics of many products being standardized are: productivity, rating, speed, resistance to various loads, geometric dimensions, weight, design arrangement, etc., and frequently also the ratio of two or more characteristic parameters. The basic parameters of shafts, pipes, profiled rolled stock and steel cables are their cross-sections. Here, steel cables require an additional characteristic determining their construction, i.e. the number of strands and of wires in each strand. Pipeline fittings are characterized by two main parameters - the nominal pressure and nominal flow-passage. Built-in electric motors of various types are characterized by the rating and rpm, compressors and pumps - by the pressure and delivery, reducers - by the transmission ratio and torque, bearings - by the allowable load and rpm.

The enumerated parameters and other indicators determining the basic characteristic of products are only main characteristics. Naturally, the more complete technical characteristic of products being standardized is determined by a certain larger or smaller number of additional parameters which depend on the basic parameters. Thus, for example, the main parameters of journal bearings are the allowable load and rpm. The bearing diameter and length, dimensions of housing cover bolts, bearing area of housing, height from the bearing surface to the shaft axis, etc., are subordinated quantities; they can be determined from equations upon assuming certain constant coefficients and relationships such as: the value of the allowable specific pressure on the working surface; rational relationship between the diame-

ter and the length of the shaft journal, proportional relationship between the bearing diameter to the distance from the axis to the housing base.

If the main parameter for high-pressure threaded fittings are the flow hole diameter (nominal flow-passage) and pressure, then the remaining dimensions such as: thread diameters, their lengths, hexagons, etc., will be a function of these parameters only.

Dimensional series of components and subassemblies depend in the majority of cases directly on the peculiarities of these machines of which they are component parts. Consequently, dimensional series of components and subassemblies shoud, with satisfactory sequence and accuracy, correspond to main parameters (speed, temperature, pressure, capacity by various criteria, load, etc.). Differences from the above arise in cases when the component or subassembly perform independent functions, for example, lubricant, cooling or heating medium delivery, etc. In these cases, it is not possible to refer to previously standardized general purpose devices. This is the reason for elaboration of separate, independent, parametric series.

Determination of the value of each parameter separately and the subsequent establishment of a parametric series is a very complex process, requiring from those performing it systematic accumulation of experience. We shall show this through an example of substantiation of one of the parameters of the general purpose compressors - the compressed air pressure. The majority of users of these compressors need a pressure of 6 kg/cm^2, some require 5 and 4 kg/cm^2 and, in individual cases, 7 and 8 kg/cm^2 is needed. To fully satisfy the existing or stated requirements, it would thus be necessary to have a pressure series including 4, 5, 6, 7 and 8 kg/cm^2. This is the series of pressure encountered by standardization workers several years ago. It became

necessary to standardize the main parameters and on this basis to develop branch standardization of common compressor subassemblies and components.

The parameter series was established in the following sequence. Statistical analysis performed of the needs of individual users has shown that the majority needs compressors providing a pressure of the order of 4-6 kg/cm^2 and the remaining requirements comprise a minority. This was followed by analysis of actual conditions under which the compressors operated. It was found that in order to satisfy the requirements of all users (i.e., production units using compressed air power), it is desirable to manufacture compressors with two pressures: 4 and 8 kg/cm^2.

It must be taken into account that the main parameter, in the given case pressure, is always a quantity on which to a lesser or greater degree depend all remaining parameters and dimensions, which additionally characterize the machine's properties. The parameter in all cases serves as a starting point for the subsequent design of objects. A high scientific and technical level of standardization of the main parameter predetermines its stability and economy and, consequently, also the perfection of design formulation of subassemblies and components upon normalization. The second operational parameter of a compressor is its delivery, determined by the cylinder diameter, piston stroke and number of piston strokes per minute. The combination of the enumerated parameters and dimensions, taking into account friction in component and subassembly joints, makes it possible to determine the parameter which characterizes the economic side of operation, i.e. the required rating. Thereupon, parameters such as compressed air temperature of cooling water at inlet and discharge and its flow rate are determined.

It is not difficult to satisfy oneself to the effect that all the enumerated parameters and dimensions can be classified as substantial quantities, characterizing the operational properties of the machine (compressor in the given case) and its economy, ensuring of which depends on structural peculiarities of components, subassemblies and joints.

Regardless of which subassembly is considered - cylinder block, connecting rod, assembled valve, etc., each of them is subordinated to one or several basic parameters and dimensions of the compressor. No additional parameters, peculiar only to subassemblies and components, arise.

In those cases when the subassemblies and components subject to standardization or normalization which are component parts of different machines are produced in more or less large series, it becomes necessary to consider the possibility of decreasing the number of standard sizes of these components and subassemblies. The purpose of this study is the feasibility of eliminating the necessity of providing each machine with its own subassemblies and components peculiar to it only. An attempt should be made at an arrangement whereby one subassembly (or component) is suitable for inclusion in the design of several different machines. In addition to clarifying the economic expedience of this measure, which promotes decreasing the number of typical sizes of subassemblies and components being produced, the technical feasibility of this step should also be considered.

We should not forget that sometimes such a measure is found to be advantageous also in those cases when a larger subassembly (or component) and, consequently, one requiring a larger labor input and expense, replaces or smaller subassembly (or component), i.e. one which requires a smaller labor input, since this decreases the cost of pro-

ducing the machine due to extending the run length of production and expansion of the field of interchangeability.

The most convincing proof of the expedience of solutions used in the field of establishing series of parameters and dimensions of machine subassemblies and components is conformance to the preference numbers system.

The dimensions of machine components are subordinated in an overwhelming number of cases to strength considerations which are determined by functions performed by these components, be they dovels, pins, gears, axles, pullrods, beams, etc. Strength indicators or characteristics are, as a rule, equivalent to the values of component cross-sections, which vary depending on the character of applied load and on properties of that material from which the component under consideration is made. The calculation of each component is thus based on a certain parametric characteristic, which is a prerequisite condition for seeking an advantageous design formulation of the component and, in particular, for determination of the geometric shape of the cross-section which is most efficient for each individual case.

The above process for establishing dimension characteristics of components shows the existence of a direct relationship between the parameters and dimensions; it makes it possible to create a method for choosing dimensional series for practical purposes. This method can be based on the following considerations.

Let us assume that the component being standardized works in tension in a certain specific mechanism, several standard sizes of these mechanisms being in existence, each of which being characterized by a parameter expressed by a specified load (force). This load is taken up by the component being standardized and, for this reason, it is its characteristic parameter. Let us assume, further, that the parameter

series for all these standard sizes corresponds to the 10th series of preference numbers, with a relative difference between adjacent terms equal to 25%. Let us also assume that, upon design considerations, this component must have a round cross-section. Consequently, it will have the diameter as its dimensional characteristic. Let us assume further that it was decided to construct the dimensional series of the components being standardized in the same manner as the parametric series, i.e. also in accordance to the 10th series of preference numbers. In this case, the relative difference between adjacent diameters will also be 25%, but the cross-sectional areas, which characterize the carrying or load capacities of components, will have a difference of the order of 60%. These components will thus have excessive safety factors.

If the diameter is series is constructed not by the 10th but by the following, 20th series, then the values of the cross-sectional areas will correspond to the 10th series, i.e. they will correspond to the parameters of the aforementioned mechanism.

The above serves as a basis for considering the practice of application of preference numbers, in which both the main parameters of mechanisms and linear dimensions of components which are used in the given mechanisms, are chosen by the same geometric progression series, as incorrect.

The relationship between parameters characterizing the load magnitudes (forces, etc.), and linear dimensions of components which take up these loads, can be expressed in the general form in the following manner.

Linear dimensions which characterize the cross-sectional areas of components should be established by a geometric series of preference numbers which is the subsequent, i.e. the higher series in the stand-

ard system of preference numbers:

R5 parameter series has a corresponding Ra10 dimension series

R10 " " " " " Ra20 " "

R20 " " " " " Ra40 " "

The following was established by analyzing 153 existing parameter and dimension series of various products, provided for in 68 domestic normal standards for components and subassemblies of metallurgical, petroleum and chemical machine-building and also for automotive vehicles, machine tools and shipboard equipment

The majority of the 153 parameter and dimension series (110 series) is devolved upon the derived R10 and R20 series and the minority belongs to the R5 derived series. Here, as a rule, the starting parameters form R5 and R10 derived series, or series close to R5 and R10 and the dimension series in these cases correspond to series derived on the basis of R10 and R20. In a considerably smaller number of cases, the starting parameter series correspond to derivatives of the R20 series, but then the dimensions series have values approaching the R40 series and its derivatives.

Analysis of 169 parameter and dimension series of various products provided for in 92 standards and normal standards of Belgium, Rumania, France and Switzerland and also in DIN normal standards has shown that a specified governing relationship exists also here. The overwhelming majority of the aforementioned 169 series was constructed on the basis of derived R10 and R20 series. However, which is also the case in Soviet normalization practice, "pure" geometric series (i.e. fully conforming to the R10 or R20 series) are a rare phenomenon also in these countries.

Among the 24 series of the 13 Belgian standards analyzed, not one parameter series was found, but dimension series, with rare exceptions,

are constructed according to derivatives of the R20 series. Among the 32 series of the 15 DIN normal standards analyzed, exist four parameter series, the values of which approach the R5 and R10 series. The major part of parameter series corresponds to derived R10 and R20 series and the minor part conforms to the R40 series. 18 series were analyzed in the 14 Rumanian normal standards, among which were found three parametric series, all of which are more or less close to the R5 and R10 series. Dimension series in these 14 normal standards are mostly conforming to derivatives of R10 and R20 series and the remainder corresponds to the R40 series.

The present-day machine building practice of the FRG [German Federal Republic] extensively uses the preference numbers system. But also here the series being standardized are subjected to certain refinements, which can be shown through an example of type TVB variable-speed drives, produced by the firm of Cherm, Muller and Co. The diameters of sheaves of these drives comprise the following series: 63, 80, 90, 100, 125, 140, 160, 180, 200, 224, 250, 280, 315 and 400 mm. This is the R20 series but diameters of 71, 112 and 355 mm were excluded from it.

The Soviet normalization practice uses predominantly parameter series based on derivatives of R5 and R10 series and dimension series based on derivatives of the R10 and R20 series. As an example, we can cite normalization of track wheels for non-self-propelled carts. Here, the allowable loads on the wheels are established by the R5 series and the diameters by the R10 series with certain moderate deviations from preference numbers values.

In practical work for elaboration of standard and normal standard proposals for common machine components and subassemblies, when the the choice of a specific series has not yet been reinforced by experienc

or substantiation, one should guide himself by the R10 parameter series and the R20 dimension series. Other parameter (for example, R5 or R20) or dimension series (for example, R10 or B40) are accepted only as a result of the most thorough study of the designs of subassemblies and components, their fields of application and, especially, of the demand for them. This recommendation with respect to the R10 parameter series and R20 dimension series corresponds to conclusions made in Chapter 8 relative to dimensional series and parametric standards for machines and equipment.

6. COMPILING A STANDARD OR NORMAL STANDARD PROPOSAL

Compilation of a preliminary standard or normal standard (general machine building or branch) proposal for common subassemblies and components of machines, has many peculiarities depending on the topic, the degree to which standardization or normalization embraces the object (or objects) and other conditions, which have in one manner or another been reflected in the engineering assignment. In addition, considrations which require introduction of corrections to the engineering assignment can also appear in the process of work. For example, the selection and techno-economic substantiation of a standardization (normalization) object are frequently based on statistical data and certain functional features, while upon analysis of the collected original data it may be found desirable to slightly expand the topic past the limits of the engineering assignment, to change the number of kinds and types of products, in order to more completely satisfy the needs of the industry, or to divide the topic into two or several separate standards (normal standards).

In individual cases, achieving general machine building standardization (normalization) is found to be practically impossible and it becomes necessary to achieve on branch scales. The cause for this

splintering into branches of a general topic is usually design and production process inheritance, the negative results of which die out very slowly. An example of this is the machine building normal standard for hydraulic cylinders. The work, conceived as an integrated and interbranch project, was performed on a considerably smaller scale. Consequently, substantial changes take frequently place in the process of elaboration, which expand or contract the boundaries of the assignment. These facts attest, at the same time, to the quality of analysis of the engineering assignment, to its completeness and long-range quality.

The basic stages in the elaboration of each standard (normal standard) proposal include:

1) compilation and sending to plants, design organizations, NII, sovnarkhozes and other competent institutions of questionnaires about the existing and expected demand for the subassemblies and components being standardized (normalized) and about the requirements put to them;

2) systematization and correlation of answers to the questionnaires; collection of missing information by visiting the plants and other organizations;

3) elaboration of the first draft of the standard (normal standard) proposal, including explanatory notes, considerations about organization of centralized production, coordination and techno-economic effectiveness and, also, about conditions of adaption;

4) compilation of a list of organizations to which the proposal is to be sent; sending it for decisions and opinions;

5) analysis of decisions and suggestions obtained and compilation of a summary of opinions received;

6) conducting a technical experts conference with participation of basic interested organizations and individual competent specialists

to discuss the summary of opinions received and to decide controversial problems;

7) elaboration of the second draft of the proposal with explanatory notes and other supplements in accordance with the existing requirements;

8) finalization of the standard (normal standard) proposal, duplicating it and submission for approval;

9) participation in the consideration of the proposal and preparation for approval and printing by typographic or other method.

In those cases when in the process of elaboration of the standard or normal standard proposal it is found necessary and feasible to adapt more pregressive objects, the appropriate planning and design and experimental work is performed, including manufacture of a certain batch of products and a thorough testing of them. All this should be reflected in the documentation included in the first draft of the proposal. In individual cases, additional experimental work is performed attendant to the elaboration of the second proposal draft. Similarly, it becomes necessary to reconsider the revised standard (normal standard) proposal. For this purpose, the second draft is again sent for comments either to all recipients of the first draft, or only to those which have actively helped by their comments to improve the proposal, which is decided at the technical experts conference called to consider the summary of replies obtained with respect to the first draft. The second mailing of the proposal for comments makes necessary the compilation of a second summary of comments and a new consideration by a technical experts conference.

The technical experts conferences are frequently called consent conferences, which emphasizes their purpose to reach a concensus of opinion, but this cannot be always achieved. The practice of general

machine building normalization has evolved a system for conducting the consent conference at the initial stage, i.e. after the preliminary revision of the machine building normal standard proposal, in order to use the decisions of this conference as a basis for elaboration of the first draft of the normal standard proposal. In this system, the second draft of the proposal is considered by the scientific-technical or scientific council of the base organization; here, experimental specimens and the experimental batch are produced attendant to the elaboration of the second draft of the normal standard proposal. However, the need to perform experimental and research work and also to produce experimental specimens and experimental batches is determined depending on their peculiarities.

Consent conferences can be conducted also in another sequence. Their purpose is clarifying the opinion of the representative of interested organizations with respect to the substance of the normal standard draft being elaborated.

It is desirable to present certain recommendations on individual stages of this work, which can be found to be valuable for persons which have not, as yet, acquired independent experience in standardization and normalization work.

Mailing of questionnaires. A list of plants, design and production planning organizations and scientific research institutes which are users and producers of the subassemblies and components, the standardization or normalization of which is contemplated, should be compiled. This list should include plants which produce the given subassemblies and components: plants which use them for assembly of goods which they produce (operating organizations), which receive these subassemblies and components as spare parts of for basic production purposes and also sovnarkhozes, ministries branch state committees

and scientific research and design organizations which use these subassemblies and components in designing. In compiling the list, one also has to include potential users, i.e. those who can use the given subassemblies and components in the case when centralized production [of them] will be organized.

A questionnaire is sent to each addressee (with reference to a decision about standardization or normalization of the given object), which should contain the following questions: a) the quantity and standard sizes of subassemblies and components produced by the given plant (or organization) annually, or the quantity which it uses per year; b) the desires about improving the existing designs; a request is expressed for sending out of drawings of subassemblies and components being used.

Processing of answers obtained. Preparations for processing of materials should begin in proper time, even before the questionnaires are returned. It is possible to prepare blanks of records showing: the names of plants and organizations, type of subassembly or component; basic parameters or technical characteristics; types of machines in which the given subassembly of component is used; the annual need and other specific data. Without waiting for the summary in its final form, work should be started on elaboration of parametric data or design analysis, depending on the topic.

In urgent cases, the information can be recorded in the order in which it is received, although it is desirable to first classify the material by uniformity of type range. parameters or other features. As the information comes in and is recorded, it is possible to decide about the type range or classification of the objects being standardized (normalized). It is expedient to base this classification on types and basic parameters. For example, pumps can be classified by types,

gear, plunger, etc., and then by the pressure and delivery. Similarly, sleeves are first classified by types and then by other characteristics.

After this preliminary classification was performed, it is possible, on the basis of statistical analysis of the collected and systematized data, to make a decision on the selection of a number (one or several) of product types for standardization (normalization). Then, the most frequently used parameters are established for each type of product (on the basis of statistical analysis). Preference is given to types which are used most frequently; however, this rule should not be misused, since new, more pregressive, products are in limited use at the beginning, which fact is very important to expose and to provide a stimulus for their more extensive use.

Grouping of products. The subassemblies of components being standardized (normalized) are grouped by dimensions and parameters on the basis of preference number series.

On the basis of the specific design of the product, its type or other properties, the author of the standard (normal standard) draft should make decisions guiding himself by the economic advantageousness, operational convenience and practical considerations with respect to conditions of adaption.

Compilation of the first draft of the standard (normal standard) proposal. The elaboration of the proposal begins with drawing all typical dimensions, preferably in their natural size and for small components - on a scale of 2.5:1 or 10:1. If the standardized (normalized) product has parts with relative motion, then they should be sufficiently accurately drawn in extreme and characteristic intermediate positions. If the product is an assembly which requires detailed drawings (as a supplement to the standard, or which are included in a normal standard), then detailing shou d be followed by test assembly on

an 1:1 scale and at a large scale for small products.

After final checking of all component dimensions and of assembly of all standard sizes, it is necessary to make a general table drawing, if all these components and assemblies retain their relative geometric similarity. If this is not the case, separate drawings are made for each design execution.

No simplifications are permitted in finalizing the first draft of the standard (normal standard). The text of the presentation must be edited with great care. Explanatory notes must sufficiently be detailed so that it will be possible to find in them an explanation and substantiation of each indicator or assumption included in the standard or normal standard proposal.

Problems of production adaptability. In elaborating standard and normal standard proposals, special attention must be paid to problems of production adaptability, especially in those cases (and they predominate), when the standard (normal standard) is elaborated for a product intended for centralized production. The product designs must be thoroughly finished off and subjected to reliable appraisal by production experts. Special attention should be paid to the use of stamping, chill casting, investment casting, hardening by high-frequency induction heating and other high-productivity production processes. Materials from which these articles will be produced must also be chosen accordingly.

Thus, for example, when normalizing high-pressure hoses, the demountable joint for insertion of ends, which could be produced by semi-primitive methods, was replaced by a nondemountable joint which, while requiring special diesets, is strong, good-looking and can be produced cheaply under mass production conditions. If the article being standardized (normalized) is an assembly or subassembly, then in this case,

it is in principle advantageous to unify components of the same type (for example, fastening) for several adjacent standard sizes of products. But in this case, an objective evaluation of the expedience of this unification should be made. It should not be detrimental to the weight, overall dimensions, individual dimensions and other qualitative indicators of products.

Design unification within the standard sizes of a product is always desirable, but attempting to achieve it, one must keep in mind that the change in dimensions of one component caused by unification does not always require a proportional change in the dimensions of adjacent components. For this reason, it is important in design unification to conform to a system of preference numbers, which ensures the greatest proportionality of dimensions.

A great deal of attention must be paid to problems of design and production process inheritance in elaborating standard and normal standard proposals. Inheritance must have sensible limits.

Comments by organizations. The most detailed reply from among those received should be that of the corresponding base organization. Unfortunately, this is not always ensured. For this reason, great importance is acquired by personal contact of the standard (normal standard) proposal author with the base organization*s workers.

The replies should contain comments pertaining to the arrangement and presentation of the material about the objects being standardized (normalized), and also about its quality, i.e. pertaining to the degree of substantiation of the proposal in all its parts. The qualitative aspect cannot be evaluated on the basis of consideration of the standard (normal standard) proposal text only.

For this, it is necessary to evaluate all prerequise conditions of the proposal which are illuminated in explanatory notes, especially

those relating to feasibility of achieving central production and its effectiveness.

If any remarks and suggestions obtained from interested organizations with respect to the first draft of the proposal are not accepted, then this should be substantiated in explanatory notes of the second draft of the proposal. The remarks should not be considered mechanically, since the quality of comments varies. Preference should be given to those comments in which the proposal is subjected to competent and subjective criticism. Comments which formally express agreement with the proposal, or which just as briefly disapprove of it, are undesirable.

7. CONTENT OF STANDARD AND NORMAL STANDARD PROPOSALS

Many practical problems arise in the process of elaborating standards and normal standards. For example, in what cases should the normal standards be elaborated in the form of product designs with all fabricated dimensions and in what cases should they be limited to giving the basic dimensions only?

From the point of view of safeguarding the interests of users, normalization of designs and all fabricated dimensions is unnecessary; it is sufficient to have a normal standard which gives the basic and joining dimensions of the product. From the point of view of providing for production needs, the same normal standard should contain exhaustive information only in those cases when the normalized products are not centrally produced. While if the production is centralized, or if prospects for achieving centralized production exist, then such a minute detailization of the normal standard is not necessary. It is not always necessary for the normal standards to replace the drawings of the specialized plant, which is obligated to constantly attempt to improve the designs of articles it produces and to improve their pro-

duction adaptability without detriment to the interest of users.

Does the question of how better to arrange the standard or normal standard require thorough consideration in the process of standardization or normalization? Should the entire available material be included, for example, in one standard (normal standard), or should it be distributed among several standards or normal standards? What should the limiting features be in this case?

As an example, we can use a normal standard for screw taps:

first version - all screw taps are included in a single normal standard, which provides for the various versions of screw taps;

second version - manual, machine and nut screw taps are normalized in three normal standards;

third version - manual screw taps for large threads are included in one normal standard, manual screw taps for small threads are included in another normal standard, etc.;

fourth version - one normal standard pertains to twin-fluted screw taps, another normal standard to three-flute screw taps, a third normal standard to four-flute taps, etc.;

fifth version - all standard sizes of screw taps which can be drawn on a standard-size sheet used for normal standard drawings, are included in one normal standard; the remaining standard sizes of screw taps are placed in other normal standards, the number of which depends on the feasibility of arranging the corresponding drawings and tables on each form sheet.

These questions cannot be resolved according to the liking of individual authors of normal standards, since they are problems of technical policy and normalization methodology and are subject to thorough consideration and deliberation with interested organizations in the process of issuance of engineering assignments for elaboration of

normal standards. Elaboration of ideas of technical standardization and normalization policy, compilation of operational methodology for their implementation with respect to a specific subject field, are a major function of standardization and normalization organs. The existence of uniform recommendations applicable in all cases is impossible.

The question of construction and presentation of state standard proposals is regulated by methodological directions of the Committee of Standards, Measures and Measuring Instruments and also by instructions of the VNIINMASh about the procedure to be followed in presentation and finalization of machine-building normal standards.

The names of standards and normal standards should precisely define the products to which they apply. In those cases when a precise definition of the products requires a long enumeration, it is permissible to give the field of application of the standard (normal standard) and its introductory part. The numberical values of parameters and dimensions are given together with the degree of precision which is required for ensuring the necessary operational properties and quality of the goods.

Standards and normal standards for common machine and tool components, with a moderate number of tabulated dimensions and standard sizes of these products, are arranged on a single sheet with all data needed for the production and inspection. The order in which these data are arranged is: a) drawings, b) a designation example, c) table, d) technical requirements. If the product is described by a large number of tabulated dimensions and standard sizes which cannot be placed on a single sheet, then the table of standard sizes can be subdivided into groups by generality attribute of one of the main dimensions, and then each group of standard sizes is given on a separate sheet together with the drawing of the component (tool). Dimensions common to the given

group of products are given directly on the drawing.

Standards and normal standards for a subassembly with a moderate number of components and tabulated dimensions is constructed as follows: a) general view drawings, b) a designation example, c) table of product's standard sizes, d) table of the standard sizes of components, e) technical requirements put to the product. The co mponents are placed on successive sheets in the following order: a) drawings, b) table of standard sizes, c) production process requirements put to the component. If the subassembly has a number of standard sizes, such which makes it impossible to place them on a single sheet, then the table of standard sizes is divided into groups by the generality attribute of one of the main dimensions. Each group of standard sizes is put on a separate sheet together with the drawing. Common dimensions are given in the drawing.

Standards and normal standards for types, parameters and basic dimensions of subassemblies of machines and complex production equipment are constructed as follows: a) instructions defining the field of applicability of the given standard (or normal standard), b) description of product; c) general viez drawing of the subassembly giving overall, joining and installation dimensions, d) table with standard dimensions of the product. Normal standards, in addition, should give the name of the organization which has elaborated drawings in accordance with the given normal standard.

The weight of components and subassemblies is given with the accuracy of: the third decimal point for weights less than 1 kg; second decimal point for weights from 1 to 9.99 kg, first decimal point for weights from 10 to 99.9 kg, weights from 100 kg and above are given in integral numbers only. If the weights of products being standardized (normalized) is measured in fractions of a kilogram, the weight

of 100 or 1000 pieces can be given.

The technical requirements are placed in the following sequence: a) materials used, b) heat treatment, c) depth of carburization or surface hardening, hardness; c) plating, d) permissible deviations for free dimensions, e) precision of relative placement of surfaces and deviation from geometric forms, f) reference to standards which establish nominal thread dimensions and precision class, g) reference to standards establishing structural elements of components, h) production process instructions, i) branding. Reference are permitted to the applicable engineering specifications of various State Committees for technology branches, of the Gosstroy [Office of State Construction] of the USSR and of the Communications Ministry and also to engineering specifications of ferrous and nonferrous metalurgy. References to plant normal standards, catalogs, handbooks, price lists, etc., are not permitted.

Explanatory notes to preliminary standard and normal standard proposals are usually compiled in the following sequence:

1) General statements: a) name and number of topic, b) authors of the proposal, c) elaboration schedule and the content of the engineering assignment.

2) Critical review: a) state of problem, b) a summary of applicability, c) a summary table of parameter and dimension series, d) analysis of series, e) analysis of existing designs pertaining to their production adaptability, metal consumption, labor input, manufacturing conditions and methods, operational reliability and service life, industrial safety, materials used, plating media, hardness, manufacturing precision and surface roughness.

3) Techno-economic substantiation: a) expedient limits and characteristics of parametric and standard dimensions series; b) economic

effectiveness of adaption of the given standard (normal standard); c) comparison of the assumed indicators and norms with indicators and norms of existing standards, normal standards, engineering specifications and foreign standards and, also, with actually produced articles; d) substantiation of the designs, parameters, indicators, dimensions and other technical specifications chose; e) total annual demand for the products; f) suggestions on organization of centralized production; g) an approximate number of plants for producing the standardized (normalized) articles and their regional location; h) strength, rigidity and stability calculations when such are necessary; i) results of experimental work (if such was performed); j) list of questions to which the author of the standard proposal wishes to obtain answers.

Explanatory notes to the final edition of the standard or normal standard proposal should reflect its basic difference from the first (preliminary) proposal draft. It should be presented together with a list of organizations to which the preliminary proposal was sent for critical comments. It is necessary to show the percentage of components thus obtained with subdivision into positive, negative and undetermined. Information about those plants and other organizations which sent in no replies, is of significance. Considerations presented by plants, sovnarkhozes and design organizations on principal questions should be presented in detail. A summary of comments should be appended to the explanatory notes.

In elaborating normal standards for machine and tool components and for components of production equipment, it is frequently desirable to make the normal standard as close as possible to the working drawing. In this case, it should contain all dimensions and technical requirements without references to general technical standards and norm-

al standards. It should be pointed out that standards and normal standards, as a rule, contain many such references. Furthermore, they frequently provide for a choice of any steel brand from among several quoted in the given standard and normal standard. In the latter case, elaboration of working drawings is inevitable, since a technical document whose use is impossible without supplementary standards or normal standards to which reference is made cannot be issued to a production unit.

The following methodological rule must always be remembered: if it is required to conduct the work in the shop directly from the normal standard (without a working drawing), then such a normal standard must contain all the necessary projections and sections, all fabricated dimensions, all technical requirements and should not contain a single reference to another document. In the opposite case, working drawings must be elaborated.

8. METHOD OF COUNTERPROPOSED STANDARD DRAFTS

To achieve on a large scale centralization and specialization in the production of components common to various machines and mechanisms, use can be made of the method of counterproposed standard drafts. This method is especially effective in those cases when it is required to standardize general machine building components produced by the same production process, but having different designs. The substance of the method consists in the following.

A list is made of components of different design, but produced by the same production process, which include all kinds of gears, spline stepped and smooth shafts, axles, levers, etc. The sovnarkhozes and base organization send out the list of these components to all plants, design, production planning and scientific research organizations which produce working drawings of machines and equipment. These organizations,

on the basis of their own needs, compile preliminary standard drafts for each kind of components included in the list, taking into account the needs of the given organization for the given standard dimensions and listing the material brands, heat treatment, the required precision and other characteristics. These preliminary standard proposal take into account the expedient unification of types, dimensions and technical characteristics and contain suggestions with respect to further unifications (second priority unification).

The preliminary proposals of organizations are sent to their sovnarkhozes and base organizations which combine and unify the standard proposals: the sovnarkhozes by the territorial subordination and the base organizations by the branch subordination. Preliminary standard proposals so combined and unified make it possible for:

1) the sovnarkhozes to achieve with the boundaries of their administrative region centralization of production of components with the same production process on the existing or newly created production base;

2) the base organization to elaborate well substantiated branch normal standards;

3) one of the central design offices or scientific research institutes (by special order) to elaborate a proposal of a state standard which is needed by a specialized plant (or a number of plants) of all-state significance, whose purpose is to produce general machine building components similar by their production process, but differing by their designs.

The method of counterproposed standards has the following characteristic features. The work for standardization of components differing by their design, but being produced by the same process, begins at enterprises which are capable to critically evaluate the existing

situation and to determine the nomenclature of components including stage by stage unification and giving the annual demand for each standard dimension. Sovnarkhozes provided by specific material, such as preliminary standard proposals submitted by their plants, are in a position to arrive at a substantiated decision about the standard dimensions of components which can be produced to an advantage in a centralized manner and those whose production should be retained by the individual machine building plants. Doubtlessly, components which were retained for production at [individual] plants will be gradually replaced by those components which can be obtained in a centralized manner. This is economically convenient in all respects since it improves the accounting indicators of machine building plants.

Branch normal standards elaborated on the basis of counterproposed standard drafts (issued by plants, design, production planning and scientific research organizations of their machine building branch), will by their substantiation and timeliness differ pronouncedly from branch normal standards elaborated on the basis of one or another progression. Their adaption will not meet with difficulties, such as are usually encountered in adapting normal standards elaborated on the basis of the "from particular to the general" principle.

State standards for general machine building components elaborated on the basis of the counterproposed preliminary standard drafts are more suitable for immediate adaption than standards elaborated on the basis of the preference numbers method. Moreover, they can be used as assignments for planning of automated production units.

The method of counterproposed standard drafts for general machine building components makes it possible to most completely combine the interrelationship of standardization specialization and automation.

All that has been said with respect to elaboration of state stand-

ards for general machine building components by the method of counter-proposed standard drafts, applies equally well to the elaboration of machine building normal standards. The latter will also be more practicable.

In elaborating standards and normal standards by the above method, consideration should be given to the normalization practice in the FRG providing for gradual expansion of the nomenclature of subassembly and component dimensions being normalized (see Chapter 17).

Chapter 11

ADAPTION OF STANDARDS AND NORMAL STANDARDS

1. SYSTEM FOR ADAPTING DIMENSIONAL SERIES AND PARAMETRIC STANDARDS FOR MACHINES AND EQUIPMENT

Two basic methods are used in adapting dimensional series and parametric standards for machines, mechanisms, apparatus and other objects:

1) the method whereby individual objects from among those provided for by the given dimensional series or parametric standard are designed:

2) the method of simultaneously designing all objects provided by the given dimensional series or parametric standard.

The first method is characteristic of the initial stage of development of parametric standardization. For example, a parametric standard for lathes has appeared 25 years ago and it provided for a certain number of typical sizes of lathes, but each of them was designed separately, predominantly by plants which have produced it. This has also resulted in situation when two plants have produced lathes with the same parameters, but with entirely different designs. However, it would be incorrect to assume that the first method is obsolete and no longer suitable for present time machine building. It is sometimes advantageous, since many domestic plants have design departments.

The basic disadvantage of the first adaption method is weak development of intraseries unification. This method involves the actual use of only certain standardized and normalized subassemblies and com-

ponents and unification proceeds along the lines of evolving various modifications.

It follows from the above, that even the less convenient, first method for adapting dimensional series and parametric standards, also makes it possible to somewhat expand the nomenclature of objects of production by manufacturing them in different versions. In order to make this method more effective, it is necessary to intensely develop branch normalization.

The second method was developed recently and is now extensively and rapidly adapted. The use of this method not only involves utilization of all merits of the first method pertaining to adaption of standardized and normalized subassemblies and components and achieving modifications, but also ensures more extensive unification of structural elements, components, subassemblies and assemblies of the entire series of machines, equipment and other products. This unification and normalization based on it, is in plant practice usually called "vertical and horizontal" unification and normalization, unlike only "horizontal" unification and normalization, peculiar to the first adaption method.

In a number of cases, simultaneous design of all machines of a series is made difficult due to various factors. Then simultaneous design of several adjacent objects which are a part of the dimensional series or parametric standard is achieved. In this case, unification of assemblies, subassemblies and components is performed, also in the two directions and modifications are evolved. We can easily satisfy ourselves to the effect that this is a particular case of the second adaption method.

Simultaneous design of machines and other objects presents difficulties for those plants which manufacture only several of the objects

making up the common series. Simultaneous design is more practicable for central design and scientific research institutes. They can evolve proposals, drawings and other technical documentation in an integrated manner, for the entire dimensional series or parametric standard, which is the factor predetermining the appearance of an extensive network of various specialized design organizations. But they sometimes encounter serious difficulties in their work, due to the evolved difference between normal standards of various plants with the same profile.

The negative effects of underestimating the significance of branch normalization and the unbounded development of local, noncoordinated normalization interfere with the work of specialized design offices. This makes it imperative to develop branch and general machine building work on a large scale.

The most substantial advantage of simultaneous design of machines of other products of the entire dimensional series or parametric standard is the creation of prerequisite conditions necessary for extensive product, assembly and component specialization of plants, which is of decisive significance for expanding the production volume, improving the quality and lowering the cost of products of the machine building industry.

The practice of achieving simultaneous design of machine series on the basis of parametric standards, as well as design unified machine series, has given positive results. Examples presented in Chapter 7 show that one portion of existing parametric standards provides for a complete integrated group of machines, including all or almost all advantageous modifications (versions of machines), and the remaining part provides only for basic standard dimensions of machines.

A second order parametric standard w[illegible] includes parameters and

technical characteristics of modifications (versions), is a design unified series of those machines to which it extends. A parametric standard without these data can be considered in two ways, namely: 1) elaboration of modifications is permitted upon agreement of [interested] parties; 2) elaboration of modifications cannot be permitted, which in the majority of cases is not desirable from the practical point of view.

The adaption of a standard which does not provide for modifications requires preliminary elaboration of a design unified series, providing for the most extensive unification of assemblies, subassemblies and components between individual standard sizes of machines, as well as between their individual versions, i.e. for such unification which proceeds in two directions.

Analysis of many existing parametric standards has shown that only an insignificant portion of them conforms to the characteristic of the first and second order standards. The overwhelming portion of standards, however, occupies an intermediate position between first and second order standards which, undoubtedly, affects not only the timetable, but also the results of adapting parametric standards.

The incomplete content of second order parametric standards makes it necessary to elaborate design unified series of machines and other equipment which can, with respect to certain indicators, differ from state standards. In addition, this situation creates a tendency to entirely forego elaboration and utilization of parametric standards.

Methodological materials with respect to this problem do not exist at all. In the meantime, a necessity exists for explanatory work which would popularize the role of parametric standardization which is a base for product and assembly specialization of the machine building industry's plants.

The necessity of elaborating design unified series when adapting parametric standards can be shown through an example of existing standards for vertical milling machines and for knee-type milling machines. Both these standards are, by their content, closer to first order standards. The vertical milling machine standard states that their design is not standardized (the second standard does not contain this statement), but it follows from the text of the standard that the machines may have a rotary spindle head, a duplicating attachment and a universal table. The standard for knee-type machines states that the machines may have a horizontal, vertical and rotary spindle, a stationary or rotary table. Neither the producer, nor the user, can clarify on the basis of these directions what actual set of milling machines can be evolved on the basis of the two aforementioned standards.

How is this problem solved in practice? Each plant engaged in the production of milling machines solves the problem by elaborating a design unified series of milling machines. For example, the Dmitrovsk Machine Tool Building Plant has elaborated for its own purposes such a series, including 18 modifications with extensive unification of subassemblies and components, reaching from 80 to 95% in comparison with the base model. These are various, vertical, horizontal, plano-milling, duplicate-milling, slot milling machines, milling machines with preset control and others.

It is advantageous to have second order standards which reflect completely the entire system of versions which is uniform for all producers. Then, the unification being performed will not be of local, but of branch character which would be a basis for the most extensive development of specialized production of subassemblies. The economic effectiveness of these second order standards and their progressive role in developing machine tool building would have been tremendous.

A similation situation prevails with respect to the four existing standards for gear machining machine tools. Two of them (the standard for gear shapers for straight-tooth bevel gears and standard for gear milling machines for spiral bevel gears), state that the design of the machines is not standardized. The other two standards (general purpose vertical gear milling machines and gear slotters for cylindrical gears) do not contain this statement. Elaboration of modifications of the aforementioned machine tool also requires elaboration of design unified seires, since this is the only way for ensuring unification of subassemblies and components.

The existing tremendous demand for special machine tools, press forging and other equipment, makes urgent the manufacture of modified designs, since this makes it possible to supply the users not only with general purpose equipment, but also with various kinds of specialized equipment. In these and other similar cases, the creative activity of designers in adapting parametric standards, or dimensional series of machines and equipment, proceeds in the direction "from the general to the particular." Actually, first order standards establish the basic type range of machines by characterizing them by their main parameters. The first order standard serves as the basis for elaborating the second order standard which already includes all versions (modifications) of the given machines and ensures the feasibility of extensively unifying their designs. The second order standards, on one hand, serve as a basis for the elaboration of proposals and working drawings and, on the other hand, for normalization of assemblies, subassemblies and components.

However, in the absence of first order standards, the work of elaboration of design unified series of certain kinds of machines can proceed in the direction "from the particular to the general."

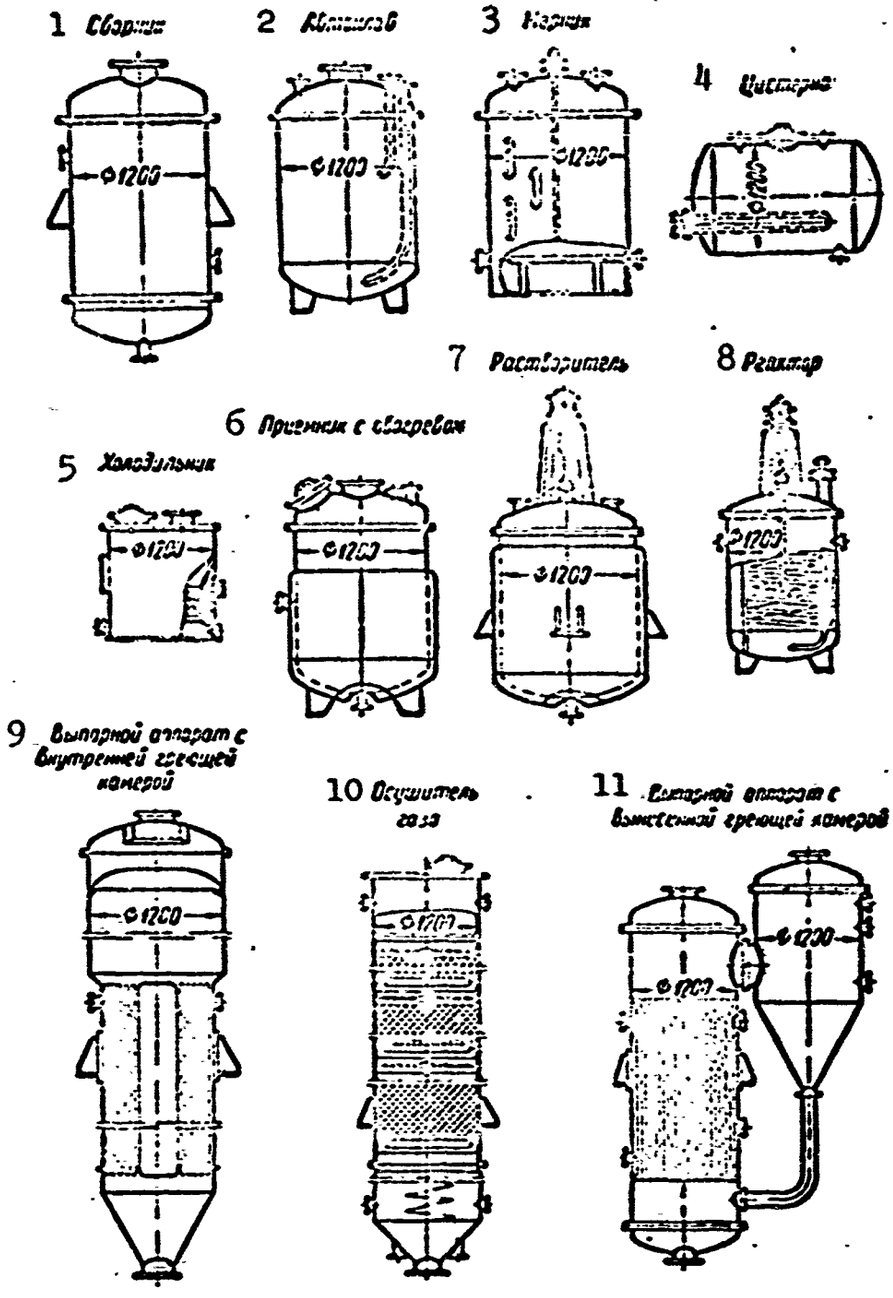


Fig. 3. A design unified series of chemical apparatus. 1) Storage tank; 2) autoclave; 3) measuring tank; 4) cistern; 5) cooling tank; 6) heated receiving vessel; 7) dissolver; 8) reaction vessel; 9) evaporator with an internal heating chamber; 10) gas dryer; 11) evaporator with external heating chamber

A classical example of this is chemical apparatus.

According to the NIIKhIMMASh apparatus serving a large variety of purposes, including evaporators, heat exchangers, fractionating

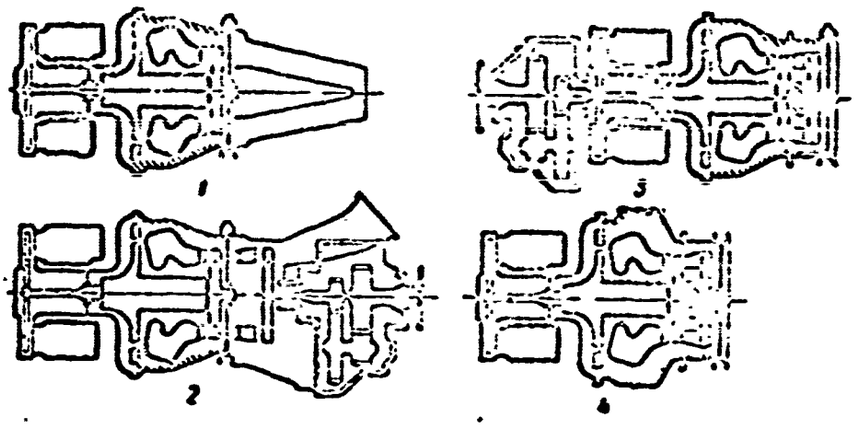


Fig. 4 Four modifications of the French gas turbine "Turbomecha" in design finalization by the English form Blackburn

columns, settling tanks, mixers, reaction vessels, autoclaves, etc., despite the diversity of their types and designs, can be produced on the basis of various combinations of 12 elements: shells, bottoms, covers, flanges, etc., (Fig. 3). The specialized purpose of each piece of apparatus, specific peculiarities of their utilization by the chemical industry relative to various production processes, are provided for in each individual case by addition of the necessary special subassemblies and components. In this case, the use of common subassemblies and components makes it possible to obtain a quite extensive design unified series of products. The basis for evolving an equipment series of different production process purpose is thus aggregation.

The aggregation method has served as a basis for producing a tremendous nomenclature of specialized purpose machine tools, which are called aggregated machines. Their nomenclature increases with each year and predominates for such operations as machining of surfaces, drilling, thread cutting, boring, etc. Aggregation can serve as a basis for constructing design unified series of many other kinds of machines and equipment. For example, gas turbines rated at 200-400 HP produced by the French firm "Turbomecha," comprise a design unified

series including four versions of turbojet engines and turbocompressors. All these machines can be assembled from almost the same components. Depending on the modification, one or two turbine stages are bolted to the hollow shaft which is connected to the compressor. In particular, a single stage turbine is installed in the turbojet and twin-shaft modifications, when the power is needed only for driving the compressor.

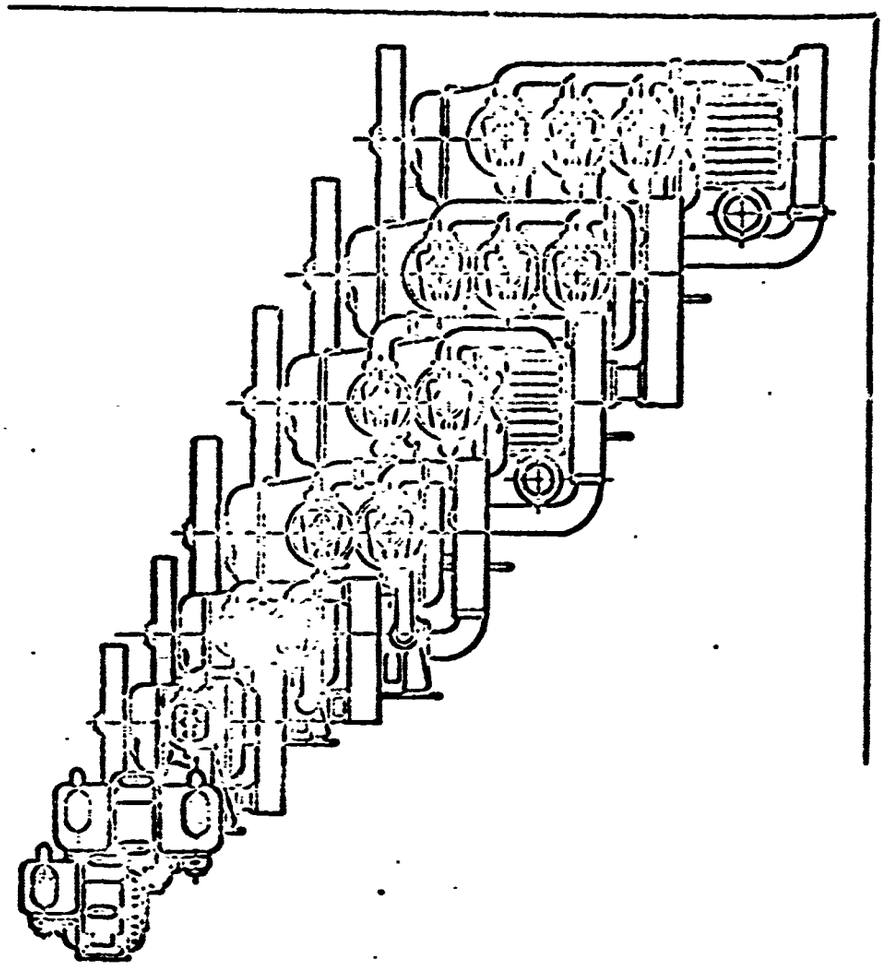


Fig. 5. Design unified series of air compressors.

Figure 4 shows all four modifications: 1 is the basic modification i.e. the turbojet engine; 2 is a twin-shaft engine obtained by replacing the jet nozzle of the basic modification by a subassembly consisting of a thrust turbine with a reducer; 3 is a single-shaft

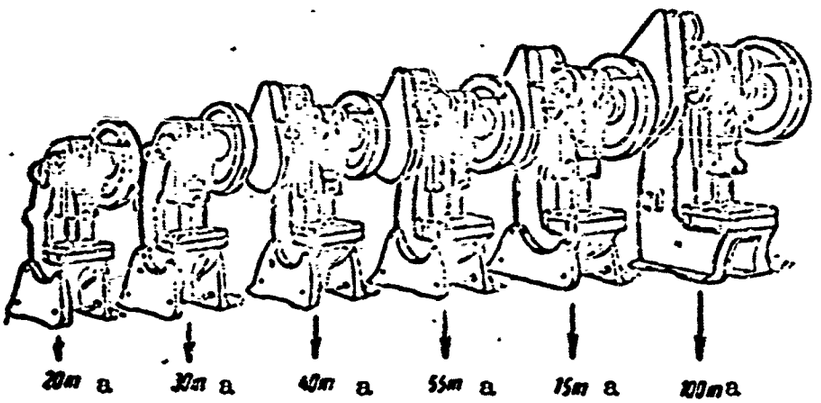


Fig. 6. Design unified series of presses.
a) Tons.

engine which can be manufactured in two capacities by adding a basic turbine stage to the turbocompressor rotor of the basic modification and transferring the reducer to the gear box of auxiliary assembly drives; 4 is a turbocompressor for compressed air delivery, which uses a more powerful compressor.

A unique example is the design unified series of air compressors (Fig. 5), the main parameter of which (at constant pressure) is delivery in cubic meters. The attempt to more completely utilize unified subassemblies and components for these compressors has inevitably resulted in the fact that their main parameter series is not strictly ordered. The same can be said also about the design unified series of presses, presented in Fig. 6. Their main parameters also form a non-ordered series.

In all cases, the design unified series promote more complete satisfaction of the national economy's machine needs and more complete and effective adaption of parametric standards and dimensional series and interrelated development of normalization.

2. SYSTEM FOR ADAPTING NORMAL STANDARDS FOR COMMON MACHINE SUBASSEMBLIES AND COMPONENTS

What are the factors responsible for difficulties encountered in

adapting machine building and branch normal standards to design and production units? Machine building normal standards have a general machine building, universal application. They are called upon to replace in the numerous machine building branches all kinds of departmental, interdepartmental, certain branch, plant and other local normal standards for common machine subassemblies and components, tools and other production tooling equipment. In accordance with a decree of the Government of the USSR, machine building normal standards are mandatory for all plants and installing organizations, SKB [Special Design Offices], OKB [Experimental Design Offices] and TsKB [Central Design Offices], NII [Scientific Research Institutes], VPTI [All-Union Production Planning Institutes], sovnarkhozes and other institutions independent of their territorial or departmental subordination. Machine building normal standards serve as a basis for developing centralization and specialization of production and also for coordination between the various machine building branches, as well as different administrative economic regions.

Branch normal standards, correspondingly, are mandatory for all plants, installing organization, SKB, OKB and TsKB, NII and VPTI of the given machine building branch, also independent of their territorial or departmental subordination.

The general system for adapting machine building and branch normal standards by design and production units, can be constructed on the following propositions.

The instructions pertaining to adaption of machine building normal standards state that their adaption is mandatory from the day of introduction: 1) for designing new machines and other products and their modifications, 2) in organizing the production of normalized products, regardless of the form in which the production is organized

(centralized or decentralized). This formulation can be interpreted in many ways. For example, is the use of the machine building normal standards, mandatory for goods being produced now? If it is mandatory, then do they apply to the case when production of normalized products is organized, or in all cases?

The following formulation for machine building and branch normal standards and both more specific and universal: the use of machine building and branch normal standards by plants, installing organizations, SKB, OKB, TsKB, NII, VPTI, sovnarkhozes and other institutions from the day of their introduction is mandatory:

a) in elaborating proposals, working drawings and other technical documentation for new and modernized machines, mechanisms, apparatus, instruments and other objects of production;

b) in the manufacture of normalized components at specialized enterprises and on centralized orders for different users;

c) in delivering normalized components according to coordination plans;

d) in current production, taking into account refinements presented below.

In the process of designing new machines, during elaboration of engineering proposals and working drawings, independent of the organization executing these proposals and drawings (plants or SKB, OKB, TsKB, NII and VPTI), should be adapted (i.e. used), all machine building and branch normal standards, which were in force at the time when planning and design work began or which will be issued later on. If the approval of certain new or revised machine building normal standards is announced in the prescribed manner before the issuance of individual parts of technical documentation being elaborated for a new or modernized machine (or other product) is finalized, then the authors

of the corresponding technical documentation must introduce into it all the necessary corrections, regardless of the volume and complexity of the required revisions.

Changes in technical documentation, the necessity for which (due to approval of new or revised machine building or branch normal standards) arises after the technical documentation has been delivered by its author (for example, by the central design office to the ordering plants, are achieved directly by the user as the new or revised normal standards are published. The user, in accepting the technical documentation from its author, can check for conformance to the applicable machine building and branch normal standards and in case of necessity, to require complete adaption of them by the author.

In the process of producing and testing of test specimens of new or modernized machines and other mass or large series produced objects, it usually becomes necessary to refine or revise certain drawings, specifications, etc. This state of refining mass or large series produced objects lends itself to adaption of all those machine building and branch normal standards which have appeared in the time of preparation and testing of the test specimens.

Before producing a head series of specimens of mass and serially produced objects, it is necessary to subject the working drawings and other technical documentation to a thorough normalization review. Certain design shortcomings are frequently exposed at the testing (including also operational conditions) of head series specimens of mass and series production. The stage at which they are eliminated includes revision or certain drawings which makes it, at the same time, possible to adapt the newly approved machine building and branch normal standards.

The adaption of machine building and branch normal standards when

producing machines and equipment by individual orders, has its peculiarities. Their use accelerates the work of designers and execution of the orders in the metal. In addition, it lowers the cost of articles being produced and improves their operational conditions by the most extensive use of interchangeable normalized components and subassemblies, which have proved themselves under operational conditions as spare parts.

The newly approved machine building and branch normal standards can, in a number of cases, be used at the stage of current production of mass and serially produced objects from the day of approval. Here, it is desirable thet the sovnarkhozes consider that actual saving which can be obtained by the producing plant, as well as by the users of its output by adaption of normal standards at the current production stage.

Periodic or random modernization of machines and other objects being produced is peculiar not only to enterprises engaged in mass and serial production, but also to those producing them in moderately sized series and single units, when orders are renewed. A characteristic example is a repeat order for sever l automatic lines used in producing a single series of electric motor shafts. For this reason, all those machine building and branch normals which were put or will be put in force during the production preparation stage, can be with success adapted on modernization of the objects or on renewal of previously completed orders.

Great significance in acquired by organization of centralized orders for normalized products by sovnarkhozes. Their execution, beyond doubt, contributes to the most extensive adaption of machine building and branch normal standards.

Thus, taking into account the above considerations, the time for

going into force, given in each machine building and branch normal standard, means:

a) the date, starting with which the plants, installing organizations, SKB, OKB, TsKB, NII, VPTI, sovnarkhozes and other institutions are to use, in technical documentation for newly proposed and modernized machines and other objects and, also, in production process preparations, subassemblies, components and other products, materials, production processes, rules and requirements established by the normal standards;

b) the date, starting with which the normalized products should be produced by specialized and other enterprises in fulfilling centralized orders and deliveries provided for by coordination, in full accordance with the new or revised machine building and branch normal standards.

The date of introduction of each normal standard is suggested by the person responsible for elaborating its proposal during elaboration of the first draft of the given normal standard and is established by the approving organization, upon consultation with the interested organizations.

In adapting normal standards at the current production stage, it becomes necessary to thoroughly consider the existing stockpile and clarify the feasibility of using them up in an efficient manner and also to determine the time needed to accumulate stockpiles of the newly assimilated components, which conform to the new or revised machine building or branch normal standard. This accumulation of stockpiles takes place in all shops and sections after producing and testing (or thorough checking) of test specimens of the normalized products.

Orders on the date of introduction of a new or revised normal standard and on the date of cancelation of the previous departmental,

interdepartmental, plant, certain branch and other normal standards for analogous products or structural elements, designation, technical requirements, norms, rules, etc., are issued correspondingly by State Committees for Branches of Technology, interested sovnarkhozes of republics and administrative economic regions, ministries, departments, base standardization and normalization organizations and also by enterprises upon receipt of typographed machine building normal standards, or branch normal standards published in one or another manner. These orders list, respectively:

1) plants which are charged with producing the normalized products in quantities which satisfy the needs of the national economy of the USSR as a whole, or of individual administrative economic regions (or individual zones);

2) plants which are charged, on the basis of coordination, with producing the necessary production equipment or cast, forged, stampled or other blanks in the required quantities and delivery of them to enterprises charged with specialized or centralized production of the normalized products;

3) the design, production planning and scientific research organizations which are charged with providing the plants with specific technical help in elaborating production, processes, production tooling and special equipment;

4) dates for introducing modifications into drawings and other technical documentation, including that issued up to the date of putting into force new or revised machine building and branch normal standards.

The order and timetable for using up existing stockpiles of materials and semifinished products, finished components and subassemblies and also purchased articles, in conjunction with the introduc-

tion of new or revised normal standards are established by sovnarkhozes. The existing stockpiles of all kinds of tools, fixtures, diesets, molds and other production equipment, their components and subassemblies should be completely used up.

Of great significance are questions of timely preparation and organization of specialized or centralized output of the normalized products. The plant, institute or design organization, i.e. the author of the machine building or branch normal standard, together with the proposal submitted for approval, submit for consideration substantiated suggestions with respect to organizing specialized or centralized output of the normalized components. These suggestions, depending on the planned scale of specializing or centralizing the production, are agreed upon together with all-union, republican and local organizations

Independent of the progress of the above question, preparation for manufacturing the normalized products in a centralized or decentralized method should be completed on a timetable ensuring assimilation of their production, prior to the effective date of application of the corresponding machine building and branch normal standards. Here, the base organizations should provide for measures for extending technical assistance to the plants. In particular, this assistance pertains to determining the applicability of the normalized products, introduction of a uniform system for classification and designation of objects of main and auxiliary production and also of other methodological problems.

The responsibility for timely introduction of modifications into working drawings, specifications and other existing technical documentation and for the timetable of preparing for production of the normalized products, rests upon managers of sovnarkhozes of republics and administrative economic regions, departments and enterprises. They

approve plans of the necessary organizational and technical measures (see below), the preparation and execution of which is assigned to the appropriate organizations. Ahead of schedule adaption of new and revised normal standards should be encouraged.

In individual cases, substantiated by technical considerations, such as, for example, utilization of existing stockpiles, inavailability of certain kinds of equipment, etc., a motivated request for delaying the adaption of machine building normal standards is permitted. Delays for up to a year could have been submitted upon approval by sovnarkhozes, but this requires an appropriate decree. Delays for more than a year could be approved only by the Committee of Standards, Measures and Measuring Instruments upon substantiated intercession of administrative economic region or republican sovmarkhozes in republics not subdivided into economic regions. A repeated delay is not permitted, which should be kept in mind by all interested organizations.

Substantiated delays with respect to branch normal standards are submitted to sovnarkhozes upon approval by base organizations. This condition of consent by base organizations is due to the necessity of coordinated adaption of branch normal standards for objects produced by enterprises of different sovnarkhozes.

Systematic control over the adaptation of machine building and branch normal standards is achieved in a planned order by State Committees for Branches of Technology, sovnarkhozes, ministries, departments and base standardization and normalization organizations. It is also performed in a systematic and random manner by state inspection and measurement laboratories of the Committee of Standardization, Measures and Measuring Instruments and by other interested organizations. The results of inspections are finalized into acts.

The necessity for thorough and manyfaceted control over confor-

mance with machine building and branch normal standards is primarily due to the fact that these normal standards establish the necessary uniformity of the tremendous nomenclature of components and subassemblies of machines and other objects of production and, also, of the entire production equipment. The significance of this normalization from the point of view of state interests is tremendous and the adaption difficulties are considerable. An effect is also exerted by departmental and local traditions, which must be overcome. Actual control can exert a positive influence on the adaption of machine building and branch normal standard .

The present day organization of machine building in our country has a number of peculiarities, related to the difference in subordination of plants, installing organizations, testing grounds, testing stations, design, production planning and scientific research organizations. In a number of cases, they are subordinated to territorial sovnarkhozes, but perform either local or all-union functions. In other cases, certain of the enumerated organizations are subordinated to state committee for branches of technology, ministries and departments. The role of base standardization and normalization organizations is substantial-upgraded under these conditions (see Chapter 15).

The above system for adapting machine building and branch normal standards corresponds to the adaption of state standards for common subassemblies and components of machines, tools and other production equipment.

It was shown above, that standards as a rule, provide for basic parameters and dimensions which are refined and further developed by machine building normal standards; consequently, the latter are not only for "fellow travelers", but also "guides" for introducing the standards into production units, i.e. the standards in this case are

adapted with the help of machine building normal standards. But one can note that a certain number of state standards which establish the fabricated dimensions of components, for example, fastening components, exist and will always exist. In such cases, the "guides" introducing the standards to the production units are branch normal standards. They establish a rational limitation of applicability of standards and this limitation is adapted to the design practices of the entire given machine building branch. All this emphasizes the necessity for ensuring the closest coordination in the development of standardization and normalization and the required interrelationship between standards and normal standards being elaborated.

The complexity of the adaption work is increased to a considerable extent, due to the necessity to ensure timely and precise adaption of all kinds of changes, supplements and corrections to the standards and normal standards. The flow of these changes, supplements and correction is not always directed in an expedient manner and is also in need of regulation.

3. CERTAIN PECULIARITIES IN THE ADAPTION OF PLANT NORMAL STANDARDS

Plant normalization in the form in which it has historically evolved in the domestic machine building industry, has a dual character: on one hand, plant normalization served as a basis for the development of standardization and branch normalization and also as a means for adaption of standards and normal standards to production and, on the other hand, plant normalization duplicated standardization and, especially, branch normalization. Under present-day conditions, the interrelationship between plant normal standards and standards, machine building and branch normal standards is even more complex.

If the plant standards limit the applicability of state standards, machine building and branch normal standards, then the adaption

of these local normal standards can successfully be achieved acco ing to the scheme presented in the preceding section. In this case, they are adapted with the general framework and in accordance with the general scheme. While if the plant normal standards duplicate analogous [state] standards, machine building or branch normal standards, then these plant normal standards should be revoked. Finally, the third case, i.e. when the plant standards do not limit the applicability of the higher level standards and normal standards and do not duplicate them; then these plant normal standards do not practically differ in any respect (except in the juridical) from machine building or branch normal standards. They can be adapted in accordance with the same system. However, the given plant normal standards should be gradually reworked into branch or general machine building normal standards in accordance with direction presented in the preceding chapters.

More complex is the adaption of local normal standards in the case when the plant normal standards of the enterprise which produces the goods are not in agreement with normal standards of those organizations which elaborate the technical documentation for it. These are typical cases showing the lack of coordination in normalization work, reflecting insufficient efforts of base organizations as well as plant standardization and normalization departments. Solution of these problems is facilitated by coordinated decisions and uniform branch standards.

4. SYSTEM OF NORMALIZATION CONTROL

Normalization control is conducted in order to ensure that the drawings and other technical documentation issued to production units does not contradict the mandatory standards and normal standards which are in effect. Normalization control is also achieved for ensuring expedient unification of brands and material profiles, threads, diame-

ters and lengths, tolerance and fits and also of various subassemblies, components and their structural elements.

Normalization control of working drawings, specifications and other technical documentation is mandatory upon all enterprises and organizations performing planning and design and production [planning] work in the field of main and auxiliary production. This kind of control applies to component drawings, assembly drawings, general views, drawings of overall dimensions and installation drawings, various layouts, composite specifications and technical requirements, documents listing previously existing and newly normalized subassemblies and components, record of purchases products and also other documents, lists, inventories and notifications about changes in drawings.

All this technical documentation cannot be accepted by the technical records sections and cannot be reproduced without the signature of the person responsible for normalization control. Quality control departments of plants should not accept products made according to drawings without the appropriate inspector's signature. Here, the responsibility for nonconformance with standards and normal standards is born by persons which have issued the drawings and other documentation.

Normalization control at plants, in installing, design, production planning and scientific research organizations is achieved by standardization and normalization departments (offices), in accordance with the general plan for issuance of technical documentation.

Normalization control work, in accordance with VNIINMASh instructions, consists in checking for:

a) utilization of standardized, normalized and unified subassemblies and components and their structural elements and also of purchased products in replacing special components and subassemblies and also for production tooling;

b) complete conformance by basic parameters of machines and other objects of production to the established standards and normal standards and also their conformance to preference numbers and normal linear dimensions;

c) utilization, in accordance with the limited nomenclature and standard dimensions established at the given enterprise, of standardized and normalized products and their elements and also of production tooling;

d) conformance of tolerances, threads, connections, materials, heat treatment, platings and other technical requirements to those estblished by standards and normal standards;

e) finalization of drawings and other technical documentation and their integrality in accordance with specifications for the object or its subassemblies;

f) presence of the required signatures on the drawings and other technical documents in accordance with standards for the drawings maintenance system and the existing normal standards;

g) use of numerical and other conventional designations of components, subassemblies and production tooling established by standards and normal standards and also for conformance of references to existing standards, normal standards, technical specifications and guiding materials;

h) use of technical terminology and the established abbreviations in the text and conventional abbreviations for technical quantities and concepts;

i) selection and use of brands and grades of materials in accordance with limiting normal standards; here, special attention should be paid to the feasibility of replacing scarce and expensive metals, including nonferrous metals, by less scarce and cheaper materials;

j) uniformity in the finalization of drawings and other technical documentation.

Normalization control should pay attention to the use of existing normal standards of those producing plants for which the design, production planning and scientific research institutes execute proposals, drawings and other technical documents.

The following sequence of control operations is recommended: 1) checking for the integrality of documents; 2) checking the use of standardized, normalized and unified products and their elements; 3) checking the quality of execution of technical documentation and its conformance with requirements of standards, normal standards and unification documents.

In order to save time and funds expended for making rectifications and corrections, it is recommended that normalization control should be performed in two stages:

the first stage involves checking of drawings and technical documents in original before they are copied, or reproduced, in another manner; all drawings and other documents which are submitted to normalization control in original, should be signed by the authors and the person who conducts the normalization control;

the second stage consists of checking traced copies (masters) of drawings and technical documents with all signatures established by requirements of standards for the drawings maintenance system, in addition to the signature of the enterprise or organization manager.

No corrections of master copies signed by the normalization inspector are permitted without his knowledge.

Notifications about changes in drawings and other documents, previously issued by the enterprise or organization, should be submitted to normalization control before they are approved by the management.

In checking references to existing standards and normal standards, the inspector should check for textual conformance of all technical documents with the texts of standards and normal standards. He has the right to return drawings and other technical documents for corrections, or he finds: a) absence of mandatory signatures or of a prescribed documents; b) careless execution, with a large number of errors; c) nonconformance with existing standards and normal standards.

In the case of repeated submission to normalization control of low quality work and also of nonconformance to requirements of standards and normal standards, the inspector must apply directly to the management of the enterprise or organization and request that the necessary measures be taken and, upon noncompliance with this request, he should complain to superior organizations about nonconformance to standards and normal standards allowed by the enterprise or organization management.

All the inspector's comments should be briefly, but clearly, presented in a list (document) of comments and to make conventional notations (put numbers of his comments) in pencil on the drawing and other documents. The checked drawings and other documents, together with the list of the inspector's remarks, are returned to the authors for corrections. Directions of the normalization inspector are mandatory upon the author of the documentation. Differences of opinion are resolved by the chief of the standardization and normalization department (office); it can be revoked only by the chief engineer.

After the appropriate changes, the masters (traced copies) or drawings, etc., are returned to the inspector with the list of his corrections for checking and signature.

The normalization control operations are recorded in a special journal.

Normalization control, as all kinds of control, can be active and passive. As an example of effective achievement of active control, we can cite the work of the standardization and normalization office of the Leningrad "Znamya Truda" [Banner of Labor] Fitting Accessories Plant. This office achieves, in the process of normalization control, unification and normalization of components of the produced industrial fitting accessories, numbering over 1500 standard dimensions.

All this work is done on the basis of classification charts, embracing over 400 kinds of basic components of the fitting accessories being produced by the plant. The classification charts were instrumental in the elaboration and adaption of type and group production processes and also in normalizing structural elements of the fitting accessories' components and the production equipment being used. Constant assimilation of new products by the plant requires systematic thorough consideration of component drawings issued to the plant from the point of view of the feasibility of their manufacture by the type production processes being used.

The plant obtains all these drawings from the branch central design office and other design organizations which do not always take into account the production processes used at the given plant. For this reason, the drawings must pass normalization control which is performed on the basis of the principle of the group method of component machining upon classification by elements.

The components are subdivided into two groups: components produced without removal of chips and those produced on metal cutting equipment. The designs of both groups of components are analyzed from the point of view of feasibility of their production, using the available production tooling. The changes thus made necessary are presented for consent by the designer, whereupon a permission for modification of

the drawing is written out in the prescribed manner.

This normalization control is of great significance to scientific organization of production. It can serve as a basis for comprehensive unification of subassemblies and components and of production tooling [25].

5. ORGANIZATIONAL AND TECHNICAL MEASURES FOR ADAPTION OF STANDARDS AND NORMAL STANDARDS

Adaption of machine building normal standards and also of branch and plant normal standards in design and production, involves taking a number of necessary organizational and technical measures. The preparation and achievement of these measures is performed by sovnarkhozes of administrative economic regions (and when these do not exist, by republican sovnarkhozes), base standardization and normalization organizations and plants.

Analogous measures must be taken in adapting standards for common machine subassemblies and components, tools and other production tooling.

Sovnarkhoz measures. Sovnarkhozes conduct work for correlation of the nomenclature of the standardized and normalized products and determine the need of their enterprises for these products. They establish limiting nomenclatures of standard dimensions. They elaborate plans for assigning to the corresponding plants the production of the normalized and standardized products, by their nomenclature, as well as by standard sizes, on scales which satisfy the needs of the given administrative economic region or adjacent regions. They elaborate the plan of coordinated supply of production tooling and also of cast, forged and stamped blanks to plants which are charged with centralized production of the standardized and normalized products.

The sovnarknozes extend technical assistance to their enterprises

through the SKB, OKB, TsKB, NII and VPTI in the field of equipment design, production process planning and production tooling design, in order to ensure on schedule adaption of standards and normal standards.

Measures of base organizations. A measure of first priority is compilation of conversion codes which ensure rapid and convenient conversion of product designations given by standards and normal standards to the designation system adopted by the given machine building branch and sending of these conversion codes to all enterprises and organizations of the given machine building branch. The obligations of the base organizations include ensuring the conversion of the designations of production tooling to the numerical designation code, in accordance with machine building normal standards and extending methodological assistance to plants, installing organizations, SKB, OKB, TsKB, NII and VPTI (of its branch), with respect to standardization and normalization problems.

Base organizations determine the applicability of standard dimensions of the standardized and normalized components, subassemblies and structural elements, are in contact with the head organization, which designs the corresponding types of machines, mechanisms, apparatus, instruments and other objects of production (vessels, transportation facilities, etc.).

Measures taken by the plant. It is advantageous to subdivide the measures for adaption of standards and normal standards, the achievement of which is planned and implemented by each plant, by departments responsible for their implementation.

The Standardization and Normalization Department (OSN) is charged with obtaining information about approval of new or revised standards, machine building and branch standards and guiding technical materials.

It orders materials from the Standardgiz [State Standards Publishing House] and from other organizations, obtains from them the required number of copies of standards, normal standards, etc., taking into account the needs of shops, departments, laboratories and other plant services. It familiarizes the appropriate plant workers with the contents of standards and normal standards, establishes the limits of their applicability by filling out the "applicability" column in all copies of standards and normal standards which it received, if such a column is provided in them, or elaborates a limiting normal standard on the basis of the nomenclature of standard sizes established by the base organization. It provides all plant services with the necessary number of copies of standards and normal standards; compiles conversion codes for plant normal standards, giving the designations of each standard dimension of the corresponding standard or normal standard, as well as the designations of these same products by the plant normal standards.

The department extends methodological assistance to all plant services with respect to problems related to the adaption of standards and normal standards. It receives from all plant services, copies of revoked standards and normal standards in conjunction with adaption of new or revised standards, machine building, branch and plant normal standards. It introduces into them the appropriate changes, supplements and corrections (see below).

The Department of the Chief Design Engineer (OGK) elaborates, when necessary, working drawings, specifications and technical requirements for machine subassemblies and components, provided for by new or revised standards and normal standards. It revises the working drawings, specifications and technical requirements, both existing as well as those in the process of elaboration, for new or modernized machines and

other objects of production, in order to clarify the character of the re orking they require as a result of adapting the standards and normal standards. The same work is done with respect to objects being currently produced, including determination of a timetable for expedient adaption of normal standards to specific production objects. Here, consultations are conducted with other plant subdivisions, including the department of tools and material supply. Then the OKG reworks the proposals, working drawings, specifications, etc.

The Department of the Chief Production Engineer (OGT) clarifies the applicability of the newly approved or revised standards and normal standards in the elaboration of production processes, elaborates the latter relative to internally produced standardized and normalized products and also designs production tooling needed for the manufacture of these products, if such cannot be obtained from a central supply base.

If the given plant is charged with centralized production of the standardized or normalized products to satisfy the needs of various users and for implementation of coordinated supply arrangements, then the OGT performs all work of elaboration of production processes and other technical documentation necessary for organizing specialized production of these products. In addition, the OGT revises production processes used in the manufacture of the new and modernized objects and introduces necessary changes directed toward adaption of standards and normal standards.

Department of Tool and Materials Supply (OMTS) performs very important work with respect to adaption of standards and normal standards. It ascertains the need for new materials, blanks and purchased products and also exposes the existing stockpiles of materials and blanks, partially and completely processed articles, finished subassemblies and

also purchased products which do not satisfy the requirements of the new or revised standards and normal standards. Together with other plant subdivisions, the OMTS establishes the feasibility of desirability of utilization of the existing stockpiles and prepares suggestions with respect to this problem, giving the timetable for using up the stockpiles.

The Tool Maintenance Department (OIKh) ascertains the plant's needs for new production equipment for manufacture of the standardized and normalized products and designs this tooling (if this work is performed at the given plant by the tool maintenance department, rather than by the chief production engineer's department). The department produces the tooling according to schedule and participates in setting it up.

The Production Department (PO), Department of Quality Control (OTK) and other plant subdivisions participate in producing the test batch of the standardized and normalized products, determine their cost and the effectiveness of the adaption of standards and normal standards by their enterprise; the OTK accepts the manufactures products, in conformance with the requirements of the new and revised standards and normal standards. Suggestions for organization of specialized production of the standardized and normalized products are also prepared for submission to the sovnarkhoz.

6. GENERAL PROCEDURE FOR SUPPLYING STANDARDS AND NORMAL STANDARDS TO WORK STATIONS

In the task of ensuring the adaption of standards and normal standards in designing and production, an important role is played by the information service and also by the general system for supplying standards and normal standards to shops, departments and other plant subdivisions. Information about newly issued and revised standards and normal

standards is given out by organizations charged with publication, reproduction and delivery of standards and normal standards to all interested plants, organizations and institutions. This purpose is served by publication of information directories, bulletins, etc.

State standards and machine building normal standards are published by the Standartgiz, branch normal standards are issued by base organizations and plant and other local normal standards are issued by the corresponding enterprises.

Timely and systematic supplying of departments, shops and plant laboratories by standards and normal standards is one of the functions of standardization and normalization departments.

The plant standardization and normalization department, upon consent of the management, empowers a responsible representative, who is charged with ensuring timely supply of standards and normal standards to the plant and delivery of them to working stations by responsible persons in plants, department and laboratories of the given plant. The necessary nomenclature and number of copies of standards and normal standards is established by the managers of the enumerated plant subdivisions, whose representatives pe on their requests to the standardization and normalization department.

The plant standardization and normalization department should retain one control copy of each standard, machine building, branch and nt normal standard needed by the given production unit. The control copies are not issued to anyone and are kept separately from working copies and are filed by the generally used groups of the state standards classification chart. Each copy of a standard and normal standard is stamped "Control Copy."

The plant standardization and normalization department, in addition, should have a book listing the standards and normal standards.

Working copies of standards and normal standards are stores in the order of increasing numbers. An inventory card is filled out for each working copy. Standards and normal standards which are no longer in force, are subject to surrender and destruction, with the exception of one control copy which is stored in the standardization and normalization department for checking purposes.

All plant subdivisions (departments, shops, etc.) store their copies of standards and normal standards in the order of increasing numbers. They are filed by groups in accordance with the state standards classification chart currently in force. Each plant subdivision should have its record book, which lists the dates of receipt of standards and normal standards, changes received and dates of revocation of standards and normal standards. Representatives of each plant subdivision issue standards on normal standards to their coworkers for which the latter sign a receipt.

The presented general procedure for supplying standards and normal standards can be extended to the SKB, OKB, TsKB, NII and VPTI, whose departments should also delegate responsible representatives.

7. THE SYSTEM FOR INTRODUCING CHANGES INTO COPIES OF STANDARDS AND NORMAL STANDARDS CURRENTLY IN FORCE

Introduction of approved changes into all copies of state standards, machine building and branch normal standards which were issued to work stations of plant, SKB, OKB, TsKB, NII and VPTI workers, is achieved in the following manner.

The Directory of Standards issued monthly by the "Standatgiz", provides information about changes, additions and corrections to state standards and machine building normal standards. Similar information with respect to branch normal standards should be supplied by base standardization and normalization organizations. They issue the neces-

sary number of copies providing information about all changes, additions and corrections introduced by them into their branch normal standards.

Standardization and normalization departments of plants, SKB, OKB, TsKB, NII and VPTI should timely provide their organizations with the necessary number of copies of the "Directory of Standards" and of information publications of base organizations. When the number of copies of these materials obtained is insufficient, these departments can reproduce them by photostating, blueprinting, etc. The responsibility forthe accuracy of copies rests with the department which has reproduced these documents.

Standardization and normalization departments of base organizations, plants, design, production planning and scientific research organizations, in lists of state standards, machine building, branch, plant and other local normal standards which are in force in the enumerated organizations which they put out, give the numbers and dates of all additions, changes and corrections which were approved. Here, extreme care is taken to ensure that the new changes, additions and corrections take into account those approved previously. All discovered errors should be immediately reported to the organizations which have permitted them to occur.

The entire work for supplying timely information is performed by responsible representatives, which are charged with obtaining and delivering the standards and normal standards to work stations. The necessary number of copies of the information is determined by the heads of departments, shops, laboratories and other subdivisions of plants and organizations. Through their representatives, they place orders with the standardization and normalization department.

The timetable for putting into effect changes, additions and cor-

rections to the existing standards and normal standards and also the persons responsible for their adaption, are det rmined by orders of the chief engineer. The standardization and normalization department retains one control copy of each change, addition and correction. These copies are stamped"Control" and are glued in succession to the corresponding standards and normal standards. An account of all changes, additions and corrections is kept in a special journal, which can be kept together with the journal, listing standards and normal standards in effect in the given organization. Card ndexes for checking purposes are kept similarly.

Notifications about approved changes, additions and corrections received at working stations of departments, shops, laboratories and other services are glued to the corresponding standards and normal standards; here, previously received notifications the substance of which has been included in the later information, are torn off and destroyed. The torn off sheets are replaced by the newly received.

In order to regulate and facilitate the adaption of changes, additions and corrections of standards and normal standards, approved by the appropriate organizations, the date for their going into effect should be designed taking into account the following recommendations:

Corrections which eliminate printing errors and other defects in printing of the standards and normal standards, are made immediately upon finalization. Changes and additions to standards and normal standards pertaining to the adaption of more progressive designs and production processes, adaption of more economical materials, improving the reliability and service life, etc., are introduced at one of the given days: 1 January, 1 April, 1 July and 1 October of each year. Here, the date for going into effect is established taking into account the time necessary for tooling for the production of goods, on

the basis of the approved changes or additions.

Control of the adaption of changes, additions and corrections to standards and normal standards, is performed analogous to the control of the adaption of standards and normal standards (see above).

The need for thorough organization of the system for delivering changes, additions and corrections to standards and normal standards to working stations arises due to the fact that they are just as mandatory as the standards and normal standards. The question can be asked: how many and what kind of notifications can be in effect at the same time? If a change is approved, then it absorbs not only the one approved before it, i.e. the preceding change, but also all additions and corrections.

A new change thus includes all previously approved changes, additions and corrections. But after the change has been approved, certain additions and corrections may again become necessary. They are in force until a new change is approved.

Chapter 12

NUMERICAL DESIGNATION SYSTEMS FOR THE PRODUCTS OF MACHINE BUILDING AND FOR THE MATERIALS USED

1. DESIGNATION SYSTEMS AND THEIR SHORTCOMINGS

More than 20 different classification systems elaborated at different times by ministries and institutes and also by the Central Statistical Administration of the USSR (TsSU) are in existence; here these systems have almost nothing in common. As a result, idential or similar products are classified into different classification subdivisions and have entirely different conventional designations or, conversely, dissimilar products have similar designations. All this creates additional difficulties in achieving general machine building normalization and unification and, also, in the development of specialization and coordination. This has also affected the feasibility of establishing, in machine building, of a single indexing system for technical documentation.

The differences and peculiarities of the existing designation systems for the products of machine building can be characterized by several examples.

Automatic lines and special machine-tools. This machine building branch uses a mixed letter-number designation system, based on single classification chart for technical documentation. In accordance with this classification chart, the conventional designations are assigned starting with the very first stage of designing the automatic line or special machine tool, i.e. from the instant the engineering assignment

is obtained from the consumer and further through all the stages of planning and design and experimental operations, up to working drawings and components.

According to this classification, the letter symbols in the designation correspond to: L - automatic line; G - individual section of the line; S a special or gang machine tool; B - magazines, hoppers, shelving, tables; T - transportation devices, including conveyor belts, hoists, etc.; A - automatic assembly machines; M - washing and drying machines and also equipment for anticorrosion treatment; U - automatic packaging machines; K - control and measuring equipment; P - heat treatment and casehardening equipment; R - various equipment. The letter symbols are also conventional, which would have also been the case with numerical symbols.

The classification chart for subassemblies designation is constructed on the basis of the decimal system: 1 - beds; 2 - fixtures, 3 - electrical equipment; 4 - hydraulic equipment and transmissions; 5 - cooling; 6 - tools; 7 - spindle heads; 8 - lubrication; 9 - control. Each such group of subassemblies is subdivided into 10 subgroups. For example, group 2 (fixtures) is subdivided into jig plates, chucks, clamps, vise, supports, swivel slides, indexing fixtures, etc.

Components have a designation system of their own, namely: cast iron components from 11 to 30; nonferrous metal components from 31 to to 40; steel and welded components from 41 to 89; components made of other materials - from 90 and further. In the case when any given group does not have sufficient free numbers, they are borrowed from the folgroups. This classification system results in the following designations: hydraulic feed cylinder 421, hydraulic cylinder of conveyor 422, hydraulic clamp cylinder 423, etc.

As a whole, the designations are constructed in the following se-

quence: first, the conventional designation of the design organization which has elaborated the given automatic line; then, the symbols of the automatic line; then the ordinal number of the automatic line. This is followed by designations of the equipment, of the subassemblies built into the line and of components.

For example, a line is designated as 6L33. Here: 6 is the design organization (SKB 6); L is the automatic line; 33 is the ordinal number of the line. The general form of designations of a subassembly of a machine included in the automatic line, is correspondingly: L33S1-31-01 and components making up this subassemblies are designated as: L33S1-31-41. Together with the two dashes, this designation system contains 11 symbols.

In using this designation system, it is possible for idential components, but which make up different automatic lines or individual machine tools, to have different numbers. However, this is excluded in practice since the divisions and groups within each division are specialized. When subassemblies or components are duplicated in a second line (or machine tool), they retain their initial numbers (indices) and are regarded as unified. For this reason, the specifications include new components, unified subassemblies and components and normalized articles.

Rolling-contact bearings. The system of numerical conventional designations for ball and roller bearings is standardized. The conventional designations characterize: a) the shaft diameter at the point at which the bearing is seated (the diameter of the bearing or sleeve hole); b) the series of the bearing, i.e. one of the standard bearing series established by standards, differing by the external diameter and width, but having the same design and same seating holes; c) the bearing type, i.e., the ensemble of features which determine its ba-

sic properties, which include the direction of the load being taken up and the shape of the surfaces of the rotating bodies; d) design peculiarities of the bearing; e) the precision of the bearing, which is denoted by a letter symbol to the left of the numerical designation.

The meaning of the numbers in the bearing designation is determined by the positions they occupy, counting from right to left: the first and second position is the shaft diameter (the diameter of the bearing or sleeve hole); the third and seven is the series; the fourth position denotes the type; the fifth and sixth places denote the design peculiarities.

The bearings are characterized as follows: the shaft diameter and design peculiarities are designated by numbers from 0 to 99 and the series and types are given by numbers from 0 to 9. Zeros to the left of the last significant figure (counting from right to left), are dropped.

In the conventional designation, with the exception of bearings with hole diameters of 495 mm and above, the first two numbers to the right give the shaft diameter at the point where the bearing is seated; here, the shaft diameter for all bearings (except for radial thrust bearings with removable outer ring, which are called magnetic), with hole diameters of 20 mm and more, is designated by a fraction obtained by divided the diameter by 5. For example, the first two numbers to the right - 04 denote a bearing for a shaft 20 mm in diameter 40 denotes a bearing for a 200 mm diameter shaft. Bearings with hole sizes from 10 to 20 mm (with the exception of magnetic bearings), are designated accordingly: diameter of 10 mm - 00, 12 mm - 01, 15 mm - 02, 17 mm - 03. The designations for bearings with hole diameters up to 9 mm give the actual size in millimeters, with the third position oc-

cupied by 0. For example, 1025 designates a spherical-seating double-row radial bearing of the light series with an internal diameter of 5 mm. A hole diameter which is not expressed by an integer, or is expressed by an integer which is not a multiple of five, is designated by the closest integral number. For example, 904 is a radial single-row bearing single-row bearing with a hole diameter of 7/8" (22.226 mm).

The bearing series are also designated by conventional numbers using fractions in the third place. Bearing types are given by a number from 0 to 9, depending on the subdivision established by the standard. The design peculiarities are given by one number in the fifth place, or by two numbers in the fifth and sixth places. However, the precision classes are designated by letter symbols: P - increased precision class; VP - extremely increased; V - high, AV - extremely high, A - precision, S - superprecision.

As a whole, this system results in a seven-symbol numerical designation of a bearing (as a product), with addition of one or two letter symbols characterizing the quality of its production, giving a total of eight or nine symbols. Here, the bearing components are not embraced by the given designation system.

Production process tooling equipment. Tooling products combined under the concept "production process tooling equipment" are extremely varied and have different dimensions, designs, purposes, service lives, materials, manufacturing precision, etc. The economic considerations pointing to the desirability of centralization and specialization of the fabrication of production tooling equipment, make themselves apparant very intensely. But in order to achieve centralized production, it is necessary to ensure not only identical names for the same products, but also the same conventional designations. For this reason, classification anddesignation of production tooling equipment

is of great significance to the national economy. The substance of this designation system can be presented as follows:

Depending on the intended service, the tools and fixtures are subdivided into 10 groups (Table 41). Each group is divided into 10 subgroups, each subgroup is subdivided into 10 kinds, and each kind, in turn, into 10 varieties.

TABLE 41

Classification of production tooling

A) Designation of group	B) name of group	C) basic significance
0	Tools and fixtures for casting, heat treatment, welding, soldering and flame cutting of metals;	For imparting a shape, dimensions and properties to metals by casting welding, soldering, flame cutting and heat treatment methods
1	Tools and fixtures for pressure working	For imparting a shape and dimensions to metals and nonmetal materials by pressure in the cold and hot state
2	Tools for machining of metals	For changing the shape and dimensions of metallic materials by machining
3	Tools for machining of nonmetals	The same as above pertaining to nonmetals
4	Reserved	
5	Reserved	
6	Auxiliary tools	For fastening of tools
7	Fixtures for machine-tool and manual operations	For fastening and positioning of blanks in machine-tools and in manual operations, for tying the machined blank to the machine-tool and tools, for assembly operations
8	Facilities for measuring and control of linear and angular magnitudes	For measuring and control of dimensions, shape and position
9	Reserved	

The classification by groups and subgroups is given in the machine building normal standard MN 74-59 and for kinds and varieties in MN 75-59 - MN 81-59. Conventional designations of eight numbers consist of two parts of four numbers (symbols) each. The first part of the designation defines the functional operational) design characteristic of the variety. Each variety can contain 9999 standard dimensions, comprising the second part of the designation.

The conventional designation can be the inventory number for branch and plant normal standards. These numbers are used for accounting and storage of production tooling at plants.

According to the given designation system, a twist drill 1 mm in diameter with a cylindrical shank, used for drilling in light alloys has the following conventional designation: Drill 2300-0801.

For the purpose of differentiation at plants between standard and special production tooling, a provision has been made for using the number group from 0000 to 3999 for normalized tooling and numbers 4000 to 9999 for special tooling. General machine building components, for example, fastening components, lube fittings, instruments, etc., used in the production tooling, retain their designations established by the corresponding standards and normal standards. The enterprises have the right to use additional distinctive marks for designation of production tooling produced for internal use (for example, Drill ZIL 2300-0001).

According to Reference [26], achieving normalization of general purpose production tooling and organizing its production at specialized plants with a single system of conventional designations, providing for the feasibility of correspondingly enlarging the size of orders, will make it possible to obtain an annual saving of more than 30 million rubles, to lower the net cost of producing the tooling by

a factor of 2-5, considerably decrease the volume of design work and to cut the time required for tooling up for production of new machines and equipment by 25-30%.

Analogous work was performed in the field of production tooling for pressureworking. This system of classification and conventional designations is given in the machine building normal standard MN 76-59.

All the enumerated examples differ substantially from one another, but all of them make it possible to make two important generalizations.

1. Mixed, letter-number designation systems are characterized by the fact that the greatest number of features being classified is denoted by numerical symbols. Features coded by letter symbols are in the minority. Here, the letter symbols are, as far as possible, mnemonic in character, thus facilitating rapid recognition of the production object or of its main qualitative characteristic. However, under production conditions, it is not always important to know whether a given specific component will be used in an automatic line or in an independently operating machine tool. Many line machine tools are used separately, as special machine tools.

Of considerably greater significance is the number of the order (for example, the order of the automatic line or special machine-tool being manufactured), and these numbers are usually designated numerically. For this reason, the replacement of letter symbols by numbers is feasible in principle and desirable. The advantageousness of this replacement can be affirmed by the necessity of conversion of all texts and letter symbols to numerical symbols when adapting to a computer.

2. Conversion to numerical designation systems promotes closer correspondence of existing designations, while the development of mixed letter-number systems prevents this from happening. Establishing a closer correspondence between the designations is necessary in order

for the same subassemblies and components in different machine building objects to have the same designations. Such a singleness of designations is impossible with the existing systems.

2. PRINCIPLES OF THE ELABORATION OF A SINGLE NUMERICAL DESIGNATION SYSTEM FOR MACHINE BUILDING

What should be the single numerical designation system for products of machine building and their elements: should it be closed or should it be a component part of the all-state designation and classification system for all kinds of goods?

The numerical system for designation of goods used by the Central Statistical Administration of the USSR (TsSU) for purposes of accounting in the national economy is definitely a single system.

Planning in the USSR extends to the entire national economy, to all its branches. But many of these branches have machine building or repair production units, which are not always account ed for separately. Finally, we must keep in mind the continuous adaption to machine building practice of products of the chemical, paper pulp, textile, radio and many other branches of the industry, without mentioning the extensive use of special shapes of rolled stock, periodic and bent profiles, shaped pipes, etc., which also requires coordinated classification and single designations.

The basic principles on which the work for elaboration of a single designation system for machine building products is based, are the following.

1. The classification system must be numerical, decimal. Machine building is a part of a single classification and designation system for products of all kinds.

2. The classification system should embrace all kinds of machines and equipment and make impossible the repetition of the same designa-

tion for different products.

3. The system of numerical designations in the given classification system should ensure a clearly defined and convenient exposure of common machine subassemblies and components.

4. The system of classifications and conventional designations should be constructed on the basis of establishing, as a rule, of seven stages of dividing features, namely: 1) division; 2) subdivision; 3) class; 4) group; 5) kind; 6) type; 7) standard dimension. The first three stages characterize the belonging of the object to a specified production unit (or branch of technology), determined by the most general features, including the functional (operational) purpose. Classification of the object by a lower-level designation (group, kind, type) depends on particular features, which more specifically characterize the given object.

5. Each classification stage in the conventional designation of any object should have always the same place and the same number of signs. The symbol of the first stage (division) has one numerical sign. The number of signs of each successive classification stage increases by one sign in comparison with the preceding stage. In conjuction with this, the numerical value of the symbol of each stage increases by a factor of 10 in comparison with the symbol of the preceding stage.

6. All products of the national economy are subdivided into 10 divisions. But the inclusion of one or another object in the industrial goods class is determined by the first three signs (numbers). Of the ten divisions, six pertain to machine building and are denoted by the the symbols 1-6. The remaining four divisions, denoted by 0, 7, 8 and 9 characterize the production of all other branches of the national economy (these are not considered in this book).

The capacity of any classification system and its long-range pro-

perty (which are determined by the number of objects which it can embrace), depend on the number of signs provided for. The capacity of a seven-symbol classification system is 10 million objects, of which 6 millions pertain to machine building production. When the number of signs is increased to nine, the number of products embraced increases to 1 milliard and of machine building products embraced - to 600 millions of articles and their elements. Each additional sign increases tremendously the capacity of the decimal system, which makes it possible to bring the numerical designation system not only to the component, but to the designation of the component with respect to the material used, heat treatment and plating, as well with respect of the manufacturing precision (in those individual cases when this is necessary).

Table 42 shows a general scheme for classification of machines, mechanisms, apparatus, instruments and automation facilities for divisions 1-6. This scheme has been elaborated as a part of problem of creating a single numerical designation system for all kinds of machine building and instrument making goods. Using divisions (symbols) 0, 7, 8 and 9, not included in this table, we can extend this system of numerical designations to all the remaining kinds of goods, including the products of agriculture and of special technology branches.

Table 42 thus establishes 60 subdivisions which, in their turn, are further classified into classes, the total number of which is 600. It is characteristic that of the 60 subdivisions provided, 20 are reserved, which is a tremendous but definitely necessary reserve, without which not a single classification system can exist for a long time. It is necessary to emphasize that any system of conventional designation which is elaborated must be capable of serving for about 50 years. This requirement is satisfied by the classification and designation

Abb. 42.

General Classification Scheme for Machines, Mechanisms, Appa[illegible] Instruments and Automation Facilities – for Numerical Code

1 Технологическое оборудование для тяжелой промышленности и строительства	2 Детали машин, технологическая оснастка и универсальное оборудование	3 Технологическое оборудование для легкой промышленности и сельского хозяйства	4 Транспортное и подъемно-транспортное оборудование	5 Энергетическое оборудование, радиотехника, средства связи и разные приборы	6 Средства автоматики и [illegible]
10 Горно-рудное оборудование	20 Детали машин	30 Оборудование для легкой промышленности	40 Средства воздушного транспорта	50 Энергетическое оборудование	60 Средства [illegible]
11 Резерв A	21 Инструмент и другая технологическая оснастка	31 Резерв A	41 Средства железнодорожного транспорта	51 Электрические машины и оборудование	61 Средства а[illegible]
12 Металлургическое и литейное оборудование	22 Резерв A	32 Оборудование для пищевой промышленности и промыслового хозяйства	42 Средства безрельсового транспорта	52 Атомная энергетика	62 Ре
13 Оборудование для обработки металлов и дерева	23 Оборудование для получения сжатого воздуха, перемещения газов и жидкостей	33 Резерв A	43 Резерв A	53 Резерв A	63 Резерв
14 Резерв A	24 Промышленные установки общего назначения	34 Оборудование для отдельных производств общего назначения	44 Средства водного транспорта, универсальные	54 Радио- и рентгенотехника	64 Резерв
15 Оборудование для добычи и переработки нефти, газа и торфа	25 Технологическое и вспомогательное оборудование общего назначения	35 Резерв A	45 Средства водного транспорта, специальные	55 Техника связи	65 Электронные управля[illegible]ва и математические машины
16 Оборудование для производства строительных материалов	26 Термоизоляционные установки и сборудование	36 Машины и оборудование для сельского хозяйства	46 Резерв A	56 Электроизмерительные приборы	66 Резерв
17 Резерв A	27 Резерв A	37 Резерв A	47 Подъемно-транспортное оборудование	57 Приборы для физических исследований и контрольно-измерительные	67 Средства автомат[illegible] и управления [illegible] порте и в [illegible] связи
18 Оборудование для химической и резиновой промышленности	28 Оборудование для торговых предприятий и коммунального хозяйства	38 Резерв A	48 Напольный безрельсовый транспорт	58 Механические приборы для измерений и испытаний	68 Приборы для [illegible] и автоматического регулирования технологических процессов
19 Резерв A	29 Медицинское оборудование и ветеринарное	39 Резерв A	49 Средства гравитационного и другого внутрицехового транспорта	59 Оптические и оптико-механические приборы	69 Резерв

1) Production equipment for heavy industry and construction; 2) machine components, production tooling and general purpose equipment; 3) production equipment for light industry and agriculture; 4) transportation and transportation and lifting equipment; 5) power equipment, radio equipment, communications facilities and various instruments; 6) automation facilities and instruments for control and adjustment of production processes; 10) ore-mining equipment; 20) machine components; 30) equipment for the light industry; 40) air transportation facilities; 50) power equipment; 60) facilities for automation and control of processes in the heavy industry; A) reserved; 21) tools and other production tooling equipment; 41) railroad transportation facilities; 51) electrical machines and equipment; 61) automation and control facilities in hydraulic engineering and construction; 12) metallurgical and casting equipment; 32) equipment for the food industry and trade; 42) highway transportation facilities; 52) atomic energy equipment; 13) equipment for machining of metals and woodworking; 23) equipment for producing compressed air, moving of gases and liquids; 24) industrial general purpose installations; 34) equipment for individual general purpose production units; 44) general purpose water transportation facilities; 54) radio and X-ray equipment; 15) equipment for extraction and processing of oil, gas and peat; 25) general purpose production and auxiliary equipment; 45) special water transportation facilities; 55) communications equipment; 65) electronic devices and computers; 16) equipment for production of building materials; 26) heat insulation installations and equipment; 36) machines and equipment for agriculture; 56) electrical measuring instruments; 47) lifting and transportation equipment; 57) instruments for physical investigations and for control measurements; 67) automation and control facilities in transportation and communications systems; 18) equipment for the chemical and rubber industry; 28) equipment for trade enterprises and municipal services; 48) ground-type transportation facilities; 58) mechanical instruments for measuring and testing; 68) instruments for control and automatic adjustment of production processes; 29) medical and veterinary equipment; 49) gravitation and other intrashop transportation facilities; 59) optical and optico-mechanical instruments.

system for products of machine-building and instrument making, which is being considered.

The appearance of the third sign in the designation system (counting from left to right) denotes the creation of classes of goods. Table 43 shows a scheme of classification and numerical designations of production equipment for the heavy industry and construction. Here, the number of reserved classes reaches 50 of the total number of 100. Table 44 illustrated a scheme of classification and numerical designations for components of machines, production tooling and general purpose equipment. This scheme of designation of the classes of the afore-

mentioned objects has 40 reserved classes of the total number of 100. Table 45 gives a scheme of classification and numerical designations for production equipment for the light industry and agriculture. 63 of the 100 classes are reserved. Table 46 characterizes a classification scheme and a system of numerical designations for various transportation facilities and lifting and transportation equipment. 49 of the 100 classes have been reserved.

The question can be asked: why does a designation system need such tremendously large reserves of classification capacity? Why should we not immediately utilize certain reserved classes for subdividing those which are provided for? We can give the following answer to these and other similar questions. The capacity of each class is so great, that it is unnecessary to decrease the reserves of the entire system. They will come in very useful in 20 years from now, when the material and technical base of Communism will be constructed and when the products of machine building and instrument making will reach a tremendous nomenclature with further growth tendencies.

The limited scope of this book makes it impossible to present tables for other kinds of goods and with respect to further classification of the machine building goods in the direction to the following levels, i.e. to groups, kinds, types and standard dimensions.

The number of signs for standardized, normalized and unified components which have been assimilated, which characterizes the seventh classification stage, can be increased to two or three. For designation of various special (original) components, standardization (normalization) or unification of which is undesirable, or still unfeasible, the seventh stage can be designated by two or three signs and the materials used, kinds of blanks, plating and heat treatment and also additional standard dimensions of the characteristic can be designated

by three or four signs. Appropriate numerical symbols are used for designation of the materials used, platings, heat treatment or casehardening.

Designation systems for fastening compone. ' and fittings can serve as examples of the construction of complete conventional designations of common machine subassemblies and components (on the basis of the classification being considered). These systems are briefly illuminated beloz.

When it is expedient o introduce unclassified indexing of common machine components and subassemblies, we can designate a single class, the designation of which ends in the number 8. This symbol is a characteristic index of common subassemblies and components in any designation. Certain subassemblies and components of general machine building purpose, which are encountered in the majority of machines and equipment, are separated out into separate classes. For example, fastening components - class 202, fittings - class 203, bearings - class 205, etc.

The basic principle in designation of subassemblies and components within the limits of each class is their subdivision on the basis of criteria of what they have in common from the functional (operational) and production-engineering aspects. The latter for example, include gears, levers, covers, plates, shafts, etc.

The index of classes, groups and kinds of components which are distinguished by the criteria of what they have in common from the functional aspect, always ends in the number 8 (for example, 136.8, 475.8, etc.). The index of classes, groups and kinds of components which are distinguished by the criteria of what they have in common from the production-engineering aspect, always ends in the number 9 (for example, 104.9; 470.19, etc.). The basic primary feature, i.e.

common functional purpose, does not as yet mean that the given objects are common for the entire series of products.

In further subdivision of the class or group, the classification features become narrower and in the end take on the character of a standard dimension designation. It is quite obvious that other methods of classification development can be used, starting, for example, from the concept "production equipment for the heavy industry and construction" and ending by standard dimensions of components of this equipment. In the given case, we only consider the principles of the solution of a problem of major importance to the national economy. Its basis is a general classification scheme for machine building objects.

TABLE 43.

Classification Scheme for Production Equipment for the Heavy Industry and Construction (Machine and Equipment Classes) for Numerical Designations.

10 Горнорудное оборудование	11 Резерв A	12 Металлургическое и литейное оборудование	13 Оборудование для обработки металлов и дерева	14 Резерв A	15 Оборудование для добычи и переработки нефти, газа и торфа	16 Оборудование для производства строительных материалов	17 Резерв A	18 Оборудование для химической и резиновой промышленности	19 Резерв A
100 Оборудование и инструмент для геологических изысканий и разведки недр	110 Резерв A	120 Плавильное оборудование	130 Металлорежущие станки	140 Резерв A	150 Оборудование для бурения нефтегазовых	160 Оборудование и инструмент для строительных, гидротехнических и дорожных работ	170 Резерв A	180 Оборудование для производства неорганических и органических продуктов и реактивов	190 Резерв A
101 Резерв A	111 Резерв A	121 Резерв A	131 Оборудование для обработки металлов давлением	141 Резерв A	151 Оборудование и инструмент для эксплуатации нефтепромыслов и аппаратура специальная	161 Оборудование для силикатного и цементного производства	171 Резерв A	181 Резерв A	191 Резерв A
102 Обогатительное и агломерационное оборудование	112 Резерв A	122 Прядильное оборудование	132 Резерв A	142 Резерв A	152 Оборудование для передачи на расстояние и переработки нефти	162 Резерв A	172 Резерв A	182 Оборудование для производства искусственных полимеров	192 Резерв A
103 Резерв A	113 Резерв A	123 Волочильное и проволокообрабатывающее оборудование	133 Оборудование для электро- и физической обработки металлов	143 Резерв A	153 Резерв A	163 Оборудование для производства железобетонных изделий, кирпича и строительных деталей	173 Резерв A	183 Оборудование для нефтехимической и лесохимической промышленности	193 Резерв A
104 Оборудование для добычи угля и горючих сланцев	114 Резерв A	124 Вспомогательное и прочее технологическое оборудование	134 Резерв A	144 Резерв A	154 Оборудование для добычи и передачи на расстояние газа	164 Резерв A	174 Резерв	184 Резерв A	194 Резерв A
105 Резерв A	115 Резерв A	125 Резерв A	135 Резерв A	145 Резерв A	155 Оборудование для добычи и переработки торфа	165 Оборудование для добычи и обработки камня, изготовления растворов и пр.	175 Резерв A	185 Оборудование для резинотехнической промышленности	195 Резерв A
106 Оборудование для добычи металлических руд, цветных и редких металлов	116 Резерв A	126 Резерв A	136 Оборудование для лесной и лесообрабатывающей промышленности	146 Резерв A	156 Резерв A	166 Оборудование для производства стекла	176 Резерв A	186 Резерв A	196 Резерв A
10 Горнорудное оборудование	11 Резерв A	12 Металлургическое и литейное оборудование	13 Оборудование для обработки металлов и дерева	14 Резерв A	15 Оборудование для добычи и переработки нефти, газа и торфа	16 Оборудование для производства строительных материалов	17 Резерв A	18 Оборудование для химической и резиновой промышленности	19 Резерв A
107 Разное горнорудное оборудование и инструмент	117 Резерв A	127 Резерв A	137 Резерв A	147 Резерв A	157 Резерв A	167 Резерв A	177 Резерв A	187 Оборудование для производства кислорода, азота и других газов	197 Резерв A
108	118	128	138	148	158	168	178	188	198
B Узлы и детали, общие для машин, механизмов и аппаратов данного функционально-эксплуатационного назначения									
109	119	129	139	149	159	169	179	189	199
C Технологически однородные, но конструктивно различные узлы и детали, характерные для машин, механизмов и аппаратов данного функционально-эксплуатационного назначения									

A) Reserved; 10) ore-mining equipment; 12) metallurgical and foundry equipment; 13) equipment for machining of metals and woodworking; 15) equipment for extraction and processing of oil, gas and peat; 16) equipment for production of construction-materials; 18) equipment for the chemical and rubber industry; 100) equipment and tools for geological surveying and prospecting; 120) melting equipment; 130) metal-cutting machines; 150) equipment for oil hole drilling; 160) equipment and tools for construction, hydraulic engineering and road building work; 180) equipment for the production of nonorganic and organic products and reagents; 131) equipment for pressure-working of metals; 151) equipment and tools for operating petroleum refineries and special apparatus; 161) equipment for production of silicates and cement; 102) enriching sintering equipment; 122) rolling equipment; 152) equipment for pipeline transportation and processing of oil; 182) equipment for the production of artificial polymers; 123) wire and wire-processing equipment; 133) equipment for electrical and physio-chemical processing of metals; 163) equipment for the production of reinforced concrete products, bricks and structural components; 183) equipment for the coal-tar and wood chemical industries; 104) equipment for extraction of coal and oil shale; 124) auxiliary and other production equipment; 154) equipment for extraction and pipeline transportation of gas; 155) equipment for extraction and processing of peat; 165) equipment for extraction and processing of stone, preparing mortars, and the like; 185) equipment for the rubber-goods industry; 106) equipment for extraction of metal ores, nonferrous and rare metals; 136) equipment for the timber and timber processing industry; 166) glass-producing equipment; 107) various ore-mining equipment and tools; 187) equipment for producing oxygen, nitrogen and other gases; B) subassemblies and components common to machines, mechanisms and apparatus of the given functional (operational) purpose; C) various subassemblies and components, characteristic of machines, mechanisms and apparatus of the given functional (operational) purpose, which have common production-engineering but differing design features.

TABLE 44.

Classification scheme for components of machines, production tooling and general purpose equipment, for numerical designations.

20 Детали машин	21 Инструмент и другая технологическая оснастка	22 Резерв A	23 Оборудование для получения сжатого воздуха, перекачивания газов и жидкостей	24 Промышленные установки общего назначения	25 Технологическое и вспомогательное оборудование общего назначения	26 Теплосиловое оборудование и установки	27 Резерв A	28 Оборудование для торговых предприятий и коммунального хозяйства	29 Оборудование медицинское и ветеринарное
200 Резерв A	210 Инструмент и приспособления для литья, термообработки, сварки, пайки и огневой резки	220 Резерв A	230 Компрессоры, турбокомпрессоры, нагнетатели	240 Резерв A	250 Дробильно-размольное и сортировочное оборудование	260 Резерв A	270 Резерв A	280 Оборудование для торговых предприятий	290 Электро, радиоэлектронное лечебное и диагностическое оборудование
201 Резерв A	211 Инструмент и приспособления для обработки давлением	221 Резерв A	231 Насосы, насосные станции и установки	241 Конденсаторы, испарители, ректификационные устройства	251 Центрифуги, сепараторы и мешалки	261 Резерв A	271 Резерв A	281 Резерв A	291 Гидравлическое, газовое и теплотехническое оборудование
202 Крепежные детали	212 Инструмент для обработки металла резанием	222 Резерв A	232 Резерв A	242 Водоочистительные и распылительные установки	252 Резерв A	262 Автоклавы, пресс-автоклавы, теплообменники	272 Резерв A	282 Оборудование для предприятий общественного питания	292 Резерв A
203 Промышленная и санитарно-техническая арматура	213 Инструмент для обработки резанием неметаллических материалов	223 Резерв A	233 Вентиляционные устройства, вентиляторы, пылесосы	243 Резерв A	253 Фильтры, пылеуловительные установки, фильтр-прессы	263 Резерв A	273 Резерв A	283 Резерв A	293 Оборудование медицинское немедицинское
204 Резерв A	214 Резерв A	224 Резерв A	234 Воздухосборные и газосборные установки	244 Резерв A	254 Смазочные устройства и приборы	264 Резерв A	274 Резерв A	284 Оборудование для коммунального хозяйства, противопожарное оборудование	294 Резерв A
205 Подшипники	215 Инструмент вспомогательный	225 Резерв A	235 Резерв A	Га... ...ии ...	255 Упаковочные, дозировочные и разливочные машины	265 Печи (кроме плавильных) и сушильные устройства	275 Резерв A	285 Резерв A	295 Оборудование оптическое и светотехническое
206 Зубчатые, ременные, цепные, фрикционные, гидравлические и другие передачи	216 Приспособления для станочных и ручных работ	226 Резерв A	236 Емкостные устройства для хранения и транспортирования газов и жидкостей	246 Резерв A	256 Оборудование для лакокрасочных покрытий	266 Резерв A	276 Резерв A	286 Оборудование для предприятий бытового обслуживания	296 Резерв A
207 Резерв A	217 Средства измерения и контроля линейных и угловых величин	227 Резерв A	237 Резерв A	247 Вспомогательные установки и технологическому оборудованию	257 Машины счетно-аналитические, вычислительные, множительные и др.	267 Холодильное оборудование, установки кондиционирования воздуха	277 Резерв A	287 Контейнеры, штучное оборудование, скобяные изделия	297 Инструмент медицинский и ветеринарный
208 Муфты, цепи, гибкие валы, пружины и др.	218 B	228	238	248	258	268	278	288	298
	Узлы и детали, общие для технологической оснастки, а также для машин, механизмов, аппаратов и приборов данного функционально-эксплуатационного назначения								
209 Детали упряжных	219 C	229	239	[illegible]	259	269	279	289	299
	Технологически однородные, по конструктивно различные узлы и детали, характерные для технологической оснастки, а также машин, механизмов, аппаратов и приборов данного функционально-эксплуатационного назначения.								

A) Reserved; 20) machine components; 21) tools and other production tooling equipment; 23) equipment for producing compressed air, transporting gases and liquids; 24) general purpose industrial installations; 25) production and auxiliary general purpose equipment; 26) thermal insulation equipment and installations; 28) equipment for trade enterprises and municipal services; 29) medical and veterinary equipment; 210) tools and fixtures for casting, heat treatment, welding, soldering and flame cutting; 230) compressors, turbocompressors, blowers; 250) crushing and pulverizing and sorting equipment; 280) equipment for trade enterprises; 290) electrical and radio-electronic therapeutical and diagnostic equipment; 211) tools and fixtures for pressureworking; 231) pumps, pumping stations and installations; 241) condensers, vaporizers, fractionating installations; 251) centrifuges, mixers and agitators; 291) hydraulic, gas and heat engineering equipment; 202) fastening components; 212) metal-cutting tools; 242) water purification and spraying installations; 262) autoclaves, autoclave presses, heat exchangers; 282) equipment for restaurants; 203) industrial and toilet fittings; 213) tools for machining of nonmetallic materials; 233) ventilation installations, ventilators, dust removing pumps; 253) filters, distilling installations, press filters; 293) hospital mechanical equipment; 234) air and gas collecting installations; 254) lubricating devices and instruments; 284) municipal services equipment, firefighting equipment; 205) bearings; 215) auxiliary tools; 245) gas generators and sprayers; 255) packing, metering and pouring machines; 265) overs (except for melting) and dry[illegible] installations; 295) optical and illumination-engineering equipment, 206) gear, belt, chain, friction, hydraulic and other transmissions; 216) fixtures for machine-tool and manual operations; 236) storage tanks and tank cars for gases and liquids; 256) painting equipment; 286) equipment for consumer service enterprises; 217) facilities for measuring and control of linear and angular quantities; 247) auxiliary industrial heat equipment installations; 257) analog and digital computers and duplicating machines; 267) cooling equipment, air conditioning installations; 287) containers, kitchen equipment, hardware; 297) medical and veterinary tools; 208) clutches, chains, flexible shafts, springs and the like; 209) control system components; B) components and subassemblies, common to production tooling equipment and also to machines, mechanisms, apparatus and instruments of the given functional (operational) purpose; C) subassemblies and components characteristic of production tooling equipment, and also of machines, mechanisms, apparatus and instruments of the given functional (operational) purpose, similar in production engineering, but differing in design.

TABLE 45.

Classification scheme for production equipment for the light industry and agriculture - for numerical designations.

30 Оборудование для легкой промышленности	31 Размер A	32 Оборудование для первой обработки животного и растительного сырья	33 Размер A	34 Оборудование для отдельных процессов общего назначения	35 Размер A	36 Машины и оборудование для сельского хозяйства	37 Размер A	3. Размер A	39 Размер A
300 Оборудование для пищевой промышленности	310 Размер A	320 Оборудование для первой обработки растительного сырья	330 Размер A	340 Оборудование для полиграфической промышленности	350 Размер A	360 Тракторы и почвообрабатывающие машины	370 Размер A	380 Размер A	390 Размер A
301 Размер A	311 Размер A	321 Оборудование для первой обработки животного сырья	331 Размер A	341 Размер	351 Размер A	361 Посевные и посадочные машины	371 Размер A	381 Размер A	391 Размер A
302 Оборудование для текстильного производства	312 Размер A	322 Размер A	332 Размер A	342 Оборудование для кабельного производства	352 Размер A	362 Размер A	372 Размер A	382 Размер A	392 Размер A
303 Размер A	313 Размер A	323 Оборудование для первой обработки растительного сырья	333 Размер A	343 Размер A	353 Размер A	363 Машины для уборки, очистки и сортировки зерна и технических культур	373 Размер A	383 Размер A	393 Размер A
304 Оборудование для швейного и трикотажно-галантерейного производства	314 Размер A	324 Размер A	334 Размер A	344 Оборудование для бумажно-целлюлозной промышленности	354 Размер A	364 Машины по заготовке животноводческих кормов	374 Размер A	384 Размер A	394 Размер A
305 Размер A	315 Размер A	325 Оборудование для мясо-молочного и молочного производства	335 Размер A	345 Оборудование для производства изделий из стекла	355 Размер A	365 Размер A	375 Размер A	385 Размер A	395 Размер A
306 Размер A	316 Размер A	326 Размер A	336 Размер A	346 Размер A	356 Размер A	366 Машины и аппараты по уходу за землей и растениями и борьбе с вредителями	376 Размер A	386 Размер A	396 Размер A
307 Размер A	317 Размер A	327 Размер A	337 Размер A	347 Оборудование для медицинской промышленности	357 Размер A	367 Размер A	377 Размер A	387 Размер A	397 Размер A
308	318	328	338	348	358	368	378	388	398
B - Узлы и детали, общие для машин, механизмов и аппаратов данного функционально-эксплуатационного назначения									
309	319	329	339	349	359	369	379	389	399
C - Технологическая оснастка, не конструктивно делимые узлы и детали, применяемые для машин, механизмов и аппаратов данного функционально-эксплуатационного назначения									

30) Equipment for the light industry; A) reserved; 32) equipment for the food industry and trade; 34) equipment for individual general purpose production units; 36) machines and equipment for the agriculture; 300) equipment for producing leather shoes; 320) chemical raw material processing equipment for the food industry; 340) printing equipment; 360) tractors and soil cultivation machines; 321) mechanical raw materials processing equipment for the food industry; 361) sowing and planting machines; 302) textile producing equipment; 342) cable producing equipment; 323) equipment for the flour-milling and cereal industry and for elevators; 363) machines for harvesting, cleaning and sorting of grain and industrial crops; 304) garment and dry goods producing equipment; 344) equipment for the paper and pulp industry; 364) machines for mechanization of livestock breeding and feed preparation; 325) meat grinding and canning equipment; 345) glass product manufacturing equipment; 366) machine and apparatus for soil and plant cultivation and for pesticide control; 347) equipment for the medical industry; B) subassemblies and components, common to machines, mechanisms and apparatus of the given functional (operational) purpose; C) subassemblies and components, similar in production engineering, but differing in design, characteristic of machines, mechanisms and apparatus of the given functional (operational) purpose.

TABLE 46.

Classification scheme for transportation facilities and lifting and transportation equipment - for numerical designations.

40 Средства воздушного транспорта	41 Средства электрифицированного транспорта	42 Средства безрельсового транспорта	43 Резерв	44 Средства водного транспорта универсальные	45 Средства водного транспорта специальные	46 Резерв	47 Подъемно-транспортное оборудование	48 Вильный безрельсовый транспорт	49 Средства грузоподъемного и другого штучного транспорта
400 Резерв	410 Тепловозы, электровозы, мотовозы, дрезины	420 Грузовые автомобили	430 Резерв	440 Грузовые сухогрузные и наливные суда	450 Резерв	460 Резерв	470 Подъемные машины и механизмы (кроме кранов)	480 Рульс и кумиковые толкачи, специальная тара	490 Грузоподъемный транспорт (склады, наливные рольганги и пр.)
401 Самолеты и планеры	411 Резерв	421 Легковые автомобили, автобусы и троллейбусы	431 Резерв	441 Резерв	451 Промысловые и рефрижераторные суда	461 Резерв	471 Краны	481 Резерв	491 Резерв
402 Резерв	412 Подвижной состав и машины специального назначения	422 Резерв	432 Резерв	442 Пассажирские и буксирные суда	452 Резерв	462 Резерв	472 Погрузочно-разгрузочные машины и оборудование	482 Резерв	492 Передвижные стеллажи, рольганги и другие средства для штучных грузов
403 Аэростаты, стратостаты и стратопланы	413 Вагоны и пассажирские	423 Автомобили специализированного назначения, автокраны и др.	433 Резерв	443 Резерв	453 Суда вспомогательные и технического флота	463 Резерв	473 Резерв	483 Самоходные тележки	493 Резерв
404 Резерв	414 Резерв	424 Резерв	434 Резерв	444 Катеры, боты, паромы и спасательные суда	454 Специальные, пожарные суда, ледоколы и пр.	464 Резерв	474 Конвейеры общего назначения	484 Резерв	494 Конвейеры специализированного назначения
405 Резерв	415 Оборудование и инструмент для строительства железных дорог	425 Механизмы, погрузчики, самосвалы	435 Резерв	445 Судовые устройства, механизмы, системы и машины	455 Резерв	465 Резерв	475 Конечные транспортные устройства	485 Резерв	495 Резерв
406 Оборудование аэродромов	416 Резерв	426 Резерв	436 Резерв	446 Резерв	456 Дизель, нефтеналивные, пищевые суда, оборудование и оборудование портов	466 Резерв	476 Резерв	486 Резерв	496 Резерв
407 Резерв	417 Резерв	427 Оборудование автостанций, гаражей, заправок и др.	437 Резерв	447 Резерв	457 Судовые устройства и подъемное оборудование и устройства	467 Резерв	477 Резерв	487 Резерв	497 Резерв
408	418	428	438	448	458	468	478	488	498
B Узлы и детали, общие для транспортных средств подъемно-транспортных машин и оборудования данного функционально-эксплуатационного назначения									
409	419	429	439	449	459	469	479	489	499
Типизированные однородные по конструктивно-различные узлы и детали, пригодные для эксплуатационного C					транспортных средств подъемно-транспортных машин и оборудования данного функционально-назначения				

40) Air transportation facilities; 41) railroad transportation facilities; 42) highway transportation facilities; A) reserved; 44) general purpose water transportation facilities; 45) special water transportation facilities; 47) hoisting and loading equipment; 48) ground-type transportation; 49) gravity and other intrashop transportation facilities; 410) diesel, electric and gasoline locomotives, hand cars; 420) trucks; 440) self and nonself-propelled freight ships; 470) lifting machines and mechanisms (except for cranes); 480) hand and trailer carts, (special packaging); 490) gravity transportation (slides, inclined roll tables and the like); 401) aircraft and gliders; 421) passenger cars, autobuses and trolleybuses; 451) industrial and refrigerated vessels; 471) cranes; 412) rolling stock and special purpose locomotives; 442) passenger ships and tugboats; 472) loading and unloading machines and equipment; 492) portable tables, roll tables and other single piece transportation facilities; 403) aerostats, stratosphere ballons and stratoplanes; 413) [railroad] cars and tank cars; 423) special purpose automotive vehicles, timber carriers and the like; 453) auxiliary and service fleet ships; 483) self-propelled carts; 444) torpedo boats, boats, ferryboats and sport vessels; "54) rescue, fire-fighting boats, icebreakers and the like; 474) general purpose conveyors; 494) specialized purpose conveyors; 415) equipment and tools for railroad right of way construction; 425) motorcycles, scooters, bicycles; 445) shipboard devices, mechanisms, systems and accessories; 475) cable-haulage installations; 406) airport equipment; 456) docks, petroleum terminals, floating workshops and port equipment; 427) automobile service station, garage and filling station equipment; 457) dry dock and diver equipment and installations; B) subassemblies and components for transportation facilities, lifting and hauling machines and equipment of the given functional (operational) purpose; C) subassemblies and components similar in production engineering, but differing in design, characteristic of transportation facilities, lifting and hauling machines and equipment of the given functional (operational) purpose.

3. GENERAL SCHEME FOR CLASSIFICATION OF MACHINE BUILDING OBJECTS

The principles presented above make it possible (as a feasible example of solution of the problem we wish to solve), to construct a general classification scheme for machine building objects with a gradual development of the first three classification features. This makes it possible to continue further the development of the remaining classification features at the appropriate base standardization and normalization organizations according to a uniform scheme. Of course, the general scheme illuminated in this chapter is only an example, and should be corrected and approved as mandatory in the appropriate manner.

As was pointed out above, the first number in the general scheme of conventional designations characterizes one of the six divisions into which the entire machine building and instrument making has been divided by convention; in other words, in which have been conventionally united all machine building, metal processing and instrument making branches.

The further development of classification features is subordinated to the main idea, i.e. to separating out of common subassemblies and components with the purpose of using their subsequent standardization, normalization and unification as a basis for accelerating the development of specialization. Singleness of the distinguishing features of common subassemblies and components is the main purpose of all this labor-consuming, complex and controversial work, since a great diversity of opinion can exist with respect to the question of inclusion of various machines, mechanisms, apparatus, instruments and automation facilities into one or another classification column. It is important to follow through the ways and means for further development of the classification of common machine subassemblies and components.

TABLE 47.

Classification Scheme for Metal Processing and Woodworking Equipment - for Numerical Designations.

130 Металлорежущие станки	131 Оборудование для обработки металлов давлением	132 Резерв	133 Оборудование для электро-и физико-химической обработки металлов	134 Резерв	135 Резерв	136 Оборудование для лесной и деревообрабатывающей промышленности	137 Резерв	138 Узлы и детали общего назначения	139 Технологически однородные, по конструктивно различные узлы и детали
A		A		A	A		A		
130.0 Автоматические линии, специальные и специализированные станки	131.0 Механические прессы	132.0 Резерв A	133.0 Резерв A	134.0 Резерв A	135.0 Резерв A	136.0 Лесопильное оборудование	137.0 Резерв A	138.0	139.0
130.1 Станки токарные, револьверные и автоматы	131.1 Гидравлические и пневматические прессы	132.1 Резерв A	133.1 Оборудование для электроэрозионной и электроимпульсной обработки	134.1 Резерв A	135.1 Резерв A	136.1 Резерв A	137.1 Резерв A	138.1	139.1
130.2 Сверлильные и расточные станки	131.2 Кузнечно-прессовые и резьбонакатные автоматы и полуавтоматы	132.2 Резерв A	133.2 Резерв A	134.2 Резерв A	135.2 Резерв A	136.2 Строгальные, фрезерные и шлифовальные станки	137.2 Резерв A	138.2	139.2
130.3 Фрезерные станки	131.3 Резерв A	132.3 Резерв A	133.3 Оборудование для индукционного нагрева, газопламенной резки и установки т. о. ч.	134.3 Резерв A	135.3 Резерв A	136.3 Токарные, строгальные и долбежные станки	137.3 Резерв A	138.3	139.3
130.4 Зубообрабатывающие станки	131.4 Молоты и кузнечные машины	132.4 Резерв A	133.4 Резерв A	134.4 Резерв A	135.4 Резерв A	136.4 Шлифовальные, полировальные и заточные станки	137.4 Резерв A	138.4	139.4
130.5 Строгальные, протяжные и долбежные станки	131.5 Гибочные машины, правильные машины и пресс-ножницы	132.5 Резерв A	133.5 Резерв A	134.5 Резерв A	135.5 Резерв A	136.5 Резерв A	137.5 Резерв A	138.5	139.5
130.6 Шлифовальные, заточные, полировальные и доводочные станки	131.6 Резерв A	132.6 Резерв A	133.6 Оборудование для сварки, резки и пайки металлов	134.6 Резерв A	135.6 Резерв A	136.6 Деревообрабатывающие специализированные станки	137.6 Резерв A	138.6	139.6
130.7 Резерв A	131.7 Средства автоматизации процессов ковки и штамповки	132.7 Резерв A	133.7 Средства автоматизации сварки и термообработки	134.7 Резерв A	135.7 Резерв A	136.7 Автоматические и полуавтоматические линии и деревообрабатывающие автоматы	137.7 Резерв A	138.7	139.7
130.8	131.8	132.8	133.8	134.8	135.8	136.8	137.8	138.8	139.8
B	Узлы и детали, общие для машин, механизмов, аппаратов, приборов и средств автоматизации данного функционально-эксплуатационного назначения							D	C
130.9	131.9	132.9	133.9	134.9	135.9	136.9	137.9	138.9	139.9
C	Технологически однородные, по конструктивно различные узлы и детали, характерные для машин, механизмов, аппаратов, приборов и средств автоматизации данного функционально-эксплуатационного назначения								

130) Metal-cutting machines; 131) equipment for pressureworking of of metals; A) reserved; 133) equipment for electro and physio-chemical processing of metals; 136) equipment for timber and timber processing industry; 138) general purpose subassemblies and components; 139) subassemblies and components, similar in production engineering but differing in design; 130.0) automatic lines, special and specialized machine tools; 131.0) mechanical presses; 136.0) timber sawing equipment; 130.1) general-purpose, turret and automatic lathes; 131.1) hydraulic and pneumatic presses; 133.1) equipment for electro-erosion and electro-impulse machining; 130.2) drilling and boring machines; 131.2) press forging and thread rolling automatic and semiautomatic machines; 136.2) shapers, milling and dovetail-cutting machines; 130.3) milling machines; 133.3) equipment for induction heating, electroplating and ultrahigh frequency installations; 136.3) lathes, drilling and slotting machines; 130.4) generating-type gear-cutting machines; 131.4) hammers and forging machines; 136.4) grinding, polishing and dressing machines; 130.5) shapers, broaching and slotting machines; 131.5) bending and straightening machines, shears and foot-operated shears; 130.6) grinding, dressing, polishing and honing machines; 133.6) equipment for welding, cutting and soldering of metals; 136.6) woodworking specialized machines; 131.7) facilities for automation of forging and pressing processes; 133.7) facilities for automation of welding and heat treatment; 136.7) automatic and semiautomatic lines and woodworking automatic machines; B) subassemblies and components, common to machines, mechanisms, apparatus, instruments and automation facilities of the given functional (operational purpose); C) subassemblies and components, similar in production engineering but differing in design, characteristic of machines, mechanisms, apparatus, instrument and automation facilities of the given functional (operational) purpose; D) subassemblies and components, common to machines and equipment of the given functional (operational) purpose.

TABLE 48.

Classification scheme for agricultural machines and equipment - for numerical designations.

360 Тракторы и почвообрабатывающие машины	361 Посевные и посадочные машины	362 Резерв A	363 Машины для уборки, очистки и сортировки зерна и технических культур	364 Машины для механизации животноводства и кормовых первых	365 Резерв A	366 Машины и аппараты по уходу за растениями и борьбе с вредителями	367 Резерв A	368 Узлы и детали общего назначения	369 Технологически однородные, по конструктивно различные узлы и детали
360.0 Тракторы общего назначения	361.0 Сеялки тракторные	362.0 Резерв A	363.0 Комбайны зерновые	364.0 Машины для уборки и обработки трав и т. п.	365.0 Резерв A	366.0 Оборудование для местного орошения, дождевальные установки	367.0 Резерв A	368.0	369.0
360.1 Пропашные тракторы	361.1 Резерв A	362.1 Резерв A	363.1 Молотилки, комбайны, молотилки, жатки	364.1 Навесооборочные силосные и другое оборудование для концентрированных кормов	365.1 Резерв A	366.1 Резерв A	367.1 Резерв A	368.1	369.1
360.2 Тракторы для садов и плодовых плантаций	361.2 Резерв A	362.2 Резерв A	363.2 Комбайны и другие уборочные машины для овощных и других культур	364.2 Резерв A	365.2 Резерв A	366.2 Оборудование для разбрасывания удобрений	367.2 Резерв A	368.2	369.2
360.3 Прочие тракторы	361.3 Посадочные машины	362.3 Резерв A	363.3 Резерв A	364.3 Заправочное и загрузочное оборудование для кормов	365.3 Резерв A	366.3 Резерв A	367.3 Резерв A	368.3	369.3
360.4 Плуги	361.4 Резерв A	362.4 Резерв A	363.4 Машины для очистки, сортировки и обработки зерна	364.4 Вспомогательное, пильное и дельное оборудование	365.4 Резерв A	366.4 Оборудование для химической обработки почв	367.4 Резерв A	368.4	369.4
360.5 Культиваторы, рыхлители, почвообрабатывающие машины	361.5 Резерв A	362.5 Резерв A	363.5 Резерв A	364.5 Оборудование для получения и обработки молока	365.5 Резерв A	366.5 Резерв A	367.5 Резерв A	368.5	369.5
360.6 Лущильники, бороны, катки, сеялки	361.6 Резерв A	362.6 Резерв A	363.6 Машины для обработки льна и др. технических культур	364.6 Резерв A	365.6 Резерв A	366.6 Оборудование для борьбы с вредителями	367.6 Резерв A	368.6	369.6
360.7 Прочее почвообрабатывающее оборудование	361.7 Резерв A	362.7 Резерв A	363.7 Резерв A	364.7 Оборудование для птицеводства	365.7 Резерв A	366.7 Сельскохозяйственный инвентарь и инструменты	367.7 Резерв A	368.7	369.7
360.8	361.8	362.8	363.8	364.8	365.8	366.8	367.8	368.8	369.8
360.9	361.9	362.9	363.9	364.9	365.9	366.9	367.9	368.9	369.9

A — Технологически однородные, по конструктивно различные узлы и детали, характерные для машин, оборудования и установок данного функционально-эксплуатационного назначения

B — Узлы и детали общие для машин, оборудования и установок данного функционально-эксплуатационного назначения

C — Технологически однородные, по конструктивно различные узлы и детали, характерные для машин, оборудования и установок данного функционально-эксплуатационного назначения

360) Tractors and soil cultivation machines; 361) sowing and planting machines; A) reserved; 363) machines for harvesting, cleaning and sorting of grain and industrial crops; 364) machines for mechanization of livestock breeding and feed preparation; 366) plant cultivation and pest control machines and apparatus; 368) general purpose subassemblies and components; 369) various subassemblies and components similar in production engineering, but differing in design; 360.0) general purpose tractors; 361.0) tractor sowing machines; 363.0) grain harvesting combines; 364.0) grass cutting and processing machines; 366.0) local irrigation equipment, sprinklers; 360.1) thorough plowing tractors; 363.1) threshing machines, stackers, pickers, reaping machines; 364.1) silage harvesting combines and other equipment for concentrated fodder; 360.2) tractors for orchards and cotton plantations; 363.2) combines and other harvesting machines for fruit and other crops; 366.2) equipment for spreading of fertilizers; 360.3) other tractors; 361.3) planting machines; 364.3) fodder scalding and loading equipment; 360.4) plows; 364.4) grain harvesting, cleaning and sorting machines; 364.4) water distributing, (animal) drinking and milking equipment; 366.4) equipment for chemical cultivation of fields; 360.5) cultivators, rippers, stone picking machines; 364.5) wool-shearing and processing equipment; 360.6) shellers, harrows, rollers, couplers; 363.6) machines for processing of flax and other industrial crops; 366.6) pesticide control equipment; 360.7) other soil cultivating equipment; 364.7) poultry farming equipment; 366.7) agricultural implements and tools; B) subassemblies and components, common to machines, equipment and installations of the given functional (operational) purpose; C) subassemblies and components, similar in production engineering, but differing in design, characteristic of machines, equipment and installations; D) subassemblies and components, similar in production engineering, but differing in design, characteristic of machines, equipment and installations.

It follows from the above that the first three numbers in the conventional designation determine the class of the product. The fourth number characterizes the group, where the feasibility of establishing uniform distinguishing features for all those subassemblies and components which are potential standardization, normalization and unification objects is exposed more clearly. Table 47 presents a scheme for construction designations of groups of equipment for metal processing and woodworking and Table 48 does the same for agricultural machines and equipment.

All classes in which the number 8 serves as the third sign are classes of common subassemblies and components, which are most characteristic for the development of standardization or general machine building normalization. All classes with 9 as the third number are classes of various subassemblies and components, similar in production engineering, but differing in design, which are most characteristic for unification for purposes of general machine building normalization. All groups with 8 as the fourth number are groups of common subassemblies and components most characteristic for extensive development of branch normalization and all groups with 9 as the fourth number are groups of subassemblies and components similar in production engineering but differing in design, which are most characteristic for extensive development of branch unification.

Further extension of classification results in concretely defining all these subassemblies and components and additionally facilitates their unification, normalization and standardization, creating conditions necessary for specialization and automation of production.

4. SYSTEM OF NUMERICAL DESIGNATIONS FOR FASTENING COMPONENTS

The above uniform classification system for machine building objects, has still an additional advantage with respect to fastening

components, consisting in the fact that it is possible to establish permanent numerical values for the given standard dimension of threaded fasteners, belonging to various groups and kinds, as is shown graphically in Table 49.

TABLE 49

Uniformity in Designations of Various Fastening Components.

Крепежные детали 1	Диаметр и длина деталей в мм 2	Обозначение 3
Болты с шестигранной головкой . . 4.	10×50	000.0758
Болты с полукруглой головкой и усом для дерева 5.	10×50	141 0758
Винты с цилиндрической головкой и прямым шлицем 6	10×50	210.0758
Винты с полукруглой головкой и прямым шлицем . 7	10×50	320.0758

1) Fastening components; 2) diameter and length of components in mm; 3) designation; 4) hex head bolts; 5) semispherical head fin bolts for wood; 6) screws with cylindrical head and straight slot; 7) screw with semispherical head and straight slot.

This construction of a designation system for fastening components with respect to their dimensional characterization has substantial advantages. In particular, it facilitates the selection of tools for producing and control of the thread and facilitates memorization. The closed coding of standard dimension characterization of fastening components is already used by a number of machine building branches; it is progressive and promising and facilitates centralization of orders and specialization of production. We should recall that rolling contact bearings and production tooling are also coded in the closed manner.

The existing standards of technical requirements have established an excessively varied nomenclature of steel brands, the use of which is permitted. For example, 11 different steel brands are provided for the fabrication of finished bolts, which creates difficulties for production specialization. Actually, over 30 steel brands are used in the production of fastening components. The numerical designation system for fastening components brings about order also with respect to this

problem. The brands of materials used, in a specified combination with the kinds of plating, are denoted by a three-digit symbol. For fastening components produced from the most widely used brand 10 steel without plating, the conventional designation does not include the material and plating symbols. In this case, the designation contains six digits.

Figure 7 shows the construction of a conventional designation for a bolt with an ordinary hexagonal head 10 mm in diameter and 50 mm long with a coarse pitch, produced from steel 10, without plating (202.000.-0758). A bolt with the same dimensions, which is nickel plated will be designated as: 202.000.0758.013.

When it becomes necessary to give a high precision class in the conventional designation and addition such as, for example, cl.2 is made, since the ordinarily used 3rd precision class is not specified.

The complete designation of a fastening component, giving the material used and the plating, thus consists of 13 digits. To the question as to whether this is too much or too little, we can give the following answer. The designation of a dowel pin 10 mm in diameter and 120 mm long according to the existing standard, consists of 41 signs. The designation of the same dowel pin by the new system is: 202.700.-1287.107.

The first three digits characterize the class of fastening components and their varieties are defined by the successive symbols. In technical documentation, when the names of specific fastening components are mentioned (for example, bolt, pin, nut, etc.), or when it is evident that this is a bolt, pin, etc., it is not necessary to give the first three numbers (in the given case 202), in all cases. This substantially shortens the conventional designation.

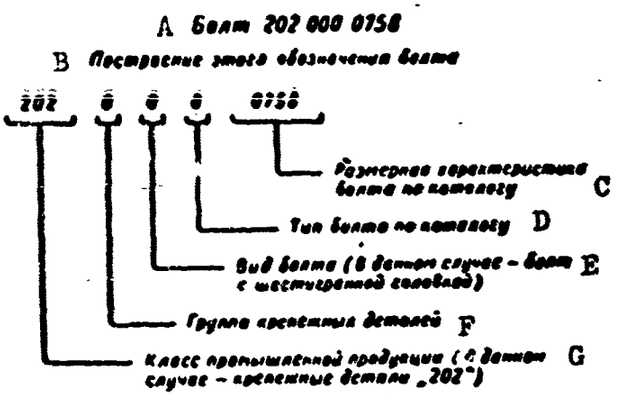


Fig. 7. Scheme for constructing the conventional designation of a hex bolt 10 mm in diameter and 50 mm long, with a coarse pitch, produced from brand 10 steel. A) Bolt 202 000 0758; B) construction of the above designation of the bolt; C) dimensional characterization of the bolt, according to the catalog; D) bolt type according to the catalog; E) kind of bolt (in this case - a hex-head bolt); F) group of fastening components; G) class of industrial goods (in the given case - fastening components "202").

The system of classification and construction of numerical designations of all varieties with respect to the fourth and fifth digits, denoting groups and kinds, is given in Table 56. The total designation of groups, for example, of screws with a spherical button-type or countersunk head, will be 202.3 and the complete designation for kinds, for example, for screws with a button head and Phillips recess will be 202.34. Further extension results in the feasibility of numerically designing any standard dimension of the fastening component, including three-digit designation of the material, plating and heat treatment used.

Groups 202.8 and 202.9 and also varieties of fastening components, whose designations (fifth digit) end in 8 and 9, are not used in Table 50, since fastening products are components rather than subassemblies. For this reason, these groups and kinds are an additional reserve, which can be used for the designation of special technical requirements put to the design and production engineering of the production of fastening components.

TABLE 50.

Classification Scheme for Fastening Components with Respect to the Fourth and Fifth Digits (Groups and Kinds) - for Numerical Designations (the First Three Digits are 202).

0	1	2	3	4	5	6	7	8	9
Болты с грибной головкой	Болты с квадратной головкой и фасонные	Винты с грибной цилиндрической головкой и фасонные	Винты со сферической полугайкой и потайной головкой	Винты без головок, с малой квадратной головкой и винтовой резьбовой	Гайки	Шайбы и кольца	Штифты, шплинты, заклепки, шурупы и винты	Резерв A	Резерв A
00 Болты с шестигранной головкой	10 Болты с цилиндрической головкой	20 Винты с шестигранной головкой	30 Винты со сферической головкой с шестигранным углублением	40 Винты установочные с шестигранным углублением	50 Гайки шестигранные	60 Шайбы скошенные	70 Штифты и шплинты	80 Резерв A	90 Резерв A
01 Болты с шестигранной уменьшенной головкой	11 A Резерв	21 Установочные винты с шестигранной головкой	31 То же с крестообразным шлицем	41 Резерв A	51 То же облегченные	61 Пружинные шайбы	71 Резерв A	81 Резерв A	91 Резерв A
02 Болты с шестигранной головкой для отверстий из-под развертки	12 A Резерв	22 Винты с цилиндрической головкой с шестигранным углублением	32 То же с прямым шлицем	42 Установочные винты с прямым шлицем	52 Шестигранные прорезные и корончатые гайки	62 Стопорные шайбы	72 Резерв A	82 Резерв A	92 Резерв
03 То же с уменьшенной головкой	13 Резерв A	23 То же с крестообразным шлицем	33 Резерв A	43 Винты с прямым шлицем	53 То же облегченные	63 Шайбы специального назначения	73 Резерв A	83 Резерв A	93 Резерв A
04 Резерв A	14 Болты с полукруглой и овальной головкой	24 То же с прямым шлицем	34 Винты с полупотайной головкой с крестообразным шлицем	A 44 Резерв	54 Шестигранные и корончатые гайки	64 Резерв A	74 Заклепки со сферической головкой	84 Резерв A	94 Резерв A
05 Резерв A	15 Болты с потайной и полупотайной головкой	25 То же с прямым шлицем установочные	35 То же с прямым шлицем	A 45 Резерв	55 Круглые гайки	65 Установочные кольца	75 То же с плоской головкой и трубчатые	85 Резерв A	95 Резерв A
06 Болты с квадратной головкой	16 Резерв	26 Винты с квадратной головкой	36 Винты с потайной головкой с крестообразным шлицем	46 Винты с малой квадратной головкой	56 Квадратные гайки	66 A Резерв	76 Шурупы	86 A Резерв	A 96 Резерв
07 Резерв A	17 Фасонные болты	27 То же установочные	37 То же с прямым шлицем	47 Шпильки резьбовые	57 Гайки с ручным регулированием	67 A Резерв	77 Шпонки	87 A Резерв	A 97 Резерв
08 Резерв A	18 Резерв A	28 Резерв A	38 Резерв A	48 Резерв A	58 Резерв A	68 Резерв A	78 Резерв A	88 Резерв A	98 Резерв A
09 Резерв A	19 Резерв A	29 Резерв A	39 Резерв A	49 Резерв A	59 Резерв A	69 Резерв A	79 Резерв A	89 Резерв A	99 Резерв A

0) Hex and square-head bolts; 1) smooth-head and fancy bolts; 2) hex and square cylindrical head and fancy screws; 3) spherical button-head and countersunk screws; 4) headless screws, screws with a small square head and threaded pins; 5) nuts; 6) washers and rings; 7) dowel pins, cotter pins, rivets, wood screws and splines; A) reserved; 00) hex-head bolts; 10) cylindrical head bolts; 20) hex head screws; 30) spherical head hex-socketed screws; 40) head socketed setscrews; 50) hex nuts; 60) bearing washers; 70) dowel and cotter pins; 01) hex bolts with a reduced-size head; 21) hex-head setscres; 31) the same as above with a Phillips recess; 51) the same as above, light duty; 61) spring washers; 02) hex-head bolts for reamed holes; 22) cylindrical head, hex-socketed screws; 32) same as above with a straight slot; 42) set-screws with a straight slot; 52) hex split and castellated nuts; 62) locking washers; 03) the same as above with a reduced-size head; 23) same as above with a Phillips recess; 43) straight-slot screws; 53) same as above, light duty; 63) special purpose washers; 14) bolts with semispherical and oval head; 24) the same as above with a straight slot; 34) button-head screws with a Philips recess; 54) hex and other nuts; 74) rivets with a spherical head; 15) countersunk and button-head bolts; 25) same as above, set-screws with a straight slot; 35) the same as above with a straight slot; 55) round nuts; 65) adjusting rings; 75) the same as above with a flat head and hollow; 06) square-head bolts; 26) square-head screws; 36) countersunk head screws with a Phillips recess; 46) screws with a small square head; 56) square nuts; 76) wood screws; 17) fancy bolts; 27) the same as above, setscrews; 37) the same as above, with straight slot; 47) threaded pins; 57) manually screwed-on nuts; 77) splines.

5. SYSTEM OF NUMERICAL DESIGNATIONS FOR FITTINGS

The existing state standards and various normal standards for pipeline and general purpose fittings which are produced in very large quantities, do not have a rigorously established system of conventional designations, which makes difficult centralization of orders and utilization of technical documentation when it is transferred from one plant to another. The designations in a number of standards are complex and include up to 29 different letters and digits, for example, 45° cross, 100 × 50 × 90° GOST 6942-54.

In the numerical designation system, the first three digits, denoting the class of the machine building goods with respect to fittings are denoted as 203, and the remaining seven digits refine the characterization of the fittings, their varieties and standard dimensions.

All the design modifications for fitting subassemblies produced from the same material, within the limits of the corresponding type, are distinguished by the eighth digit of the designation. In those cases when the same design modification is used for different media, or for the same media, but with a different temperature, the difference in the eighth digit of the designation characterizes the functional modification, for example, the material of packing devices, the kind of internal plating (rubberizing, enameling). The dimensional characterization is designated by a system of ordinal numbers.

The classification and designation scheme for fittings with respect to fourth and fifth digits (groups and kinds) is presented in Table 51. Groups 203.8 and 203.9 and also varieties having numbers 8 and 9 as the fifth digit, serve for designating common fitting subassemblies and components, or for those similar in production engineering but differing in design. This classification promotes the development of unification and normalization in the fittings industry.

The conventional numerical designation of fittings consists of two parts, the first of which is substantially the name of the product and the second denoting those elements which characterize the distinguishing features of the given product. Illustrated tables have been elaborated for fittings.

6. NUMERICAL DESIGNATIONS SYSTEM FOR MACHINE BUILDING OBJECTS AND FOR FERROUS AND NONFERROUS METALS AND ALLOYS

The system of classifications and numerical designations for machine building goods, very naturally, interested the industrial workers. Practical problems have arisen. In particular, the coworkers of the technical and economic council of the Moscow Oblast Sovnarkhoz wanted to have specific designations for various machines and equipment produced by the sovnarkhoz plants. Acting on their request, the author

TABLE 51.

Classification Scheme for Fittings with Respect to the Fourth and Fifth Digits (Groups and Kinds) - for Numerical Designations (the First Three Digits are 203).

0 Запорная, регулирующая, предохранительная арматура	1 Резерв А	2 Маслёнки	3 Резерв А	4 Соединения трубопроводов	5 Фитинги трубопроводов	6 Резерв А	7 Резерв А	8 Узлы и детали общего назначения	9 Технологические однородные, по конструктивно реализованные узлы и детали
00 Задвижки, затворы	10 Резерв А	20 Маслёнки для жидких масел	30 Резерв А	40 Резерв А	50 Резерв А	60 Резерв А	70 Резерв А	80	90
01 Вентили	11 Резерв А	21 Резерв А	31 Резерв А	41 Соединения с угольниками	51 Угольники	61 Резерв А	71 Резерв А	81	91
02 Краны	12 Резерв А	22 Маслёнки для густых масел и смазок	32 Резерв А	42 Соединения с тройниками	52 Тройники	62 Резерв А	72 Резерв А	82	92
03 Регулирующая арматура	13 Резерв А	23 Резерв А	33 Резерв А	43 Соединения с крестовинами	53 Крестовины	63 Резерв А	73 Резерв А	83	93
04 Контрольная арматура	14 Резерв А	24 Приборы для смазки	34 Резерв А	44 Соединительные гайки и муфты	54 Муфты	64 Резерв А	74 Резерв А	84	94
05 Предохранительная арматура	15 Резерв А	25 Резерв А	35 Резерв А	45 Штуцерные соединения	55 Ниппели, штуцера	65 Резерв А	75 Резерв А	85	95
06 Резерв А	16 Резерв А	26 Резерв А	36 Резерв А	46 Резерв А	56 Резерв А	66 Резерв А	76 Резерв А	86	96
07 Резерв А	17 Резерв А	27 Резерв А	37 Резерв А	47 Резерв А	57 Резерв А	67 Резерв А	77 Резерв А	87	97
08	18	28	38	48	58	68	78	88	98
09	19	29	39	49	59	69	79	89	99

B Узлы и детали, общие для арматуры данного функционально-эксплуатационного назначения

A Узлы и детали, общие для арматуры данного функционального назначения

C Технологически однородные, по конструктивно реализованные узлы и детали арматуры

D Технологически однородные, по конструктивно реализованные узлы и детали, характерные для арматуры

0) Closing, adjusting, control and safety fittings; A) reserved; 2) lube fittings; 4) pipeline connections; 5) pipelines fittings; 8) general purpose subassemblies and components; 9) subassemblies and components similar in production engineering by differing in design; 00) plunger valves, shutoffs; 20) lube fittings for liquid lubricants; 01) gate valves; 41) elbow joints; 51) elbows; 02) taps; 22) lube fittings for heavy lubricants and greases; 42) tee joints; 52) tees; 03) adjusting fittings; 43) cross-piece joints; 53) cross pieces; 04) control fittings; 24) lubricating instruments; 44) connector nuts and unions; 54) unions; 05) safety fittings; 45) connecting pipe joints; 55) nipples, connecting pipes; B) subassemblies and components common to fittings of the given functional (operational) purpose; C) fitting subassemblies and components similar in production engineering, but differing in design; D) subassemblies and components, similar in production engineering but differing in design, characteristic of fittings.

of this book has compiled conventional numerical codes applicable to the nomenclature of the various machine building objects which they presented. Complete numerical codes and codes for practical purposes are given in Table 52. These numerical codes were called conventional, because a uniform numerical designation system for machine building goods cannot be elaborated in a decentralized manner for individual sovnarkhozes, without taking into account analogous products manufactured by plants of other sovnarkhozes.

The existing situation with respect to designation of ferrous and nonferrous metal and alloys brands cannot be called normal. The mixed letter-number system, used for their conventional designations contains a large number of symbols, is complex and difficult to memorize (for example, OKh14N28V3T3YuR). In addition, it promotes the formation of absolutely unnecessary, parallel alloy brands.

The following propositions were found to be desirable in the process of elaborating the new designation system:

1) the designation of brands of all metalling materials should be numerical and uniform;

2) each brand should correspond to a rational classification of metallic materials;

TABLE 52.

Numerical Designations (Conventional, in the Form of Examples) of Certain Machine Building Objects.

1 Объекты машиностроения из числа изготовляемых Мособлсовнархозом	2 Полный цифровой код	3 Цифровой код для электрических целей
4 Среднесортовой прокатный стан технические характеристики завода тяжелого машиностроения в г. Электросталь	122.0209	5 Среднесортовой стан 0209
6 Трубопрокатный стан с техническими характеристиками завода	122.0804	7 Трубопрокатный стан 0804
8 Трубосварочный стан с техническими характеристиками завода	122.0911	9 Трубосварочный стан 0911
Экскаватор мод. ЭТУ-353 10	170.0105	Экскаватор 0105 11
Траншейный экскаватор модели БТЭ 12	170.0702	Экскаватор 0702 13
Конечный манипулятор грузоподъемностью 1 т 14	211.0101	Манипулятор 0101 15
То же грузоподъемностью 2 т 16	211.0102	Манипулятор 0102 17
То же грузоподъемностью 5 т 18	211.0103	Манипулятор 0103 19
То же грузоподъемностью 10 т 20	211.0104	Манипулятор 0104 21
То же грузоподъемностью 30 т 22	211.0107	Манипулятор 0107 23
Молотковая дробилка с техническими характеристиками завода 24	250.0101	Дробилка 0101 25
Одновалковая дробилка с техническими характеристиками завода 26	250.0201	Дробилка 0201 27
То же двухвалковая 28	250 0301	Дробилка 0301 29
То же четырехвалковая 30	250.0401	Дробилка 0401 31
Дискозубая дробилка с техническими характеристиками завода 32	250.0501	Дробилка 0501 33
Грузовой тепловоз мод. ТЭ-3 для магистральных железных дорог 34	410.0102	Тепловоз 0102 35
Пассажирский тепловоз мод. ТЭП-60 для магистральных железных дорог 36	410.1102	Тепловоз 1102 37
Тепловоз для железных дорог узкой колеи с техническими характеристиками завода 38	410.5103	Тепловоз 5103 39
Вагон метрополитена модели завода 40	413.0405	Вагон 0405 41
Пассажирский вагон для железных дорог узкой колеи с техническими характеристиками завода 42	413.0901	Вагон 0901 43
Торфовозный саморазгружающийся вагон для железных дорог узкой колеи 44	413.0954	Вагон 0954 45
Тележка для изложниц грузоподъемностью 60 т с техническими характеристиками завода 46	414.0201	Тележка 0201 47
То же грузоподъемностью 120 т 48	414.0203	Тележка 0203 49
Автомобиль-цементовоз грузоподъемностью 3 т с техническими характеристиками завода 50	420.0501	Цементовоз 0501 51
То же грузоподъемностью 5 т 52	420.0502	Цементовоз 0502 53
То же грузоподъемностью 7 т 54	420 0503	Цементовоз 0503 55
То же грузоподъемностью 12 т 56	420.0504	Цементовоз 0504 57
То же грузоподъемностью 21 т 58	420.0505	Цементовоз 0505 59
Самоходная коляска для инвалидов с техническими характеристиками завода 60	425.0903	Коляска 0903 61
Автокран грузоподъемностью 7,5 т с техническими характеристиками завода 62	471.0107	Автокран 0107 63
Тепловозный дизель мод. 2Д100 64	504.0302	Дизель 0302 65
Вагон энергопоезда с установкой мощностью 1500 квт с техническими характеристиками завода 66	505.0203	Энергопоезд 0203 67
Паровой прямоточный котел с параметрами и техническими характеристиками завода 68	500.0107	Котел 0107 69

1) Machine building objects from among those produced by the Moscow Oblast Sovnarkhoz; 2) complete numerical code; 3) numerical code for practical purposes; 4) medium-section rolling mill with technical characteristics of the heavy machine building plant in the city of Elektrostal'; 5) medium-section rolling mill 0209; 6) tube rolling mill with technical characteristics of the plant; 7) tube rolling mill 0804; 8) tubewelding mill with technical characteristics of the plant; 9) tubewelding mill 0911; 10) model ETU-353 excavator; 11) excavator 0105; 12) model BTM trench excavator; 13) excavator 0702; 14) forging manipulator with a rating of 1 ton; 15) manipulator 0101; 16) same as above, with a rating of 2 tons; 17) manipulator 0102; 18) same as above, with a rating of 5 tons; 19) manipulator 0103; 20) same as above, with a rating of 10 tons; 21) manipulator 0104; 22) same as above, with a rating of 30 tons; 23) manipulator 0107; 24) hammer crusher with technical specifications of plant; 25) crusher 0101; 26) single-roll crusher with technical specifications of plant; 27) crusher 0201; 28) same as above, twin-roll; 29) crusher 0301; 30) same as above, with four rolls; 31) crusher 0401; 32) disk crusher with technical characteristics of plant; 33) crusher 0501; 34) model TE-3 freight diesel locomotives for main railroads; 35) diesel locomotive 0102; 36) model TEP-60 passenger diesel locomotive for main railroads; 37) diesel locomotive 1102; 38) diesel locomotive for narrow-gauge railroads with technical characteristics of plant; 39) diesel locomotive 5103; 40) subway car produced by plant; 41) car 0405; 42) passenger car for narrow-gauge railroads with technical characteristics of plant; 43) car 0901; 44) peat hauling self-dumping car for narrow-gauge railroads; 45) car 0954; 46) ingot mold cart with a freight capacity of 60 tons with technical characteristics of plant; 47) cart 0201; 48) the same as above, with freight capacity of 120 tons; 49) cart 0203; 50) cement truck with a freight capacity of 3 tons with technical characteristics of plant; 51) cement truck 0501; 52) same as above, with a freight capacity of 5 tons; 53) cement truck 0502; 54) same as above, with a freight capacity of 7 tons; 55) cement truck 0502; 56) the same as above, with a freight capacity of 12 tons; 57) cement truck 0504; 58) same as above, with a freight capacity of 24 tons; 59) cement truck 0505; 60) self-propelled invalid chair with technical characteristics of plant; 61) [invalid] chair 0903; 62) truck crane with a lifting capacity of 7.5 tons with technical characteristics of plant; 63) truck crane 0107; 64) diesel locomotive diesel engine, model 2D100; 65) diesel 0302; 66) power train car with a 1500 kwt installation, with technical characteristics of plant; 67) power car 0203; 68) straight-flow steam boiler with parameters and technical characteristics of plant; 69) boiler 0107.

3) the brands should contain the main characteristic features of the alloys they designate;

4) the numerical designations system should be promising and contain reserves sufficient for the future development of metallurgical production during a prolonged period;

5) the brands should be written in a simple manner and should not

TABLE 53.

Examples of Designating General Purpose, Standard Quality Steel Brands.

Цифровые A	Существующие B	Цифровые A	Существующие B	Цифровые A	Существующие B
1	Ст. 1кп C	133	I КСт. 3кп	243	O МСт. 3
2	Ст. 2кп D	143	J КСт. 3	231	PМСт. 4кп
3	Ст. 3кп E	153	KВКСт. 3кп	241	Q СМт. 4
223	FСт. 3	163	LВКСт. 3	253	RВСт. 3кп
113	БСт. 3кп G	173	MКСт. 3пс	253	S ВСт. 3
123	БСт. 3 H	233	NМСт. 2кп	265	T ВСт. 5

A) Numerical; B) existing; C) St. 1kp; D) St. 2kp; E) St. 3kp; F) St. 3; G) BSt. 3kp; H) BSt. 3; I) KSt. 3kp; J) KSt. 3; K) VKSt. 3kp; L) VKSt. 3; M) KSt. 3ps; N) MSt; 3kp; O) MSt. 3; P) MSt; 4kp; Q) SMt. 4; R) VSt; 3kp; S) VSt. 3; T) VSt. 5.

TABLE 54.

Examples of Designating Special Purpose Steel Brands.

Цифровые 1	Существующие 2	Цифровые 1	Существующие 2	Цифровые 1	Существующие 2
313	3 Ст. 3С	333	15К	372	7 Л20
314	4 Ст. 4С	334	20К	392	8 Л55
322	5 М16С	371	А12	393	Ст. 3Тс
323	Ст. 3 мост 6				

1) Numerical; 2) existing; 3) St. 3S; 4) St. 4S; 5) M16S; 6) St. 3 bridge; 7) L65; 8) St. 3Ts.

contain any dividing signs (periods, dashes, fraction signs, etc.).

The new system of numerical designations elaborated by taking the aforementioned principles into account, provides for designations:

by one, two and three numbers - of all carbon steels:

by five numbers - of all kinds of alloyed steels, including steels and alloys with special properties;

by five numbers cast irons and ferro-alloys:

by four numbers - of all kinds of nonferrous materials and alloys.

The first numbers of the five-digit designation of ferrous alloy brands are distributed as follows:

1, 2, 3 - alloy structural steels; 4 - alloy tool steels, 5 - stainless, high-temperature oxidation resistant, heat resistant and

high ohmic resistance steels and alloys; 6 - steels and alloys with special properties; 7 and 8 reserved; 9 - cast irons and ferroalloys; 0 - reserved.

Standard quality carbon steels are designated by one number in those cases when the delivery of these steels is determined by the mechanical properties only. This designation conventionally expresses the level of mechanical properties established by the standard for the given steel brand. New numerical and existing designations of these steels are given in Table 53.

A two-digit number is used for high-quality skilled structural steel brands. It expresses the average carbon content in terms of hundreds of a percent.

A three-digit number is used to designate the brands of the remaining kinds of carbon steels. In this case, the first digit expresses the kind of the steel (for example, ship plate, free-cutting steel, bridge building steel, etc.), and the second and third digits characterize the smelting method, properties and peculiarities of the steel. Their designations are given in Table 54.

Examples of designations for high quality carbon steels and steels for intricately shaped castings are given in Table 55.

Numerical designations for alloyed steel brands are based on their subdivision by attributes of the alloying elements used and of their combinations. Ten groups are provided for, of which three are kept in reserve, which makes this numerical system very promising. Examples of designations of structural alloyed steel brands are included in Table 56.

Designations of brands of alloyed tool and of the type of tool steels (with the exception of high-speed cutting) are constructed according to a scheme characterizing the type of alloying, the alloying

TABLE 55.

Examples of Designating Brands of High-Quality Carbon Steels and of Carbon Steels for Intricately Shaped Castings.

Цифровые A	Существующие B		Цифровые A	Существующие B		Цифровые A	Существующие B	
10	10		610	10пс	F	448	К У8А	
15	15		715	15Г	G	450	L У10А	
608	08кп	C	720	20Г	H	478	M У8ГА	
610	10кп	D	408	У8	I	438	N У8Г	
635	08пс	E	410	У10	J	920	O 20Л	
						925	P 25Л	

A) Numerical; B) existing; C) 08kp; D) 10kp; E) 08ps; F) 10ps; G) 15G; H) 20G; I) U8; J) U10; K) U8A; L) U10A; M) U8GA; N) U8G; O) 20L; P) 25L.

TABLE 56.

Examples of Designating Alloyed Structural Steel Brands.

Цифровые 1	2 Существующие		Цифровые 1	2 Существующие		Цифровые 1	2 Существующие	
11091	3 09Г2		15601	17 60С2ХА		26188	32 18ХСНРА	
11151	4 15Г2		16301	18 30ХГС		27107	33 36ХСГНЛ (МС-1)	
12151	5 15ГС		16352	19 35ХГСА		27302	34 30ХГСНА	
12255	6 25Г2С		17102	20 40ХФА		31382	35 38ХМЮА	
12602	7 6002А		17502	21 50ХФА		32101	36 40ХНМА	
13151	8 15Х		21107	22 10ГНЛ		36216	37 30Х2Н2ВФМА	
13158	9 15ХРА		22123	23 12Х11Г2		36314	38 30Х2Н2ВФА	
13401	10 40Х		22201	24 20Х11		37181	39 18Х2Н4ВА	
13407	11 40ХР		23122	25 12Х13А		12200	20ГСЛ	40
14121	12 12ХГ		23124	26 12Х21НА		12300	30ГСТЛ	41
14185	13 18ХГТ		25121	27 12ХГН		32303	30ХНМЛ	42
14407	14 40ХГР		25156	28 15ХГНТА		26309	30ДХСНЛ	43
14506	15 50ХГФА		25168	29 15Х2ГН2ТРА				
15381	16 38ХС		26157	30 15ХСНД				
				31 (СХЛ-1, НД2)				

1) Numerical; 2) existing; 3) 09G2; 4) 15G2; 5) 15GS; 6) 25G2S; 7) 6002A; 8) 15 Kh; 9) 15KhRA; 10) 40Kh; 11) 40KhR; 12) 12KhG; 13) 18KhGT; 14) 40KhGR; 15) 50KhGFA; 16) 38KhS; 17) 60S2KhA; 18) 30KhGS; 19) 35KhGSA; 20) 40KhFA; 21) 50KhFA; 22) 10GND; 23) 12KhN2; 24) 20KhN; 25) 12KhN3A; 26) 12Kh2N4A; 27) 12KhGN; 28) 15KhGNTA; 29) 15Kh2GN2TRA; 30) 15KhSND; 31) (SkhL-1, ND2); 32) 18KhSNRA; 33) 10KhSGND (MS-1); 34) 30KhGSNA; 35) 38KhMYuA; 36) 40KhNMA; 37) 30Kh2N2VFMA; 38) 30Kh2N2VFA; 39) 18Kh2N4VA; 40) 20GSL; 41) 30GSTL; 42) 30KhNML; 43) 30DKhSNL.

system, carbon content and an ordinal number which differentiated between brands with the same alloying system and the same carbon content. Examples of designations for these steels are given in Table 57.

Numerical designations of brands and stainless, high-temperature oxidation resistant, heat-resistant and high ohmic resistance steels and alloys, are constructed according to a scheme reflecting the alloy-

ing systems, average chrome content (for steels with chrome as the primary alloying agent), average nickel content (for steel with nickel or nickel-chrome combinations as the primary alloying agent), the ordinal number, differentiating between brands with the same alloying system and the same chrome or nickel content. Examples of designations of these steels are included in Table 58.

TABLE 57.

Examples of Designations of the Brands and Type and Tool Steels.

Цифровые 1	Существующие 2	Цифровые 1	Существующие 2	Цифровые 1	Существующие 2
41213	3 Х09	42212	7 4Х8В2	44251	11 5ХНМ
41218	4 ШХ15	42351	8 5ХВГ	44311	12 45ХНВ
41354	5 5ХГМ	42152	9 5ХВ2С	46091	13 Р9
41491	6 9ХС	43282	10 85ХФ	46181	14 Р18

1) Numerical; 2) existing; 3) Kh09; 4) ShKh15; 5) 5KhGM; 6) 9KhS; 7) 4Kh8V2; 8) 5KhVG; 9) 5KhV2S; 10) 85KhF; 11) 5KhNM; 12) 45KhNV; 13) R9; 14) R18.

TABLE 58.

Examples of Designations of Brands of Stainless, High-Temperature Oxidation Resistant; Heat-Resistant and High Ohmic Resistance Steels and Alloys.

Цифровые 1	Существующие 2	Цифровые 1	Существующие 2
51131	3 1Х13	55140	9 0Х20Н14С2
51172	4 1Х17Н2	56144	10 4Х14Н14В2М
53101	5 4Х10С2М	56147	11 4Х15Н7Г7Ф2МС
54090	6 0Х18Н9	56183	12 1Х14Н18В2БР1
54094	7 0Х18Н9Т	56281	13 0Х23Н28М3Д3Т
54238	8 Х25Н16Г7АР	56282	14 0Х14Н28В3Т3ЮР

1) Numerical; 2) existing; 3) 1Kh13; 4) 1Kh17N2; 5) 4Kh10S2M; 6) OKh18N9; 7) OKh18N9T; 8) Kh25N16G7AR; 9) OKh20N14S2; 10) 4Kh14N14V2M; 11) 4Kh15N7G7F2MS; 12) 1Kh14N18V2BR1; 13) OKh23N28M3D3T; 14) OKh14N28V3TYuR.

Numerical designations of steel and alloy brands with special properties (electrical steel, steels and alloys with special magnetic properties, nonmagnetic and low magnetic sensitivity steels and alloys, precision alloys) are characterized by a number of additional features and by ordinal numbers which characterize the peculiarities of the

steel or alloy. Among these features are: silicone content in electrical steel, specific losses on magnetic polarity reversal, magnetic induction, etc. Examples of designations for steel brands with special properties are given in Table 59.

TABLE 59.

Examples of Designations of Special Properties Steel Brands.

Цифровые 1	Существующие 2	Цифровые 1	Существующие 2	Цифровые 1	Существующие 2
61311	3 Э31	62169	7 ЕХ9К15М	66333	12 Н29К18А
61312	4 Э310	62222	8 ЮНДК24Т2	66369	13 Х18ТФМ
61313	5 Э3100	62232	9 ЮНДК25КА	66113	14 Н43ХТ
62155	6 ЕХ5К5	66127	10 79НМА	66103	15 Н36ХТЮ
		66163	11 50НХС		

1) Numerical; 2) existing; 3) E31; 4) E310; 5) E3100; 6) YeKh5K5; 7) YeKh9K15M; 8) YuNDK24T2; 9) YuNDK25KA; 10) 79NMA; 11) 50NKhS; 12) N29K18A; 13) Kh18TFM; 14) N43KhT; 15) N36KhTYu.

Cast iron and ferro-alloy brands are assigned five digit numerical designations, starting with the number 9.

The second digit in the designation of cast iron and ferro-alloy brands denotes; 1 - ordinary nonalloyed steelmaking pig iron; 2 - same as before, high-quality; 3 - nonalloyed foundry pig iron; 4 - alloyed steelmaking and foundry pig iron; 5 - machinery cast iron (casting of intricate shapes); 6 - cast iron with special mechanical, physical and chemical properties (casting of intricate shapes); 7 - ferro-alloys; 8, 9 and 0 are reserved.

The third digit in the designation characterizes the allowable sulphur content and the fourth gives the allowable phosphorus content. The fifth number is used as an ordinal number characterizing the properties of the cast iron. The fourth and fifth digits in individual cases [also] characterize the minimum value of the ultimate strength in tension (in brands of machinery cast irons for casting of intricate shapes). Examples of designations of machinery cast irons (casting of

intricate shapes) are given in Table 60 and of cast irons with special properties - in Table 61.

TABLE 60.

Examples of Designations of Machinery Cast Iron (Casting of Intricate Shapes) brands.

Цифровые 1	Существующие 2	Цифровые 1	Существующие 2
95112	3 СЧ 12-28	95335	6 КЧ 35-10
95118	4 СЧ 18-36	95546	7 ВЧ 45-5
95337	5 КЧ 37-12	95540	8 ВЧ 40-10

1) Numerical; 2) existing; 3) SCh 12-28; 4) SCh 18-36; 5) KCh 37-12; 6) KCh 35-10; 7) VCh 45-5; 8) VCh 40-10.

TABLE 61.

Examples of Designations of Special Properties Cast Iron Brands.

Цифровые 1	2 Существующие	Цифровые 1	2 Существующие
96111	3 АСЧ-1	96512	6 ЖЧСШ-5,5-0,1
96152	4 АВЧ-2	96531	7 ЖЧХ-0,9
96132	5 АКЧ-2	96551	8 ЖЧНДХ-15-7-2

1) Numerical; 2) existing; 3) ASCh-1; 4) AVCh-2; 5) AKCh-2; 6) ZhChSSh-5, 5-0, 1; 7) ZhChKh-0, 9; 8) ZhChNDKh-15-7-2.

Designations of ferro-alloy brands are constructed by taking into account the alloying elements, the ordinal number of the ferro-alloys, whose brands are distinguished by other features and the content of the alloying element in percents for those ferro-alloys, whose brands differ by the quantity of the alloying element. For example, brand 97301 corresponds to the existing designation "Khr0000 with 1% silicone".

The numerical designations system for nonferrous metals and alloys is based on the following meanings of the first digit: 1 - aluminum and its alloys; 2 - cupper and its alloys; 3 - tin, lead, mercury, bismuth, cadmium, barium and their alloys; 4 - zinc, magnesium, antimony, strontium, calcium, manganese and their alloys; 5 - nickel, titanium, berillium, silicone, cobalt, vanadium and their alloys; 6 -

TABLE 62.

Examples of Numerical Designations for Nonferrous Metals and Alloys.

Цифровые 1	2 Существующие	Цифровые 1	2 Существующие
1007	3 АВ0000	2857	28 Зл Ср М375-160
1043	4 АПС1	3871	29 ПСр 3 Кд
1226	5 АВД1-2	4200	30 ПМц36
1250	6 АЧ-2Ф	5023	31 ПНК1
1256	7 АЛ10В	5203	32 НМЖМц 28-2,5-1,5
1265	8 АЛ15В	5621	33 ХН80ТБЮ
1428	9 АМг5п	5624	34 ХН20Н80Т3
1560	10 АЛ14ЧП	5611	ХН70МВТЮБ 35
2126	11 Бр. АЖМц 10-3-1,5	5655	ХН60В 36
2127	12 Бр. АЖН 10-4-4	6525	Т5К10 37
2130	13 Бр. АЖС 7-1,5-1,5	6529	38 Т15К6
2131	14 Бр. АЖН 10-4-4Л	6531	39 Т15К6Т
2135	15 Бр. АЖН 11-6-6	6557	ВК15 40
2301	16 Бр. ОФ 6,5-0,15	8130	41 Ср ПдМ 30-20
2317	17 Бр. ОЦС 4-4-2,5	8318	42 Зл. Ср. М 920-40
2328	18 Бр. ОЦСН 3-7-5-1	8353	43 Зл. СрМ 750-125
2418	19 ЛАЖМц 66-6-3-2	8103	44 ПдСр-40
2431	20 ЛМцОС 58-2-2-2	8142	45 ПдСрМ-36-4
2441	21 ЛЖС 58-1-1	8151	ПдСрН-13-2 46
2481	22 ПСр 12М	8162	47 ПдСрК-35-5
2497	23 МНМц 3-12	8505	ПдПдРд-4-3,5 48
2531	24 МНЖМц 30—0,8-0,1	8522	ПдРд-15 49
2567	25 БрБИТ 1,9	8533	50 ПдИ-17,5
2818	26 ПСрММц 40-50-10	8571	ПдН-4,5 51
2855	27 ЗлСрМ 333-333	8946	Рд-99,7 52

1) Numerical; 2) existing; 3) AV0000; 4) APS1; 5) AVD1-2; 6) ACh-2F; 7) AL10V; 8) AL15V; 9) AMg5p; 10) AL14ChP; 11) Br. AZhMts 10-3-1, 5; 12) Br. AZhN 10-4-4; 13) Br. AZhS 7-1, 5-1, 5; 14) Br. AZhN 10-4-4L; 15) Br. AZhN 11-6-6; 16) Br. OF 6, 5-0, 15; 17) Br. OTsS 4-4-2, 5; 18) Br. OTsSN 3-7-5-1; 19) LAZhMts 66-6-3-2; 20) LMtsOS 58-2-2-2; 21) LZhS 58-1-1; 22) PSr 12M; 23) MnMts 3-12; 24) MNZhMts 30-0, 8-0, 1; 25) BrBIT 1, 9; 26) PSrMMts 40-50-10; 27) ZlSrM 333-333; 28) Zl Sr M375-160; 29) PSr 3 Kd; 30) PMTs36; 31) PNK1; 32) NMZhMts 28-2, 5-1, 5; 33) KhN80TBYu; 34) KhN20N80T3; 35) KhN70MVTYuB; 36) KhN60V; 37) T5K10; 38) T15K6; 39) T15K6T; 40) VK15; 41) Sr PdM 30-20; 42) Zl. Sr. M 920-40; 43) Zl. SrM 750-125; 44) PdSr-40; 45) PdSrM-36-4; 46) PdSrN 13-2; 47) PdSrK-35-5; 48) PlPdRd-4-3, 5; 49) PlRd-15; 50) PlI-17, 5; 51) PlN-4, 5; 52) Rd-99, 7.

molybdenum, tungsten, chrome, zirkonium, niobium, tantalum and their alloys; 7 - rare earth, trace and alkali metals and their alloys; 8 - precious metals and their alloys; 9 and 0 are reserved.

The second digits in the designations conventionally express the subgroups by pure metals or by basic alloying components. The ensemble of the third and fourth digits is an ordinal number, characterizing: a) in the designations of pure metal brands - the metal and the degree of its purity; b) in designations of alloy brands - the basic metal, the additional alloying and the peculiarities of the alloys.

Individual examples of numerical and existing designations of nonferrous metals and alloys are presented in Fig. 62. They graphically characterize the advantages of the numerical system.

Chapter 13

INTERRELATIONSHIP BETWEEN STANDARDIZATION, SPECIALIZATION AND AUTOMATION OF PRODUCTION IN MACHINE BUILDING

1. THE SSA (STANDARDIZATION-SPECIALIZATION-AUTOMATION) SYSTEM

A system which came in into widespread use in the USA industry and then in the capitalistic countries of Western Europe is called SSS (standardization-simplification-specialization). It is emphasized in the extensive foreign technical literature advocating this system (see Chapter 16) that conformance to the three S ensures greatest convenience to manufacturers, i.e. highest earnings. The SSS system defines the goal of standardization and simplification as increasing the production scale and stabilization of requirements put to the produced goods and to the materials being used, which ensure the feasibility of achieving large scale specialization of enterprises.

The tasks of the Soviet system are more extensive, since standardization and specialization in the USSR make it possible not only to enlarge the production scale and to lower the net cost of goods, but [also] to systematically improve the quality of the produced goods, to sharply increase the productivity of labor and to make it more effortless by automating effort-consuming and monotonous manual operations. Here, the work becomes highly skilled, which promotes the elimination of the basic difference between physical and mental labor.

The present day conditions of expanded construction of the material and technical basis of communism are best satisfied by a system

based on close interrelationship between standardization, specialization and automation. This promising scheme can be conventionally called SSA (standardization-specialization-automation).

Why is the condition of their interrelationship put forward? Why should we not recommend a relationship in one direction only, from standardization to automation of production. These questions can be answered as follows.

The content of working drawings, technical specifications and other technical documentation depend to a large extent on the character of the production. That which is satisfactory for unit and small series production of goods is unsatisfactory for large series and mass production. Automation presents its requirements to technical documentation, in conjunction with which the drawings and technical specifications are subjected to substantial revision, even in those cases when they are valued as completely progressive, satisfying the requirements of mass flow production. In an analogous manner, it may be found that the contents of individual existing state standards, machine building and branch normal standards do not conform to conditions of automated production of those products to which the given standards and normal standards apply. But this is not always taken into account by the authors of standards and normal standards and by those organizations which approve them.

It follows from the above, that standarfization, specialization and automation are interrelated. They are most effective when acting together, i.e. in those cases when standardization promotes organization of specialized enterprises with integrated automation of the production processes and automation, in its turn, makes it necessary to enlarge and specialize the production and to standardize the refined technical requirements put to the design of components and to product-

ion engineering requirements put to their production. This is the substance of the SSA system.

If we assume that it will be more correct to have a system in which the development of standardization proceeds only in the direction of specialization and automation of production and the latter exert no influence on standardization, then any state standards, machine building and branch normal standards would be suitable for the purpose of automation of production. However, experience tells us that standards and normal standards which establish design dimensions of components and technical requirements to their production, should be subjected to substantial modifications and refinements when the production of the components is automated.

Machine building and branch normal standards, as a rule, establish types and dimensions of components and due to this fact, the normal standards have a preliminary rather than final character when the production is automated.

The examples presented below show the character of the interaction between standardization, specialization and automation.

Automation of the production of rotor shafts of single series standard electric motors. Automatic lines producing electric motor rotor shafts with the 2nd degree of precision, are for a number of years successfully operated by a number of electric machine building plants. Each of these lines can be reset to produce rotor shafts of eight different standard dimensions. The need to reset the automatic lines is due both to their great output, as well as to the fact that each of the plants produces several standard sizes of electric motors. These conditions have required that the shafts be unified in such a manner as to make possible the use of a single production process for their manufacture.

The unified shafts of all standard dimensions are similar in shape. The ratio of the shaft length to the diameter is 10, i.e. in the given case, use was made of a system of relative dimensions which was discussed in Chapter 1.

In elaborating the automated production, it was not permissible to mechanically use the previously existing technical documentation. It was necessary to ensure stability of bases in the process of machining the shaft and, as far as possible, identical duration of each operation, including pressfitting the rotor onto the shaft, machining and balancing them together.

Automation of the production of rotor shafts has substantially improved their quality. Rejects at the "Vol'ta" plant in Tallin comprise 0.5%. The technical-economic indicators have improved sharply. The number of production workers was decreased by a factor of 6.3, the production area by a factor of 1.4, the cost of machining by 1.48 and the labor input by a factor of 3.7. The long years of operation of these automatic lines affirmed their operational reliability and, also, the feasibility of their use as typical automatic lines in a number of machine building branches for producing stepped shafts with the 2nd precision class [28].

The given example of achieving automated production of unified products is characteristic by the fact that the production process has distated its requirements to the fabricated dimensions of the motor shafts, the standard dimensions of which were unified in the elaboration of a design unified series of electric motors of a single series. Here, the SSA system has acted in two directions: from standardization to automation and from automation to normalization, since it was necessary to introduce substantial modification in the technical documentation for rotor shafts elaborated before their production was automa-

ted.

Automation of the production of standard bolts and nuts. The goal of automating the production and improving the quality of standard bolts and nuts in the dimension range from M8 to M12, in accordance with the 3rd precision class, was put forward in order to satisfy the needs of agricultural machine building. The automatic lines constructed for this purpose consist of standard press forgings and metal cutting automatic machines, which can be reset in a narrow range of standard dimensions of bolts and nuts. Before the automatic lines were evolved, bolts and nuts were produced by a number of agricultural machine building plants, at which the technical level of the production process used in fabricating these components was very low, the metal wasted in chips reached 80% [29], the bolts and nuts were produced with large tolerances.

The automated production was elaborated on the basis of the most progressive production process, i.e. the cold upsetting method, which ensures high productivity of labor and the necessary strength of the bolts and nuts including anticorrosion coating. The above method has required the use of pre-sized cold drawing steel of the 15 and 10 brands with a restricted content of chemical elements, i.e. of selective steel brands.

The adaption of automatic lines by agricultural machine building plants has sharply increased the technical level of the production engineering aspects of the production processes, has considerably improved the quality of the produced standard nuts and bolts and has increased the productivity of labor by approximately a factor of 5 [29]. The adaption of seven automatic lines for the production of bolts and of eight lines for producing s has freed a total of 663 workers.

Simultaneously, the automated production of bolts and nuts has

made it necessary to revise the existing standards for these products with the purpose of stimulating the adaption of the most effective production methods (cold upsetting), and also of standards for the metals with the purpose of improving its chemical composition, forbidding the issuance of material with a thinned-out end (it has to be cut off and then deburred), etc. This attests to the fact that also in this [illegible], the SSA system works in both directions.

Automating the production of standard ball bearings. Integrated automation of the production of standard ball bearings of the N precision class, achieved in Moscow at the 1GPZ (1st State Bearings Plant) is based on complete automation of all production processes, including assembly, final inspection, preservation and packing of the bearings.

The bearing rings are produced within limits of established tolerances. The finished rings, which have passed all the automated machining and heat treatment operations, are received by automatic inspection devices, each of which is an object of automation interesting in the technical respect. The bearings are assembled in an automatic installation. The outer and inner rings supplied to this installation are automatically measured. Here, is determined the actual distance between the rolling surfaces, in accordance with which a set of rolling contact bodies (balls) is selected, i.e. selective assembly by ball dimensions is used here.

After the actual distance between the rolling groove surfaces of the given pair of rings delivered for assembly has been determined, the automatic device signals the hopper device and balls of the required size are delivered through the appropriate trough into an automatic assembly installation, consisting of an automatic device for delivering the balls, automatic device for assembly of the bearings, automatic inspection device and a measuring device. The assembly time is 10 sec-

onds. The automatic installation is equipped by 50 hopper sections; the capacity of each is 1200-1300 balls, sorted into groups by their diameters (within the limits of the common production tolerance) differing by 0.001 mm. A 7 piece group of balls demanded by an appropriate command is transported into the automatic assembly device, which is also supplied by a set of rings from the automatic inspection device.

This example of automating the production of ball bearings is characteristic in three respects: 1) it proves the feasibility and expedience of achieving automatic selective assembly of mass produced goods; 2) automation of assembly processes makes possible individual measuring of the assembled components; 3) the use of selective assembly substantially increases the quality of the finished products.

The experience acquired in the operation of the automatic assembly installations shows that about 90% of the standard bearings assembled has a precision higher than the N class and this means an increased service life and feasibility of their use in precision subassemblies.

Automation of assembly thus not only solves the problem of sharply increasing the productivity of labor and relieving workers from monotonous tiresome work, but simultaneously also of substantially increasing the quality of the finished products.

This example shows the action of the SSA in the direction from standardization of mass produced items to automation of their production; it proves the feasibility of increasing the quality of the bearings by adapting selective assembly. A change should be introduced into the existing standard, establishing technical requirements to rolling contact bearings, providing for mandatory subdivision of the balls into a number of dimensional groups and for achieving selective assembly of all bearings, regardless of the assembly method; this could

substantially improve the quality of these products, which are of major significance to machine building and instrument making. However, this has not been done.

When using the SSA system, the standards and normal standards should be corrected as the more refine production processes are adapted, so as to stimulate their adaption on a wider scale.

Automating the production of standard threading dies. The "Frezer" plant produced threading dies in accordance with plant drawings for this kind of tools. No special requirements were put to their production. For example, the stepped holes were drilled manually on vertical drilling machines using a jig and the large nomenclature of diameters D locating the centers of the chip holes (Fig. 8 and Table 63) did not present any special production difficulties. The threading dies were also sharped manually by using grinding wheels 3 mm and more in diameter; the large allowance only increased the machining time.

After it has been decided to machine the threading dies on automatic lines, the SKB-6 and the SKTBI of the Moscow Municipal Sovnarkhoz, which plan and design these lines have raised the question of unifying the threading dies and of introducing additional technical requirements. They have unified the diameters D locating the centers of the chip holes for a group of threading dies with threads M7, M8 and M9, machined on one automatic line and for the group of M10 and M11 threading dies, machined on a second line.

The distance between chip holes in these threading dies is small; they cannot be drilled simultaneously by using a multispindle drilling head and, for this reason, these holes are drilled at different positions on the automatic lines. The threading die being machined is fastened in a multioperation fixture, in which it goes through all the basic machining operations.

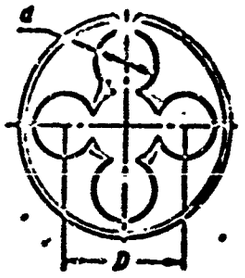


Fig. 8. Threading die.

The distance between chip holes in these threading dies is small; they cannot be drilled simultaneously by using a multispindle drilling head and for this reason these holes are drilled at different positions on the automatic lines. The threading die being machined is fastened in a multioperation fixture, in which it goes through all the basic machining operations.

TABLE 63.

Compiling the Threading Die Dimensions.

1 Номинальный размер	2 Размер D (без допуска) по ГОСТу 2173-51	3 Размер D (без допуска) по чертежам завода «Фрезер» до 1961 г.	4 Размер D ± 0.05 мм по чертежам 1961 г. для автоматических линий	1 Номинальный размер	2 Размер D (без допуска) по ГОСТу 2173-51	3 Размер D (без допуска по чертежам завода «Фрезер» до 1961 г.	4 Размер D ± 0.05 мм по чертежам 1961 г. для автоматических линий
M7×1.0	11.3	11.3	12.1	M8×0.5	11.7	12.0	12.4
M7×0.75	11.3	11.3	12.1	M9×1.25	12.6	12.8	12.4
M7×0.5	11.3	11.3	12.1	M9×1.0	12.6	13.0	12.4
M8×1.25	11.3	12.0	12.1	M9×0.75	12.6	—	12.4
M8×1.0	11.3	12.4	12.1	M9×0.5	12.8	—	12.4
M8×0.75	11.7	12.4	12.4	M9×0.35	12.8	—	12.4

1) Nominal dimension; 2) dimension D (without tolerance) according to GOST 2173-51; 3) dimension D (without tolerance) according to the drawings of the "Frezer" plant up to 1961; 4) dimension D ± 0.05 mm according to drawings of 1961 for automatic lines.

Had the dimension D not been unified in elaborating the automated process, then when machining threading dies M7, M8 and M9 or threading dies with the same thread size but with different pitches (M8 × 1.0 and M8 × 1.25 or M9 × 1.0 and M9 × 1.25) on the line it would have been necessary to reset the line five times, while now only two resetings are necessary; in addition, the setting operators work has become easier. Automated sharpening was found to be entirely unfeasible, since neither the standard nor the drawings have specified tolerances and technical

requirements. It was found necessary to introduce a tolerance for the diameter of chip holes (d $\pm$ 0.1 [sic] mm) and for their locating diameter (D $\pm$ 0.05 mm), which has resulted in changing the production process, i.e. in introducing the counterboring of holes after drilling. In addition, it became necessary to make the tolerance for the width of any two fins more rigid and to introduce a tolerance for the displacement of the chip holes from the groove axis, which has also resulted in changing the production process (an operation was introduced for push broaching the fins by a special cutting tool).

The standard should give the dimensions of D d with tolerances, since in the subsequent designing, other plants will produce threading die drawings which are not suitable for purposes of production on automatic lines.

Automating the production of unified automotive engine valves. Under conditions of ordinary, nonautomated production of automotive vehicles and tractors, no requirements are presented to unification of the dimensioning and to the specification of identical tolerances and requirements to the surface roughness for similar components (valves, pushrods, bushings, etc.). This is due to the fact that each of these plants produces a limited number of brands of automotive vehicles or tractors, their output is relatively not too great, and the production process and the equipment stock are set up at each plant individually, in accordance with local conditions. When the automotive vehicle or tractor components are mass produced at specialized plants on automatic lines (for delivery of components according to coordinated plans and in the form of spare parts), it becomes necessary to unify the technical requirements put to these components, since otherwise automatic production will become difficult and economically ineffective.

As an example, we consider below the unification of automotive

engine valves which are produced at a specialized plant using typical automatic lines.

Engine valves of the ZIL [Lenin Plant] and GAZ [State Automobile Plant] automobiles differed before unification. The new specialized plant was supposed to machine the valves on a single automatic line with minimal resetting. The surface finish of the valve disk before unification fluctuated from a rough surface obtained in the stamping process to ground (7th surface finish class) or even polished, and the surface finish of the working cone and stem varied between the 7th to the 9th class. The dimensioning methods differed, no provision was made for a surface on the reverse face of the disk needed for supporting the valve for machining on two-sided face grinding high-productivity machine tools, etc. All this has resulted in different production processes and varying composition of the equipment on lines.

The decisive factor in elaborating automatic lines is their typification, i.e. the feasibility of, for example, machining all automotive engine valves on a single line and also, with an insignificant change in the process of all tractor engine valves and, with addition of specific equipment, of all heat resistant valves with sodium cooling. This statement of the problem makes it possible to evolve new specialized automatic equipment, which in the case of series production, will be reliable in operation and not expensive to manufacture. Typical automatic lines set up for various components of the same type can be rapidly evolved from this equipment and typical transfer systems.

The above work was performed in 1961 by SKB-6 of the Moscow Municipal Sovnarkhoz, which is occupying itself by elaboration of automatic lines for components of bodies of revolution, together with the ZIL, GAZ and the State Committee for Automation and Machine Building. As a result of mutual agreement, technical requirements put to basic

parameters and characteristics of the valves, determining a single production process and composition of equipment, were unified. This has made it possible to elaborate typical high-productivity automatic lines which, with proper resetting, can be used for machining intake valves for the ZIL-130, GAZ-21D and GAZ-13 engines, or of discharge heat resistant valves with sodium cooling for the ZIL-130, GAZ-130M and other engines.

The valve stem remained nonunified. The valve of the GAZ-130M engine has a special groove for the block which is due to the use of these valves in engines of the old design. This has resulted in building into the typical line of special machine tools, serving only for machining the given groove in the stem of the given valve, namely, of rotary vertical six-spindle automatic lathes for cutting the groove and of centerless automatic grinding machines for grinding its surface. When the valve of the ZIL-130 engine is machined on this line, this equipment must be disconnected and special transfer facilities must be created for transfering the valves to the following operations, bypassing the groove machining operation. Branch normal standards for valve types are needed.

The existing standards for automotive engine valves do not provide for all the technical requirements necessary for producing the valves at specialized plants; in addition, they do not provide for unification. However, it is precisely unification of technical requirements which is a decisive factor. For example, the new drawings of ZIL and GAZ valves, proposed by SKB-6 retain their individual dimensions, but unify the following technical requirements (Fig. 9): roughness of surfaces, tolerances, hardening depth and the hardness of the stem face, specifications for chrome plating the rod, a flat surface of 2 mm on the internal face of the disk, etc. It is expedient to standardize these

requirements put to valves, upon considerations of regulating the further design of new engines, since in any individual case, unification of technical requirements takes up a long period of time and the elaboration of automatic lines is retarded.

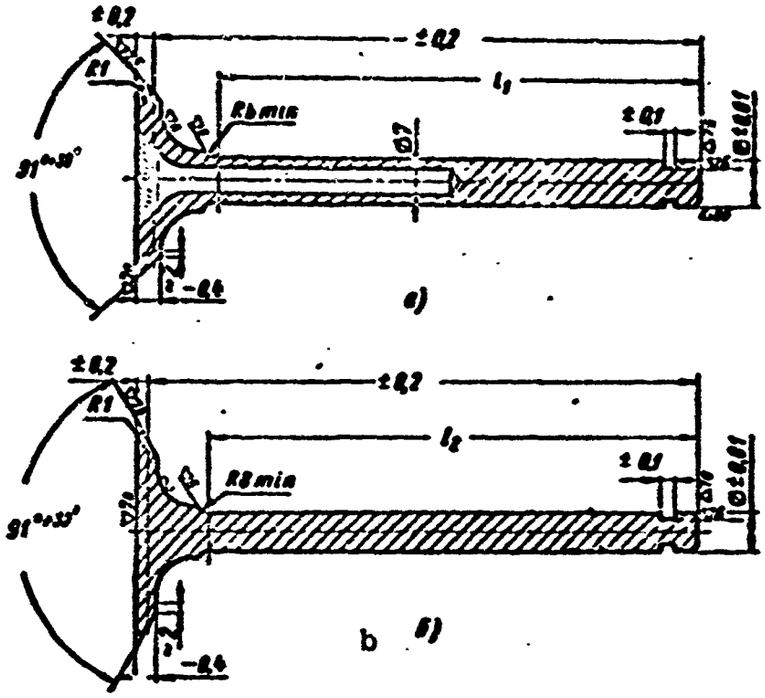


Fig. 9. Valves of ZIL and GAZ automotive engines. a) heat-resistant valves with sodium cooling; b) standard valves.

2. DEVELOPMENT OF PRODUCT SPECIALIZATION AND THE APPEARANCE OF A NEW VARIETY, i.e. ASSEMBLY SPECIALIZATION IN MACHINE BUILDING

The contemporary Soviet machine building is subdivided approximately into 60 branches and is characterized by the production of tens of thousands of different products. Each machine building branch encompasses a large number of plants, whose product specialization is complex and multifaceted. Their intrabranch and interbranch coordination relationships are varied and not always developed in a rational manner.

The existing specialization of machine building branches has evolved historically. Many of the plants produce goods for intrabranch

and interbranch utilization, i.e. assemblies, subassemblies and components of machines, various blanks, tools and production tooling equipment. Despite all this, the growth in the production volume of the branches of the national economy being served and the increase in the output of the corresponding machines and equipment is not in direct proportion. In some cases, priority is given to the output of such machines and products which reflect technological advances in the industry, for example, adaption of mechanization and automation and, in other cases, the lead is taken by those machines and equipment which, for a comparatively constant level of technology and production organization, ensure a considerable increase in the productivity of labor.

An opinion exists to the effect that the automation of production basically consists in the use of instruments, which follow the progress of the production process and which influence the machine controls, in a manner such as to make the participation of an operator unnecessary. This idea about the tasks and facilities of automation is onesided. The problems of automation are extensive and their solution requires the participation of a large variety of facilities, with different operational principles. Frequently, achieving automation requires the use of more advanced production processes or different designs of equipment, satisfying the pertinent problem of integrated automation. For example, transition from a discrete production process to a continuous one, the use of flow lines and concentration of operation at a single installation are major means of automation, which make it possible to achieve in a considerably simpler and effective manner.

In standardizing machines and equipment, we must keep in mind the fact that brisk advances in increasing productivity of labor can be achieved only by substantially changing the production process. And

this ilvolves continuous increases in the number of models and standard sizes of various machines and equipment delivered by machine building plants to all branches of the national economy, for the purpose of most complete development of productive forces.

How can this problem be related to the tasks of standardization. Two points of view prevail. According to one of them, standardization is called upon to comprehensively limit the type range of the machines and equipment produced, in order to ensure better conditions for product specialization by machine building plants. According to the second point of view, standardization should find such practical solutions which would simultaneously satisfy two conditions, namely: 1) best specialization of plants and 2) such a development of machine building, in which all branches of the national economy would be provided with all the necessary high-productivity equipment for complete mechanization and integrated automation of production.

Goals put forward by the new Program of the CPSU attest to the fact that the first point of view is outmoded, not corresponding to the contemporary problems of technological development. Standardization should be directed in such a manner that it could become an active means in the fight for unconditional fulfillment of the program for creating the material and technical base of Communism in the shortest time.

The necessity of all inclusive limiting of the type range of machines and equipment being produced is usually justified by the consideration that product specialization is effective only in those cases when the production at each plant is limited to only one standard size of a product. But this is not only impossible in all cases, but is also unnecessary. Is it advantageous to limit, for example, the Dmitrovsk Machine Tool Building plant to the manufacture of only one modification

of milling machines? Conversely, it is more desirable to develop the production by this plant of the entire design unified series of milling machines, constructed on the basic model, which is the actual case. In addition, specializing each plant for the production of only one standard size of a product would have required a tremendous number of plants and, even given all conditions, would not solve the main problem, i.e. of increasing the scales of production of all components. This increasing of the production scale should be primarily achieved by elaborating design unified series of machines, i.e. of equivalent second order standards.

Limiting the objects produced by each plant to a single standard size does not solve the problem of increasing the scale of production of components, because the contemporary high-productivity production processes require a very large output in order to fully utilize the capacity of automatic or flow line equipment and, in the majority of cases, this cannot be achieved at product specialized plants. As a result, it is necessary to organize, where this is possible, group machining and to resort to series production in the remaining cases.

The adaption of design unified series substantially increases the production scale of unified components with all the production engineering advantages which follow from thos. The output of many modifications of special purpose machines and equipment is ensured simultaneously.

Elaboration of design unified machine and equipment series, as was shown above, is at the present time one of the major tasks of machine building standardization. The common assemblies, subassemblies and components used in these series are the most desirable objects for general machine building and branch normalization.

The problem of the most complete saturation of the national economy by high-productivity specialized machines and equipment, which was

formulated above, can thus be successfully solved by standardization methods and by creating a system of assembly-producing plants which would supply their products to product specialized plants. The more completely will the assembly specialization be developed in machine building, the more effective will be the work of the entire machine building industry as a whole. This is the reason why it is important to pay serious attention to the new variety of specialization, i.e. assembly specialization.

We shall present several examples of production specialization being achieved in machine building, so as to show the role of assembly specialization.

Individual designing of tractors has resulted in weakly developed assembly and product specialization. During 1959-1965, the output of tractors will increase by a factor of 2.5. Solving this problem assists in specialization which can be achieved by creating a number of plants, serving for producing engines and other assemblies and mass produced tractor components, which is characterized by Table 64 [30].

TABLE 64.

Indicators of Specialization in Tractor Building

Агрегаты, узлы и детали 1	2 Увеличение выпуска	3 Снижение трудоемкости в %
	12	
Двигатели в сборе 4	в 6—8 раз	38
Водяные и масляные насосы 5	» 8—12 »	42—46
Топливные и масляные фильтры . . 6	» 12—15 »	35
Водяные радиаторы 7	» 8—12 »	40
Поршни 8	» 10—12 »	30
Гильзы цилиндров 9	» 10—20 »	42
Клапаны 10	» 20—30 »	35
Вкладыши 11	» 20—50 »	27

1) Assemblies, subassemblies and components; 2) increasing the output; 3) lowering the labor input in %; 4) assembled engines; 5) water and oil pumps; 6) fuel and oil filters; 7) water-cooled radiators; 8) pistons; 9) cylinder sleeves; 10) valves; 11) inserts; 12) by a factor of.

The removal from the operating tractor plants and assigning to specialized enterprises the production of a number of assemblies, subassemblies and components will make it possible to sharply curtain the nomenclature of components produced by strictly tractor [building] plants, which will make it possible to increase the output of tractors by a factor of 2.5-3, using the existing production areas. This will also be aided by limiting the type range of tractors being produced at each plant to several necessary modifications. In addition, it is planned to build three new tractor assemblying plants, which will assemble tractors produced in small series: cotton, beet, orchard-and-garden, etc. These plants will receive unified subassemblies and components.

The integrated type range of tractors, elaborated by the NATI, is characterized by the extensively achieved unification of assemblies, subassemblies and components, increasing the ratings of the tractors and lowering their metal consumption from 70-100 to 50-60 kg/HP. As a result of adapting the aforementioned dimensional series of tractors and achieving on its basis of production specialization, the output of goods increases more than 3-fold, the productivity of labor is increased by a factor of 4-4.5, the labor costs will be lowered by a factor of 2.5-3 and the net cost by approximately 40-45%. The initial capital expenditures will pay for themselves in 2-2.5 years [30].

The high economic indicators of the specialization in producing tractors, their assemblies, subassemblies and components involve the elaboration and adaption of a single dimensional series of tractors and achieving coordination of design and planning work.

In order to ensure the proposed output of tractors, it is necessary to create 17 assembly-producing plants for the manufacture of: engines; hydraulic distributors, hydraulic cylinders, compressors, jacks

soil detainers; wheels, radiators, starting motors, fuel apparatus, water pumps with ventilators, oil pumps, gear pumps, fuel filters, air purifiers, turbocompressors. In addition, it is necessary to build or reorganize seven product specialized plants for mass producing tractor engine components: cylinder sleeves, pistons, piston rings, piston pins, valves, pushrods and liners. Interbranch coordination should extend to industrial rubber goods, castings, forgings, fastening components, standard tools, gaskets springs and electrical equipment [30].

The above shows that assembly specialized plants are organized as branch plants, but this is only the beginning. Actually, they will begin to serve several machine building branches, supplying interchangeable assemblies to product specialized plants, producing self-propelled agricultural machines, peat equipment, construction and other specialized purpose machines.

The wider the achieved normalization, the faster and more extensively will the relationships between assembly-producing plants develop.

Assembly specialization in the automobile industry develops in an analogous manner. In the initial period, the assembly specialized plants are branches of the basic plants, but the assembly specialization process will inevitably result in more extensive coordination relationships. And this will also influence the development of the type range of special purpose automotive vehicles.

Small series production is characteristic for special machine tool building. Here, the delivery time for automated equipment and its cost are very high. The creation of an average special machine tool requires 2-3 years and a heavy machine takes 4 years. They cost 10-15 times more than a general purpose machine tool.

Small series machine building with its characteristic extensive

nomenclature and frequent change of objects of production must still resort to the use of general purpose equipment. Under these conditions, a large economic effect is given by specialized knockup-knock-down machine tools, assembled from normalized subassemblies. When tooling up for the output of new products, this equipment can be partially or completely disassembled and its subassemblies can be used for assemblying other specialized equipment.

It has become necessary to make a new approach to the aggregation of designs of metal-cutting machines, welding, riveting, blank stamping, casting and other equipment. Extensive standardization of assemblies and normalization of subassemblies and components of plant equipment is necessary. Certain branches of the domestic small series machine buildings have successfully solved this problem. Specialized machine tools and automatic lines of convertible design, assembled from normalized beds, cables, brackets, power heads, control assemblies and automation facilities have been created.

Normalization must embrace up to 80-90% of the total number of assemblies and subassemblies being used, including programmed control units. Specialized adjustable equipment can be efficiently provided with work, even when different machines are being produced in moderate numbers. The feasibility appears of concentrating the production of standard assemblies and normalized subassemblies of equipment at specialized plants. Medium size and large machine building plants are provided with an opportunity to design by themselves and rapidly assemble for their own purposes, automatic machine tools and lines from a line of ready-made assemblies and subassemblies. The time needed for tooling up for production is cut by a factor of 8-10 [31].

It is required to briefly characterize the ways for developing specialization in other machine building branches, in order to better

clarify the role of standardization in all its manifestations in the task of developing specialization and automation of production. For example, the peat machine building has its peculiarities. At the present time, the plants of this branch produce about 100 standard sizes of equipment for the mechanization of extraction, drying, loading and carting away of peat and also of machines for preparation and exploitation of peat fields. In particular, large machines were elaborated for completely mechanizing the extraction of shreded and block peat, for which a large number of tractor and automotive assemblies, subassemblies and components is used.

This shows that the assembly producing plants created for serving the basic plants of the tractor and automotive industry should definitely also supply their products to peat machine building plants, road construction equipment plants and other machine building branches. Thus, a large, new machine building branch with extensive relationships is being organized.

Plants are specialized, not only in the branch but also in the territorial respect, which is illustrated graphically by the practice of the Union Republics. For example, machine building has now become a leading branch in the economy of the Uzbek SSR. More than 50 plants produce agricultural machines, production equipment, road construction machines, electrical equipment, etc. However, the output of these plants cannot satisfy the need in equipment needed for the integrated development of this republic and of other cotton growing regions of the Soviet Union. As a result, a large number of excavators, transformers, equipment for the food and other branches of industry are being brought in into Uzbekistan. Specialization and locating of machine building plants in each Central Asia republic are now achieved, according to a single plan for the entire Central Asia economic and geogra-

phic region [32].

Each machine building branch serving the economy of Central Asia republics is expanded by taking into account the evolved specialization of the existing plants. Here, the machine building plants with all-union specialization are developed in a manner such that will enable them to completely satisfy all the needs of the Central Asia republics. Under these conditions, the remaining important problem is concentrating the production of similar items and eliminating duplication in the production of machine components and of articles used in large quantities. Refinement of the specialization of plants involves their reorganization and expansion. For example, the Tashkent tractor assemblying plant specializes in the production of self-propelled chassis for a system of [tractor] mounted agricultural machines.

This plant will receive the unified tractor assemblies from corresponding specialized assembly-producing plants, which were mentioned before. Production of rice sowing machines, large excavators, irrigation equipment, etc., will be organized at other plants [32].

The results of specialization can be defined by a system of indicators or measuring scales. They can be used for estimating the planned and achieved state of specialization at individual plants and also to determine the volume of its further development. The level of specialized production can be expressed by a numerical index smaller than or equal to unity. This index is a sum of several components. Each of them is defined as a function of previously chosen indicators, characterizing the nomenclature of products being manufactured, the level of the production engineering, the state of the organization of production, etc. General indicators are: 1) the specific weight of the profiled products, characterizing the ratio of the cost of the products conforming with the plan according to which the given plant was orga-

nized to the total gross output; 2) the number of product groups of the same type.

Characteristic indicators for the product and assembly specialized production units will be: the specific weight of all manual operations and the specific weight of coordinated deliveries which determine the ratio of the volume of all externally supplied goods to the entire gross output; for component specialized plants, these will be: the specific weight of specialized equipment, including special and gang machine tools, automatic and semiautomatic machine tools, for production units specialized with respect to the production process, these indicators will be: the specific weight of manual operations and the specific weight of series production, characterizing the ratio of the labor input going into the output of goods produced in large series and on a mass scale, to the total gross output.

Indicators characteristic of individual machine building branches are: 1) the specific weight of all manual operations; 2) the specific weight of production concentration, determining the ratio of the volume of products produced by the plants of the given branch to the total volume of this kind of products produced in the given economic region; 3) the specific weight of centralized production, which is a ratio of the cost of articles produced by the plants of the branch for centralized deliveries to the total gross output of the given branch.

Achievement of specialization is in the final count directed toward increasing the volume of production by improving the productivity of labor. Each of the original indicators which make up the integrated concept of specialization level influences the productivity of labor. But the degree of this influence differs. For example, curtailing the nomenclature of articles of the same production engineering types being produced, can increase the productivity of labor by 25-50% and that

achieved by automating the production can be as high as 300-400% and more [33].

3. THE ROLE OF STANDARDIZATION IN AUTOMATING THE PRODUCTION MANAGEMENT

The adaption of automation in the field of production management at plants, is characterized by the fact that it necessitates large-scale standardization of the designation systems and normalization of conversion codes, without which it is impossible to adapt modern computer equipment. It is also necessary to develop standardization of the basic parameters of analog computers and other equipment used for mechanizing and automating managerial work and also normalization of assemblies, subassemblies and components of these machines and equipment. Without standardization and normalization, it is impossible to organize large series production of equipment on the basis of extensive coordination.

The extent to which this equipment is varied was shown by the subject field exposition* of modern technological facilities for organizing and mechanizing of mental work. The exhibits included series produced articles, numerous experimental specimens and models of new types of equipment, from office furniture to domestically produced electronic computers. Predominant attention was paid to the exhibit of an integrated group of mechanization and automation facilities for operational production management.

Mechanization and automation of managerial work on the basis of adaption of modern computer equipment requires performing a number of complex and labor consuming operations for the elaboration of standards and normal standards with ciphered codes of numerous reference and grouping features and also modifying the existing form of documentation and their standardization.

Adaption of modern computer equipment by machine building plan-

design and research organizations is made difficult by the absence of uniform all-union systems of numerical designations. The coding adapted, for example, by the "Kalibr" plant for tools and instrument is not mandatory for the ordering plants. This makes it necessary to encode and decode the entire incoming and outgoing documentation at the plant, which lowers the effectiveness of the utilization of computers. The same situation has been created in the case of designations of components and subassemblies by normal standards of branch institutes which include 12-15 sings, among which are Roman numerals and letter symbols.

It is necessary to standardize uniform numerical code systems, obligatory for all enterprises, production planning, design and other organizations. They should include codes of component, subassembly and product drawings, classifications and designations of equipment, codes of the worker's professions and designations of brands and profiles of all kinds of materials.

The "Kalibr" plant has issued a plant normal standard for replacing written requisition slips by numerical designations. This has required thorough preparation of primary technical documentation for recording on punch cards of all the original data, including labor expenses, calculations of the work time put in, work assignment to equipment, the number of components needed per program, etc. As this information is accumulated, sets of punch cards are formed which are used periodically in calculations. Systematization of requests for tools issued at the plant by their kinds and standard sizes (more than 100,000 items) requires labor consuming computational work. When done manually, this would have required the performance of over 1 million technical accounting operations.

A great effect can be obtained by the use of computer equipment

for engineering calculations. For example, one of USA plants uses an analog computer for elaborating within 3-6 minutes of transformer designs, including the issuance of all data including the amount of materials needed and also data about cooling, housing configuration, etc., according to a specified standardized system.

4. POSSIBLE VERSIONS OF ACHIEVING COMPONENT SPECIALIZATION AND THE ROLE OF NORMALIZATION

Component specialization is very extensively used in the world practice because it makes it possible to concentrate the production of components of the same type in large numbers and, due to this, to achieve integrated mechanization and automation of production processes. Most desirable is such component specialization which makes it possible to create an automatic plant producing components of the same type, for example, valves, pushrods, inserts, piston rings, etc., but this is not always possible.

The effectiveness of component specialization is determined by increasing the productivity of labor and lowering the net cost of products. Of tremendous significance, is saving of metal and this problem should be discussed first.

The cost of raw and processed materials by the entire machine building industry comprises 2/3 of the total production costs. The specific weight of metal costs is highest in the tractor, agricultural and transportation machine building. These are the high metal consuming machine building branches. In the machine tool building and instrument industry and also in heavy machine building, this indicator is considerably lower, since here the products are manufactured in smaller series and the specific weight of labor costs is higher - these are high labor input machine building branches.

Lowering the metal consumption by 1% in the entire machine build-

ing industry lowers the net cost of products by 0.3-0.4%. On a country-wide scale, this results in tremendous savings. Efficient utilization of metal promotes increasing the production capabilities of machine building plants. Comparison of the absolute and relative weights of machines and subassemblies of the same type manufactured at different plants shows that they frequently differ by 10-20% and more. The coefficient of serviceable output in automobile manufacture is 0.53-0.7, in metal cutting machine manufacture it is 0.4-0.5 and in the production of chemical apparatus it is 0.67-0.68. This shows that 30-40% and sometimes even 50% of metal is wasted in chips.

By concentrating and automating production at specialized plants, it becomes possible to use the most convenient methods for obtaining blanks, with shapes and dimensions maximally close to the shape of finished components. But this requires performing thorough standardization with the purpose of establishing rational series of components. The advantages of this can be shown through an example of fastening components.

The production of fastening components in the USSR in 1958 has comprised, according to [34], 538,000 tons, with the specialized plants producing 44% of large and 34% of the small components. In the USA, 85% of fastening components were produced at specialized plants in 1957. At the present time, 2350 USSR enterprises are engaged in the production of fastening components, but only several tens of them are specialized. The majority of the remaining enterprises are characterized by their outdated technology, insufficient use of cold upsetting. The annual output of one enterprise varies between 1000 and 32,000 tons and the net cost of 1 ton of components with a diameter over 6 mm fluctuates correspondingly from 3000 to 280 rubles [34]. The net cost of components with diameters less that 6 mm is in individual cases as high

as 12,000 rubles. The metal consumption per 1 ton of finished components goes as high as 3 tons; only 20 to 40% of the equipment capacity is utilized. As a result, the total losses to the national economy, according to [34], have comprised several hundred millions of rubles in 1958.

It is planned to bring up to 108.5 tons per year the aberage output per one worker at the new specialized plants and the production output per 1 meter^2 of area called for is 4.27 tons per year. The metal consumption will be be cut to 1.1 tons per 1 ton of products. But this has required a revision, in 1962, of the existing standards for fastening components.

The future need for fastening components in the Soviet Union has been calculated in Reference [34] by analogy with their production in the USA, taking into account the indicators of output per inhabitant of the specific metal consumption, of the average annual rates of production expansion and of increasing the quality of fastening components by the use of stronger materials. The expected lowering of the weight of fastening components in 1960-1975 can, on the average, comprise about 20%. Taking these considerations into account, the needs of the machine building industry of the USSR for 1975 are estimated, according to [34], as 1,650,000 tons.

The geographic distribution of production units depends on the cost of transporting the components to the points of consumption. The maximum possible increase in the distance increases the net cost of transportation by 78 rubles per ton. The saving, given by specialization even in this most unfavorable case, will comprise 347 rubles per each ton of fastening components.

Achievement of the technological progress and production specialization plan for the production of fastening components in the USSR

during 1959-1965 will result in a more than two-fold increase in the output of fastening components. The production of these products at specialized plants will increase to 78.3%. The contemplated specialization plan will require over 70 millions of rubles of capital expenditures during 1960-1965 [34].

The expediency of achieving at a large scale specialization and automation of the production of standardized and normalized tools and other production tooling equipment can be characterized by the following basic indicator. The existing costs of tools and other tooling equipment in the machine building industry comprise 6-8% of the total shop expenditures. The total outlays for production tooling equipment in 1958 has reached 1130 million rubles and the expenditures at the present time are even higher.

Since the fabrication quality and technical perfection of production tooling equipment determine the level of the production culture in machine building and directly influence the productivity of labor of a multimillion army of machine building workers, standardization and normalization of production tooling equipment is of tremendous importance to the national economy.

As a result of extensive normalization of production tooling, the designing expenses are decreased by 25-30%, the cycle of tooling up for new production at machine building plants is cut by a factor of 2-3 and when production is centralized, it lowers its net cost by not less than a factor of 2.

Great promises for specialization and automation of production exist also in the radio equipment industry, which unites over 40 different kinds of production. The extensiveness of their nomenclature is characterized by over 6000 designations of products; here, the majority of enterprises combine series production with small series pro-

duction. The continuous and rapid growth of the nomenclature of products is considerably ahead of the number of plants, which additionally increases the extent of the nomenclature.

The state of specialization and the development of automation of production depend entirely on achieving unification and normalization work. This work has created the prerequisite conditions for the first automatic lines producing electrical vacuum devices, electrolitic condensers and other radio components and also for automation of individual production operations; however, integrated automation was not always achieved due to the lack of certain kinds of special equipment. This shows that unification and normalization create the prerequisite conditions for automation and ensure the necessary conditions for the appearance of new kinds of automated high-productivity special equipment. More than 2000 types of this equipment was elaborated during the last few years. Their adaption has made it possible to decrease the number of inspectors by 13.5% and to lower the losses due to rejects by 25%, the productivity of labor was, on the average, increased by 20% and, in individual cases, even by 270%. The labor input of certain operations decreased by a factor of 4. However, the automation scales for the entire radio equipment industry as a whole are not entirely sufficient.

The basic trend of work in this branch of industry is normalization, performed on an extensive scale and elaboration of a production organization system which would have made possible, despite the extensive nomenclature of the normalized articles being produced, to achieve integrated mechanization and automation of the processes for the manufacture of: a) receiving tubes, including low power amplifiers; b) radio resistors and condensers, etc; c) incandescent and fluorescent lamps; d) variable condenser units, dynamic loudspeakers, multi-way

switches, various transformers, etc.; e) radio receivers and television sets.

Integrated mechanization and automation based on extensive normalization ensure the adapting into production of progressive production processes and the freeing of about 50,000 persons, which will be utilized at other positions requiring higher skills. As an example, we can point to the Moscow television plant, which is achieving with success an integrated automation plan, as a result of which the output of television sets is increased by a factor of 3 using the existing production areas. Here, the labor time going into production is lowered by a factor of 2.

However, practice tells us that, as a result of insufficient development of standardization and normalization, it is by far not always possible to create plants with narrow product specialization, the output of which would be limited to several standard dimensions of a single component.

The following versions of plant specialization can be suggested.

The first version. Automatic plants, producing in large quantities various types and dimensions of components of the same designation. The output of each type of components should correspond to employing the full capacity of one or several automatic lines, which can be rapidly reset to produce components of the given type but with different dimensions.

The second version. It is the same as the first, except for the addition of a shop for producing medium and small series of analogous components to fulfill single [nonrecurrent] moderate orders. This shop is equipped by flow lines with group machining methods; in addition, the plant should have general purpose equipment for fulfilling single orders.

The third version. Plants for mass and large series production of components similar in design and production engineering. These plants are equipped by flow lines with group machining methods and should have general purpose equipment for fulfilling single orders.

The fourth version. Plants for series production of components differing by their design features, but similar in production engineering. These plants should be equipped by flow lines with group machining methods and should have general purpose equipment. Figure 10 shows 17 groups of these components and Fig. 11 shows 8 groups, but other combinations of components similar in production engineering are also possible.

The first version is the highest form of specialization, but not the limiting form, since it is possible to have automated plants producing only one standard dimension of a certain component. The fourth version is characterized by the fact that here is achieved the initial stage of component specialization with great perspectives for future development by separating out the production of one or another component to individual enterprises. The second and third versions are characteristic of intermediate specialization. All the four versions are stages in the process of gradual development of component specialization based on standardization and normalization.

These ways for creating specialized plants producing machine components are verified by the following practical examples.

According to the first version. A completely automated plant of automotive engine valves producing valves for various automotive engines and automated plants of piston rings, cylinder sleeves and other components were created in the Soviet Union.

According to the second version. Automated shops and also shops for small series production, ensuring the output of large-size and

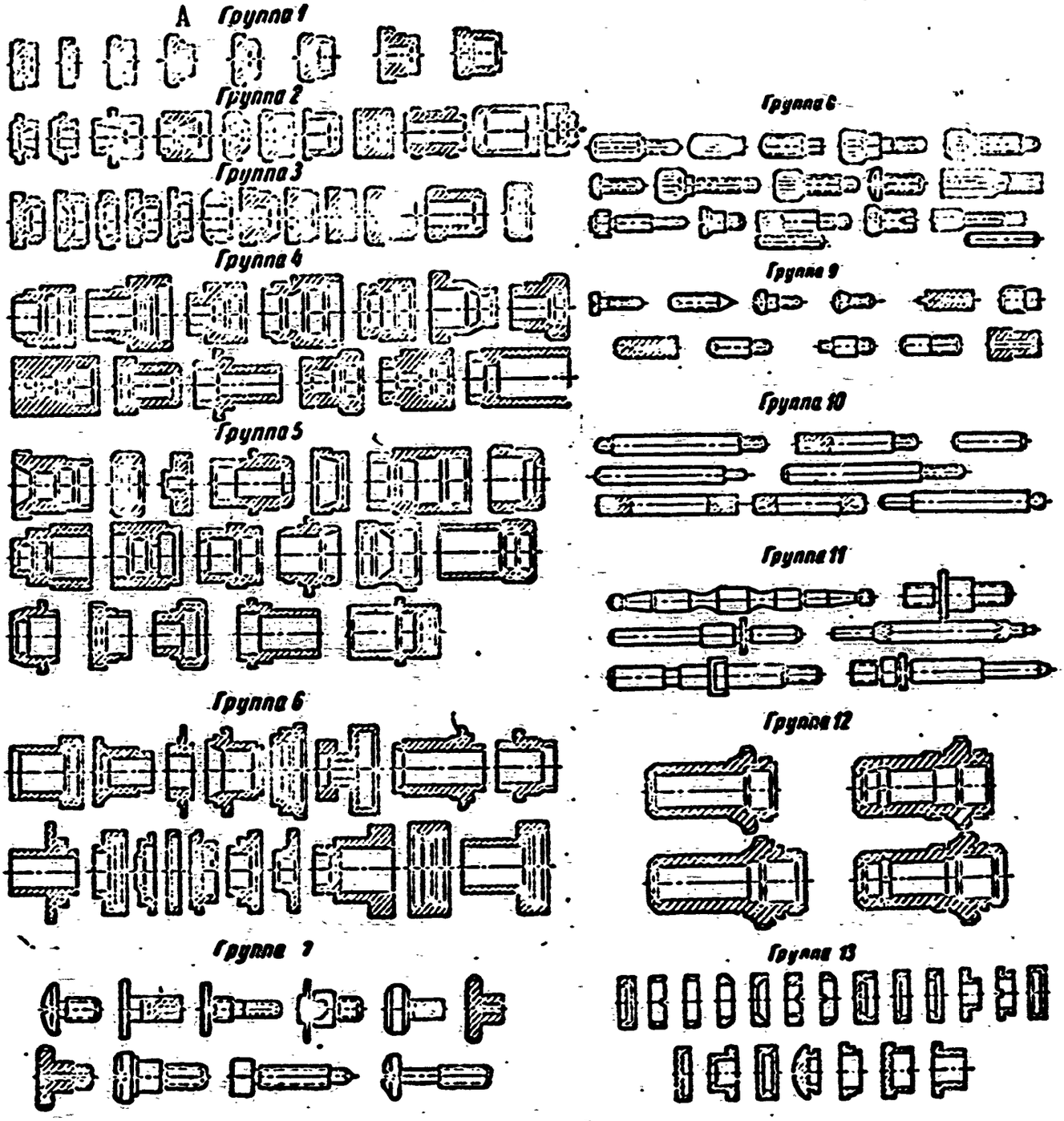


Fig. 10.

(continued)

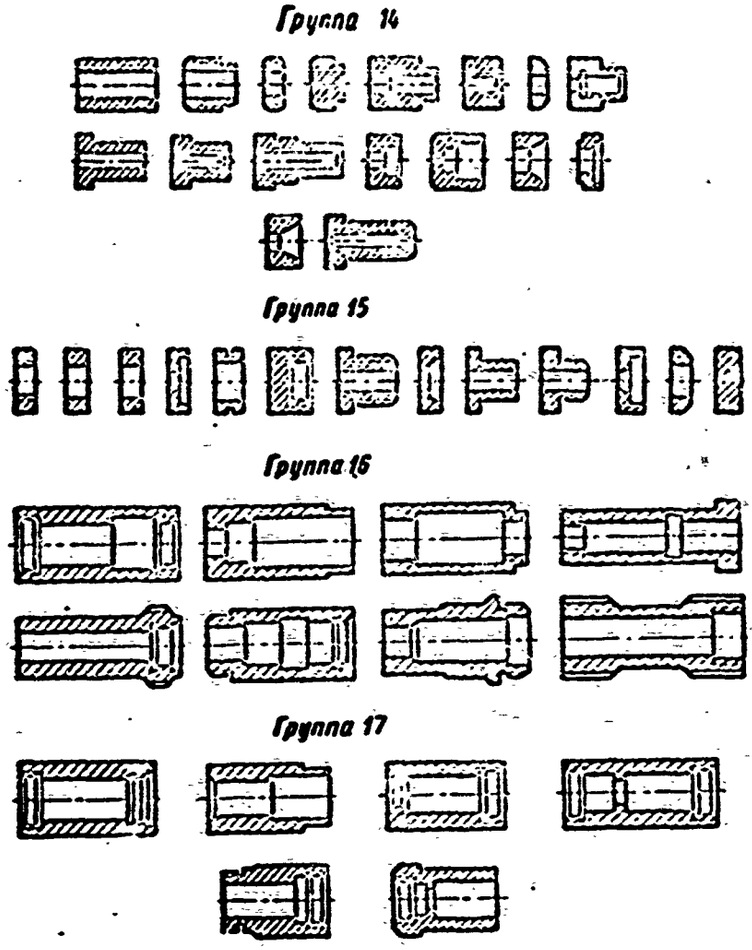


Fig. 10. Groups of components differing in design but similar in production engineering. A) Group.

miniature bearings, even in single units, were organized at bearing plants.

According to the third version. Plants were created for the mass production of automotive and tractor components and spare parts. These plants employ automatic and flow lines and also use ordinary general purpose equipment. Plants with this kind of specialization are gradually converted into enterprises specializing according to the second or first versions.

According to the fourth version. Several plants are in operation with series production of tractor components, including spare parts, with variable run lengths. These plants are of regional significance

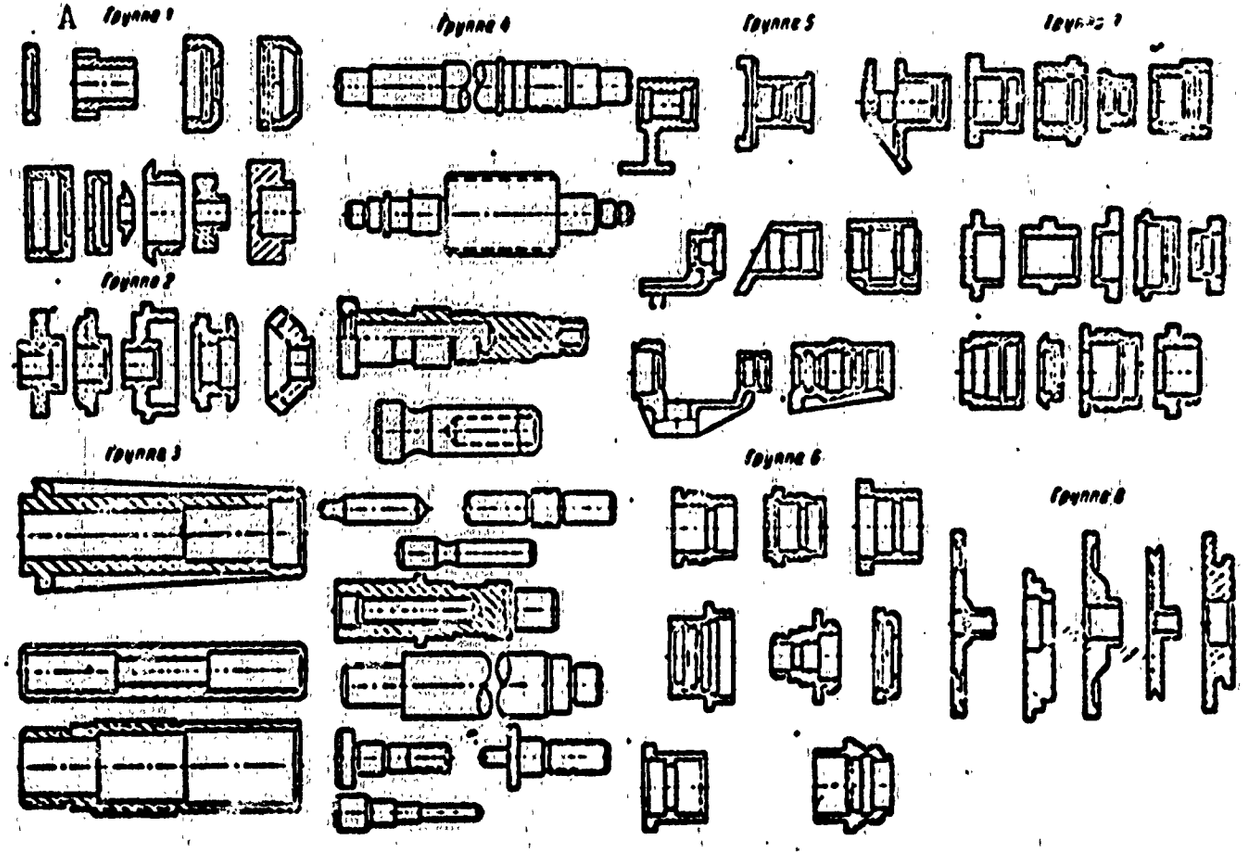


Fig. 11. Groups of components differing in design, but similar in production engineering. A) Group.

and gradually limit the nomenclature of components they produce by assigning the production of individual component nomenclatures to plants with a narrower specialization.

The economic advantage accruing from organizing component specialized plants according to the fourth version is determined by the fact that considerable increase in the scale of component production based on extensive normalization can be achieved at them and this makes it possible to use more progressive production processes. Increasing the production run length influences the labor input required for production of components and, according to the VNIIStroymash, enterprises properly equipped can then achieve very substantial lowering of the labor input required, (see Table 65).

TABLE 65.

Dependence of the Labor Input Decrease on Increasing the Production Run Length.

Коэффициент увеличения серийности производства A	1	2	3	4	5	6	8	10	15	20	30
Снижение трудоемкости B в %	0	15	20	25	30	33	35	37	42	47	50

A) Coefficient of production run length increase; B) lowering the labor input in %.

The run length in component production can be easily increased by a factor of 2-4 by employing normalization. Further enlargement of the component output can, in the majority of cases, be achieved by centralization of orders. Using the fourth specialization version, it is fully possible to achieve a more significant increase in the component production run length, for example, by a factor of 5 and this lowers the labor input by approximately 30%.

A question frequently raised is: where are the limits of the economic effectiveness of normalization and where the effectiveness begins

to be determined by centralization of orders at specialized plants?

The above information about the dependence of the labor input decrease on increasing the production run length makes it possible to answer this question. Adapting normal standards by series production plants and corresponding planning for producing the normalized components "for stockpiling", and not in accordance with individual orders, can result in increasing their output by a factor of 3-4. This is the indicator which should be used at the present time as a boundary between increasing the production scale achieved by normalization, since any further increase in the run length in producing normalized components involves centralization of orders and specialization of production.

Organization of all the above four versions of component specialized plants is justified from the practical point of view, is fully expedient and, for this reason, can be recommended for revision of specialization plans with the further progress in developing general machine building and branch normalization. It should be noted that the prevalent practice at the present time calls for submitting gosplan [state plan] proposals only, pertaining to problems of specializing the production of individual components according to the machine building normal standards being approved; this does not promote rapid solution of the problem of developing component specialization on a large scale. Taking this into account, renewed attention should be paid to the advantages of creating regional or zone component specialized plants, producing components similar in production engineering, but differing in design. These well equipped plants can also fulfill orders for spare parts for plant equipment, finally relieving enterprises from inefficient and not always skilful production of spare parts. For this purpose, plants of the fourth specialization version can have

small series production shops. By the character of production activities, these plants are close to plants specialized by the production engineering aspect.

5. THE SIGNIFICANCE OF STANDARDIZATION IN DEVELOPING SPECIALIZATION BY THE PRODUCTION ENGINEERING ASPECT

Castings, forgings and hot stampings comprise more than 55% of the total weight of all machines being produced. At the present time, the development of certain machine building branches is retarded by insufficient capacity for production of castings and other blanks. This is due to the fact that our country still has a very small number of specialized regional plants, which produce castings, forgings and stampings.

It has been proven that increasing the production volume lowers the average net cost of 1 ton of iron and steel castings several fold. From the point of view of economics, it is most expedient to produce more than 20,000 tons of castings per year, in connection with which the Moscow Municipal Sovnarkhoz has closed down 60 small casting shops. The Leningrad Sovnarkhoz is also in the process of consolidating its casting production by initial organization of 14 centralized casting shops. This problem is solved similarly also at other sovnarkhozes.

It is contemplated to organize, in the next few years, 77 new large specialized plants and shops for the production of steel and iron castings, 9 specialized plants for production of forgings and 25 shops specializing in hot stamping of mass produced components. Automatic lines for casting mass consumption components are being created. Plants such as the "Stankolit" in Moscox, producing up to 10,000 different designations of castings per year in series of varying run length, at which the flow lines are organized not by component types, but by production engineering features, have justified themselves.

A new machine building branch for production of blanks is being created and it already puts forward its requirements to standardization and normalization. What are these requirements?

Primarily they include the establishment of requirements with respect to different kinds of production, to the precision of blank fabrication and to the size of machining allowances. Of great significance is regulation of material brands used in the fabrication of blanks and of technical specifications for accepting of the output of plants specialized by the production engineering aspect. The fact that these problems are of general machine building significance requires that they be made subjects of state standards.

What then is suitable for normalization? Stimulating the adaption of such production processes which will make the blanks closest in shape and size to the finished components. At the present time, normalization in this direction is very little developed. Of great significance is unification of the dimensions of forged blanks for the purpose of using them in producing different components. Two problems are being faced by standardization: 1) to maximally limit the machining allowances of specific blanks and 2) to increase the production scale of certain blanks in order to be able to produce several standard dimensions of components from a single blank, which makes it possible, for example, to replace forging by hot stamping. Normalization is called upon to find optimal solution in such cases [7].

The above shows that by ensuring the proper interrelationship between standardization, specialization and automation, it is possible to effectively solve all those problems which, at the present time, must be resolved by many machine building and instrument making branches.

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431 Took place in Moscow in 1960.

Chapter 14

THE TECHNICAL AND ECONOMIC EFFECTIVENESS OF STANDARDIZATION

The technical and economic significance of standardization and normalization was during a number of years estimated by the effectiveness of individual standards and normal standards. However, this evaluation has a considerable number of gaps, which are frequently due to the absence of methodological directions, the use of which would have made it possible to rapidly and with sufficient accuracy, estimate the effectiveness of any standards and normal standards. But even if this methodology is available the problem of the advantages accruing to our economy by the use of standardization remains open.

1. THE EXISTING METHODOLOGIES FOR DETERMINING THE EFFECTIVENESS OF STANDARDS AND NORMAL STANDARDS

Authors of a number of works devoted to the problem of effectiveness of individual standards and normal standards recommend that their economic substantiated be performed in two stages.

The substantiation at the first stage is approximate in character and has, as its purpose, to prove the expedience of including the suggested topic in the standardization or normalization plan. Its goal consists in preventing noneffective expenditures for the elaboration of standards and normal standards, either ineffective or of little interest. This approach to the choice of standardization topics and objects has its advantages and disadvantages. The advantages include the fact that attention is called to economic problems and the disadvantages

consist in the haphazardness of this kind of standardization, since individual very actual problems, for which it is difficult to immediately find economic criteria, can be found to be outside to the scope of consideration of standardization organs.

The refined economic substantiation, performed at the second stage, has as its purpose to prove the expedience of the standard* proposal which was elaborated and of the proposed plan for its adaption, including also specialization of enterprises.

Proper calculation of the effectiveness of standardization presents certain practical difficulties. An estimate of the economic effect on the lower side is undesirable, because it lowers the role and significance of standardization as an economic factor. An estimate on the higher side creates doubts about its credibility, which has a destructive effect on the entire development and utilization of standardization, since it creates mistrust, which is very difficult to fight.

The technical and economic substantiation of any standardization measure must, first of all, be convincing. It should be taken into account that the adaption of the standard may cause increased expenditures at one adaption stage, but may create the prerequisite conditions for obtaining savings at another stage, as a result of which the economic effect is determined as the difference between the total savings and the individual expenditures.

The economic effectiveness of standards is not a stable quantity; it can increase and decrease depending on the conditions and scales of utilization. Many different formulas were proposed for determining the economic effectiveness of standards; however, they differ very little from one another in principle. Thus, for example, V.S. Churin proposed a formula of economic effectiveness of any norm which, in a form more convenient for practical use in standardization work, can be represented

in the following manner:

$$Э_0 = (\Phi_1 + \Phi_2 + \Phi_3) - P_0 = (Э_1 - P_1) + (Э_2 - P_2) + (Э_3 - P_3) - P_0$$

where $Э_0$ is the total average annual effectiveness of adapting the standard; Φ_1 is the same as above pertaining to adapting it to design; Φ_2 is the same as above pertaining to adapting it to production; Φ_3 is the same as above pertaining to adapting it to operation; P_0 are nonrecurrent expenditures for elaboration of the standard (normal standard); $Э_1$ is the annual saving obtained by adapting it to design; $Э_2$ is the same as above pertaining to adapting it to production; $Э_3$ is the same as above pertaining to adapting it to operation; P_1 are individual nonrecurrent expenditures incurred in adapting the standard (normal standard) to design; P_2 is the same as above pertaining to production; P_3 is the same as above pertaining to operation.

This formula can be used to determine both the approximate and actual effectiveness of a standard. In the first case, the calculations are based on assumed data and, in the second case, on recorded data.

Nonrecurrent expenses for elaboration of the standard P_0 are composed of the cost of its elaboration, consent conferences, publication and distribution and also of costs of the elaboration, reproduction and sending of working drawings and other technical documentation pertaining to the adaption of the given stard. Expenditures P_0 include the outlays for:

a) preliminary technical and economic substantiation and proof of the expedience of elaborating the standard;

b) selection, systematization, study and correlation of original materials needed for the elaboration of the standard, including foreign materials;

c) compilation, agreement and approval of the technical assignment

for elaborating the standard;

d) conduct of the necessary experimental work;

e) elaboration of working drawings and other technical documentation, including that pertaining to the methodology for testing the head [series] specimen of the product being standardized;

f) elaboration, agreement and approval of the standard proposal, including the cost of technical experts conferences and sessions of the technical council, etc.;

g) the production and testing of the head specimen of the product being standardized;

h) technical and economic substantiation, including the cost of elaboration of the adaption plan and calculations of the technical and economic effectiveness;

i) elaboration of working drawings and other technical documentation for all standard dimensions of products according to the given standard;

j) publication of the standard, reproduction of working drawings and other technical documentation;

k) transportation expenses and postage costs related to sending out the standard proposals for comments, etc.

The annual average saving obtained by adapting the standard into designing $З_1$ is comprised of the following elements:

a) decreasing the volume, labor input, cost and time required for performing planning and design work in all organizations, using the given standard, due to the feasibility of secondary utilization of previously issued working drawings and other technical documentation for the main and auxiliary production;

b) lowering the labor input going into the execution of various installation schemes as a result of the created feasibility of using

standard conventional graphic presentations and designations;

c) relieving the designers from the need of secondary issuance of technical documentation, which makes it possible to utilize them for creative work in the elaboration of new designs;

d) decreasing the consumption of materials (in this case of drawing, photographic and other paper, etc.) and the volume of copying work, decreasing the area of record keeping premises, blueprinting shops, etc., due to decreasing the number of drawings and other technical documentation;

e) decreasing the expenditures for revising drawings and other technical documentation by virtue of the general increase in their stability brought about by standardization;

f) cutting the time required for agreeing upon and approval of newly issued drawings, technical specifications, acceptance rules, etc.;

g) eliminating the necessary of repeated calculations for corresponding planning and design work.

Individual nonrecurrent costs of adapting the standard to design P_1 include the expenditures for:

a) obtaining standards, normal standards and other norm setting documents, working drawings, technical specifications, etc.; had they not been obtained without cost from the corresponding design organization;

b) the elaboration, agreeing upon and issuance of local limitations of the standard, taking into account the production peculiarities;

c) familiarizing the designers and workers of the quality control department with the new standard, the conditions under which it should be used, working drawings, technical specifications, etc.;

d) correcting the drawings and other technical documentation, in order to bring them into conformance with the standard being adapted

and also drawing up and issuance of notifications about introduction of modifications into technical documentation and other expenditures related to the adaption of the standard into designing.

The average annual saving afforded by adapting the standard to production $З_2$ is formed by:

a) organizing specialized or centralized production according to the new standard;

b) decreasing the volume, labor input, cost and time required for tooling up for production of the given kind of articles;

c) decreasing the nomenclature of materials purchased by each plant, which lowers hauling and warehouse expenses, simplifies the issuance of orders for materials, semifinished products, subassemblies and components being used, facilitates accounting and planning, frees warehouse and storeroom areas and decreases the need for operating capital;

d) decreasing the nomenclature of the required production tooling equipment, which facilitates and accelerates tooling up for new production and ensures more equivalent utilization of the production tooling and also decreases the amount of area needed for its storage;

e) decreasing the expenditures for purchase or manufacture of second order tools;

f) the use of more progressive material kinds with the purpose of lowering the net cost of the product and its weight;

g) adaption of more progressive form of production organization and specialization, which aid in automation of production processes, accelerating the production cycle, lowering overhead expenses and increasing the productivity of labor;

h) adapting of more progressive production processes for large series and also for mass production;

i) improving the utilization of equipment and increasing the yield of production from 1 meter^2 of production area;

j) adaption of interchangeability and elimination of manual adjustments on assembly;

k) use of active inspection methods and the lowering of the percentage of defectives, which results from it;

l) decreasing the time required for assimilation of new types of products by using typical production engineering documentation.

Individual nonrecurrent costs of adapting the standard to production P_2 are composed of expenditures for:

a) organization or reorganization of production at specialized plants, including the costs of their reequipment, planning and fabrication of production tooling;

b) for adjusting the equipment, training and preparation of personnel and other expenditures related to assimilation of new products.

The average annual saving accruing from adapting the standard to operation $З_3$ is achieved by:

a) lowering the operational costs by improving the quality of products and prolonging their service lives;

b) lowering the operational costs (of fuel, lubricants, etc.) by increasing the efficiency of the machines;

c) decreasing the expenditures for training or preparation of service personnel, by aggregation of machines and by their more extensive use in the given branch of the national economy;

d) lowering the cost of purchase and storing of spare parts;

e) the feasibility of achieving assembly replacement repairing of machines (by the use of replacement interchangeable subassemblies and components).

Individual nonrecurrent expenditures of adapting the standard to

to operation depend on:

a) the cost of training or retraining of operating personnel;

b) the cost of dismantling of equipment being replacement by the new equipment necessary for the adaption of the standardized products.

However, we must consider the fact that the more complex are the products being standardized, the wider range of questions which is being embraced by the standard, especially by a parametric standard, the more complex the determination of the technical and economic effectiveness becomes. With respect to these standards and certain normal standards, the adaption conditions of which involve the performance of large organizational and technical measures in the industry, use can be made of the "Typical methodology for determining the economic effectiveness of capital expenditures and new equipment in the national economy of the USSR," elaborated by the Academy of Sciences of the USSR. This typical methodology is being extensively used by the industry; it is well known to designers, production engineers, economists and fiscal personnel.

2. ESTIMATING EFFECTIVENESS USING A SYSTEM OF COEFFICIENTS

The degree to which common components and subassemblies are used in new designs of machines and equipment, the results of unification and the degree to which the objects of production are saturated by standardized and normalized assemblies, subassemblies and components is estimated by various coefficients, which are also used for clarification of the volume of coordination in main and auxiliary production. They make it possible to compare the old with the new. The theory and practice of the application of one or another coefficient is illuminated in a number of works, the bibliography of which is given in [1].

A system of coefficients is necssary for estimating and substantiation of the effectiveness of indicators, technical characteristics,

requirements, parameters, etc., used in the elaboration and adaption of standards; it can be constructed on the basis of work [35]. A system of coefficients for use in practical standardization and normalization work is given in Table 66.

Table 66 includes coefficients which are common to machine building. But it is also possible to use coefficients reflecting specific features of individual machine building branches and also individual work projects performed in the field of standardization and its varieties. Taking this into account, it seems expedient to compile the working system of coefficients, containing a larger or smaller number of the latter, for use in each specific case of estimating the results of the work performed.

The values of the coefficients change, depending on the problems which are solved by standardization methods. In some cases, they should be increased, in others, conversely, decreased, which will characterize the results which are achieved. It should be kept in mind that opposite end purposes may serve as goals, depending on the specific conditions.

For example, in some cases it is expedient to adapt large scale utilization of pig iron castings instead of steel rolled stock and, in other cases, the opposite may be desirable. In the first case, the coefficient characterizing the use of pig iron castings in the product should be increased and, in the second case, it should be decreased. An example of the second case is the production of emery [producting] machines at the Volgograd shipyard. Increasing the output of these machine tools for complete satisfaction of the demand is held back by the scarcity of iron castings, although a number of components can be made by other methods, in particular by welding. In this case, a lowering of the coefficient will characterize achieved results.

TABLE 66.

System of Coefficients for Estimating the Effectiveness of Standardization and Normalization Work.

Обозначение коэффициента	2	3	4
K_1	Весовой коэффициент 5	Отношение веса изделия к параметру, характеризующему его производительность, мощность, размеры и т. п. 6	Экономия материалов, снижение трудоемкости и стоимости изготовления 7
$K_{вн.д.с}$ 8	Коэффициент, характеризующий удельный вес деталей, изготовленных из проката профильного и периодического сечений 9	Отношение чистого веса деталей, изготовленных из такого проката, к весу изделия, а также к весу всего использованного проката 10	Экономия проката, снижение трудоемкости изготовления 11
$K_{вн.д.с}$ 12	Коэффициент номенклатуры применяемого проката (профиль, размеры, марки материала) 13	Число наименований каждого из видов проката и общее число наименований проката 14	Улучшение снабжения, уменьшение отходов, повышение коэффициента использования металла, высвобождение оборотных средств, упрощение складского хозяйства и пр. 15
K_4	Коэффициент использования проката 16	Отношение чистого веса деталей, изготовленных из проката, к весу использованного проката 17	Экономия металла; снижение трудоемкости и себестоимости изготовления изделий 18
$K_{вн.д.л}$ 19	Коэффициент, характеризующий литые детали 20	Отношение чистого веса литых деталей из серого, ковкого и модифицированного чугуна, стального и цветного литья, вместе и в отдельности каждого вида, к весу заготовок 21	Экономия металла; снижение трудоемкости и обработки и стоимости изделий 22
K_5	Коэффициент, характеризующий использование литых деталей 23	То же к весу готового изделия 24	То же 25
K_7	Коэффициент, характеризующий удельный вес деталей, не подвергающихся механической обработке (включая детали с механической обработкой менее 30% поверхности) 26	Отношение количества деталей, не подвергающихся механической обработке, и количества деталей с механической обработкой менее 30% поверхности, к общему количеству деталей в изделии 27	Экономия металла; снижение трудоемкости и себестоимости изготовления деталей; сокращение производственных запасов заготовок, приближающихся к форме готовых деталей 28
K_8	Коэффициент, характеризующий удельный вес деталей, имеющих более 30% поверхностей, подвергающихся механической обработке 29	Отношение количества деталей с механической обработкой более 30% поверхности к числу деталей в изделии 30	Экономия металла; снижение трудоемкости и себестоимости изготовления деталей, ожидаемое прирост сложных заготовок 31
K_9	Среднесложенный показатель точности изготовления 32	Сумма произведений количества деталей разных классов точности по номер класса, деленная на общее число деталей в данном изделии 33	Снижение трудоемкости и себестоимости обработки деталей и сборки изделия; упрощение технического контроля и снижение процента брака 34
K_{10}	Среднесложенный показатель шероховатости поверхности 35	Сумма произведений количества деталей разных классов шероховатости поверхностей на номер класса, деленная на общее число деталей в данном изделии 36	То же 25

Обозначение коэффициента	Характеристика коэффициента	Показатели и характеристики	Эффективность
$K_{1вн.д.с}$ 37	Коэффициент, характеризующий удельный вес стандартных, нормализованных и унифицированных агрегатов в узлах в изделии 38	Отношение количества этих агрегатов в узлах к количеству всех агрегатов в узлах в изделии 39	Развитие и большая насыщенность специального и высокопроизводительного оборудования; повышение качества; снижение стоимости 40
$K_{1вн.д.с}$ 41	Коэффициент, характеризующий удельный вес стандартизованных, нормализованных и унифицированных деталей в изделии 42	Отношение количества этих деталей к количеству всех деталей в изделии 43	Сокращение сроков подготовки производства и их удешевление; применение рационального инструмента и типовых технологических процессов, улучшение планирования производства и инструментального хозяйства 44
K_{11}	Коэффициент, характеризующий количество наименований деталей на одно изделие 45	Отношение количества наименований деталей, входящих во все узлы и сборочные (за исключением крепежных), к общему числу этих деталей 46	Снижение трудоемкости и себестоимости изготовления новых изделий по сравнению с существующими 47
K_{12}	Коэффициент повторяемости деталей 48	Отношение количества деталей в штуках на одно изделие к количеству оригинальных деталей 49	Сокращение сроков подготовки производства и уменьшение от-ти уникального оборуд конструкторских и технологических работ, повышение стройности и снижение трудоемкости изготовления изделия 50
$K_{пов.ф.р.с.о}$ 51	Коэффициент повторяемости размеров крепежных деталей по каждому виду в отдельности (болты, винты, гайки, шпильки, шайбы и т.п.) 52	Отношение количества крепежных деталей каждого типоразмера к количеству соответствующих типов деталей в изделии 53	Уменьшение числа типоразмеров, применяемых инструментов и другой технологической оснастки; облегчение взаимозаменяемости и улучшение условий сборки изделия; повышение стройности производства на специализированных заводах 54
$K_{пр}$	Коэффициент конструктивной преемственности деталей 55	Отношение количества ранее освоенных на производстве деталей к числу деталей в новом изделии 56	Сокращение сроков подготовки производства и увеличение от-ти использования высвобождающейся технологической оснастки и оборудования; сокращение трудоемкости внутризаводских перемещений, облегчение условий обучения конструкторских и других работ 57
$K_{пов.ф.о.с.}$ 58	Коэффициент повторяемости конструктивных элементов: отверстий, имеющих свободные размеры; отверстий, имеющих различные допуски, нарушающих резьб; внутренних резьб; наружных диаметральных размеров, имеющих различные допуски; нарушения плоскостных поверхностей, имеющие чаще на валах, имеющие чаще в отверстиях и т.п. 59	Отношение количества данного конструктивного элемента в изделии к количеству одноименных этого же элемента 60	Сокращение номенклатуры применяемой технологической оснастки, улучшение организации технического контроля; сокращение сроков подготовки производства 61

Обозначение коэффициента	Наименование коэффициента	Показатель и характеристика	Эффективность
$K_{пов.ф.р.с}$ 62	Коэффициенты унификации 63	64 Отношение суммарного количества унифицированных деталей в изделии к общему их количеству; 65 отношение суммарного количества оригинальных унифицированных деталей в изделии к общему количеству оригинальных; 66 отношение веса всех унифицированных деталей в изделии к общему его весу; 67 отношение суммарной трудоемкости изготовления унифицированных деталей к полной трудоемкости изделия	Сокращение номенклатуры четырех конструктивно-унифицированных рядов изделий; снижение трудоемкости изготовления и себестоимости, повышение качества, облегчение ремонта и т. п. 68
$K_{пр}$	Комплексный коэффициент унификации 69	Характеризует отношение части производственных затрат на изготовление унифицированных деталей к производственным затратам на изготовление всего изделия 70	То же 25

1) Designation of coefficients; 2) coefficient; 3) indicators and characterizations; 4) effectiveness; 5) weight coefficient; 6) the ratio of the weight of the product to a parameter characterizing its productivity, capacity, dimensions, etc.; 7) saving of materials, lowering the labor input and the cost of production; 8) $K_{2a,b,c}$; 9) coefficient characterizing the specific weight of components fabricated from rolled stock with profiled and periodic cross sections; 10) the ratio of the net weight of components produced from this rolled stock to the weight of the product and also to the weight of all the rolled stock being used; 11) saving of rolled stock, lowering the labor input required for production; 12) $K_{3a,b,c}$; 13) coefficient of the nomenclature of rolled stock being used (profiles, dimensions, material brands); 14) number of designations of each kind of rolled stock and the total number of brand-profile-dimensions; 15) improving the supply, decreasing waste, increasing the coefficient of material utilization, freeing of operating capital, simplification of warehouse administration, etc.; 16) coefficient of rolled stock utilization; 17) ratio of the net weight of components made from rolled stock to the weight of rolled stock being used; 18) saving of metal, lowering the labor input and the net cost of producing the article; 19) $K_{5a,b,c,d}$; 20) coefficient characterizing cast components; 21) ratio of the net weight of components cast from gray, malleable and modified pig iron and of steel and nonferrous castings, together and separately for each kind, to the weight of blanks; 22) saving of metal, lowering the labor input for machining and the cost of products; 23) coefficient characterizing the use of cast components; 24) the same as above, to the weight of the finished product; 25) the same as above; 26) coefficient characterizing the specific weight of components not subjected to machining (including components where less than 50% of the surface is machined; 27) ratio of the number of components not subjected to machining and of the number of components with less than 50% of the surface subjected to machining, to the total number of components in the product; 28) saving of metal; lowering the labor input and net cost of producing the components; adaption of progressive kinds of blanks, close to the shape of the finished components; 29) coefficient characterizing the specific weight of components more than 50% of the surface of which is subjected to machining; 30) ratio of the number of components with more than 50% of the surface subjected to machining to the number of components in the product; 31) saving of metal; lowering the labor input and net cost of producing the components; adaption of progressive blanks; 32) average weighted indicator of the manufacturing precision; 33) sum of the products of the number of components with different precision classes by the number of the class, divided by the total number of components in the given product; 34) lowering the labor input and net cost of machining the components and of assemblying the product; simplification of quality control and lowering the percentage of rejects; 35) average weighted indicator of surface roughness; 36) sum of the products of the number of components with different roughness classes by the number of the class, divided by the total number of components in the given product; 37) $K_{11a,b,c}$; 38) coefficient characterizing the specific weight of standardized, normalized and unified assemblies and subassemblies in the product; 39) ratio of the number of these assemblies and subassemblies to the number of all assemblies and subassemblies in the product; 40) develo[illegible] the specialization and coordination of plants at a large scale; [illegible]proving the quality; lowering

the cost; 41) $K_{12a,b,c}$; 42) coefficient characterizing the specific weight of standardized, normalized and unified components in the product; 43) ratio of the number of these components to the number of all components in the product; 44) decreasing the time required for tooling up for production and making it less expensive; use of standard tools and typical production processes; improving the production planning and tool maintenance; 45) coefficient characterizing the number of component designations per one product; 46) ratio of the number of component designations going into all subassemblies and joints (excluding fastening [components] to the total number of components in pieces; 47) lowering the labor input and the net cost of producing the new product as compared with the existing one; 48) component duplication coefficient; 49) ratio of the number of components, in pieces, per one product to the number of original components; 50) decreasing the time required for tooling up for production and making it less expensive by decreasing the volume of design and production engineering work, increasing the run length and lowering the labor input required for producing the article; 51) $K_{15a,b,c,d,e}$; 52) coefficient of duplication of fastening component dimensions, separately for each kind (bolts, screws, nuts, pins, washers, etc.); 53) ratio of the number of fastening components of each standard dimension to the number of designations of these components in the product; 54) decreasing the number of standard dimensions, of the number of tools used and other production tooling; ensuring interchangeability and improving the conditions for assembly of machines; increasing the production run length at specialized plants; 55) coefficient of design inheritance of components; 56) ratio of the number of components the production of which was previously assimilated to the number of components in the new product; 57) decreasing the time required for tooling up for production and making it less expensive by using the existing production tooling and equipment; decreasing the labor input required for tooling up for production, including decreasing the volume of design and other work; 58) $K_{17a,b,c,d,e,f}$; 59) coefficient of duplication of design elements: of holes with free dimensions; holes with different tolerances; external threads; internal threads; external diameters with different tolerances; external slotted surfaces; internal slotted surfaces; keyways in shafts; keyways in holes, etc.; 60) ratio of the number of the given design element in the product to the number of designations of the same element; 61) decreasing the nomenclature of the production tooling being used; improving the organization of quality control; decreasing the time required for tooling up for production; 62) $K_{18a,b,c,d}$; 63) unification coefficients; 64) ratio of the total number of unified components in the product to their total number; 65) ratio of the total number of designations of unified components in the product to the total number of designations; 66) ratio of the weight of all unified components in the product to its total weight; 67) ratio of the total labor input required for producing the unified components to the total labor input required for making the product; 68) decreasing the nomenclature of components in a design unified series of products; lowering the labor input going into production and the net cost; improving the quality; facilitating repairs, etc.; 69) integrated unification coefficient; 70) characterizes the ratio of that part of production costs of making the unified components to the production expenditures of making the entire product.

When performing normalization control of drawings, which is done by plants and various design organizations, care must be taken in determining the values of coefficients, which undoubtedly will have a positive effect on improving the production adaptability of machine and equipment designs. Statistical analysis of the values of coefficients could yield a large amount of information of interest and utility to the industry.

3. SEARCH FOR NEW METHODOLOGIES FOR DETERMINING THE EFFECTIVENESS OF STANDARDIZATION

What is the cause of the search for new methods of technical and economic substantiation of standard and normal standard proposals, can they be found, if all the existing methodologies are based on exactly the same principle? What other principles can be suggested so that the search for new methodologies would have, at least, a moderate chance for success?

The principal defect of the existing methodologies is the need of using in the economic effectiveness calculations of a tremendous volume of varied recorded data, for which reason it should not be assumed that no other methodologies could be found. It seems expedient to create such a methodology for calculating the economic effectiveness of standardization and its varieties, which would not require the use of a large amount of recorded information, since their selection presents difficulties to the industry and, in addition, cannot be always achieved in practice. In addition, not all the needed specific data is available in the existing plant records.

The first principle thus pertains to the necessity to forego the use and systematization of extensive recorded data. The second principle follows from the first and provides for the construction of nomograms, tables or graphs, which could be used to find a solution in

a number of typical cases. But the construction of the nomograms tables and graphs requires labor consuming preparatory work, collection of extensive factual material which must be systematized and analyzed. Finally, the third principle of this research work pertains to making a distinction between economic effectiveness obtained directly as a result of standardization and effectiveness obtained only as a result of centralization, specialization and automation of the production of standardized products or their subassemblies and components (see below). What should be done in order that the impossibility at the present time of organizing specialized enterprises or centralized orders, should not put in doubt the problem of adapting standards and normal standards?

However, for a number of reasons, no work was developed in the above direction. Only the methodology of technical and economic substantiation of the designs of objects being normalized was elaborated. The substance of this methodology consists in the following.

Technical and economic substantiation of the expedience of the design being normalized is achieved by technical and economic indicators which are being established. Technical indicators are considered as progressive if they ensure higher productivity of labor and create conditions for specialization and centralization of the production of the products being normalized.

The basic economic criterion of the effectiveness of the assumed technical indicators is the net cost of products and the operational costs.

The specific nomenclature of indicators being analyzed in comparing the different versions, depends on the peculiarities of the products being normalized. Their number can include the material used, weight of the article, kind of blank, labor input required for machining,

feasibility of the use of progressive blanking methods (precision casting, cold stamping, etc.), the expected service life, repair complexity category, etc. In all cases, only those indicators are considered which vary substantially in the versions being compared.

Two most probable cases of selection of the starting normalization versions exist; 1) when the starting version is chosen from among existing designs, including those taken from normal standards and foreign standards; 2) when a principally new design version is chosen for normalization.

The entire collected material is grouped in comparison tables, on the basis of which the best version is chosen for the elaboration of the normal standard proposal. Value indicators are decisive. Net cost data is collected at plants which use more progressive production processes, or which perform net cost calculations. In a number of cases, increasing the product quality requires new expenditures of materials and labor, which effects the net cost of the product being normalized. In those, cases, it is necessary to approximately estimate the cost increase and to establish the time during which it can pay for itself.

Technical and economic substantiation of a principally new design of the product being normalized is conducted by comparing it with the best existing specimen from among those available. In determining the expected net cost, it must also be kept in mind that the expenditures for production tooling and assimilation of the product are made in centralized order. They are not included in the net cost, although they must be analyzed.

If the starting version of the design being normalized is technically and economically substantiated, then it is accepted as final. Additional substantiation is necessary when improvements are introduced to the starting version.

Economical calculation of the final version includes the following basic variable indicators of the design elements being considered: a) materials to be used, giving the cost of unit weight; b) material used up by one product; c) the cost of processing, including shop expenditures related to the operation of equipment. Other factors, exerting a substantial influence on the technical and economic effectiveness of the design being normalized are also considered.

The above considerations serve as the basis for the methodology elaborated by the VNIINMASh for technical and economic substantiation of the designs of products being normalized. Machine building plants were extensively familiarized with the proposal of this methodology. The substance of this methodology, elaborated by G.B. Kats, was published in 1961 in the journal "Standardization."

From among the research works, we should mention the methodology of economic substantiation of a standard proposal pertaining to machine parameters, suggested by S.A. Tilles and G.B. Kats in 1960. It is based on choosing an optimal number of standard sizes of products (the "density" of the series), for which the total production and operational costs will be the smallest. Substantiation of the series starts with establishing a bank of end dimensions of the product (machine, instrument, etc.). The basic criterion for establishing limits of the series is a sufficient large schedule for the output of the products (machines, equipment, etc.), which makes it possible to ensure effective centralized production. After the limits of the series have been established, a determination is made of the number of standard sizes of the given product, that is, of the number of terms in the series. The contemplated production schedule for each standard size of product serves as starting information.

When using this methodology an R20, R10 or R5 parametric series

is chosen as the starting series for subsequent analysis and technical and economic substantiation (in accordance with data presented in Chapter 8, it is expedient to use the R10 as the basic series). If no absolute data about the production schedule are available, it is possible to use a relative quantity, expressed in percents. In those cases when starting data with respect to the main parameter of the series is available only for certain standard sizes, then the same data for the remaining members of the series is obtained by interpolation, or by the graphical method.

After the contemplated series of values of the main parameters has been assumed, the annual cost of producing all the objects in this series is determined. Using factual data of the plants charged with the manufacture of the standardized or analogous objects (or on the basis of theoretical calculations of the net cost and the theoretical demand), a table is drawn up in which the net cost of each standard size is subdivided into two groups: 1) the cost of materials; 2) other expenditures, i.e. wages, shop and other expenses. The cost of materials is separated out due to the fact that in machine building (according to S.A. Tilles and G.B. Kats), they comprise from 30 to 80% of the total cost of the product. In addition, the cost of materials and other expenditures vary in inverse proportion when the series is contracted or expanded. When the series is contracted, the cost of materials usually increases and the other expenditures decrease. The opposite prevails when the series is expanded.

Having distributed the expenses among cost elements, that number of standard sizes is determined for which the production and operational costs of the product will be minimal. Further, analysis is made of the annual expenditures per the starting series on contracting it (by transition from the R10 to the R5) and by expanding it (by transition

from R10 to R20). The relationships between expenditures for materials and other expenses, as a result of reconstructing the parametric series from R10 to R5 and R20 will inevitably change. In the first case, the decrease in the number of standard sizes of machines (or other products) will make it necessary for the users to obtain machines and other products of greater rating or size, which will result in increased material consumption. In the second case, the type range of products is increased by a factor of 2 which will effect the production run length and the labor input. The operational expenses will also vary. The series which, according to calculations will ensure the most favorable relationship between expenses and lowest total costs will be optimal.

As an example, the authors of this method have substantiated by technical and economic considerations parametric series of crane electric motors and milling machines. Their calculations showed that the R40 rather than the R20 series of crane electric motors is optimal, which creates doubts as to the reliability of the calculations. With respect to parametric series of horizontal, vertical and general purpose milling machines, produced by the Gor'kiy, Dnitrovsk and other machine tool building plants, the calculations affirmed the fact that the R10 series is optimal. Contraction or expansion of this series results in additional expenses in production as well as in operation.

At the present time, many machine building branches elaborate dimensional series of machines and equipment needed by our national economy. This work is based primarily on the technical and economic effectiveness of one or another series. As a characteristic example, we can refer to work performed in the field of food machine building, which is characterized by an extensive nomenclature of machines and equipment that it produces. The main parameter for the majority of kinds

of this production equipment is productivity; equipment series are only infrequently constructed by the volume, capacity and other parameters. According to the opinion of specialists of this branch, such a dimensional series would be desirable, in which the greatest shop would be served by either one machine or one flow line, operating at full capacity. Versions in which each shop is served by several machines or, conversely, when one machine gives full value service to several shops are also possible.

The optimal version of a dimensional series is determined by calculating, using a typical method, the economic effectiveness of capital expenditures and new equipment. In calculating the effectiveness of different versions of dimensional series of good equipment in the given case, consideration is given only to those expenses which vary depending on the chosen value of the main parameter. Cost elements which do not change with the choice of any dimensional series are not considered in these calculations. For example, the dimensional series of salami producing equipment, based on unification, includes six standard equipment sizes with an output of 1.25, 2.5, 5, 10, 20 and 40 tons/hour (according to the derived R10 series). Economic effectiveness calculations show that the series optimal for the nearest future is still that which includes only three standard sizes of equipment with an output of 2.5, 10 and 40 tons/hour, i.e. constructed from the derived R5 series. This shows the great significance of the problems of economic substantiation of the dimensional series being elaborated.

Creation of a methodology of technical and economic substantiation of dimensional machine and equipment series and of corresponding parametric standards being elaborated, which would be convenient for practical purposes, is at the present time, the most urgent from among all the methodological tasks in the standardization and normalization

field. Much too little was done in this direction. For a number of reasons, research work has not been properly developed. They have, in the end, been reduced to some or other modifications of the existing methodologies, based on collecting, analyzing and comparing various recorded and other data.

Substantiation of the technical and economic effectiveness by using all these methodologies is distinguished by being very work consuming and complex. In the meantime, a need exists for a methodology which would make possible to rapidly determine results with sufficient accuracy. This is the reason why we must return to those original thoughts which were briefly illuminated in the beginning of this chapter.

Much can be achieved by mathematical methods, however, the great opportunities presented by mathematics are extremely little used in standardization and normalization work. In particular, it is possible to theoretically solve also the problem of elaborating guiding materials for rapid and reliable calculation of the economic effectiveness of standardization and of substantiation of proposals of parametric standards for machines and equipment, which is being considered.

4. THE EXPECTED SAVING EFFECTED BY ADAPTING NORMAL STANDARDS

The evolved practice and methodology for elaboration of machine building normal standards call for estimating their economic effectiveness in the form of savings achieved by the lowering of the net cost made possible by centralized production of the normalized items at specialized plants. Thus, according to calculations of the VNIIMASh, the net cost of normalized reducers can be lowered by 40-50%, of variable speed drives by 50%, of sprocket gears by 30% which, according to Table 65, corresponds to increasing the output of reducers by a factor of 15-30, of variable speed drives by a factor of 30 and of sprocket

gears by a factor of 5. Decreasing the number of standard sizes of crossed belt pulleys by a factor of 10 and of packing rings by a factor of 3, as a result of normalization, will correspondingly affect a possible 37 and 20% saving, when these will be produced at specialized plants.

The question arises: why is the specialization of the production of a number of products, characteristic for machine building normal standards, so relatively weakly developed, if it is so highly effective? Before we answer this question, we should recall that a major task of the present time development of the economy of the Soviet Union is maximal gain of time in the world-wide economic competition between socialism and capitalism. Practical experience shows that at the present time, this condition is best satisfied by branch specialization of production and, necessarily, the branch normalization that goes with it. They exert a substantial effect not only on lowering the net cost of assemblies, subassemblies and components, but also on increasing the output of machines, i.e. they are instrumental in achieving a maximal time gain in most rapidly providing the national economy of the USSR by the machines and equipment it needs. This can be shown through an example of tractor building.

In order to sharply increase the tractor output in the next few years, a system of assembly and component specialized plants is being created. Branch centralization and specialization of production will ensure lowering the net cost of assemblies, subassemblies and components by up to 46% and increasing the tractor output by a factor of 2.5. Had the product specialization of the existing plants been retained, it would have been necessary to construct five-six more new large tractor plants. And this involves large capital investments and a long time for complete assimilation of production at these new plants-

combines. In addition, creation of assembly and component specialized plants will make possible more extensive use of tractor assemblies, subassemblies and components in machines of other functional purpose. Branch specialization in the automotive industry is developed in a similar manner.

Unlike branch specialization and branch normal standards, machine building normal standards are directed toward achieving general machine building specialization. Machine building normal standards positively promote considerable lowering of the net cost of individual subassemblies and components, but this decrease has, as yet, only an unsubstantial effect on the net cost of those machines and equipment in which these individual subassemblies and components are used. Machine building normal standards also only slightly influence the actual increase of the output of machines and equipment, since the production areas fred in this case are not of decisive significance.

The greatest economic effect is obtained by simultaneously utilizing assemblies, subassemblies and components, made in accordance with state standards, normal standards and unified working drawings.

5. EXAMPLES OF TECHNICAL AND ECONOMIC EFFECTIVENESS

The scope of the book requires that we limit the number of examples to those most characteristic with respect to methodology. They primarily illustrate those standardization and normalization results and those technological advances which are effected by them in the practice of machine building plants. These measures can be recommended for extensive use. It is required to show also ways of achieving the results of certain work in the field of unification, typification and aggregation and of the adaption of interchangeability. More detailed information and a bibliography are given in Reference [1].

The significance to the national economy of the standardization

of allowances for cast and forged blanks is confirmed, for example, by this fact. The metal wasted in chips at mass production plants comprises 20-30% and in unit and average series production it is up to 50% and more. In the single case of heavy machine building plants, about 300,000 tons of chips is taken off annually from cast and forged blanks for the existing production volume. The losses in the given case are measured not only by the cost and weight of the metal converted into chips, but also by the cost of excessive machining; here, to this cost we should add the depreciation costs for the additional equipment and production areas which are required. Rational limitation of the allowance sizes frees production capacities, especially in machine shops, which can be used for increasing the output of machines or spare parts. Decreasing the size of allowances by only 25% gives, at the scales of heavy machine building, a 75,000 ton saving of metal and tremendous saving of the labor required for machining.

The production of blanking shops (casting and forging) of heavy machine building plants is still planned in tons and not in sets, which does not stimulate the tightening of machining allowances provided for in the standards. This planning principle, in addition, promotes concealment of outmoded techniques and production organization. All kinds of distortions and misalignments, which result from outmoded production processes are covered up by large allowances. Standards and normal standards, by tightening and limiting the allowances, promote the adaption of modern production processes, but this requires radically changing the planning system.

The scale of plant normalization at the Uralmash plant is characterized by data given in Table 67.

Normalized components comprise, on the average, 51%, general purpose components 42.5% and special components 6.5% of the total number

TABLE 67.

Saturation of Machines by Normalized Components, in %.

Детали A	Дробилки B	Агломерационные машины C	Прокатное оборудование D	Крановое оборудование E	Прессы F
Нормализованные . . .G. .	66,1	49,3	48,5	52,1	37,4
Общего назначения . .H. .	27,0	41,4	45,0	41,7	52,0
Специальные . . . . . I .	6,9	6,3	6,5	3,2	10,6

A) Components; B) crushers; C) sintering equipment; D) rolling equipment; E) crane equipment; F) presses; G) normalized; H) general purpose; I) special.

of parts in machines produced by this plant. As a result of developing normalization, the designing at the plant of new machines has already been accelerated by 35% and the cycle of elaboration of working drawings has been cut by 25-35%. This normalization process is continuously developed; here, the quality of machines is improved by using normalized and unified subassemblies and components, which have been in repeated use. The cost of machines saturated by normalized and unified subassemblies is lowered and the operational reliability is improved.

As a result of aggregating the machine designs, the designers are in a position to more thoroughly finish off the subassemblies. The elaboration of production processes is also accelerated; here, the production preparation cycle is decreased by 25-50%. Typification of production processes makes it possible to improve the utilization of machine tools, which increases the productivity of labor by 15-20%. Normalization exerts a great influence on improving the production adaptability of machine designs, with the result that the labor input is decreased to 20 and even to 40%. Group orders for components are a result of standardization and normalization; they sharply increase the the productivity of labor. For example, a group order of fastening com-

ponents placed with the Uralmash plant combined with the use of more efficient production processes and equipment has increased the productivity of labor by a factor of 4-5. Only a single measure - group production of normalized components - has lowered the labor input at the Uralmash plant by 95,000 norm-hours [36].

The use of interchangeable assemblies accelerates the assembly cycle by a factor of 2-4. Producing excavators by series production methods has lowered the labor input required for machining by 47% and for assemblying by 50% and has decreased the total labor input needed for the manufacture of drilling installations by a factor of 5.

With respect to blast furnace equipment, we should mention the results of unifying large air blowers, where up to 90% of components were unified. This has correspondingly affected the level of production equipment/output ratio, lowering the labor input and increasing the productivity of labor. Aggregation of the design of the twin-motor winch of a skip loader has made it possible to produce at different plants, in a coordinated manner, operational and emergency brakes, reducers and a number of other subassemblies. A large amount of work was performed in the field of unification of hoisting and transport equipment, as a result of which the labor required for production was decreased by 20%. In certain designs, the weight of unified subassemblies and components comprises 19 tons for a total weight of the machine of 27.4 tons [14].

Aggregation and interchangeability gradually extend to new fields of heavy machine building. A characteristic example of this is a boiler unit, designed for operation on various brands of coal and lignite and also on shredded peat which are burned in the pulverized state. The metal part of the boiler weighs 335 tons. The boiler design provides for placing it on the mounting platform in the form of 27 large units,

which makes it possible to assemble the boiler in three weeks using a minimal labor force. The dimensions and weight of each unit are such that they can be transported by railroad. The ratio of the weight of the brick furnace wall erected prior to assemblying the boiler to the total weight of the wall comprises about 80%. Aggregation of the boiler giving the numbers of the component units is shown in Fig. 12.

Unification of stem turbines has made it possible to ensure a continuous increase in their output together with decreasing the number of workers by a factor of 2. The total labor input of the steam turbine production, as a result of unification of the design elements of turbines, their subassemblies and components, has decreased by a factor of 6. However, it should be noted that the given unification could have been much more effective if it were performed not only on the scale of one plant (in the given case of the Leningrad Metal Products Plant), but on the scale of the entire domestic turbine building industry.

The Leningrad Metal Products Plant has elaborated a series of standard sizes of hydraulic turbines, which use 10 wheel types with a corresponding gradation of diameters (17 dimensions). The number of standard sizes of subassemblies and components has been decreased by a factor of 6 (of some components even by a factor of 20). The unified subassemblies and components of hydraulic turbines comprise 40% of the total weight of the machines. As a result of utilizing many common components and subassemblies, the time required for designing the hydraulic turbines has been decreased by 30-40%. Unification of the hydraulic turbine designs has made it possible to use an entirely new process for machining the turbine components on special and gang machine tools, instead of the previously used general purpose unique machine tools, the insufficiency of which has slowed down the development of turbine building. Unification of designs and the new production process

has lowered the labor input required for producing hydraulic turbines by a factor of 2 and more.

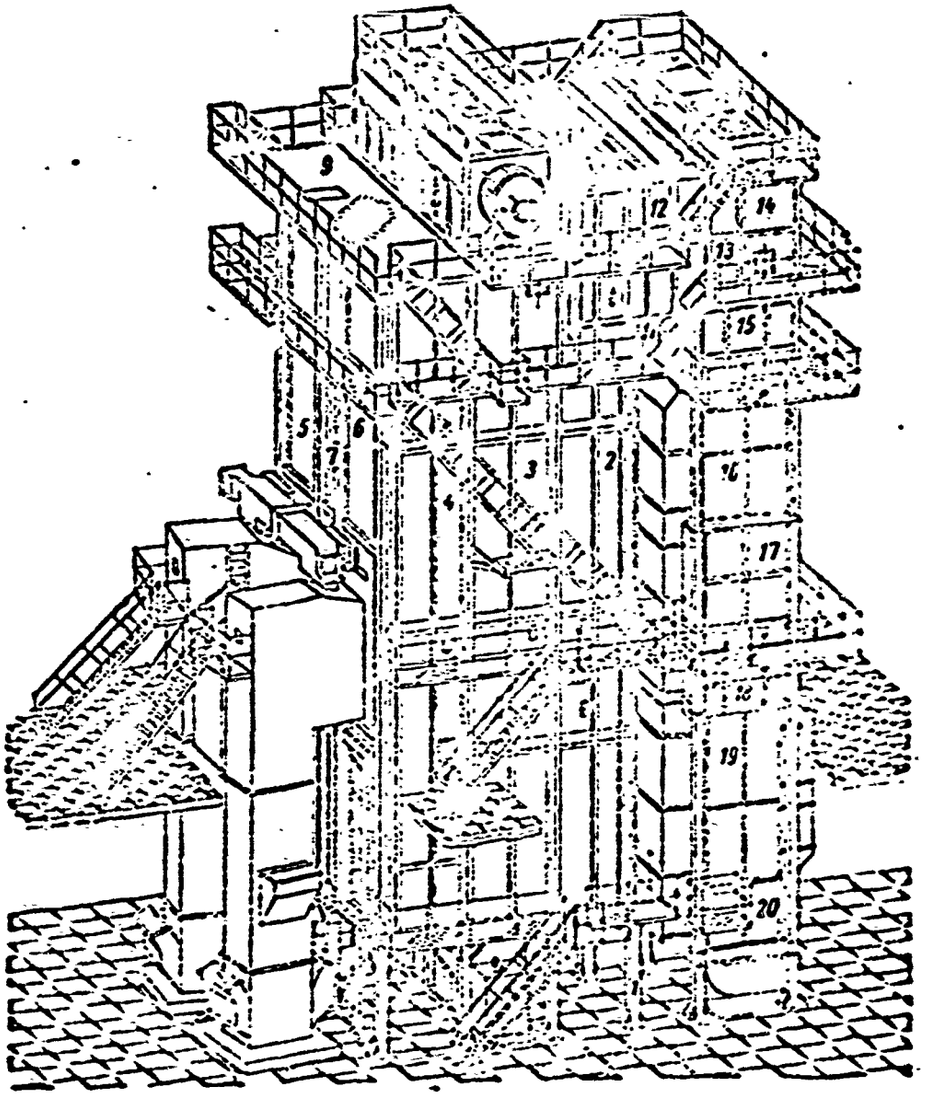


Fig. 12. Aggregating a steam boiler.

The Nevskiy Lenin Plant performed unification of turbocompressors by establishing identical dimensions for the most labor consuming cast parts (housing, diaphragms) for specified output and pressure intervals. Thus, for example, five standard sizes of large blast furnace air blowers use identical intake chambers, diaphragms and bearings and only two sizes of heating chambers. The degree of unification of components of these air blowers comprises 75-90%. The housings of two- and three-stage low delivery blowers (from 450 to 750 meters^3/min)

were unified at this plant, using the principle of composite models, which makes it possible to obtain housings of varying length by using changeable elements of the model. The degree of unification reaches 75-95%. As a result of unification performed at the Nevskiy plant, the number of machine types was decreased by a factor of 2-3 and their output has increased by 25%.

As is demonstrated by the experience of a number of plants, considerable savings are obtained in those cases when typification of machines is performed concurrently with unification of their subassemblies and components. Considerable work in this direction was performed by the Giprouglemash [State Institute for the Design and Planning of Coal Mining Equipment]; which resulted in regulating the type range of mine electric locomotives, scraper conveyors, mine cars for operating mines, screening machines, pulverizers and other mining and shaft equipment and in unification of their components. A summary of this work is characterized by Table 68. This typification would not have been fully valued if it were not accompanied by unification; results of this work deserve study and utilization by those machine building branches in which these problems have not as yet been properly solved. Table 69 presents a summary of data characterizing the results of unification of mine electric locomotives.

Unification of subassemblies and components of mining equipment had a positive effect also on the present machine stock operating in the mines, since by additional design of relatively simple components, it has become possible to replace subassemblies of old machines by unified interchangeable subassemblies. This shows the way for achieving large scale modernization of older equipment by using, in scheduled repairs of the equipment, unified subassemblies made at specialized plants.

TABLE 68.

Typification of Mining Equipment.

A Оборудование	Число типов: B	
	до типизации C	после типизации D
Рудничные электровозы . . E . . .	53	23
Скребковые конвейеры . . F . . .	17	8
Вагонетки . G . .	79	8
Грохоты . . H . .	60	15
Дробилки . I . .	21	10

A) Equipment; B) number of types; C) before typification; D) after typification; E) mining electric locomotives; F) scraper conveyors; G) mine cars; H) screening machines; I) pulverizers.

Aggregation of large capacity overhead cranes, involving the replacement of transmission driven track wheels by self-propelled rocker-bar carriages, has sharply decreased the labor time required for production. The above rocker-bar carriages are assemblies contained from the design and production engineering point of view, which can be manufactured and tested independently from the manufacture of the crane proper. This makes it possible to organize centralized production of rocker-bar carriages at specilized enterprises. It is expedient to establish a standard parametric series of these carriages, taking into account supplying the standard carriages to all plants producing heavy overhead and gantry cranes. Aggregation of rocker-bar carriages has cut the weight of cranes by 2-15 tons (depending on the capacity and span of the crane). The number of crane components has been decreased by 180-200 designations; here, all these components required machining. The labor time required was decreased by 6-10%. This entire work was performed at the Sibtyazhmash [Siberian Heavy Machinery] plant.

The Siberian Heavy Machinery Plant is occupied for a long time already by designing and producing large capacity cranes, but these cranes has shortcomings. They were heavy, had a short service life and were not convenient in servicing; their net cost was high and the plant lost income. All this was due to the fact that the cranes were designed and produced individually, each crane was designed anew, with the result that designs were elaborated having a variety of shapes and sizes.

TABLE 69.

Unification of Mine Electric Locomotives.

Элементы унификации 1	2 Количество		Сокращение в % 5
	до унификации 3	после унификации 4	
Конструкции узлов 6	91	22	76
Типоразмеры узлов 7	185	45	76
Типоразмеры деталей 8	1436	495	65
Сортамент металлов 9	220	50	77
Сортамент неметаллических материалов 10	22	9	59
Марки металлов 11	30	12	60
Типы крепежных деталей 12	38	24	37
Типоразмеры крепежных деталей 13	278	61	78
Диаметры проходных отверстий 14	62	19	69
Резьбы 15	20	14	30
Посадки 16	49	15	69
Предельные калибры: 17			
пробки 18	65	23	65
скобы 19	93	28	70

1) Elements of unification; 2) number; 3) before unification; 4) after unification; 5) decrease in %; 6) designs of subassemblies; 7) standard sizes of subassemblies; 8) standard sizes of components; 9) metals grades; 10) grades of nonmetallic materials; 11) metal brands; 12) types of fastening components; 13) standard dimensions of fastening components; 14) diameter of through holes; 15) threads; 16) fits; 17) (fixed-) limit gages:; 18) plug gages; 19) snap gages.

Under these conditions, it was difficult to adapt modern high-productivity production processes, it was impossible to organize series production of subassemblies and components.

The new crane designs were elaborated on the basis of extensive unification of subassemblies and components. Despite the fact that the nomenclature of this plant (according to A.V. Vernik) embraces about 300 standard sizes of overhead cranes with considerable differences in design, it was possible to find not only common principal solutions, but also to use components and subassemblies of the same type and, frequently also, entirely identical elements.

As a result of this, the cranes produced at the present time consist in 85-90% of unified components, which are constantly re-used in the production. Extensive unification has made it possible to use se-

ries production methods at the plant. As a result, the new crane designs are more refined, have a longer service life and are less labor consuming than the old designs. The net cost of the cranes was decreased and this production unit became profitable, rather than money losing. The considerable decrease in the utilized assortments of rolled stock, cables, electrical equipment, bearings and other purchased articles and materials has, as a result of unification, made it possible to improve the organization of material and tools supply.

The Novo-Kramatorskiy machine building plant has typified hot-forging machines, in which it has unified the designs and dimensions of friction clutches, pneumatic control and lubricating system apparatus, brake drives and a number of other components.

The Staro-Kramatorskiy machine building plant has typified adjusting machines, with the result that the number of their standard sizes was decreased by 20%. The subassemblies and components within the series of these machines were extensively unified.

The basis of technical policy for all machine building and instrument branches is transition to more progressive production processes, based on extensive use of special and gang machine tools; the Soviet machine builders still produce them in insufficient numbers. More extensive use of standard assemblies in the design of metal cutting machine makes it possible to use up to 90% of common components, whose production can be fully centralized and specialized. One recently made automatic line, put together from gang machine tools, uses only 5.5% of special components; all the remaining components are unified. The time required for designing gang machine tools, including preparation of working drawings, is by a factor of 3-4 shorter than that needed for designing special machine tools, which contain a very low percentage of unified components. At the present time, the field of machine

tool aggregation is continuously expanding and begins to embrace machine tools of varying production process purposes.

Large-scale and considerably effective work was also performed by the shipbuilding industry. Characteristic examples are presented in the first edition of this book [1].

[illegible]

[Footnote]

449 Here and subsequently, this term denotes a standard or a normal standard.

Chapter 15

THE FUNCTIONS, STRUCTURE AND STAFFS OF STANDARDIZATION AND NORMALIZATION ORGANS IN MACHINE BUILDING

1. THE EXISTING SITUATION

The general picture of the state and activity of standardization and normalization organs in the different echelons of the machin. building industry is variegated and, in many cases, unsatisfactory. Many plants still do not have fully staffed standardization and normalization departments or offices (OSN or BSN). Their staffs, as a rule, are insufficient for normal development of work. The attitude of the enterprise administrations toward the activity of local and branch standardization and normalization organs depends to a large extent on the level of, at which the problems are evaluated and on the technical and economic conveniences which are obtained by the use of standards and normal standards. This attitude not only determines the place of the OSN or BSN in the general system of the enterprise organization and their subordination, but their position with respect to the significance of the work being performed. Conjunctive factors also exert their influence.

For example, one of the largest Leningrad plants had before the war an active normalization and standardization department, with a staff of 26 persons. This department has implemented a large volume of work in the field of adapting standards and normal standards, has elaborated many useful plant normal standards, not only for production tooling but also for the main production and has also elaborated (with the participation of the plant's design department), a series of branch

normal standards and unclassified working drawings for all plants of the given branch of industry, according to these normal standards. After the war has ended and the plant reconstructed, the staff of its BSN consists of several persons, who are barely capable of keeping up with current work.

However, it would be incorrect to assume that this picture is characteristic of the majority of Soviet enterprises. We can quote other examples showing that, given the proper organizational preparation and well formulated problems, the standardization and normalization organs operate with high economic and technical results. The experience of their work should be propagandized. The organization of standardization and normalization in the shipbuilding industry is characteristic in this respect.

The principal difference in the standardization situation in the shipbuilding industry in comparison with many machine building branches is the existence of the Central Design Standardization Office (TsKBS), created by the decree of the Government of the USSR toward the end of 1943 on the basis of one of the largest branch TsKB [Central Design Office] of the shipbuilding industry. The TsKBS has been charged with extensive tasks in the field of standardization, normalization and unification. Briefly, they can be presented in the following form:

1) elaboration of state standard and branch normal standard proposals predominantly in the field of shipboard machine building; 2) elaboration and establishment of basic, principal norms, such as: steam parameters, types of main and auxiliary mechanisms, the kind of electricity and its voltage for shipboard installations, strength norms and other general technical problems; 3) elaboration of proposals and issuance of working drawings of unified shipboard mechanisms and equipment; 4) conduct of research and experimental work in the field of

standardization and normalization; 5) study, systematization and utilization of foreign and domestic experience in the field of standardization and normalization; 6) organization of a central records office providing all enterprises of the shipbuilding industry with methodological instructions; 7) planning the standardization and normalization work, control and correlation of experience acquired in the operation of standardized, normalized and unified products; 8) technical and economic analysis of the adaption of state standards and normal standards, etc.; 9) performing the obligations of the base organization with respect to standardization and normalization.

During the last few years, the TsKBS is performing an ever expanding volume of work in the field of ship machine building, it has intensified its control over the adaption of standardized, normalized, and unified mechanisms and other products into the design and construction of seagoing and river vessels; the quality of norms documentation being put out has been improved, since they are now elaborated by specialized TsKBS departments and specialized organizations to which the TsKBS assigns work.

The leadership and organization of all work in the field of shipbuilding standardization and of all forms of normalization (including local normalization) and unification, is in the hands of one of the departments of the TsKBS, which has been organized especially for this purpose, which ensures the necessary uniformity and coordination of the enumerated work in the entire system of the shipbuilding industry.

The activity of the TsKBS is very varied; as an example it can be characterized by the work performed in the field of unification. Unification of shipboard, mechanical and electrical equipment, which embraces simultaneously a very considerable number of future ship designs, was performed in several stages. As a result of this work, the

production of more than 10,000 standard sizes of unnecessary and outmoded products used in shipbuilding, has been discontinued and a new nomenclature of various products has been established. This nomenclature is now used by all shipbuilding organizations for design and production purposes.

Unification performed on an integrated scale has contributed to the adaption into the design and production practice of more refined specimens of mechanisms, equipment, fittings and other products. Alongside with unification of mechanisms and other products as a whole, the time consuming work of unification of their subassemblies and components was also performed. For example, the unification of pipe fittings (valves) has decreased the number of standard dimensions from 354 to 140, the number of their components from 938 to 487 and the number of design elements was reduced from 79 to 54. The number of standard sizes of products in another group of fittings was decreased from 202 to 51, the number of their components was reduced from 871 to 311 and the number of design elements from 1240 to 690. All this has made it possible to decrease the need in production tooling for the manufacture of fittings only as follows: the number of fixtures was cut by 680 pieces, of diesets by 55 pieces, of patterns by 63 pieces and of tools by 1866 pieces.

The unification performed by the TsKBS has made it possible to achieve product specialization of production. A number of plants have organized specialized production of many subassemblies and components. Extensive adaption into production of unified mechanisms and other products is ensured by the fact that the shipbuilding system has centralized design, performed in the SKB and TsKB. All order documents, compiled by the branch SKB and TsKB are inspected by the department of specialized production of the TsKBS, which does not permit production

of mechanisms and other products, not listed in catalogs of the recommended nomenclature. All designs of new specimens must be substantiated in the prescribed manner; only in this case are order for them taken. Inspection of order documents is one of forms of control of the adaption of standards and normal standards. Another form of control is periodic inspection of enterprises, performed by the TsKBS.

Standardization, as a factor of tehnological progress in machine building, can be characterized by the following example. Up to quite recently, shipbuilding, as well as other branches of the national economy, has used steel and bronze pipeline fittings, barrel-shaped in form, while the foreign practice was to use fittings of a more refined design, using a stremlines housing. Standardization has established this, more refined, type of fittings, which has gradually replaced fittings with the barrel-shaped housing.

The activity of the TsKBS has justified itself especially during transition to territorial management of plants, since this office is actually a base standardization and normalization organization, the staff of production specialization in that branch of the industry, implementing a uniform technical policy in the field of ship machine building.

During a number of years, the TsKBS was the only central branch standardization and normalization organization. But, now, the experience this office has acquired has been transmitted to a number of branches of industry. For example, the instrument making and other branches of the industry have specialized design offices for standardization and normalization. The activity of these SKBSN [Specialized Design Offices for Standardization and Normalization] is especially effective at those points where the objects of production are frequently replaced by new ones and their design and manufacture is time consuming and long. Stan-

dardization and normalization help leading designers to more rapidly and better, elaborate new objects of production and they also aid the plants in more rapidly and qualitatively reproducing them in the metal.

The creation of branch organization of the type of TsKBS or SKBSN promotes the participation in standardization and normalization work of experienced, highly skilled specialists.

In accordance with the decision of the Council of Ministers of the USSR, all machine building and instrument making plants organize standardization and normalization departments, offices or groups. An ever increasing number of engineers and technicians participate in their work.

The scientific and technical propaganda of standardization and normalization, especially in the field of propagandizing better forms for their organization is, as yet, very weakly implemented by us.

Of interest is the experience of Japan, which annually conducts a standardization week. A large number of activities take place during this week, such as conferences, reports, lectures, exhibitions. Standardization is popularized as a field of work for industrial engineers, the use of standards is also propagandized. The activity of individual specialists, which have during this performed best standardization work, is noted.

The solution of organizational problems in other countries, for example, of France, is also characteristic.

2. FUNCTIONS OF STANDARDIZATION DEPARTMENTS OF FRENCH MACHINE BUILDING PLANTS

French engineers, which have developed a national school of normalization, have enriched its practices by a number of valuable methodological manuals. One of these manuals is the normal standards engineer's handbook, issued by the French Normalization Association AFNOR

in 1958. This handbook illuminates in detail the functions of the normalization service at a machine building plant, which are of interest in the elaboration of the Soviet system of organization of standardization and normalization services in machine building.

The first function. The activity of the plant normalization service (department) begins with establishing the technical policy of normalization at the given enterprise. The technical policy, after it has been carefully formulated, is approved by the plant administration. The implementation of this policy is the main function of the plant normalization department. The enterprise administration has an exact idea about the goals and problems of normalization work being performed and, for this reason, it is in a position to demand effective working methods from the entire plant personnel. As experience is accumulated, the staff of the normalization department prepares suggestions for refinement or modification of the normalization policy.

The normalization department organizes and further systematically conducts simplification of products and their elements being made by the plant, of purchases products, materials and semifinished products used and, also, elaborates, together with the staff of the quality control service, instructions about uniform testing methods. Here, necessary attention is paid to the clarification of the profitability of their activity. It should be noted, that systematic work for determining the profitability of its activity is a characteristic trait of the organization of normalization at French plants.

The second function. The normalization department also provides its enterprise with a complete set of French national normal standards (in our terminology these are called state standards), which are of interest to the given enterprise and also with the corresponding branch, plant, company and other local normal standards used in France, of fo-

reign standards and normal standards, obtained through the AFNOR. The department selects technical journals pertaining to normalization and related problems. The employees of the plant are granted access to various literary works, particularly with respect to the techniques and methodology of elaboration of normal standards and to the problems of improving skills in the field of normalization. It also organizes proper storage of the entire enumerated external normalization documentation.

The third function. This function is related to the adaption of the aforementioned normalization documentation at the given enterprise. Two adaption methods are used. One of them, consists in the adaption of normal standards and other technical documentation, without any revisions to make them to conform to specific needs. The second method involves some kind of revision. The methodology recommended for these revisions takes into account conformance to copyrights.

The fourth function. The plant normalization department elaborates its own, local normal standards and also certain branch normal standards, which are of interest to a number of enterprises. This function is performed in those cases when the normalization problem, solved within the framework of the given plant, was not first analyzed (in the French terminology - studied) at the national scale. This means that the establishing of branch and plant normal standards for certain specific products is recommended only in the case when the elaboration of a state-wide normal standard is considered as inexpedient or premature. All this requires inspired work by the staff of the plant normalization department, especially at the initial stage of their activity, when the technical policy of normalization and the subject field of future work is being determined. The implementation of this function is related to the proper execution of work in accordance with the second and third

functions.

The fifth function. The distribution of the plant normal standards to the corresponding services, shops and other enterprise subdivisions. A procedure for distribution of normal standards (giving the quantity) and also a pro edure for controlling their actual use, is also recommended. The system of this work is distinguished by its variety and depends on the structure of the enterprise and on the profile of its specialization. Frequently, the persons which implement control over conformance to normal standards are not subordinated to the normalization department. Normalization control is performed systematically only at large plants (by our concepts, these are medium-sized plants). The methods of this control are varied and not regulated. It is not even mandatory that the inspector be on the staff of the given plant. Systematic control of drawings and other technical documentation is frequently performed by representatives of various scientific and technical societies.

The sixth function. The staff of the plant normalization department systematically participates in the work of national and international technical committees, subcommittees and commissions concerned with the solution of individual problems, which are of interest to the given enterprise. The normalization department studies the effect of this activity on the current work of the plant normalization department and analyzes the accumulated experience. The work of the staff of the plant normalization department in committees and commissions promotes widening their horizons and upgrading their skills and, for this reason, it is encouraged by the plant administrations.

The seventh function. Consideration of normal standard proposals of various levels supplied to the plant, their thorough study and preparation of conclusions, comprise the seventh function of plant normalization departments. In addition, the department critically evalua-

tes the values and suggestions with respect to normal standard proposals elaborated by the given plant, supplied by other plants, industrial associations, scientific and technical organizations and societies and also from individual specialists. The department prepares summaries of these remarks and suggestions and prepares its own conclusions.

The eighth function. This function is administrative in character and touches upon the activity of the normalization department personnel with respect to personal contacts with the enterprise management. The enterprise management should pay attention to normalization work performed at the plant and also to the staff of this department; it should understand and properly evaluate the advantages and results obtained, in the final count, by the use and development of normalization. The AFNOR handbook points out that, if no such attitude with respect to normalization work is exhibited by the plant administration, then the workers of the department should find support for their work from persons more competent in the field and, through them, to fight for the acknowledgement of the usefulness of their work by the plant administration. Thus, the eighth function involves exhibiting the necessary persistence, purposefulness and faith in principles.

In the plant structure, the normalization department has direct connections with the administration. In 23 cases of 100, the department is directly subordinated to the general manager of the firm. A situation prevails at a number of plants such that the normalization department is a more important echelon in the plant structure than all the remaining technical plant services. For the general benefit of an enterprise all its departments, offices, shops and other subdivisions should ensure coordinated joint work in elaborating and adapting the normal standards.

Large plants, with numerous shops, departments, laboratories and other services use a decentralized system of normalization organization. The central normalization department maintains direct relations with national and branch associations, committees and other organizations working in the normalization field. The basic function of the central department is elaboration of directives to lower standing normalization services at its enterprise, consultations with respect to their work and prevention of duplicate activity.

The principal scheme of the decentralized system of normalization work is called the "functional hierarchy," which shows the extensiveness of the functional system of organization. Such a system, as we know, operates well only when run by highly skilled personnel and when the responsibility for the work is divided.

The structure, composition and staffs of normalization departments for centralized and decentralized organization change, depending on the number of problems being solved, the extent of coverage of production objects by normalization, complexity of the subject field being elaborated, peculiarities of the enterprise, the scales of its production and coordination, the variety of types of machines or other articles it produces and, also, on the frequency with which the models of these articles are changed.

The staff of the normalization service at the plant, including the central department and local normalization services in the plant's subdivisions, are determined by the number of workers at the given enterprise. According to the AFNOR handbook, for example, the staff of the normalization service at a moderately-sized plant, employing 500 persons consists only of two co-workers - an engineer and a highly skilled draftsman. But the normalization activity at a moderately-sized plant is not limited to the work of only these persons.

The technical department of the plant keeps records of the subassemblies and components being used at the plant, puts in order the maintenance of drawings, etc. It classifies the products being made and their components and uses this classification as a basis for simplification, which promotes lowering the net cost of products. The chief mechanic/s department performs unification of subassemblies and components of plant equipment in order to facilitate and accelerate its repairs. The production department performs systematic work for decreasing the number of designations of components being produced and for lowering the labor time going into production by adapting normalized subassemblies and components, which are produced by large batches.

An increase in the annual demand for the same components and sub assemblies results, in the terminology of the handbook, in "lengthening the production series," with the result that, according to the AFNOR the net cost changes inversely proportional to the fourth root of the series length. This means that, under conditions of French machine building, a certain mathematical relationship was found, relating increasing the production scale (as a result of normalization) and the net cost.

The plant's supply department derives a direct benefit from normalization and because of this it participates actively in it, ensuring close cooperation between normalization workers and supply workers with respect to all kinds of materials, semi-finished products and finished articles. The co-workers of the supply department promote effective adaption of local, branch and other normal standards, ensure operation control of its use and do not permit writing out of orders not conforming to the normal standards in force.

The number of persons actually occupied by normalization at moderately-sized machine building plants, thus considerably exceeds the

number of co-workers of the normalization service (department, office).

The number of workers occupied by normalization only at medium-sized French machine building plants, not including those charged with storing and issuance of normal standards, reaches 10. This number does not include workers of other shops, departments and services of the plant, which perform certain normalization functions (in a manner similar to that described above), alongside with their main activity. According to other published data, for example, according to the work of G. Boe "General conclusions about normalization at enterprises, its cost and results," which was also published by AFNOR, the normalization work at French machine building plants occupies 3 to 5% of the total number of the plant personnel and work in the field of research and preparation of objects for new production (in our terminology, this means in the chief designers department), occupies from 5 to 10% of the enterprise personnel.

The main function of plant normalization in France (according to G. Boe) consists in classifying the production and utilizing subassemblies and components already assimilated and, also, purchased semi-finished products and general purpose articles for new production objects. According to him, the decrease of the component nomenclature achieved by machine building plants by classification methods, reaches 15% and more.

The total saving due to the use of normalization at French plants, according to G. Boe, reaches 5% of the cost of the articles being produced. This saving is created mainly by "product versatility" which, in our terminology, denotes more extensive use of the same components and subassemblies, materials and semifinished products and grades of products for various purposes.

The staff of the normalization service studies the character of

the equipment, production tooling, accessories owned by the plant and, also, the stocks of materials, semi-finished products, components and purchases products. Normalization methods are used for comparing the available with that which could be ensured by more extensive use of normal standards. The net cost of articles being produced can, according to G. Boe, be decreased by 10-20%. If we compare these economic results of normalization to the cost of maintaining the personnel of the plant normalization service, comprising only 0.5% of the cost of products, then the useful effectiveness of normalization, according to G. Boe, reaches considerable dimensions.

3. THE FIELD OF ACTIVITY OF STANDARDIZATION AND NORMALIZATION ORGANS

The range of problems with which the local, branch and territorial standardization and normalization organs are connected, or touch upon, is very extensive and these problems are varied and complex. Below, we give a list of these problems, subdivided into a number of sections.

1. Technical Policy of Standardization and Normalization. Determination of the role of standardization and normalization in the progress of the given enterprise (enterprises), in increasing the productivity of labor, improving the quality of the produced articles, mechanization and automation of production. In connection with these, the goals and problems of standardization and normalization are refined and the subject field of prospective and annual work plans is concretely defined. The role of the enterprise (enterprises) in the development of state standardization, general machine building and branch normalization is determined. The character of work for simplification and unification of objects of the main and auxiliary production is clarified. The relationship between the local standardization and normalization organ with the base organization and also with other local organs at analogous or related enter-

prises is concretely defined.

2. Classification and Designation of Products.

The purpose of this work is ensuring expedient uniformity of designation of analogous products, their subassemblies and components and also of production tooling, materials, semi-finished products and purchased articles being used. A connection with base organizations and analogous enterprises is established and conversion tables (codes) for designations are prepared. A number of other measures directed toward the creation and adaption of numerical designation systems, which are necessary for mechanizing the accounting operations, are implemented. The staff of the OSN participates in the work of classifying the products and their elements and also of tools, fixtures and other production tooling.

3. Methodological and Research Work. This part of activity of standardization and normalization organs provides for substantiation of the selection of stardardization and normalization work and principles for achieving it, most suitable for the given plant or organization. The fields of plant (local), branch and general machine building normalization are established from among the subassemblies and components being produced at the given plant, or which are characteristic of the proposals implemented by the design and scientific research organizations. Work is done for refining the optimal content of standard and normal standard proposals of various levels. Methodological materials with respect to all aspects of the activity of standardization and normalization organs are elaborated.

4. Elaboration of standard and normal standard proposals. Proposals are elaborated by almost all plants, design, production planning and scientific research organizations. It involves the selection of original materials, clarification of the applicability of objects of main and auxi-

liary production and their elements, refining the problems of coordination and expedient centralization in manufacturing the products being standardized and normalized and also conducting economical and production engineering calculations, performance of a number of mandatory formalities in the field of content. This activity touches upon the problems of drawing up and agreeing upon the standard and normal standard proposals being elaborated, accepting or declining suggestions and comments of interested organizations, including the users, the order of submission for approval, publication, etc.

5. Experimental Work. Test work, investigations and tests are performed in two cases: 1) in elaborating standards and normal standards, when it is necessary to prove by experiment, calculation or operation, the correctness of parameters, dimensions, requirements and characteristics specified by the standard or normal standard and, in individual cases, also of the designs or production processes specified;

2) in adapting the standards or normal standards, when it is necessary to check the executed working drawings and experimental specimen of the products and the production processes specified and also the prepared production tooling and, in individual cases, also the special equipment.

6. Comments about Standard and Normal Standard Proposals. The majority of plants and other organizations, either systematically or episodically, receive proposals of standards, normal standards, methodological instructions, guiding technical materials, technical specifications, etc. for comments. Comments should be prepared for all these technical documents. The preparation and approval of these comments by the plant managements, or by other organizations, are facilitated if the standardization and normalization departments have lists of specialists to which the preparation of comments is assigned. These lists are compiled with

the consent of specialists (experts) and are approved by the administration.

7. Adaption of Standards and Normal Standards. Close ties should be ensured between the standardization organs and the workers of the departments of the chief design engineer, chief production engineer, OTK [Quality Control Department], materials and tool supply, laboratories etc. and also with all shops where the technical documentation is adapted and also with the base organization and design offices which prepare the working drawings of the standardized and normalized objects. A special place is assigned to normalization control achieved at all stages of the production preparations.

8. Elaboration of Proposals and Working Drawings. Organization of simultaneous elaboration of proposals of standardized machines, equipment and other objects is the duty of only certain base standardization and normalization organs. The majority of these organs participates in organizing the elaboration of working drawings of the standardized and normalized products. This work is usually done by the chief design engineer's department - with respect to objects of main production and by the chief production engineer's department - with respect to production tooling objects. The Department of the Chief Production Engineer also participates in the tooling up for production of the standardized and normalized products, which involves designing the necessary production tooling. The role of local standardization and normalization departments clnsists in performing organizational and control functions.

9. Elaboration of unclassified working drawings. This function is usually performed by the organization which has elaborated the standard (or normal standard) proposal, according to which the working drawings are centrally compiled and supplied to the interested plants and other organizations. The role of local standardization departments pertains to

organizing the elaboration of drawings and it is operational with respect to sending these out to the interested plants and design offices.

10. Unification and simplification. Unification is frequently conducted at plants and in design organizations independently of standardization and normalization, i.e. as an independent measure. Organizing this unification, embracing all elements of the production unit, is the duty of the local OSN, whose staff should actively participate in this work as leaders or their close assistance. Organizing simplification, which is simple limitation or simplification of production is the duty of all plant subdivisions under the methodological and operational leadership of the local OSN.

11. Applicability of machine components and of production tooling. Clarification of the applicability is the basic stage in elaborating any standard or normal standard. However, applicability analysis was and is performed as an independent measure, in order to decrease the continuously expanding nomenclature of components being produced and materials used. Work for establishing applicability is done by the staff of the chief design engineer - with respect to main production objects, of the chief production engineer - with respect to production tooling and special equipment, of the chief mechanic - with respect to objects being repaired, by the department of the chief power engineer - with respect to power [supply] and electrical objects and by the supply department - with respect to documents for ordering materials, semi-finished and finished products. The methodological leadership of all this work is achieved by the OSN.

12. Typification. Typification is used as a method in the elaboration of standard and normal standard proposals. But typification is also implemented as an independent measure, directed mainly toward adapting group machining methods. In this case, the production procerses and t

components produced by group machining methods are typified. The OSN is charged with methodological assistance in the field of establishing classification features.

13. Aggregation and interchangeability. The problem is seeking, together with design and production engineers, possibilities for aggregating the designs of the machines, mechanisms, apparatus, instruments and various automation facilities being produced and also of production tooling; systematic work for extending the fields of application of interchangeability; elaboration of selective interchangeability systems and participation in work leading to their adaption.

14. The economic effectiveness. The OSN calculates the economic effectiveness of each standard or normal standard proposal being elaborated. Records showing the results of adapting standards and normal standards are kept by the corresponding shops, divisions and other subdivisions of the enterprise, with the OSN providing methodological assistance. Analogous records are kept of the results of unification, simplification and typification.

15. Information work. Inspired activity should be ensured with respect to obtaining information and presenting orders for the necessary state standards, machine building and branch normal standards, various local standards and technical specifications, working drawings of the standardized and normalized products, etc.; with respect to distribution of the received materials to divisions, shops and other subdivisions of the given enterprise. Completing sets and storage of standard copies; introduction of additions, changes and corrections into the copies of standards and normal standards; compilation of all kinds of information indices, lists, etc.

16. Determining the profitability of the work. Technical reports about the work of the OSN should be supplemented by indicators showing the

profitability of the executed work.

Individual plants, design, production planning and scientific research organizations may be faced with other problems, more narrow in character, which should be solved by the local standardization and normalization organs. This specific work can also be classified with one or another of the 16 enumerated groups.

The work was subdivided into groups in order to make it possible for each plant (or other organization), to establish for itself a specific range of activities in the field of standardization and normalization and to build the OSN structure and staff on its basis.

4. FUNCTIONS OF LOCAL STANDARDIZATION AND NORMALIZATION ORGANS

Functions performed by the local standardization and normalization organs at plants, in design, production planning and scientific research organizations, cannot be the same in all cases. At plants, they depend on the scale and character of production specialization, the product nomenclature, coordination being achieved, ties to design organization not subordinated to the given plant and the technical policies pursued in the standardization and normalization field, which depends on the scale of activities. For this reason, the functions of local standardization and normalization organs, quoted below, should be considered as a scheme which can serve as a basis for a refined list of functions, corresponding to the specifics of each individual plant or organization.

The following subdivision of plants and other organizations into conventional groups can be assumed:

group I - moderately-sized machine building plants working according to their own technical documentation;

group II is the same as above, working according to the technical documentation of head plants, or that obtained from special, separate

and central design offices or scientific research institutes;

group III are machine building plants with a medium-sized production scale, working according to their own technical documentation;

group IV is the same as above, working according to the technical documentation of head plants, or that obtained from SKB, OKB, TsKB or NII;

group V are large machine building plants working according to their own technical documentation;

group VI is the same as above, working according to the documentation of head plants, or that obtained from SKB, OKB, TsKB or NII;

group VII is the sa e as above, working according to their own technical documentation, as well as according to that obtained from head plants, SKB, OKB, TsKB or NII;

group VIII are special, branch and central design offices, elaborating technical documentation for plants and also narrowly specialized SKB and TsKB;

group IX are base organizations, serving enterprises of the corresponding machine building branch;

group X are technical planning institutes of sovnarkhozes and also i stitutes such as VPTI, servicing the enterprises of its machine building branch by technical documentation in the field of production engineering and organization.

The enterprises and organizations of the instrument making, shipbuilding, electrical and other branches of industry can also be classified within these ten conventional groups.

Table 71 presents a list of functions performed by local and base standardization and normalization organs (functions performed by the given plant or organization are denoted in the table by an x).

The distribution of functions given by Table 71 is, of course,

approximate and is subject to refinement by taking into account the peculiarities of each enterprise and its relations with other analogous and related plants and also with design, research and other organizations.

It is characteristic, that even when the production scales are small and, in addition, the work is done according to technical documentation obtained from the head plant or from the SKB, OKB, TsKB or NII, the nomenclature of the work of the local standardization and normalization organ is still considerable. In this case, 32 of the 88 functions of the table are included in the duties of this department. For a moderately-sized machine building plant, working according to its own technical documentation, the number of functions performed, increases to 40.

5. BASE ORGANIZATIONS AND THE PROSPECTS FOR THEIR DEVELOPMENT

In the majority of cases, it is the branch scientific research institutes which are charged with the functionsoof base organizations. But, according to the structure of the domestic machine building which has evolved in the last few years, the duties of base organizations are also discharged by certain large plants and TsKB. In the given case, the functions of the base organizations are supplemented by the functions of the local standardization and normalization department, servicing its plant or its TsKB. Totalling these functions, shows that separating the entire local standardization and normalization work for subsequent entrusting it to a separate sector or office, is entirely expedient.

The base organizations are, at the present time, charged with elaborating state standard and normal standard proposals; compiling coordination plans of the work of leading plants, scientific research and planning and design organizations in elaborating branch normal standards;

TABLE 71

Functions of Local and Base Standardization and Normalization Organs

А Функции	В Группы									
	I	II	III	IV	V	VI	VII	VIII	IX	X
1. Планирование работ										
1. Определение технической политики предприятия в области стандартизации и нормализации, их целей и задач	×	×	×	×	×	×	×	×	×	×
2. Разработка перспективных, годовых и других оперативных планов по стандартизации, нормализации и унификации	×	×	×	×	×	×	×	×	×	×
3. Определение характера участия в работах по общемашиностроительной и отраслевой нормализации	—	—	—	—	×	×	×	×	×	×
4. Выяснение характера целесообразных работ по симплификации	×	×	×	×	×	×	×	—	—	—
5. Определение связи с базовой организацией своей отрасли машиностроения	×	×	×	×	×	×	×	×	—	×
6. Определение связи с другими местными органами стандартизации и нормализации на аналогичных или смежных заводах и др. организациях	×	×	×	×	×	×	×	×	×	×
2. Классифицирование и обозначения продукции										
7. Установление связи с базовой организацией, заводами и учреждениями по вопросам разработки и внедрения единой системы классифицирования и обозначений продукции	×	×	×	×	×	×	×	×	×	×
8. Составление переводных таблиц обозначений продукции машиностроения	×	×	×	×	×	×	×	×	×	×
9. Подготовка к внедрению цифровых систем обозначений продукции, а также технологической оснастки	×	×	×	×	×	×	×	×	×	×
3. Методические и исследовательские работы										
10. Разработка методик стандартизации и нормализации, в том числе по ограничению стандартов и нормалей	—	—	—	—	—	—	—	—	×	×
11. Уточнение области применения местных нормалей	×	×	×	×	×	×	×	×	×	×
12. Уточнение содержания местных нормалей, руководящих технических материалов и методических указаний по вопросам основного и вспомогательного производства	—	—	—	—	—	—	—	—	×	×

TABLE 71 (Cont'd.)

4. Разработка проектов стандартов и нормалей										
13. Разработка проектов государственных стандартов на машины и их элементы	—	—	—	—	×	—	×	×	×	—
14. То же на технологическую оснастку	—	—	—	—	×	—	×	—	—	×
15. Разработка проектов нормалей машиностроения на общие узлы и детали машин	—	—	—	—	×	—	×	×	×	—
16. То же на технологическую оснастку	—	—	—	—	×	—	×	—	—	×
17. Разработка проектов отраслевых нормалей на общие узлы и детали машин	—	—	×	—	×	—	×	×	×	—
18. То же на некоторые виды специализированной технологической оснастки	—	—	×	—	×	—	×	—	—	×
19. Разработка проектов местных нормалей на специальные узлы и детали машин	×	—	×	—	×	—	×	×	×	—
20. То же на специальную техническую оснастку	×	—	×	—	×	—	×	—	—	×
5. Экспериментальные работы										
21. Опытные работы, проводимые для доказательства правильности разработанных проектов стандартов и нормалей	×	—	×	—	×	—	×	×	×	×
22. Опытные работы, проводимые в процессе внедрения стандартов и нормалей	×	—	×	—	×	—	×	—	×	×
6. Заключения по проектам стандартов и нормалей										
23. Подготовка заключений по проектам государственных стандартов на машины и их элементы	—	—	—	—	×	—	×	×	×	—
24. То же на технологическую оснастку	—	—	—	—	×	—	×	—	—	×
25. Подготовка заключений по проектам нормалей машиностроения на общие узлы и детали машин	—	—	—	—	×	—	×	×	×	—
26. То же на технологическую оснастку	—	—	—	—	×	—	×	—	—	×
27. Подготовка заключений по проектам отраслевых нормалей на общие узлы и детали машин	—	—	×	—	×	—	×	×	×	—
28. То же на некоторые виды специализированной технологической оснастки	—	—	×	—	×	—	×	—	—	×
29. Подготовка заключений по проектам местных нормалей	—	—	—	—	—	—	—	×	×	×

TABLE 71 (Cont'd)

7. Внедрение стандартов и нормалей										
30. Подготовка внедрения стандартов и нормалей, установление связи с отделами главного конструктора, главного технолога, ОТК, материально-технического снабжения, лабораториями и др.	X	X	X	X	X	X	X	X	X	X
31. Организация нормализационного контроля во всех подразделениях завода и других организациях . .	X	X	X	X	X	X	X	X	X	X
32. Участие в приемке опытных образцов стандартизованных и нормализованных изделий	X	X	X	X	X	X	X	X	X	X
33. Участие в комиссиях и бригадах по проверке соблюдения стандартов и нормалей на других заводах	—	—	—	—	X	—	X	X	X	X
8. Разработка проектов и рабочих чертежей										
34. Организационная работа по обеспечению разработки проектов и рабочих чертежей стандартизованных и нормализованных изделий . . .	—	—	X	—	X	—	X	X	X	X
35. Участие в разработке рабочих чертежей	—	—	X	—	X	—	X	X	X	X
9. Разработка обезличенных рабочих чертежей										
36. Участие в работе по определению номенклатуры изделий, на которые должны быть разработаны обезличенные рабочие чертежи	—	—	—	—	—	—	—	X	X	X
37. Организация рассылки обезличенных рабочих чертежей заинтересованным организациям (составление списков таких организаций, определение числа отправляемых экземпляров в каждый адрес и т. п.) . . .	—	—	—	—	—	—	—	X	X	X
38. Надзор за своевременным и правильным уведомлением заинтересованных организаций по всем принимаемым изменениям чертежей . .	—	—	—	—	—	—	—	X	X	X
39. Связь со специализированными заводами по вопросу использования обезличенных рабочих чертежей . .	—	—	—	—	—	—	—	X	X	X

TABLE 71 (Cont'd.)

10. Унификация и симплификация										
40. Организация систематических работ по унификации применяемых материалов, полуфабрикатов и покупных изделий	×	×	×	×	×	×	×	×	×	×
41. Методическая помощь в области унификации узлов и деталей машин	—	—	—	—	—	—	—	—	×	—
42. То же по технологической оснастке	—	—	—	—	—	—	—	—	—	×
43. Организация периодического проведения симплификации в части применяемых марок и сортаментов материалов, полуфабрикатов и покупных изделий	×	×	×	×	×	×	×	×	×	×
44. Участие в работах по установлению целесообразных запасов материалов, полуфабрикатов и покупных изделий на складах предприятия	×	×	×	×	×	×	×	—	—	—
11. Применяемость деталей машин и технологической оснастки										
45. Организация работы по установлению применяемости деталей машин	×	—	×	—	×	—	×	×	×	×
46. То же по материалам, полуфабрикатам и покупным изделиям	×	×	×	×	×	×	×	×	×	—
47. То же по технологической оснастке	×	×	×	×	×	×	×	×	—	×
12. Типизация										
48. Методическая помощь подразделениям предприятия в области установления классификационных и иных признаков типизации деталей машин	×	×	×	×	+	×	×	×	×	×
49. То же в области технологической оснастки	×	×	×	×	×	×	×	×	—	×
13. Агрегатирование и взаимозаменяемость										
50. Участие в работе по расширению областей агрегатирования выпускаемых машин или оборудования с целью использования покупных агрегатов и узлов	×	—	×	—	×	—	×	×	×	—
51. Участие в работе по расширению областей применения взаимозаменяемости с целью снижения трудоемкости ручных работ	×	×	×	×	×	×	×	×	×	×
52. Участие в разработке систем селективной взаимозаменяемости	×	×	×	×	×	×	×	×	×	×

TABLE 71 (Cont'd.)

14. Экономическая эффективность										
53. Организация работы в области подсчетов экономической эффективности разрабатываемых проектов стандартов	—	—	—	—	×	—	×	×	×	×
54. То же по проектам нормалей	—	—	—	—	×	—	×	×	×	×
55. То же по проведенной унификации	×	×	×	×	×	×	×	×	×	×
56. То же по осуществленной симплификации	×	×	×	×	×	×	×	—	—	—
57. То же по внедрению стандартов и нормалей	×	×	×	×	×	×	×	×	×	×
58. То же по внедрению осуществленной унификации	×	×	×	×	×	×	×	×	×	×
15. Информационная работа										
59. Организация получения информаций и осуществление работы по заказу и получению стандартов, нормалей, руководящих технических материалов, методических указаний, инструкций, справочников и др.	×	×	×	×	×	×	×	×	×	×
60. Распределение получаемых стандартов, нормалей и других материалов по отделам, цехам и подразделениям предприятия	×	×	×	×	×	×	×	×	×	×
61. Осуществление работы, связанной с получением, хранением и доведением до рабочих мест изменений, дополнений и поправок к стандартам и нормалям	×	×	×	×	×	×	×	×	×	×
62. Организация хранения контрольных экземпляров	×	×	×	×	×	×	×	×	×	×
63. Ведение учетных книг и карточек на стандарты и нормали	×	×	×	×	×	×	×	×	×	×
64. Участие в организации выставок, лекций, докладов и др. мероприятий в области пропаганды стандартизации и нормализации	—	—	—	—	×	×	×	×	×	×
65. Организация библиотек стандартов и нормалей	×	×	×	×	×	×	×	×	×	×
66. Организация корреспондентских постов журналов	×	×	×	×	×	×	×	×	×	×
16. Определение рентабельности своей работы										
67. Систематическое проведение подсчетов рентабельности своей работы	×	×	×	×	×	×	×	×	×	×
68. Составление годовых и квартальных отчетов о деятельности и достигнутых результатах	×	×	×	×	×	×	×	×	×	×

Table 71. Functions of local and base standardization and normalization organs. A) Functions; B) groups; 1. Planning the work; 1. Determining the technical policy of the enterprise in the field of standardization and normalization, their goals and problems; 2. Elaborating prospective, annual and other operational plans with respect to standardization, normalization and unification; 3. Determining the character of participation in general machine building and branch normalization work; 4. Clarifying the character of expedient simplification work; 5. Determining the relations with the base organization of the given machine building branch; 6. Determining the relations with other standardization and normalization organs at analogous or related plants and other organizations 2. Classification and designation of products; 7. Establishing connections with the base organization, plants and institutions with respect

to problems of elaborating and adapting a single system for classification and designation of products; 8. Compiling conversion tables for designations of machine building products; 9. Preparing for adaption of numerical system of designations for products and, also, for production tooling; 3. Methodological and research work; 10. Elaborating standardization and normalization methodologies, including those pertaining to limiting the applicability of standards and normal standards; 11. Refining the field of application of local normal standards; 12. Refining the methodological directions with respect to problems of main and auxiliary production; 4. Elaborating standard and normal standard proposals; 13. Elaborating state standard proposals for machines and their elements; 14. The same as above, for production tooling; 15. Elaborating machine building normal standard proposals for common machine subassemblies and components; 16. The same as above, for production tooling; 17. Elaborating proposals of branch normal standards for common subassemblies and components of machnes; 18. The same as above, for certain kinds of specialized production tooling; 19. Elaborating proposals of local normal standards for special machine subassemblies and components; 20. Same as above, for special production tooling; 5. Experimental work; 21. Experimental work performed for proving the correctness of the elaborated standard and normal standard proposals; 22. Experimental work performed in the process of adapting the standards and normal standards; 6. Comments on standard and normal standard proposals; 23. Preparing comments about proposals of state standards for machines and their elements; 24. The same as above, for production tooling; 25. Preparing comments on machine building normal standard proposals for common machine subassemblies and components; 26. Same as above, for production tooling; 27. Preparing comments on branch normal standard proposals for common machine subassemblies and components; 28. Same as above, for certain kinds of specialized production tooling; 29. Preparing comments about local normal standard proposals; 7. Adapting standards and normal standards; 30. Preparing the adaption of standards and normal standards, establishing ties with the departments of the chief design engineer, chief production engineer, OTK, of materials and tool supply, laboratories, etc.; 31. Organizing normalization control in all plant subdivisions and other organizations; 32. Participating in the acceptance of experimental specimens of the standardized and normalized products; 33. Participating in commissions and brigades charged with checking for conformance with standards and normal standards by other plants; 8. Elaborating proposals and working drawings; 34. Organization work for ensuring elaboration of proposals and working drawings of the standardized and normalized products; 35. Participating in the elaboration of working drawings; 9. Elaborating unclassified working drawings; 36. Participating in the work for determining the nomenclature of products for which the unclassified working drawings should be elaborated; 37. Organizing the distribution of the unclassified working drawings to interested organizations (compiling lists of these organizations, determining the number of copies sent to each address, etc.); 38. Supervising the timely and correct notification of interested organizations about all changes made in the drawings; 39. Communicating with specialized plants with respect to the use of the unclassified drawings; 10. Unification and simplification; 40. Organizing systematic work for unification of the materials, semifinished products and purchased articles used; 41. Methodological assistance in the field of unification of machine subassemblies and components; 42. Same as above, for production tooling; 43. Organizing periodic simplifications with respect to the utilized brands and grades of materials, semifinished products and pur-

chased articles; 44. Participating in work for establishing expedient supplies of materials, semifinished products and purchased articles at enterprise warehouses; 11. Applicability of machine components and production tooling; 45. Organizing work for establishing the applicability of machine components; 46. Same as above, for materials, semifinished products and purchased articles; 47. Same as above, for production tooling; 12. Typification; 48. Methodological assistance to enterprise subdivisions in the field of establishing classification and other typification features of machine components; 49. Same as above, for production tooling; 13. Aggregation and interchangeability; 50. Participating in the work for expanding the field of aggregation of the machines or equipment being produced, with the purpose of utilizing purchased assemblies and subassemblies; 51. Participating the work for expanding the fields of application of interchangeability with the purpose of lowering the amount of manual operations; 52. Participating in elaboration of selective interchangeability systems; 14. Economic effectiveness; 53. Organizing work in the field of calculating the economic effectiveness of the standard proposals being elaborated; 54. Same as above, for normal standard proposals; 55. Same as above, for the implemented unification; 56. Same as above, for the implemented simplification; 57 Same as above, with respect to the adaption of standards and normal standards; 58. Same as above, with respect to adaption of the implemented unification; 15. Information work; 59. Organizing the acquisition of information and performing work with respect to ordering and procurement of standards, normal standards, guiding technical materials, methodological directives, instructions, manuals, etc.; 60. Distributing of the acquired standards, normal standards and other material to divisions, shops and subdivisions of enterprises; 61. Implementing work involved in acquisition, storage and distribution to work stations of changes, additions and corrections to standards and normal standards; 62. Organizing the storage of control copies; 63. Accounting and indexing work with respect to standards and normal standards; 64. Participating in organizing exhibitions, lectures, reports and other measures in the field of standardization and normalization propaganda; 65. Organizing libraries of standards and normal standards; 66. Organizing correspondents' positions in journals; 16. Determining the profitability of its work; 67. Systematically calculating the profitability of its work; 68. Compiling annual and quarterly reports about the activity and the results achieved.

control of fulfilling the plans for elaborating the normal standards; implementing the necessary scientific research and experimental work related to the elaboration and adaption of standards and normal standards; preparing suggestions about timely revisions of standards and normal standards. They have the right to approve branch normal standards, to present for approval standard and machine building normal standard proposals, to control the adaption and conformance to standards and normal standards in organizations and enterprises of their machine building branch, to assign, through sovnarkhozes and also through State Com-

mittees of corresponding branches of technology, ministries or departments, standardization and normalization work to plants and organizations which produce and design the corresponding products.

The base standardization and normalization organizations implement communications with the following organizations and enterprises:

a) with gosplans of the Union Republics - with respect to problems of joint planning of standardization and normalization work, of agreement between their implementors (plants and other organizations) and elaborating of joint recommendations to sovnarkhozes and other institutions, to which the executors of individual standardization and normalization operations are subordinated;

b) with sovnarkhozes - with respect to problems of agreeing upon the plans of standardization and normalization work being elaborated, determining those who will be charged with their implementation and taking of measures directed toward the adaption of standards and normal standards;

c) with State Committees of the Council of Ministers and the USSR for branches of technology - with respect to problems of prospective planning, elaborating, agreeing upon and approving standardization and normalization plans, with respect to problems of simultaneous designing of machines and equipment on the basis of parametric standards, design unified or dimensional series and also with respect to problems of adapting the standards and normal standards;

d) with the Committee of Standards, Measurements and Measuring Instruments at the Council of Ministers of the USSR - with respect to the subject fields and the methodology of elaboration of standard and normal standard proposals, presenting standard proposals for approval and other organizational problems;

e) with the All-Union Scientific Research Institute for Normaliza-

tion in Machine Building - with respect to problems of planning, preparing technical assignments for the elaboration of machine building normal standard proposals, normalization planning, calculation of technical and economic effectiveness, analyzing measures for specializing the output of normalized products;

f) with plants - with respect to problems of developing plant standardization, adaption of standards and machine building and branch normal standards, technical and economic effectiveness, profitability of the work, etc.;

g) with base organizations of other machine building branches - with respect to exchange of experience and information and also with respect to problems of developing general machine building normalization, agreeing upon standard and normal standard proposals, their adaption, developing centralized production units, etc.;

h) with the SKB, OKB, TsKB and other organizations - with respect to problems of planning standardization and normalization work, giving out assignments for elaboration of standard and normal standard proposals, methodological leadership, control of the implementation of work for adapting standards and normal standards, establishing normalization control, etc.;

i) with all the enumerated organizations - with respect to the problems of creating authoritative technical commissions for elaborating individual standard and normal standard proposals, brigades and commissions for inspecting plants and other plants with respect to their adaption of standards and normal standards, organizing specialized or centralized production of standardized and normalized products, organizing exhibitions pertaining to certain subject fields, conferences, consultations, etc.

Practically, with rare exception, the functions of base organiza-

tions are performed by standardization and normalization departments of the corresponding NII, SKB, TsKB and plants whose structure and staff are frequently incapable of solving these tremendous new problems which must be resolved by the base organizations.

What are the ways which can be suggested for developing the activities of the base organizations? Several of these ways exist and they depend on many factors, mainly on the inter-relationships between branch institutes and design organizations with plants that have been evolved and on the existence at plants of design departments and engineering services.

Briefly, the ways for developing the activities of base organizations are represented in the following form.

The first way is characteristic for those machine building branches where the elaboration of new equipment, including elaboration of proposals, working drawings and other technical documentation is implemented by narrowly specialized TsKB and SKB and where the plants perform design work for refining all this documentation and putting into final form the drawings for series production, or where work is performed on episodic assignments (The NII perform research and experimental work for the SKB and TsKB). Under these conditions, further development of the activity of the branch base organization can result in completely transforming one of the narrowly specialized SKB or TsKB into a branch central standardization and normalization design office (TsKBSN).

The second way, for machine building branches where all basic planning and design work is concentrated in a single branch NII, is now charged with the duties of a base organization. The functions and work volume of the existing standardization and normalization department of such an NII in the development work for elaboration of design unified or dimensional series of machines and equipment and parametric standards

and then in the simultaneous designing of an integrated set of these machines and equipment, increase sharply. It becomes necessary to more expediently distribute the functions, which follow from the duties of a base organization, amont many departments and other subdivisions of the given NII. The basic activity of the NII, as a result of this evolution, will become work in the field of standardization and normalization (in the extended concept).

The third way is for machine building branches where the basic design and planningwwork is performed at the plants and the NII conduct all kinds of theoretical and experimental investigations. Their standardization and normalization departments have not, as yet, been properly developed. In those cases, the existing standardization and normalization department, should serve as a basis for the creation of a branch standardization and normalization designing office (OKBSN) which would be subordinated to its branch NII, with a structure and staff such which would ensure the discharging of all duties and functions of a branch base organization.

The fourth way is for machine building branches, which do not have branch NII and certain specialized plants serve as the base organizations (for example, in transportation machine building). Here, it is expedient to form a special standardardization and normalization designing office (SKBSN), subordinated to the corresponding head specialized plants. These SKBSN can be organized on the basis of existing standardization and normalization departments. They can also contain the plant design departments.

The fifth way is characteristic for those numerous machine building branches where planning and design work is performed in various combinations by plants, as well as by SKB and NII (for example, in agricultural machine building). Here, the base organization can be success-

fully developed on the basis of the NII, except that the overwhelming volume of work for the elaboration of dimensional series of machines and of parametric standards, and also for achieving simultaneous designing of objects of production, should be transferred to specialized design organizations.

The above considerations about the ways of developing the activity of base standardization and normalization organizations show, that no trite solutions can be presented for this problem. Each machine building branch has its characteristic peculiarities which depend on many factors.

6. STRUCTURE AND STAFFS OF STANDARDIZATION AND NORMALIZATION DEPARTMENTS

Taking into account the problems and functions characterized above, we can recommend for the nearest future, the following structure of standardization and normalization organs at plants, in design, production planning and scientific research organizations. Primarily, these should be departments and not offices or groups, because the functions and character of activities of departments should embrace all the elements of preparation and actual production, including tests and issuance of the products to consumers. Standardization and normalization departments (OSN) work together with the departments of the chief design engineer, chief production engineer, chief mechanic, quality control, materials and tool supply, laboratories and other plant management subdivisions and also with all of the plant's shops. They also work together with numerous outside organizations and other enterprises. For this reason, the plant standardization and normalization service should be subordinated to the administration (management) of the plant and not to some department of the plant administration, irrespective of the scales of the enterprise and of the staff of this service.

It should be called a department, because it occupies an important place in the work for elaborating new equipment, production processes and production organization and it should occupy a position of equal importance with other main departments in the plant management structure.

The standardization and normalization departments of design, production planning and scientific research organizations should also be subordinated to the management.

Functions of the OSN presented in Table 71, are grouped in accordance with some given features, with the result that certain stages, determining the structure of the departments, are exposed. For example, the functions can be subdivided into the following six stages.

1) problems of subject field and operational planning, external connections, coordination and organization of work in the field of standardization and its varieties and also problems of the development of of specialization and coordination of production;

2) problems of elaboration of standard and normal standard proposals, preparing comments on standard and normal standard proposals being sent in for this purpose and also participation in various (subject field) technical commissions;

3) problems of achieving aggregation, unification and simplification, expending the fields of application of interchangeability, etc.;

4) problems of adapting standards and normal standards and unification suggestions, including problems of elaborating drawings, achieving normalization control, participation in brigades charged with checking for the adaption of standards and normal standards, etc.;

5) problems of information activity in all its manifestations;

6) problems related to calculating the economic effectiveness, determining the profitability, compiling reports, etc.

The character of activities of the OSN varies, depending on the production scale or kind of design activity, technical connections, development of specialization and coordination and a number of other features, which is graphically shown in Fig. 71. The structure of these departments cannot be identical, the same being true of their staffs. For this reason, we can give our recommendations also with reference to the same ten groups of plants and other organizations which are given in Table 71.

For moderately-sized machine building plants (groups I and II), it is not expedient to subdivide the OSN into offices or sectors. Here, it is sufficient to have: a) a technical group, uniting problems of work planning, classification and designation of products, elaboration of local normal standards, unification, simplification, applicability of components and materials, interchangeability and b) an adaption group, which achieves all the information activity and also implements the work for adapting and determining the technical and economic results of standardization and normalization.

For medium-sized machine building plants (groups III and IV), the following structure is more suitable: a) a planning group, uniting problems of planning, achieving experimental work, preparing comments about branch normal standard proposals; b) a technical group, dealing with problems of product classification and designation, implementation of methodological work, elaborating normal standard proposals, experimental work, elaborating working drawings, unification and simplification, problems of applicability of components and materials, adapting aggregation and interchangeability; c) an economic group, implementing work in the field of determining the economic effectiveness of standardization and normalization, profitability of the work, compiling reports, etc.; d) an information group, performing information work.

Large machine building plants (groups V, VI and VII) require a more expanded OSN structure, conforming to the aforementioned function-grouping echelons, namely: a) planning sector; b) sector for elaborating standards and normal standards; c) unification sector; d) adaption sector; e) information sector; f) sector for economic calculations.

This structure (i.e. the OSN structure of a large plant), is entirely suitable also for the SKB, OKB, TsKB, NII. Here, it is also expedient to have six sectors or groups, depending on the work scale.

The following structure will be more suitable for organizations of the type of production planning institutes (group X): a) a planning and information group, uniting the problems of: planning, experimental work and informations; b) a technical group, dealing with problems of classifying and designating production tooling and other products, methodological work, elaborating standard and normal standard proposals, preparing comments about standard and normal standard proposals being sent in for this purpose, elaborating working drawings, adapting interchangeability, etc.; c) and economic group, acting in the field of determining the economic effectiveness of standardization and normalization, profitability of the work, compilation of reports, etc.

Most expedient for base organizations (group IX) is the formation of TsKBSN or SKBSN at the branch NII. Therefore, the structure of the base organization, consisting of a number of departments, can be represented as follows: a) technical planning department; b) department of methodological and experimental work; c) department for elaborating standards and normal standards; d) department for adapting standards and normal standards; e) unification department; f) department of classification and designations; g) department of typification, aggregation and interchangeability; h) department of economic calculations; i) information department; j) inspection department.

The structure of base standardization and normalization organizations can be discussed only in a preliminary manner, since this is a problem for the future. Other considerations about their expedient structure can also exist. But this should be a large, competent organization, subdivided into a number of departments, to which are assigned specific functions and staffs.

Certain considerations should be expressed with respect to the necessary staffs, pertaining primarily to the system of operation. Should the organizational system of the entire service at an enterprise be centralized or decentralized? Experience shows that the decentralized system, which is more promising and economical and which requires smaller staffs, due to utilizing workers of other departments for performing individual standardization and normalization functions, has been predominantly developed in the domestic machine building industry. In addition, it involves in the standardization and normalization work, a wider circle of skilled specialists, which is a substantial prerequisite for improving the quality of the task.

Taking all this into account, we should recommend a decentralized system for organizing standardization and normalization work in all echelons of the machine building industry.

Under these conditions, the staffs proper of OSN at plants and other organizations can be substantially decreased. However, it should be emphasized, that even for a decentralized system they will still be considerable. According to approximate considerations, the staff needs for performing all the functions provided for and for properly developing the work of OSN at plants, SKB, OKB, TsKB, NII and VPTI and in base organizations in the form of SKBSN, are characterized by the following data:

Enterprise group	I—II	III—IV	V—VII	VIII	IX	X
Staff	5—6	10—15	25—30	15—30	60—90	10—15

The staffs of unit and small series production machine building plants should be slightly larger than those of mass production plants. This is due to the large scale and complexity of the parametric standardization, general machine building, branch and plant normalization being performed. In addition, the range of problems being solved is considerably wider.

The OSN of large machine building plants, which work together with several SKB, OKB, TsKB or NII and also with VPTI and which have a developed coordination, should be directly subordinated to the plant director and, in all other cases, they should be in charge of the chief engineer.

Great significance is acquired by problems of adapting self-sufficiency, especially at base organizations. The substance of this problem consists not only in saving capital allotted by the state budget, but also in calling the attention of economists to increasing the effectiveness of standardization and normalization work, to their high profitability and importance in the task of ensuring progress of productive forces.

7. ORGANIZING THE WORK AT PLANTS

In accordance with the decision of the Council of Ministers of the USSR, the standardization and normalization organs at all enterprises should be strengthened and should be formed in those places where they do not exist. This means that many engineers and technicians, including those who never worked in this field, are now involved in standardization and normalization work.

Very naturally, the problem arises: where should their work in the plant OSN begin? Table 71, presented above, shows a variety of functions, some of which are permanent in character, while others are periodic or episodic.

We can recommend, to begin the activity of the plant OSN, with solving of organization problems. This is very important if the work is to succeed. These, for example, include the following functions (the functions numbers are those used in Table 71): 1,2,5,6,30,31,59, 60,61,62,63 and 65. Having surmounted the organizational period which involves execution of first order functions and staffing the department, it is expedient to develop work characterized by the following functions 3,4,7,9,11,39,40,43,45,46,47,67 and 68. After the proper level in developing the above functions has been ensured, all the remaining functions and duties should be assimilated.

8. PROBLEMS OF TRAINING STANDARDIZATION SPECIALISTS ABROAD

It was considered for a long time, that five years of engineering experience in the design and production engineering field, is a sufficient prerequisite for successful standardization and normalization activity. However, further developments in this field have made necessary organizing systematic training of engineers, possessing methodological and practical knowledge necessary for the elaboration and adaption of standards (normal standards). Certain measures in this direction are taken in the USA, France and FRG [West Germany], but most systematic training of standardization specialists has been organized in the German Democratic Republic [East Germany]. In 1955, the GDR has made a decision to the effect that standardization be included as a mandatory course in the curricula of engineering colleges.

The following are the basic principles which, in the GDR, determine the level of knowledge of an engineer capable of working in the standardization and normalization field.

Each engineer should be familiar with the fundamentals, peculiarities and substance of standardization and normalization, if he desires to correctly solve practical problems in the field of machine design

and of organizing their production. Naturally, a normal standard (standards) engineer cannot personally (by himself) conduct normalization (standardization); he must seek the assistance of scientists, design engineers, production engineers and other specialists. However, the normal standard (standards) engineer should have extensive knowledge of production engineering and should have extensive design experience. The college familiarizes all future design and production engineers with fundamentals, peculiarities and the substance of standardization and normalization, to a satisfactory degree.

The opinion to the effect that the standards engineer is only capable of checking drawings and specifications from the point of view of conformance to standards and normal standards and to choose from among them to satisfy the needs of this enterprise (limiting the standards by the simplification method), should be overcome. Engineers which are capable of doing only this, cannot be of use to socialist standardization. The standards engineer should not only be a good design and production engineer, but should also be capable of rationally thinking and properling evaluating the economic opportunities of the socialist state.

The socialist economy needs standards engineers which will be sufficiently determined to travel over new paths, overcome traditions and elaborate new methods. For this, are needed specialists which have recognized the inter-relationship between technology and economy.

Full time standardization and normalization departments are being organized in colleges of the GDR. The task of these departments is instruction in the fundamentals, substance and peculiarities of standardization and normalization in close cooperation with the industry and, also, implementation of systematic scientific investigations in this direction. The general problems subject to study include:

1) substance of standardization and normalization of the period of

existence of capitalism and socialism;

2) economic significance of standardization and normalization;

3) the usefulness of standardization and normalization to the national economy;

4) plant and branch normalization and all-state standardization;

5) standardization and normalization organs at all echelons of the national economy;

6) standardization and normalization in other countries;

7) international standardization;

8) guaranteeing the quality on the basis of state standards;

9) standardization and normalization techniques;

10) characterization of the profession and prospects for developing the activity of the standards (normal standards) engineer.

Starting with the very first days of instruction, the future engineer should be convinced in the fact that not that design is best whose all elements have been designed anew but, conversely, the best design differs from the other by the fact that all the requirements put to it were satisfied by using the greatest number of standardized and normalized components and of design elements which have proved themselves under actual operating conditions. The more extensive the use of components and subassemblies, whose production has been assimilated and which were proven under operating conditions, the less chances exist for various errors and misunderstandings. The more extensive the use of standardized and normalized products, more rapidly is the output of new articles assimilated; here, their cost is lowered and the operational reliability of machines and other products is improved.

Good taste does not contradict standardization and all kinds of attempts to ascribe triteness to standardization are inventions of incompetent persons.

An inseparable connection exists between designing, production engineering, standardization, normalization and profitability. Design and production engineers and economists can successfully solve problems which they face if they have mastered the fundamentals of standardization and normalization, if they understand the qualitative relationships governing them and their peculiarities and if they operate on the assumption that standardization and normalization are not an end in themselves, but a technological and economic necessity.

Systematic training of normalization specialists is conducted in France.

The complex duties with which the normal standards engineers of French enterprises are charged and the required level of their knowledge have made it necessary to achieve an appropriate technical training of persons specializing in this field, which is conducted by secondary schools and colleges.

Technical training is one of the active forms of normalization propaganda in France. The published materials on pedagogy and techniques reflect problems in the field of normalization theory and practices. Systematic use of normal standards trains the future specialists, even before they complete their education, in finding the required normal standards and in their use for practical purposes. Instructors of the technical schools are closely familiar with the state of normalization in France, know the available works in this field and are informed of investigations being performed.

The demand for normalization specialists has made necessary their training. The problem has arisen of the manner in which the future engineers should be trained and in which standardization disciplines they should be instructed. Each engineer, in order to promote the development of normalization, should have knowledge of and skills in, the field

of all normalization processes. Young engineers should be trained not only to use normal standards in their work, but also to actively participate in the elaboration of new normal standards.

The established curriculum includes: normalization principles, methodology of rules for its implementation, use of the system of preference numbers and of mathematical statistics, administrative normalization techniques, classification and designation systems and scientific and technological terminology.

Young engineers should familiarize themselves with the structure of institutes and offices working on the scale of national and branch normalization and to clarify their connections with the activity of the International Standardization Organization. Attention is paid to the study of legislative normalization problems. In their practical work, the new engineers are trained to ensure the closest possible contacts with plant normalization organs. They should not consider standardization as the task of a narrow circle of specialists only. The available knowledge and experience frequently are found to be insufficient for elaborating of new normal standards. For this purpose, seminars are conducted systematically and materials, which help in achieving the above goal, are published.

Chapter 16

STANDARDIZATION IN THE USA

At the present time, it is impossible to mention a country with a more or less developed industry in which no standardization work is carried on and in which an official national organization has not been formed for this purpose. The organization forms, structure, problems and methods and work principles and also names of these organizations are extremely varied, but all of them are similar in their desire to extensively develop standardization and to use its results for economic purposes. In many countries, the national standardization organizations exist already for decades and have already accumulated extensive experience in the elaboration and use of standards.

Among the capitalist countries, standardization is most extensively developed in the USA. It has gone through a number of changes during the long period of its development, but its substance has remained practically unchanged. Standardization in the USA is primarily industrial standardization, directed toward adapting mass production on the basis of interchangeability and specialization.

Standardization in the USA has many peculiarities and is implemented in accordance with a very ramified scheme, embracing all basic production elements. It also has extensive commercial uses.

Despite the fact that the metric system of weights and measures was made legal in the USA as early as 1866, it is so far used only in electrical equipment, photometry and, partially, in aviation. The commonly known disadvantages of the inch [English] system have resulted

in the appearance in the USA of the so-called micro-inches (1 micron = 40 microinches), which makes possible to ensure interchangeability of inch and metric dimensions with sufficient accuracy.

Standardization has achieved its greatest successes in the beginning of the current century in the automobile industry. Ford automobiles have come into widespread use, primarily due to the fact that all their parts were standardized and any worn-out or broken part could be everywhere replaced by new, interchangeable automobile components or subassemblies, obtained at a similar price.

In addition to national standards, extensive use is made in the USA of branch standards, which are elaborated and approved by committees of the different branches of industry, departmental standards of the corresponding government institutions and also company, plant and other local standards, elaborated and approved by companies and their enterprises.

1. THE BASIC PRINCIPLES

The basic goals and purposes of the American Standardization Association (ASA) are presented in its charter in the following manner: the association promotes further development of standardization as a means for the progress of the national economy. The work of the association is based on branch committees and local industrial organizations.

One of the characteristic principles of USA standardization is the specified sequence for its implementation:

1) terminology - in order to eliminate difficulties in ordering materials, semifinished products and various articles and also of spare parts;

2) system of tolerances and requirements with respect to interchangeability - with the purpose of eliminating manual adjustments, adapting flow production methods and expanding coordination and special-

ization of industrial enterprises;

3) standard dimensions - for component specialization of enterprises and limiting the nomenclature of articles, components, semifinished products and materials with the purpose of extending the production run length and enlarging orders;

4) technical specifications - with the purpose of stabilizing the quality of the manufactured products and also of purchased materials, semifinished products, components, etc.

Company, plant and other local standards, as a rule, do not duplicate federal (national) standards of the USA, but only limit their applicability.

A large number of published works illuminate the practice of applying standardization in the USA. The weak development of theoretical work in the USA, is evaluated as a serious defect in organizing standardization and measures are now taken in the USA for developing theoretical investigations. Characteristic in this respect is the publication in New York in 1956 of a collection "National Standards in Modern Economics", which touches upon many problems of standardization theory and practices and of the significance of science to the USA industrial standardization.

Primary recognition and emphasis are given to the necessity of further deepening the collaboration between science and the standardization practice, which will result in even greater development of mass production.

Here, the contemporary period of standardization is subdivided into two stages:

1) creating national research institutes for maintaining the measuring and quality control equipment at the level of scientific achievements and of the industrial progress related to it;

2) adapting standards into the everyday industrial practices.

Considerable attention is paid in the USA to the history of standardization. K.A. Adams, the first president of the American Committee of Technical Standards, in his work "The National Standardization Movement, its Evolution and Future", presents the history of standardization organization in the USA, which is peculiar (according to the above author), by the following guiding principles: 1) most extensive dissemination of standards; 2) coordination between individual association working in the field of standardization; 3) creating a central standardization organ for elaborating, revising and approving the standards. The future (prospects) of American standardization is considered in a plan of very extensive coverage of electrical equipment and automation objects, synthetic materials and of the use of atomic energy.

Two parallel ways for evolution of standards are in existence. The first of them is based on the activity of various governmental institutions, which systematically implement coordinated development of national standardization. The second way, which is brought about by the fact that national USA standards are not mandatory, is determined by the activity of many private and public organizations, which elaborate and approve all kinds of branch standards. The relationship between company and national standards is considerably weaker and this makes it necessary to fight for their better coordination on a voluntary basis.

In order that the standards be widely used, they should be effective, feasible and economical. The role and significance of the USA National Bureau of standards in industrial progress is emphasized on this basis. This Bureau not only elaborates standards in the field of measurements and other problems, related to properties of materials and various products, but also prepares recommendations for enterprises, which are instrumental in their achieving greatest production economy.

The contemporary works devoted to the role and significance of industrial standardization point out that the purpose of standardization is describing the products or the methods of their manufacture in such a manner that uniformity, coordination and all their accompanying advantages could be achieved under actual conditions. But industrial standardization must be sufficiently flexible in order to derive benefits from improvements in production practices, in the use of new materials and other effective changes in the industry, based on scientific and technological achievements. One of its tasks is establishing tolerance limits, sufficiently wide to economically convenient in production and, at the same time, sufficiently rigid to ensure interchangeability of parts.

In many cases, technical progress in the industry requires developing and improving the existing standards, which by themselves, do not serve as a source of new investigations and of progress. The standards assist the design engineers in developing and perfecting the products in such a manner that their quality should improve and their cost decrease. This, first of all, requires standards for materials, machines and equipment, their subassemblies and components. Proper coordination of the programs of industrial development for a prolonged period requires taking certain measures in the field of standardization on the basis of the assumption that standard accelerate the adaption of results of research work.

The known American scientists, E. Buckingham, the author of the book "Principles of Interchangeable Production", in his new book "National Standards and Company Standards in Interchangeable Production", relates interchangeability with mass production, on the basis of considerations of economic effectiveness. As an example, he quotes the cost of a typewriter: 1200 dollars when produced in single units, and 30 dol-

lars on mass production. E. Buckingham calls standards for mass produced items commercial or company standards. The dimensions of products in these standards are established on the basis of preference numbers series.

Since the industrial enterprises should fight for efficiency, quality and usability of the articles they manufacture, they then should be prepared to extract maximal conveniences from the standard system of preference numbers. It was noted that the dimensions of certain products which were periodically revised (during the entire or part of the standardization development period), have gradually approached the values of preference numbers.

Preference numbers and modular coordination are two useful standardization methods in the USA. Standardization in the USA usually is not applied to a single product (one thing).

The mandatoriness, or nonmandatoriness, of standards are important problems. Prescriptions of the law pertain to industrial safety standards and also to standards establishing systems of weights and measures, units of measurement, etc., on which the reliability and convenience of industrial and commercial operations depend. Other standards, which regulate the strength and quality indicators, can be considered obligatory (mandatory), in those cases, when they pertain to safeguarding the health of personnel and the safety of the population. Nonmandatory standards are valued as voluntary. They are elaborated by the manufacturers or consumers of the products being standardized or, jointly, if an agreement to this effect exists. These standards embrace types of products, gradations of their dimensions and other indicators in order to achieve a certain uniformity, eliminate losses and adapt interchangeability.

Dimensional standardization has been extensively developed. The

name of dimensional standards in the USA applies to those standards which fix individual basic or fabricated dimensions and their combinations in the designs of machines, mechanisms, apparatus and instruments as a whole, or of their parts. The component and subassembly dimensions being standardized are usually chosen in a manner such that they should best satisfy requirements resulting from the dimensions of existing machines and various kinds of equipment, ensuring proper mating, joint operation and interchangeability.

Certain standards, irrespective of their level (national, branch, departmental, company, plant, of scientific societies, etc.) are basic. Basic standards are in force permanently or, at least, considerably longer than those standards which deal directly with production processes and practices. For example, the standard for threads is a basic standard, it does not change and remains stable during a quite long time period, while the standards for the dimensions of bolts, nuts and pins, in which the standard threads are being used, are frequently subjected to changes, which are necessary from the production point of view.

2. SIGNIFICANCE OF STANDARDIZATION TO DEFENSE

The activity of the USA Defense Department in the field of standardization has, as its purpose, to ensure elaboration of standards for the more important supply subjects suitable for mass production.

In the prewar period, the USA Department of Navy, more than any other federal department, has popularized and implemented standardization in practice, which is partially due to the character of activity of this department for which, for example, supplying the navy by interchangeable spare parts is of special significance, since it directly affects the time of ship repairs. In addition, this is of significance in determining the nomenclature of the necessary spare parts, stored in shore warehouses. Standardization was instrumental in solving this

problem. In ordering materials, various products and ship equipment, the USA Department of Navy requires rigid conformance to standards. It, earlier than any other USA department, has begun to present detailed requirements, since the standards serve as a guarantee for quality conformance by the purchased products.

The defense significance of American standardization was illuminated in detail in technical literature.

Watts (the chief of the standardization staff) in his work "Standardization in the Federal Supply System", presents a program for the development of standardization for defense purposes. It provides for standardization of materials, equipment and production methods for those components which are approved for use by the Army, Navy and Air Force and also for standardization of the so-called technical practices and procedures, necessary for designing, supply, production, inspection, acceptance, storage, packing and transporting of defense materials.

Standardization in the practice of the USA Defense Department denotes a process, in which on the basis of common agreement are established all kinds of limits, technical criteria, terms, principles, practical measures, properties of materials, types of products, manufacturing methods (including production processes), characteristics and sizes of equipment, its assemblies, subassemblies and components. From this, the goals of standardization are improving the supply, mobility and operational preparedness of the Army, Navy and Air Force, saving of capital, time, production capacities and natural resources. The following is considered necessary for achieving these goals.

1) to establish minimal quantities of dimensions, types and grades of products;

2) ensure an optimal degree of interchangeability of component parts, used in fighting equipment;

3) develop work in the field of standard terminology, conventional designations, of the system of drawing maintenance and designing, in order to achieve uniform understanding and interpretation;

4) implement the preparation of technical and commercial documents corresponding to the volume and purposes of defense standardization;

5) supply the defense subdivisions with the most reliable equipment, suitable for the designated purposes.

In implementing in the USA of a centralized system of Governmental purchases, standardization is recognized as the basis of an efficiently organized supply system. To avoid parallelism, the supply requirements of defense and civil organizations which are reflected in standards, are coordinated.

The co-incidental accumulation of standards in the USA industry has resulted, for example, in the appearance of various types of threads and fastening components which, according to the aforementioned manual, has resulted during the second World War in losses, measured in hundreds of millions of dollars. The absence of interchangeability between components of American and English tanks was instrumental in the breakdown of many of these machines, due to the fact that no repairs could be made. Only after this happened, were measures taken for elaborating single standards.

It follows from the above, that the ideas of standard elaboration planning become subjects of investigations and find their partisans in American standardization practices. Here, it is assumed that company standards (local standards) should characterize the products by their fabricated dimensions and detailed specifications, i.e. by such technical requirements and specifications, which are necessary and sufficient for mass production.

After the end of the Second World War, a single system of identi-

odes and classification of products used for supplying the Army, Navy and Air Force has been established in the USA. R.E. Gay in his work "On the Significance of a Classification System", informs that about 600,000 new products are launched annually and up to 150,000 products are discontinued during the same period. In each such case, the federal classification system must immediately give identification data.

The federal classification system provides for about 500 commodity classes, each of which includes several thousand products, which practically embraces all defense supply objects. The commodity classes have been distributed among a number of organizations in order to accelerate the elaboration of standards. Thus, for example, elaboration of standards for elements of electrical and electronic equipment has been assigned to the Signal Corps, the elaboration of standards for articles of food was assigned to the Office of the Quartermaster, standards for paints have been assigned to the Navy, etc. Annually, plans for elaboration of standards are distributed to the departments.

3. SIMPLIFICATION AND THE "SSS" SYSTEM

A constant companion of USA standardization is simplification, whose origin dates to the years of the first world war, which has subsequently resulted in the appearance and extensive popularization of the "simplification - standardization - specialization" system, abbreviated as SSS. Simplification is regarded in the USA as the most primitive, simplified form of standardization.

Certain American engineers tend to regard simplification as the first stage of standardization, with the next stage being the elaboration of standards on a theoretical basis. Thus, the term simplification does not denote scientific standardization of product types, but rather standardization based exclusively on experience, predominantly

on sales data. The manual "Increasing the Productivity by Means of Simplification, Standardization and Specialization" is of greater interest to those who study the American simplification and standardization practice, than other analogous publications.

In the majority of cases, compilation of a simplification program in the industry and subsequent consideration of all conveniences, encounters certain difficulties of technical character. In conjunction with this, it was necessary to elaborate certain principles which laid the basis for the work and to use them as guidelines. The most important of these is the principle, according to which the simplification method should always be purposeful.

Simplification results in maximal savings in those cases when pro per agreement of each individual convenience is ensured.

The considerable success of simplification in the USA shows that simplification, properly applied, is useful simultaneously to both the manufacturers and consumers of goods. Despite difficulties in calculations, an attempt was still made to determine the economic effectiveness obtained from simplification. The steel drum manufacturers, for example, have declared that they have achieved the following savings (in dollars) as a result of:

lowering the cost of the necessary inventory and production equipment	10,000
decreasing the need for warehouse space	1,200
cutting transportation costs	1,200
improving equipment utilization	300
increasing the productivity of labor	2,500
improving the product quality	2,000
accelerating the turnover of capital	20,000
improving production planning	5,000
decreasing sales expenses	1,000

These data are characteristic by the fact that they show the economic effect of simplification on such indicators of enterprise operation, as for example, accelerating the turnover of capital, lowering the net cost of production tooling and the amount of various overhead expenses.

The authors of the manual estimate the total economic effectiveness of simplification at approximately 5% of the net cost of products.

4. BRANCH, COMPANY AND PLANT STANDARDIZATION

As appears from standardization works published in the USA, most noticeable influence on the productivity of labor is exerted by those its factors which act directly at the point of production. For this reason, the main emphasis in the American practice is on simplification and standardization within the industrial enterprises and within the branches of industry, i.e. on branch, company and plant standardization.

Branch standardization committees are in contact with a large number of production and scientific and technical organizations. Thus, for example, the National Bureau of Standards maintains contacts with 66,000 companies, associations and individuals. The scale of its operation is characterized by its staff, which consists of over 1200 specialists.

The Detroit Edison Company has a main standardization committee, which determines the total program of work in the standardization field, its goals, principles and tasks. It organized appropriate technical subcommittees. The work program of the main committee, which was elaborated immediately following its formation, provided for: a) elaborating classifications of all materials, semifinished and finished products and equipment used by the company's enterprises; b) establishing a standard terminology; c) elaborating technical specifications; d) decreasing the nomenclature of purchased and used materials, semifinished and finished products by eliminating superfluous brands, kinds, types and

dimensions and by unifying them; e) tying the company's standards to national USA standards. The managers of this company actively participate in standardization work, which promotes extensive use of standards.

The General Electric Corporation has a standardization department created for coordinating the activity of the company's enterprises in the field of elaboration and use of various standards. The scale of this work is characterized, for example, by the fact that about 70 employees of the company constantly participate in the work of technical committees of the American Standardization Association as permanent company representatives. In addition to the above standardication department, this company has numerous technical committees which specialize in individual problems. These committees are made up of specialists of each plant of the given firm which is interested in the object being standardized. The basic principle of adapting standards in this company is not by administrative order to the producing plant, but by increasing its interest in the use of standards. The practice of standards utilization at the company's enterprises has shown that expedient recommendations are accepted by the plants without objections. The company systematically issues collections of its standards.

Since the productivity of labor and industrial safety are interrelated, then the companies were forced to establish a single standardization program in the field of industrial safety. Here, it was acknozledged that it is not mandatory to centralize the standardization of industrial safety, since each production branch can elaborate its own standards. As a result, 20 branch council now exist in the USA, dealing with the elaboration of proposals about industrial safety in different branches of industry.

The practices of branch standardization in the USA in the postwar period can be demonstrated through an example from machine tool

building, where three kinds of standards are usually used, namely: 1) standards of machine tool components; 2) standards used for quality control; 3) production standards. The component standards include standards for elements, subassemblies and component parts of machine tools, the use of which is basically stable. National standards exist for certain of these components, for example, for T-slots, for bolts with nuts for these slots, chucks and chuck jaws for turret lathes and automatic lathes, spindle tips for different kinds of general purpose and automatic lathes, centers, adjustable couplings for multispindle drilling heads, spindle tips and arbors for milling machines, etc. and also precision norms for general purpose lathes and other machine tools. National standards of quality norms for machine tools and in the machine tool building subject field in general are not numerous in the USA. When necessary, the individual companies elaborate their own standards.

However, it should be noted that the National Association of Machine Tool Manufacturers has elaborated a number of temporary standards for general purpose lathes and has attained their acceptance as ASA standards, but this was brought about cy considerable orders placed by [federal] departments. As to the ordinary consumer, he depends on the conscientiousness of the company and does not require performing standard tests when purchasing the equipment. Approximately the same situation has evolved also in the relationships between machine tool building companies and the suppliers of individual subassemblies and components of machines (pumps, hydraulic devices, bearings, electrical equipment, automation facilities, etc.). The local (company and plant) standards in the USA include:

1) technical standards, containing general rules and norms and also designing norms, rules for execution of drawings and testing methods

for products;

2) production standards, used in the manufacture of subassemblies and components and also those extending to equipment and production processes, tolerances and fits (the industrial safety standards are also included here);

3) purchasing specifications (technical conditions) for materials, spare parts, equipment and purchased components.

The subject field of local standardization in the USA is subdivided variously. The following can be remarked with respect to this problem:

1. The practice of limiting the application of national (federal) USA standards, as applied to the production needs of the given company and plant, is widespread. A result of this trend in the company and plant standardization is the widespread use of limiting standards, their subject field due to this, corresponding to the subject field of national standards.

2. Extensive use is made of the so-called specifications (according to the terminology evolved in the USSR, these correspond to standards of technical requirements and local technical conditions [specifications] of plants, SKB, OKB, TsKB, NII and sovnarkhozes). They are elaborated in the closest possible coordination with analogous USA national standards.

3. Wide use is made of standards establishing types and dimensions of individual subassemblies and components used by different machine building branches. A characteristic tendency here is to impart a branch character to these standards. This tendency is based on the feasibility of rapidly obtaining subassemblies and components, provided for in the branch standards, from the appropriate specialized company.

4. Standards of testing methods are characteristic of companies

with specialized production. These standards are of great significance for the development of coordination. In connection with this, trade companies extensively participate in the elaboration of these standards, many of which are of branch character.

5. The subject field and content of standards has been greatly influenced by the use of the preference numbers system. Standards have appeared, containing series of components, subassemblies and more complex products.

6. All varieties of American standards are characteristic by the subject field of industrial safety, including safety rules and norms and also types and dimensions of the corresponding equipment, devices and necessities.

7. Standards exist with respect to the painting and finishing of products.

Standardization of production processes is extensively used in the practice of USA company and plant standardization.

The advantages accruing to the companies due to the development of company and plant standardization include: 1) the extensive prevalence of machines and other products and also interchangeable subassemblies and components of the same type; 2) easier servicing of operating machinery; 3) more reliable basis for comparison; 4) a lesser number of disagreements between the purchaser and seller; 5) simpler tooling up for new production; 6) improved coordination of the entire production at the enterprise; 7) increasing the output per unit equipment.

Standardization makes products commonly accessible and increases the scale of their production; for example, before the production of television transmitters is started, all companies should agree among themselves about a number of standards, so that all television sets produced by different firms would be able to receive with equal success

all the transmitted programs.

The standards of large industrial companies (for example, of the General Motors) are accessible and are used at enterprises of other companies, since their economic interests require the use of precisely these standards. In addition, it is recommended to supplement branch and national standards by individual standards, inasmuch as this is expedient in the output of special products.

Standards of product quality are characterized by the fact that they recommend economically advantageous control methods. These standards are subdivided into four categories: 1) purchasing specifications; 2) production specifications; 3) specifications characterizing the finished products; 4) standards of testing methods. These are primarily company and plant standards. Purchasing specifications provide for physical and chemical characteristics and other requirements put to raw materials. Production specifications include directions about the production process and methods and the necessary equipment. Stringent requirements are put to these specifications with respect to the simplicity of presentation, reachability of formulations and briefness. Specifications (technical conditions) for new products contain detailed information about the quality of products, including physical and chemical properties, external characteristics and other indicators. Standards of testing methods, as a rule, include rules for selecting the type of specimen for testing, the rules for making the specimen, the type of testing equipment, testing techniques and the rules for recording their results.

Standards of technical conditions (specifications) are constantly modified in accordance with the needs of enterprises. Extensive use is made of the method of statistical quality control, based on the use of the basic laws of the probability theory under production conditions.

Establishing the boundaries of limits on the basis of statistical data promotes improving the quality of standards elaboration and, at the same time, makes them more effective from the point of view of economics, since they are instrumental in decreasing the net cost of products.

The above shows the great role played by branch, company and plant standards in the problems of coordinating the materials and tools supply and purchasing operations in the USA industry. As a result of standards the manufacturer knows that he can buy the materials and other products he needs with specific standard dimensions and quality. If this condition is not conformed to (i.e. if standards do not exist), then the supply conditions force the manufacturer to change his production process which sets back the production schedule and increases its net cost. To ensure stable quality of manufactured products, it is also necessary to have standards with precise specifications.

Great significance was acquired by company catalogs listing their products, since they make it possible to rapidly purchase all that is necessary and to eliminate the need for large stocks of implements, various materials and purchased interchangeable products. Compilation of catalogs is regarded as the first step in the elaboration of standards of specifications. The participation in the preparation of specifications standards and in their approval of the manufacturer, consumer, selling agent and other persons expressing interest in the given standard, is mandatory. The participation of all these persons in the elaboration of standards promotes improving the effectiveness of standardization.

Standards are the most concrete means of controlling production processes in the industry, which again emphasized the industrial character of USA standardization. This important property of standardization

not only promotes its development, but also proper utilization of standards irrespective of the degree to which they are mandatory.

The eighth National Standardization Conference in the USA has paid its attention primarily to the problems of savings, which can be obtained from the adaption of standards. Here, it was emphasized that standards are the key to progress and increasing the earnings. It has determined the necessity to elaborate perspective standards; with the need for standards most acutely felt in such fields as nuclear power, electronics and automation. It was noted that it is possible to avoid tremendous losses, confusion and delays by timely elaboration and implementation of standards, i.e. by putting them into force at an earlier date.

A stated goal was to attain a situation whereby the standards will be written in clear and understandable language, will be logically compiled and would not leave doubts with respect to their purpose. Standards are frequently weakened by all kinds of remarks, which are occasionally made for circumventing these same standards. Specificiations should be neither too detailed, not too fragmentary. Extensive representation in committees charged with elaboration of standards, of various branches of industry, consumers and government organizations and solution by their representatives of disputed technical problems, taking into account the interests of the different organizations, was recognized as the most important goal. Here, special attention should be paid to the principle according to which one standard satisfies extensive needs.

In connection with the aforementioned conference, detailed deliberations were conducted about the effect of standardization on lowering the net cost and the selling prices, about the problems of collaboration, helped by standardization, between materials and tool supply

organs with engineering and designing departments and offices, and also the role of standardization in the activity of industrial companies.

The influence of large companies and of monopolies negatively affected, in the first place, the feasibility of achieving in the USA a nationwide standardization of tolerances and fits, threads, material brands and other common technical norms. This has inevitably resulted in the predominating development of branch and company standardization and has influenced the character of the assembly, component and production engineering specialization of production in the USA machine building industry.

Competing companies willingly use standards of other companies, because they can be used as a basis for ordering at a more favorable price and for more rapidly receiving corresponding products, than this could be done in accordance with special specifications.

The interest in the use of standards is due to economic reasons. Company owners seek any sources of income and the standards promote lowering the net cost and stabilizing the quality of the manufactured products. Company employees are interested in the use of standards, since this is encouraged financially and allows them to switch to full-time standardization work where, in addition, the pay is higher.

Characteristic is the fact that despite the widespread unemployment, a shortage of highly skilled standardization specialists is observed in the USA. For this reason, training of them was begun in colleges and also in permanent scientific seminars. Works are published, illuminating the extensive range of standardization problems, and conferences about individual problems are systematically conducted.

It should also be noted, that standardization in the USA, as all other fields of creative activity, is widely advertized and this advertizing is called upon to conceal its main shortcoming, i.e. the nar-

row industrial character. Standardization in the USA, least of all, ensures the interests of consumers.

American scientists and engineers assume that they have created their own school of standardization, which is primarily characterized by branch development and by economic interest of all production echelons in its extensive use in the spheres of production, scientific and technological, commercial and administrative activity. American standardization is distinguished by the variety of its standards with respect to their kinds, purpose and content and also by its terminological uniformity, which is important from the practical point of view. With respect to methodology, American standardization is characteristic by its subdivision into simplified and [standardization] that based on scientific principles. Intercoordination of standards extends to all their levels, which is an important prerequisite condition for developing product specialization and coordination in the industry. Of great practical importance, is work performed in the field of classification of products, regulating the use of main and auxiliary materials and exposure of internal resources.

Despite periodic changes in organization, the substance of American standardization remains the same. It is called upon to increase the war potential and ensure maximum income to enterpreneur.

Chapter 17

NORMALIZATION IN FRANCE, PREWAR GERMANY, THE GDR AND FRG

Normalization has been considerably developed in the machine building industries of many countries. However, the principles and the practices of its implementation are most characteristic of the French and German normalization.

1. NORMALIZATION IN FRANCE

As a rule, French AFNOR normal standards, which ensure interchangeability of joining dimensions of products and establish their overall dimensions, give considerable freedom to the manufacturers with respect to the choice of products designs, their fabricated dimensions and the production methods. It should, also, be noted that theoretical investigations in the field of normalization are developed in France more extensively than in other countries.

The French assume that they have evolved their own school of standardization. They regard normalization as the putting into order of a large number of phenomena in all fields of though and human endeavor with the purpose of ensuring a precise, logical and harmonious order. Normalization in technology has, as its purpose, unification of basic elements of production and equipment, testing methods and ensuring interchangeability, due to which it becomes possible to organize mass or large series production. Unlike normalization, simplification is characterized by limiting, as far as possible, the number of products and their components to a certain limited number, as a result of selecting

from among the best existing types.

The appearance of the theoretical work by Dr. Razu has given rise, in postwar France, to numerous investigations in the field of normalization theory and methodology. In particular, P. Vleton in his work "The consumer and standardization" has substantiated a basic economic method, recommended by him, according to which normalization will equally satisfy the needs of the manufacturer and of the consumer. This normalization enables the manufacturer to rationalize and typify his output. Typification has, as its purpose, concentrating the activity of the company or plant in series production of a limited number of products, i.e. the production cycle is accelerated, the labor time going into it is decreased, the utilization of machines is improved and the net cost is lowered as much as possible, in other words, maximum profit is achieved. Typification, as one of the normalization methods, is used extensively in various branches of French industry.

The consumer of industrial goods frequently does not even notice the difficulties of achieving normalization. His main desire was and is to have the necessary guarantee of the high quality of the purchased product. If the normal standards suit this condition, then the consumer begins to notice them, since they become a brand, certifying the quality. This brand, AFNOR, is widely used and easily idertified.

Present day standardization in France, which strictly pertains to establishing various norms and quality indicators, is less strict with respect to the external appearance of the products. Mandatory and voluntary normal standards exist in France. The mandatory normal standard is distinguished by the fact that its application should be all inclusive and immediate (from the date of adaption).

Plant normalization is limited to production objects of the given enterprise. Plant normal standards are less desirable, since they make

impossible interchangeability of analogous products and their components produced by different plants.

Normal standards establish that quality limit, below which no manufacturer is allowed to lower the quality of their products. However, French normal standards engineers assume that it is impossible to establish criteria which would embrace all problems pertaining to the quality of a given product. They assume that this, in addition, is not necessary from the practical point of view. Basic quality factors, which the manufacturer himself cannot easily and rapidly control, serve as the criterion. For this reason, quality criteria should be elaborated and fearlessly enforced by competent organizations.

Administrative and commercial normal standards are valued as norms giving corresponding guiding direction peculiar to the individual management (administration) and commercial fields. In particular, these normal standards extend to forms of documentation and the rules for filling them out.

Basic normal standards in France incluse those which establish characteristics, indicators, norms, dimensions, etc., suitable for use in various normal standards. Basic normal standards establish preference numbers, the direction of rotation of machines, conventional designations and other general data. All remaining normal standards are elaborated on the basis of the basic normal standards. A special category of normal standards is provided for the so-called prescriptions. They pertain, for example, to industrial safety.

French normal standards are subdivided into:

1) individual normal standards, especially elaborated by the consumer or design engineer, or by an individual shop of an enterprise for satisfying only its own (individual) needs;

2) enterprise normal standards, elaborated with general consent

of the various services and subdivisions of the given enterprise as guidelines in all operations pertaining to manufacturing and selling;

3) normal standards of an association or production branch, elaborated by a group of associated interested enterprises and other organizations;

4) national normal standards, published after receiving comments from interested enterprises and other organizations and individual specialists through the French National Normalization Organization AFNOR;

5) international standards or recommendations of the ISO [International Standards Organization] and MEK [IEC, International Economic Conference], which are a result of international agreement.

As is pointed out in works of French normal standards engineers, duplication of normal standards of different fields of application should not be permitted, i.e. national, branch and all kinds of local normal standards should not duplicate one another. It becomes necessary to closely conform to existing normal standards and prevent issuance of arallel normal standards, indicators and recommendations which would contradict one another. However, the recommended form of normal standards is not conducive to interrelation between the subject field and content of the normal standards.

According to the work of Dr. Verman, which he has performed for the ISO/STACO *, we note that the number of points on the diagram (Fig. 13), corresponding to a combination of the topic, characterization and field of application of the given normal standard, will gradually increase as the given topic is displaced from the lower form of a normal standard to the higher, i.e. from local to national normal standards. Scientific knowledge and newest technological achievements, which are at the disposal of the industry at the given instant, are taken into account in the elaboration of normal standards.

Of primary importance in elaborating national normal standards is analysis of technical and economic needs. Here, still another normalization feature must be taken into account, i.e. conformance of French national normal standards to international standards and recommendations and when these do not exist, conformance to the level of world science and technology. The goals of local normalization on the enterprise scale, according to Dr. Verman, are analogous to the aforementioned goals of national standardization; but a number of French specialists give a slightly different evaluation of the task of local standardization. Thus, for example, it is noted in the work of Dr. P. Razu, that normalization in France does not have as its goal the achievement of uniformity. Items normalized include components, elements of complex products, processed and raw materials, general norms, etc., with the result that creative workers, without experiencing difficulties in the selection of expedient materials, components, etc., can, with lowest expenditures, solve the most complex and original engineering problems.

Series production, together with normalization and mechanization of production, is partially responsible for the decline of small industrial enterprises and workshops. At the same time, normalization facilitates hiring of personnel for industrial and commercial enterprises and increases their productivity of labor. But all this process of perfecting the production process on the basis of normalization, according to Dr. P. Razu, makes it necessary to systematically look out for the so-called "crystallization of progress."

Its substance consists in the fact that normal standards should not slow down the development of technological progress. They should promote the progress, concentrating all which is most progressive and efficient. And this consideration, leads Dr. Razu to the conclusion that

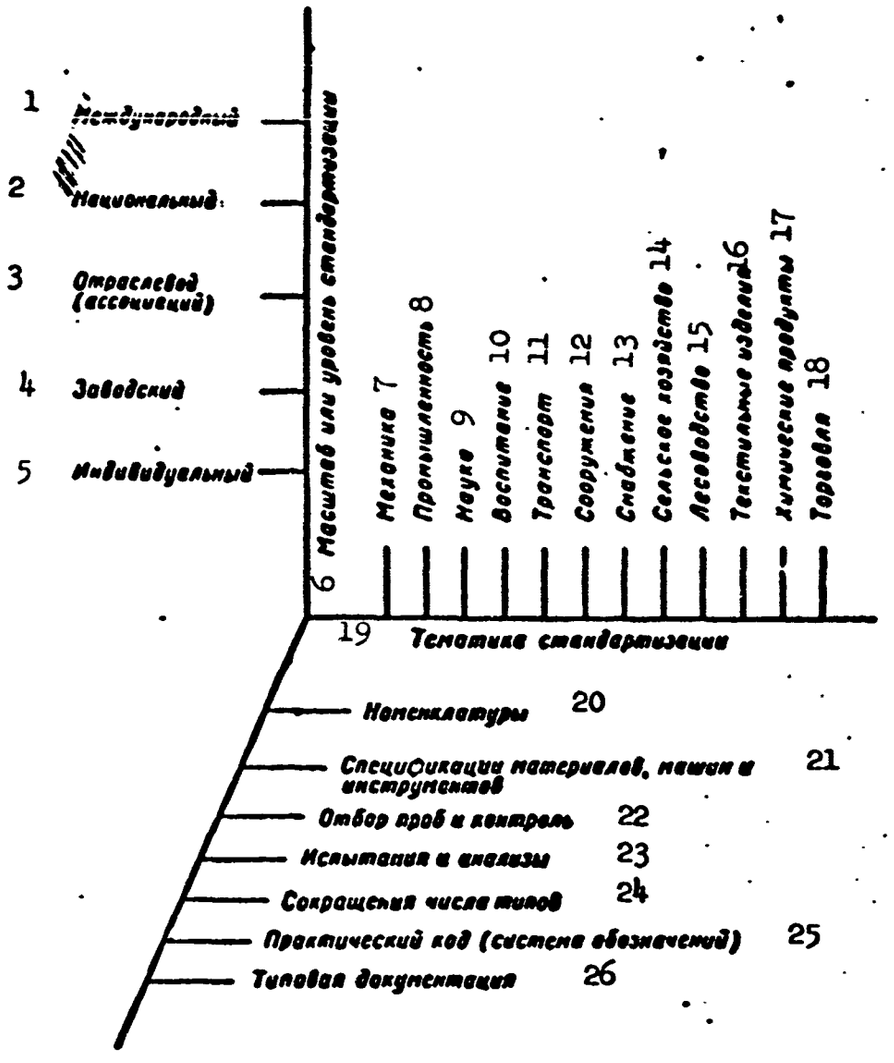


Fig. 13. Dr. Verman's (France) diagram "Formulating the subject field of standardization." 1) International; 2) national; 3) branch (of associations); 4) plant; 5) individual; 6) scale or level of standardization; 7) mechanics; 8) industry; 9) science; 10) education; 11) transportation; 12) structures; 13) supply; 14) agriculture; 15) forestry; 16) textile goods; 17) chemical products; 18) commerce; 19) subject fields of standardization; 20) nomenclatures; 21) materials, machine and tool specifications; 22) sampling and inspection; 23) tests and analyses; 24) decreasing the number of types; 25) practical code (designation system); 26) typical documentation.

it is possible for erroneous normalization ("pseudonormalization") to exist, which can appear in two forms. One of them, takes place in those cases when the relationships between the subjects being normalized and other products are not sufficiently considered. The second kind of pseudonormalization is characteristic by its unsubstatiated exclusion from normal standards of those products, the demand for which is insig-

nificant and whose turnover is moderate. Unlike pseudonormalization, actual normalization is based on convenience, usefullness and efficiency.

Normalization is very extensively propagandized in rance. Many works devoted to the theory and practices of normalization are being published. A great deal of attention is paid to the history of normalization, its peculiarities and, to that effect which it exerts on the industry and economy. The structure of standardization organs, including numerous branch narrowly specialized scientific and technical offices, technical committees and other subdivisions, is regarded as a great achievement, determining one of the features of the French school of normalization.

Normalization was instrumental in the development of branch and product specialization of industrial enterprises. Branch normalization can be demonstrated through an example of casting plants, which produced various castings which are supplied to [other] plants engaged in machining them. These casting plants specialize their output to conform to the needs of one or another maching building branch. This is the origin of the name "branch specialization."

To achieve the greatest possible economic effectiveness, specialization extends to the output of products which are close by their design and production engineering aspects and, for this reason, possesses the greatest number of common features. If such correspondence does not exist, then it can be brought about by normalization. This provides impetus for evolving and reducing to a system, an ensemble of conditions instrumental in lowering the net cost of products and improving their quality, which are mainly achieved by normalizing the product dimensions and the quality indicators. Of importance, is persuasion of the users to accept the decreased nomenclature of the normalized products.

The practical side of this normalization development can be shown through an example of the work of plants of the Arthur Martin company, which manufactures gas stoves, refrigerators and other products. The commercial policy of this company was to offer to its customers the greatest selection of product types and models, which differed by shape, dimensions and color. The number of standard sizes of products reached 250, the number of models was 80 and the number of types was 40. Subsequently, this company has modernized its production on the basis of normalization principles, which required revising the type range and characteristics of the items being produced. The number of types was cut from 40 to 8, the number of models was decreased from 80 to 25 and the number of standard sizes (fabricated versions) was decreased from 250 to 70. The use of white paint only, also had a beneficial influence on the production organization.

The character of normalization problems at small series production plants, is slightly different. In the production of hydraulic turbines, electric locomotives and various heavy equipment, each order is subjected to the most thorough study. The largest series comprises 10 or 20 identical products and, usually, even less than this. When performing normalization at these plants, it is necessary to very thoroughly consider the designs of previously produced machines, mechanisms, etc. For example, an electric machinery plant has previously produced more than 100 various kinds of products. A goal was stated to elaborate one model with several execution modifications based on the use of common subassemblies and components. This has required determining the applicability of various components and subassemblies, clarifying their relationship with other mating elements and the necessary classification. Of several possible classification methods, that one was chosen which allowed the problem to be solved gradually, in three stages.

The first stage of this work involved a preliminary study which consisted in comparing various drawings, exposing common design elements (for example, hole diameters) and the applicability of each of them and also the feasibility of a certain decrease in the number of elements used. But here an attempt was made to retain the existing production methods and tooling. The relatively small increase in the production run length, achieved as a result of this work, has not required changes in the production tooling.

The second stage has achieved grouping of components by their fabrications method, with the purpose of adapting group machining methods. Here, components with different geometric shapes were united on the basis of commonnes of production processes and of typical machining sequence.

The third step, which involves adaption, is subdivided into two parts. The first consisted in successively adapting such measures which can be easily implemented, without waiting for the solution of the entire stated goal as a whole. Components subject to machining were assigned to strictly specified machine tools, placed in a line, with the optimal production schedule determined by the plan. The second part of this stage included unification of design elements, critical analysis of permitted dimensional deviations and improving the machining.

Of considerable interest is normalization in the field of French railroad transportation. This work was made complicated by the fact that the rolling stock of French railroads crosses national boundaries of many countries, which requires considering a number of requirements existing in these countries (overall dimensions of structures and rolling stock, dimensions and point of placement of automatic couplings, braking systems, etc.). Here, tremendous significance is acquired by international and regional standardization.

In conjunction with organizing the International Railroad Union, the normalization conducted in France has touched upon not only general parameters and characteristics, but also types of cars. At the present time, work is done for normalizing diesel locomotives and problems of normalizing equipment for signaling, communication and contact rails of electrified railroads. Certain of the normal standards thus elaborated, have been proposed as drafts of international recommendations.

Branch normal standards pertaining to French transportation machine building and to railroad transportation are coordinated with French national normal standards (standards). The Railroad Normalization Bureau is in constant contact with the AFNOR, the most important work of the former being conducted according to the general AFNOR plan, the remaining being implemented by its own plan. The contact between design organizations and plants with operating organizations promotes the development of normalization, in particular, of unifying the designs and dimensions of components and subassemblies and also providing the rolling stock by interchangeable spare parts. Norms for storing them at warehouses are also a subject of systematic study for normalization purposes.

The French normalization practice uses a concept "polyvalence", characterizing the trend and practice of developing standardization of production tooling and various auxiliary equipment, as well as of parameters of electric power, compressed air and steam, properties and characteristics of lubricants, cooling fluids, safety devices, etc. Determining their optimal nomenclatures and values by normalization methods exerts a substantial influence on lowering the net cost of the manufactured goods.

Local normalization at French plants pertains to measures for study

exposure and utilization of all kinds of internal reserves, including determination of the degree of effectiveness of their implementation. The purpose of this study is lowering the net cost of products. Here, the materials used are normalized first and then normalization is extended to the field of their application and to costs. Thereafter, a study is made of storage and transportation costs, whose indicators are also normalized. This system of work makes it possible for normalization to deeply penetrate all elements of production organization and management at the plant. Normalization becomes a basis on which the entire production planning, accounting and calculations is built.

Normalization of nomenclatures, quality and dimensional characteristics of materials and other elements used, which are united under the "polyvalence" concept, promotes computerizing of accounting operations and sharply cutting the ranks of servicing and auxiliary personnel, which cannot but be reflected in the net cost of products. This also improves clearly defined managerial responsibility.

Normalization at an enterprise with respect to dimensions, properties and other features of the manufactured products is conducted in several stages.

The first stage is classification of products by two basic features: 1) purpose and field of application of the manufactured goods; 2) shape, dimensions, structure, etc. The selection of one or another classification feature depends on the purpose of normalization.

The second stage provides for consultations with the users of goods. Here, the conformance of the given product to their requirements, as well as the degree to which the requests of users is satisfied and the expedience of replacing the given products by others, more modern, is established.

The third stage is characterized by the study of problems of net

cost, conditions under which the goods are sold, delivery schedules, etc.

The fourth stage is direct elaboration of normal standards performed by the plant normalization department (office, group). The normal standard proposal is sent to users, giving the desired deadline by which their replies, with remarks and suggestions, should be received.

The fifth stage involves the study of the standard proposal and of all remarks and suggestions which were received at a technical conference with the participation of the users of the products being normalized.

The sixth stage completes the elaboration of the final normal standard or catalog proposal, which are one of expedient forms of norm documents, which can be used for choosing and ordering the goods.

The normal standards engineer of a plant maintains contacts with the users of the products manufactured by the plant. In connection with this, he must have information on which of the products put out by the plant, can be used by some consumers but cannot be used by others. The normal standards engineer should, better than anyone at the plant, know which kind of products should be entirely discontinued and which finished goods, stored in the warehouses, or which existing semifinished goods should be scraped.

Experience shows that decreasing the number of standard dimensions of components which is achieved by normalization methods, is usually between the limits of 15-20%. The total saving due to the use of standardization at French enterprises reaches 5% of the cost of the goods being made. This saving is mainly obtained by "product versatility", i.e. by more extensive use of the same components and subassemblies, materials and semifinished products, assortments and rolled stock and purchased products for various production objects.

All normalized products carry a special AFNOR label, which gives the right to increase the selling price of products by 10% in exchange for the quality thus guaranteed.

2. NORMALIZATION IN GERMANY BEFORE THE SECOND WORLD WAR

Of certain interest are the practices of German normalization, whose origin dates to the second half of the past century.

The German normalization committee DNA was organized during the first world war, when great expansion of production was required, despite limited material resources. As early as several months after organization, the work of the Committee has taken on such an extensive character that it practically embraced the entire German industry as a whole.

Among the first projects of the German normalization committee, we should count the elaboration of a uniform system of threads, tolerances and fits, i.e. work dealing with interchangeability problems. When the DNA was organized several systems of tolerances and fits were used in the German machine building industry, the most well-known of which being systems of the following firms: A. Kirsh, L. Leve, K. Mar and I. Reynoker, which were developed for about 20 years.

From the enumerated four systems of tolerances and fits, the system of the L. Leve Company, based on results of research work by Prof. Shlezinger, was most extensively used in Germany. Each of the aforementioned systems of tolerances and fits included a system for the shaft and another for the hole and the difference between these systems consisted in the fact that each of them used its own measuring temperature and also had a peculiar approach to the establishing of a zero line. Thus, for example, the temperature for measurements was usually taken as equal to 20°C, while the Leve and Kirsh companies used the temperature of 0°C and the Reynker company used 14°C.

Taking all this into account, the following were the tasks in elaborating a country-wide system of tolerances in Germany:

1) establishing a single temperature for measurements;

2) establishing a zero line;

3) creating a single system instead of two (instead a system for the shaft and of another for the hole);

4) establishing several degrees of adjustment precision, to enable work in accordance with limit gages with corresponding tolerances, not only for the precision but also for other branches, including heavy machine building;

5) establishing a scale of standard diameters for preferential use by all machine building branches.

The stated problems were successfully solved with the exception of one - unification of the shaft system with the hole system could not be achieved. Both systems, due to their specific advantages have become so deeply rooted in the German industry, that it was practically impossible to replace them by a single system.

The methodological works of the DNA note that the activity of the plant standardization office, under conditions prevailing in machine building, has its peculiarities. Its work, especially in the initial period, increases the work load of a part of the plant personnel. In the meanwhile, the tasks of German normalization do not include the creation of anything new. Its tasks are study of existing objects in order to include all that is most efficient and technically refined in normal standards, which promote mutual understanding between the design engineer, consumer and manufacturer.

It was pointed out, at one of the first conferences of German industrial engineers, that the work of the German normalization committee would have been entirely fruitless if production staffs would not in-

clude persons recognizing the great economic significance of normalization.

In years preceding the second world war, normalization was very extensively propagandized. Normal standards were published in technical journals, calendars, references, in special collections, etc. Lectures on individual normalization topics, which were subsequently published in a large number of copes, were held at plants. In addition, a large amount of money was spent for expositions.

In the prewar period, in addition to the intensified elaboration of new normal standards of military significance, reforms were conducted in Germany in the normalization field, which were of military significance and which required certain exertion on the part of the German industry. Thus, for example, the international ISA system of tolerances was made mandatory in 1938, which involved annulment of DIN tolerances in the military industry and related branches. This has provided for far-reaching plans with respect to capture and utilization of the French and Belgian machine building industries, which have for a long time already used the international ISA system of tolerances. In December of 1939, i.e. soon after the beginning of the second world war, Germany has introduced new normal standards for standard diameters and length in accordance with the ISA, which was also a decisive step in the cause of interchangeability, which was of greatest concern to the war industry. Starting with 1 October 1940, the use of inch [English system] threads in festening components, was forbidden entirely.

After Germany has occupied Czechoslovakia, it has immediately revoked all national standards which were replaced by German normal standards. After ISA tolerance system was adapted in Germany, the same system was introduced by the Germans into Czechoslovakia. From this, we understand the practical significance of the enumerated measures in

the normalization field to the war machine of Fascist Germany.

Shortly before the beginning of the war, a large volume of work was performed in Germany in the field of normalization of river shipbuilding, which was due to the substantial development and role of internal water transportation. Normal standards were elaborated for dry cargo, ore carrying and liquid cargo barges with a capacity of up to 3000 tons and measures were simultaneously taken for mandatory adaption of these normalized vessels into operation. With this purpose, the "German Lloyd" has terminated the classification and insurance companies have ceased insuring those vessels which were not built according to the given normal standards. After barge normalization was completed, work began for normalization of tugboats.

It follows from the above, that normalization in Germany was subordinated to militarism. Normalization as actively used for creating the war machine and for implementing the policy of invasion.

After Fascism in Germany was crushed in the war, normalization was given a substantially new direction in the German Democratic Republic. Normalization is now entirely directed toward the development of the peacetime economy of the GDR.

The goal put forward by the GDR is to develop standardization and normalization in a manner such that, on one hand, the socialist national economy should have at its disposal a sufficient number of good standards and normal standards and, on the other hand, systematic suggestions should be introduced on further product specialization. Due to measures taken up to the beginning of 1957, the GDR already had about 2400 DIN normal standards and 900 GDR state standards. Then, the goal was set to bring the number of GDR state standards to 8000-10,000 which will make it possible to fully utilize in the national economy, all these advantages and opportunities provided by standardization.

Technical normalization is implemented in the GDR at various echelons of the national economy, starting with the lowest point - the plant and ending with the central state administration. Various industry management echelons are located between them. Technical normalization within the boundaries of the GDR is called state standardization.

The term standardization, as distinguished from normalization, is used in the GDR to denote the establishing, selection, determining and adaption of one or the minimal permissible number of engineering solutions of one or another problem, which are most profitable from the point of view of efficiency, quality, reliability, significance, to the national economy and its progress. They pertain to common components and elements and also to machines, mechanisms, apparatus, instruments, installations, semifinished products, raw materials, production processes, testing methods, production organization, designations, assortments, physical and engineering units, formulas, dimensions, etc.

3. NORMALIZATION IN THE FRG

The machine building industry of the FRG produces machines, mechanism, apparatus and instruments of the greatest variety of types and service purposes. But still, the heavy machine building, with its characteristic unit and small series production and frequent change of models of machines and other products put out by it, predominates. This imparts characteristic features to normalization.

Contrary to existing opinion, the role of normalization is especially great in unit and small series production. The work by Dr. I. Ikert, "Normalization in individual production," presented by him in June of 1958 in Stuttgart to the conference on problems of standardization practices, is devoted to this problem. While in both, large series and mass production in planning the production program for a certain, relative long time, the designs of machines and other products being

made are known in all their details, in unit machine building, the products of an individual order or only known in general features and production in each specific case, must be preceded by very labor consuming design work. The peculiarities of normalization follows from this.

In I. Ikert's words, normalization in mass and series production usually consists to a considerable degree in selecting and testing existing products and their components and contains almost no creative elements. While in unit production, normalization pertains predominantly to future products, which are yet to be designed. In addition, normalization in unit production, in his opinion, is also charged with planning. The following conclusion, of importance to organization of development of normalization, is drawn from this: it should be more closely connected with design work, since the majority of problems which arise can be solved only by the design office chief, which must constantly consult the normalization engineer who has special knowledge and experience in solving these problems. Here, attention is primarily paid to ensuring profitability to the enterprise.

Normalization functions which ensure a direct economic effect are called by Dr. of engineering Kincle "frequency functions" and "energetic function" of the normal standard. The purpose of the frequency function is to decrease the number of standard dimensions of components which then, as a result of centralization, can be produced in large series with a large economic effect. The purpose of the energetic function is saving of energies by finding a single solution for most frequently reoccuring problems.

The percentage of individual components subject to normalization can be as high as 50%. Actually, this percentage is considerably lower. When performing normalization in order to decrease the net cost, it is expedient to first analyze the current plant expenditures in or-

der to determine their distribution among the individual elements. With this purpose, I. Ikert considers the following case, typical of individual machine building, which characterizes cost elements:

Materials	28%
Wages	11%
Production costs	28%
Total manufacturing costs	67%
Administrative and design expenditures	13%
Total	80%
Installation	15%
Selling and other costs	5%
Grand total	100%

In contrast to mass and series production, the administrative and design costs incurred by FRG plants engaged in unit production of machines comprise a considerable part of the net cost and can be equal to the wage expenditures and even exceed them. In addition, for large production objects, this amount is increased by considerable cost of equipment installation, especially when performed overseas.

It follows from this, that normalization in unit machine building considers the lowering of not only production costs, which is always characteristic of normalization, but also of other expenditures, which comprise a considerable percentage. It is the duty of design offices to most extensively use normalized components and subassemblies, irrespective of the production scale. The purpose of normalization in unit machine building of the FRG is, therefore, creating conditions for producing components in large series and providing a stockpile of these interchangeable components (the frequency function). Normalization of

individual components is considered to be expedient, even if they are produced in single units, if this can even slightly decrease the design cost and accelerate its implementation.

The succeeding extension of normalization of individual components is normalization of subassemblies. Its first stage consists of selecting most frequently encountered subassemblies. As an example, we can use a housing of a reducing unit which can be produced in series for stockpiling. Then, in conformance with an order which is received, the housing is equipped with all the necessary components, including special components. The limit of normalization is achieving the assembly of the entire unit from normalized subassemblies and components. However, this has not yet been achieved.

The large variety of machines results in differing manufacturing conditions. For this reason, special significance is acquired by normal standards which limit the variety of production tooling. Normalization work at FRG plants begins with the selection of tolerances according to the ISA, or other systems. At the present time, lesser importance is ascribed in the FRG to the problem of unification of tolerances and fits, since measurements are increasingly taken over by recording measuring instruments, replacing the previously used gages.

Of great significance to limiting the variety of production tooling is normalization of its elements which are repeated in different designs. Dr. of engineering Kincle uses here the term the "law of prevalence of elements." If the designer is called upon to design varied production tooling, then such work should be facilitated for him. For this purpose, the machine building plant of the Augsburg-Nuremberg joint-stock company has issued a handbook "Production Facilities," showing how it is possible to use previously available tooling in new designs of production tooling, thus eliminating the need for acquiring new tools

and fixtures.

Great significance is imparted to normalization which has, as its purpose, to facilitate and accelerate the assembly of large machines a and their assembly at destination, since any decrease in the number of the necessary installation tools and fixtures, reduces the cost of expensive overseas freight.

A new normalization methodology, in which certain components dimensions remain open, i.e. are not normalized, has been considerably developed in the FRG. This means that the component design is normalized only in principle. In each individual case, the designer, using the so-called blank-drawing, inserts into the latter all the necessary dimensions. Each such drawing is assigned its individual number. Subsequently, these drawings can become a basis for elaborating a more complete normal standard, if similar dimensions, which can be arranged in some series, are exposed.

Unit machine building plants in the FRG very rarely receive repeat orders for previously produced machines or other products. In order to limit the increasing variety of possible designs, I. Ikert recommends to single out optimal designs, parameters and dimensions which would then be utilized in the elaboration of individual drafts. This system of preference parameters and dimensions has, in its time, become very controversial. However, experience showed that systematic gradation of dimensions has substantial advantages in certain fields. We can bring here many examples, starting with various parameters of steam tube-boiler installations and gas turbines and crane lifting capacities and ending with the output and other parameters of pumps, compressors, air blowers and air pipelines, the normalization of which has previously encountered difficulties.

Suppliers of machine building products should conform as close as

possible to normal standards, since any deviations from them cause unnecessary loss of time and increased prices for products of coordinated enterprises. Despite the fact that this is obvious, the joining and installation dimensions of electric motors have not been standardized in the FRG, which makes it necessary in each individual case to order electric motors instead of obtaining them from available stock.

The weak development of normalization of conventional designations results, at FRG plants, in unnecessary labor time spent in executing drawings.

A great deal of attention is paid in the FRG to organizing the storage of materials, semifinished and finished products. This is due to the fact that the warehouse of a machine building plant should have the required capacity and, at the same time, be suitable for storing not only those kinds of purchased products which are known to the plant at the present time, but also of prospective goods. Warehouse managers, together with the normalization department, should find an optimal solution with respect to the needed nomenclature of materials, semifinished and finished products, so as not to idle the operating capital and not to cause production stoppages, taking into account the fact that the characteristic of future production objects cannot be determined beforehand. Timely choice of material brands and profiles also involves certain difficulties. Underestimating the future need for some given material brands or profiles may cause lengthy delays in obtaining them.

In order that the new DIN normal standards for steel be economical and the use of different brands of steel be more effective, I. Ikert has suggested that hard (stable) prices be established for each steel group, using coefficients. This will enable the design engineers to make a more considerate selection of steel brands. The introduction of new normal standards for steel will put on the order of the day, the revo-

cation of departmental specifications which are in force, for example, in the Department of Railroads of the FRG.

Many machine components, for example shafts, cannot be normalized due to the evident variety of dimensions and other characteristics, but their manufacturing process can be normalized. This justifies the expedience of typifying and normalizing the production processes. Subsequent development of this normalization should result in the appearance of new kinds of normal standards, which are called "manufacturing normal standards."

The degree to which products are covered by normalization is considered in DIN 820 in three aspects: extent of coverage denotes total requirements put to specific finished products; depth of coverage is the completeness of coverage of all kinds of products; and volume of coverage which denotes the limits (field) of normalization coverage. The following explanations of these normalization aspects are given in DIN 820. Frequently, requirements which are put to finished products are given in different normal standards which, in their turn, belong to different groups. This shows the extent of normalization coverage. The depth of coverage differs in different normal standards. The majority of normal standards for dimensions should limit the number of dimensions in order to increase the production run length. Conversely, normal standards for testing methods have a tendency to expand the number of methods being used, in order to achieve positive possibility of comparing test results. The volume of normalization coverage depends to a large extent on the practical necessity and technical feasibility.

The procedure for elaboration of normal standards, their issuance and revision is also included in DIN 820, i.e. it is normalized. Thus, DIN 820 establishes all basic methodological rules and normalization procedures, which is very expedient from the practical point of view.

To get the proper concept of the normalization procedure of a given product, or its elements, the following must first be established:

1) for which elements, or characteristics, of the product being normalized can a normal standard be elaborated?

2) what general or particular goals should be achieved, as a result of implementing the normalization?

3) what are the relationships between the given normalization object and other possible objects of norma ization?

The first question involves the study of a large number of normal standards, with the purpose of exposing certain elements which reccur in different normal standards. Then, a list of such elements, classified by the following six groups, is made: 1) explanatory and descriptive notes; 2) data pertaining to the shape, dimensions, etc.; 3) information pertaining to materials; 4) guidelines for use; 5) directions with respect to methods of calculation; 6) other information and directions.

The task pertaining to the second question is to develop normalization, so that the following will be ensured: 1) achieving saving of labor, time, power, etc.; 2) providing for orderly production; 3) interchangeability; 4) commercial advantages; 5) achieving production savings; 6) decreasing the area and volume of the required warehouses; 7) scheduled deliveries to consumers; 8) improving the product quality; 9) unification; 10) required industrial safety precautions; 11) proper protection from fatal accidents in operation; 12) promoting technical training and education of personnel.

With respect to the third question, it is necessary to clarify the existence of interrelationships between the products being normalized and their similarity and, also, the existence of an ordered relationship between individual normal standards. These relations are also of

importance in establishing the procedure for elaborating normal standards.

The thing which becomes immediately apparent when considering the state of normalizatien in the FRG, is its scale. It has penetrated into all fields of mental labor, of production and cultural life. What is the purpose of such extensively developed normalization? In the opinion of FRG normalization workers, each normal standard "puts into order,"; with the normal standards representing a certain system, i.e. composing levels and series. And each of the normal standards is a part of "systematic putting into order." However, any system is a compulsion of its kind, which should be flexible enough not to slow down industrial progress and not to suppress creative activity. FRG specialists feel that the practice of DNA operation has proven that this can be achieved. The harmoniousness of FRG normalization is based on flexibility of normal standards. A specified sequence is followed in their elaboration. If one of the normal st ndards established certain designations and dimensions, then they are thoroughly considered in the elaboration of other normal standards.

It is pointed out in one of the methodological works, that each individual normal standards depends on another and that the entire normalization work is accompanied by a search for orderly construction of this relationship. It follows from this, that the concept "basic normal standard" is not considered in the absolute sense, but only with respect to another normal standard. The normal standard is basic to the extent to which it supplements another special normal standard.

With this as a starting point, DNA normalization practice has evolved a procedure whereby the elaboration of any new normal standard is preceded by the most thorough analysis of previously established normal standards, in order to determine the feasibility of using them as

basic standards. On the other hand, it is [also] taken into account that the special normal standard being elaborated can subsequently become a basic normal standard with respect to some other normal standard. From this, each normal standard should be integrated within the general intercoordination system. This is the basis for full value utilization of DIN normal standards.

The following system of interrelation between newly elaborated normal standards has evolved in the normalization practice. Normal standards for conventional designations, which can be used without limitations in any special normal standard, are normal standards more general in character than, for example, a normal standard for testing of materials. A normal standard for testing of materials under specific climatic conditions is even more narrow.

A very extensive or, conversely, limited application of a certain normal standard does not always make it into a basic normal standard and only points out to the feasibility of using it for wider, or narrower purposes. Here, the problem of whether the given normal standard has been put into effect by special measures (orders, directives) by interested departments, or whether it has been introduced in another manner, is of no decisive importance.

Indicators, dimensions and other technical characteristics given by DIN normal standards are voluntary and expedient. The normalization system "special normal standard - basic normal standard - adjoining fields" is not a frozen, but a changing, harmonious system, the stability and refinement of which depend on a number of factors.

During a long period of time, the DIN normal standards have served as a basis for product brand designation. Reference to DIN was regarded as a characteristic of the product quality. The brand of quality is DIN normal standards was always a special concept, differing from

the concepts of an "industrial brand" and other characteristics of product quality.

The functions of the central organization for introduction of brands are in FRG discharged by the Committee for supply conditions and ensuring of quality, at the DNA. Its tasks consist in consulting organizations participating in ensuring quality and in collaboration with departments, ministries, patent offices and the Union of Cartels. In a number of cases, the quality indicators which are characterized by the brand are based exclusively on DIN normal standards (for example, quality brands for plastics, laboratory accessories and other products).

It follows from the above that normalization in the FRG, based on the work of the DNA and on the DIN normal standards which it issues, is in the stage of methodical research. Its initial range of activities embraced common machine subassemblies and components, tools and elements of production tooling. Then, it has become necessary to establish uniform requirements to ferrous and nonferrous metals and alloys, plastics and other nonmetallic materials. Then, a need has become apparent for establishing parametric and dimensional series for many kinds of equipment. The limits of normalization are constantly expanded and it has, to a considerable extent, become in the FRG, that field of activity of scientists and engineers which is known in the Soviet Union as standardization.

4. CERTAIN CONCLUSIONS AND REMARKS

The existing terminological confusion has resulted in a situation in which the French and German normalizations, which are called by the same name, actually differ substantially from one another.

Normalization in Germany has arisen during the first world war and has, subsequently, been always considered as an important military measure. Having adapted to its industry the international system of tole-

rances and fits, Fascist Germany has created convenient prerequisite conditions for its conquest and utilization of the French and Belgian industry for war purposes, which could not but influence the course of the war.

The fact that German normalization has arisen in war time, has also affected the methods of operation of the German normalization committee DNA. Elaboration of normal standard proposals, which was conducted at plants and in technical commissions, was regarded as the preliminary stage. The normal standard proposals were put in their final form, prior to approval by DNA workers. This work method, which has evolved during the first world war, was permanently retained, which accounts for the substantial difference between the German and American practices. In the USA, a federal standard proposal is put into final form by one of the branch, company or local organizations and this is the form in which it is presented for approval by the central organization. It either approves the proposal as submitted, or rejects it without any revisions.

French normalization is characteristic by the fact that all the work, from start to finish, is performed by specialized technical committees.

Why has the activity of specialized technical committees or commissions been developed in a number of countries? Primarily, because these committees or standing commissions combine the experience of many specialists from different organizations. They keep track of all their normal standards (standards) and, at the same time, revise them. This committee (or commission) is the creator and master of the normal standards or standards which it has elaborated and since a relatively small number of them exist with respect to any special problem, it is not too difficult to keep detailed track of the state of standards and normal

standards. For this reason, more extensive expansion of the activities of specialized committees (commissions) to the entire subject field of machine building normal standards and to a large part of the subject field of domestic standards, should be recommended.

A problem of importance is the completeness of normal standards content. The French and German practices with this respect, are diagonally opposite. The French fix in their normal standards only the basic dimensions, characterizing the standard ize of the product. The German fix the fabricated dimensions. What causes both these nations to hold on to its system?

French normal standards are oriented on specialized production units. For this reason, it is important to specify the type range of the normalized products and the fabricated dimensions are determined in the working drawings of the specialized enterprises, which reflect the limitations of their production setup. The German work out their normal standards for existing plants, independently of the character of their product, or component specialization, on the assumption that the plant, using the DIN normal standards, manufactures all the products it needs. The DIN normal standards, as conceived by German normalization leaders, effect savings primarily in design work, freeing engineering personnel of the plant from having to spend its time and effort in elaborating technical documentation for all those products which are already normalized.

Development of normalization in France and in the FRG is accompanied by the elaboration of scientific fundamentals and methodolical principles. A search is in progress for new normalization methods with the purpose of more extensive coverage of machine building and instrument making elements. A profound revision was begun of theoretical normalization problems, directed toward increasing its economic effective-

ness. Such new concepts as pseudonormalization, polyvalence, crystallization of progress, product versatility, frequency functions, the energetic function of normalization, etc., are considered from the practical points of view. The operation of the law of prevalence of common elements in machine designs is studied, a system of optimal designs and, also, the feasibility of achieving normalization of components on the basis of the methods of their manufacture, rather than the generally used normalization of components on the basis of their functional design and dimensional features, is analyzed.

Methodological work includes the search for a normalization system which could ensure a wider coverage of individual and small series production by normalized elements. Of interest also to work performed in the field of normalization of indicators of the consumption and storage of basic and auxiliary materials and of establishing stable coefficients, reflecting the relationships between prices of different brands of steel.

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Chapter 18

INTERNATIONAL STANDARDIZATION

First actual standards which, however, were not officially approved, but extensively recognized in their international capacity, were metric units of weights and measures which are, at the present time, used by over 40 governments including the USSR.

The official origin of international standardization belongs to the 70 ties of the past century, when a proposal was made of international units in the field of electrical equipment. But it was only in 1921 that the first conference of seven national standardization committees, which has established specific organizational principles for the development of international standardization, has met in London.

1. THE INTERNATIONAL ORGANIZATION FOR STANDARDIZATION ISA

The first international standardization organization was created in 1926 and was named "The International Federation of National Standardizing Associations - ISA." Its charter was elaborated in New York in 1926 and was formalized in Prag in October 1928. The ISA was comprised of about 20 national standardizing organizations of various countries.

The tasks of the ISA included: 1) evolving methodological bases for international agreements in standardization problems; 2) elaboration of guiding standardization principles to assist the national organizations in their work; 3) uniting standards elaborated by the different national standardization organizations.

The ISA has laid the groundwork for international collaboration in the field of standardization. As a result of its activity for unit-

ing the national standards, 32 "ISA Bulletins", including about 130 international standard proposals were elaborated and recommended for use.

"The International Federation of National Standardizing Associations" has ceased its activity in 1942, although the second world war has caused certain nations to leave this organization as early as in 1939. The last ISA conference took place in June 1939.

2. THE INTERNATIONAL ORGANIZATION FOR STANDARDIZATION ISO

The Standards Coordination Committee (SCC) at the UN, consisting of 18 member nations has, in 1944, replaced the former ISA. After the end of the Second World War, the ISA organization has lost its significance, since the conditions required another form of work in the field of international standardization. On 14 October 1946, representatives of the SCC at the UN have assembled in London, together with delegates of national standardization organizations of member nations of the SCC, in order to deliberate and approve a charter of a new international organization and also to compile proposals of recommendations for the development of technical work. As a result of a discussion in which participated 65 delegates from 25 countries, it was decided to form the International Organization for Standardization - ISO.

The preliminary meeting of the General Assembly of ISO took place in London on 24 October 1946. The basic documents of the ISO, i.e. the charter and procedural rules were unanimously approved at this meeting. It was decided that the ISO will begin to function officially, when these documents will be ratified by fifteen national standardization committees. The fifteen required ratifications were received by the provisional general secretariat of the ISO on 23 February 1947. The charter and rules of procedure were subsequently approved by many other national standardization organizations, which participated in the London conference or desired to become members of the ISO after it was formed.

The ISO charter gave this definition of the organization's goal: "The goal of standardization is to promote favorable development of standardization in the entire world in order to provide for international exchange of goods and to develop mutual collaboration in the field of mental, scientific, technological and economic activity." To achieve this goal, the ISO may: a) take measures to facilitate coordination and unification of national standards and to publish the necessary recommendations for its members; b) establish international standards, conditioned on agreement of all members; c) promote and facilitate the use of new standards, which contain general requirements and which can be used in national, as well as in the international fields; d) organize exchange of information about the work of its members and technical committees; e) collaborate with other international organizations interested in similar problems, especially with respect to standardization work.

Membership in the International Organization for Standardization is open to all national standardization organizations which have expressed their readiness to abide by the charter and procedural rules and which can be accepted into the organization, in accordance with the procedure established by these rules. Here, only one standardization organization of a given country can become a member of the ISO.

The ISO, being an international nongovernmental organization, has the status of a consultant to the UN. The ISO representative maintains connections with the Main Administration of the UN and a liaison assistant maintains connections with the UNESCO with which the ISO also has an agreement establishing its status as a consultant. The ISO keeps in touch with local commissions, with the organs of the general secretariat with the majority of specialized UN agencies and with the Economic and Social Council of the UN.

The official languages of the ISO are: Russian, English and French.

The functions of the general secretariat include the execution of and obtaining the consent for, the entire technical activity of the organization. He checks for conformance with the charter and procedural rules of the ISO and direct to the organization's members, information obtained by him pertaining to standardization work performed by other international organizations. In order for the general secretariat to be able to inform the Council and the membership about technical work, whether in the process of implementation or of planning, he is supplied by technical committees of the organization by copies of all documents pertaining to their work, including also an annual report of activity. The general secretariat prepares and presents to the Council, an annual report describing the organization's activity during the year.

The general secretariat publishes the ISO Journal and its supplements, which periodically contain information about the composition of administrative organs, lists of acting technical committees and subcommittees, information about changes in the membership of the organization and of its technical committees, about the approved international standards and ISO recommendations and also data about forthcoming meetings of the General Assembly, Council, technical committees, subcommittees and working groups and other information.

3. THE TECHNICAL COMMITTEES OF THE ISO AND THE SUBJECT FIELD OF THEIR WORK

The basic function of the ISO, consisting in elaborating, debating and presenting for approval by the Council of international standard proposals, is discharged by specially created technical committees (ISO/TC) and subcommittees (ISO/TC/SC), each of which specializes in a specific field. Each technical committee is assigned an ordinal number

and name, reflecting the profile of its work, its specialization. For example: ISO/TC 1 - "Threads"; ISO/TC 3 - "Tolerances and Fits"; ISO/TC 10 - "Drawings"; ISO/TC 22 - "Automotive Vehicles"; ISO/TC 23 - "Agricultural Machines"; ISO/TC 29 - "Tools"; ISO/TC 39 - Machine Tools," etc.

The members of a technical committee may agree to establish a subcommittee, which is charged with the study of one or several problems pertaining to the given technical committee.

At the present time, more than 100 technical committees and 50 subcommittees are in operation.

A technical committee is formed from among the organization's members which have expressed their desire to actively participate in the work of the given technical committee. If the majority of members does not object to the formation of the technical committee and if at least five members of the organization desire to take an active part in its work, then such a technical committee should be formed. Before the technical committee begins its work, the extent of its work should be clearly defined. In accordance with the ISO rules of procedure, the field and volume of the work of a technical committee must be approved by the Council. They can, subsequently, be modified only by a decision of the Council.

4. THE STRUCTURE OF THE ISO

In addition to technical committees, subcommittees and working groups, several additional permanent committees subordinated to the organization's Council have been formed, which are charged with the study of problems of general order in order to improve the organization of work in the field of international standardization.

The Planning Committee (PLACO) was formed in order to achieve coordination of work of those technical committees with interconnected

work fields. For example, ISO/TC 5 - "Pipes" elaborates international standards for pipes from ferrous and nonferrous metals and from plastics. These standards, in addition to dimensions, usually have specific requirements to the material from which they should be made. At the same time, problems of materials quality and of standardizing their brands, are the field of work of technical committees such as: ISO/TC - 25 "Pig Iron," ISO/TC 26 - "Copper and Copper Alloys," ISO/TC 61 - "Plastics," ISO/TC 17 - "Steel" and ISO/TC 79 - "Light Metals and Their Alloys," and in the field of technological problems such as ISO/TC 11 - "Unification of Norms for Boilers," ISO/TC 67 - "Materials for Petroleum Pipelines and Other Stationary Installations in the Petroleum Industry," etc. This specialization, naturally, makes it necessary to precisely separate controversial problems which arise in the process of their work. These are the tasks of the Planning Committee.

The PLACO is composed of representatives of national organizations i.e. of ISO members, personally appointed by the President and approved by the Council. Their membership tenure is not limited. PLACO consists of four persons, which number can be increased by request of any member of the organization, if a desire is expressed to include its representative. The PLACO conducts its work by correspondence. Once a year, the members of this committee meet, consider their suggestions and submit them for approval by the Council. If the Council approves these suggestions, they are published and sent out to members of the organization as the Council's recommendations.

The Directives Committee (DICO) consists of four members, including the secretary general of the organization, which are annually appointed by the president. The tasks of the DICO include periodic consideration of directives for the work of technical committees and elaboration of suggestions for their improvement and change. The DICO also

considers proposals of technical committees and of the secretary general pertaining to the above field and provides the Council with comments about requests by the organization's members with respect to interpretation of directives. After the interpretations submitted by the DICO are approved by the Council, they are sent out to the organization's members and to secretariats of technical committees.

The Redacting Committee (REDCOM) consists of four members, appointed by the Council annually from among the organization's members to assist the secretary general. The REDCOM's functions include the study and elaboration of proposals with respect to formulation of ISO recommendations pertaining to presentation, the order for placing the materials, kinds of type, etc.

The control committees, provided for by the organization's charter, consists of a vice president and treasurer and also of one Council member, elected by the Council for one year (for the period between two Council sessions). The tasks of this committee include assisting the organization's president in checking the activity of the general secretariat of the ISO.

The Standards Index Catalog Committee (SICC) consists of four permanent members, appointed by the Council; the SICC elaborates the form of index cards (for index catalogs), in which the published standards and recommendations are recorded and the order for their use is given; it organizes exchanges of these cards between the organization's members, for which purpose it issues appropriate instructions which go into force upon approval by the Council.

The Committee for Study of Scientific Standardization Principles (STACO) should consist of the most informed scientific experts, which elaborate problems in the field of standardization chosen by them and provide them with a scientific basis. Each of the members of STACO has

the right to express his opinion or to present any proposal with respect to standardization problems.

The opinions and proposals of each STACO member are considered by the organization's Council and are then submitted for familiarization and utilization by the organization's members and by technical committees. The representative of any national standardization committee is eligible for membership in STACO. The number of STACO members is not limited. STACO sessions are held annually.

5. THE PROCEDURE FOR ELABORATING AND APPROVING INTERNATIONAL STANDARDS

The elaboration and approval of international standards and ISO recommendations takes place in accordance with rules established by "Directives for Technical Work," approved by the ISO Council. In order to make a clear distinction between the stages of elaboration and approval of a national standard, or an ISO recommendation, these directives recommend to use the following terms and their definitions in the work of technical committees:

1. Draft proposal is the initial draft of an international standard or recommendation prepared by the secretariat of the ISO/TC and submitted to members "P" of the corresponding technical committee for consideration. If the following standard or recommendation drafts on the same topic are also elaborated at this stage, then they are called: "The second draft proposal"; the third draft proposal," etc.

2. Draft of an ISO recommendation is a draft of a proposal approved by the majority of "P" members of the corresponding technical committee and submitted to all the organization's members for consideration.

3. An ISO recommendation is a draft of a proposal, approved by the majority of members and by the organization's Council.

4. An ISO standard denotes the case when no member of the organi-

zation expresses objections to transform an ISO recommendation into an ISO standard.

The following is the sequence of elaboration and approval of an international recommendation or an ISO standard.

The ISO/TC secretariat prepares the first draft proposal, taking into account: a) data, collected as a result of investigations performed in the course of consideration of the proposal and also during the study of any other problem submitted by one or several members of the organization; b) information collected from other sources, including ISA bulletins. After the draft proposal is elaborated, the secretariat of the corresponding technical committee prepares an "explanatory report," including the history of the problem list of documents serving as the basis for studies and argumentation in support of the draft proposal.

The first draft proposal and explanatory report are sent to:

1) "P" members of the technical committee with a notation "for consideration and deliberation,"

2) "O" members of the technical committee with a notation "for information." Each "P" member of a technical committee is required to compile remarks about the submitted draft proposal and to send them to the ISO/TC secretariat and to other "P" members of the same committee. In addition, the first draft proposal is sent to the general secretariat of the ISO.

The draft proposal is considered and agreed upon at a meeting of the members of the ISO/TC, called by the secretariat of technical committees (upon agreement with the general secretariat), at which "P" members have the right to vote, with the "O" members present as observers. If the submitted draft is not approved by a majority of "P" members of the given technical committee, then the secretariat revises it,

taking into account the available comments and submits a second draft proposal, which then passes all the consent stages passed by the first. This procedure is repeated until the draft proposal is approved by the majority of "P" members of the given technical committee and is given the right to be called "Draft of ISO recommendation."

If any of the organization's members has not sent in a reply within four months, the general secretariat should send him a second reminder with a request to reply within another two months If the recommendation draft was not approved by the majority of the organization's members, then the secretariat of the technical committee may prepare a second draft of an ISO recommendation for resubmission to all members of the organization. In the case when the draft of an ISO recommendation was formally approved by a majority of members, then the ISO/TC secretariat prepares a final report consisting of a description of the revision of the problem, remarks by the organization's members and a list of those members which have either partially or wholly approved the recommendation draft. The ISO recommendation draft and the final report is sent by the ISO/TC secretariat to the secretary general for submission to the organization's Council; the Council decides by a majority of votes whether the recommendation draft should be approved as an ISO recommendation. The Council may also introduce a resolution about submitting the ISO recommendation to the organization's members in order to ratify it as an international standard.

The international recommendations and ISO standards are published by the general secretariat. Recommendations are usually issued only to the organization's members. International Standards can be issued to any interested organization.

The right to reprint international recommendations and standards is vested in the organization's members. Accordingly, the right to re-

produce these documents in each country is vested only in the national committee of standards.

A request for revision of international recommendations and standards, with supporting documentation, is sent to the general secretariat which submits it for consideration and decision to the organization's Council. If the Council agrees to revise the international recommendation or standard, then it assigns this work to the appropriate technical committee.

6. PARTICIPATION OF USSR ORGANIZATIONS IN THE WORK OF THE ISO

The Committee of Standards, Measures and Measuring Instruments at the Council of Ministers of the USSR is the Soviet Union's representative in the ISO. Our national standardizing organization was an ISA member starting with 1926 and an ISO member starting with 1946. The Soviet Union's representative is a member of the organization's Council.

At the present time, the USSR participates in the work of 46 different technical committees and an active member ("P" member) and obtains information from 26 [more] (as an "O" member). In addition, the Committee of Standards, Measures and Measuring Instruments performs the function of the secretariat for three technical committees, namely: ISO/TC 55 - "Coniferous Lumber"; ISO/TC 57 - "Surface finishes" and ISO/TC 65 - "Manganese Ores."

Membership in the ISO, gives Soviet organizations the right to obtain, by mutual exchange, national standards of other countries and the necessary information about the achievements of world's science and technology. This information is correlated by the secretariats of ISO technical committees in the process of preparing a given international standard or recommendation. At the present time, the library of the Committee of Standards, Measures and Measuring Instruments disposes of about 100,000 foreign standards; in addition, this library systematical-

ly receives 25 various foreign journals on standardization problems issued by national organizations - ISO members.

In order to popularize and develop work in the field of international standardization and also in order to engage in the ISO activities a wider circle of highly-qualified specialists from different branches of the national economy, the Committee of Standards, Measures and Measuring Instruments familiarizes representatives of plants, design organizations, scientific research institutes and also individual specialists with the international standardization work. They participate in the consideration of materials supplied by the ISO and its technical committees, in preparing comments and suggestions about ISO documents. As members of Soviet delegations, they participate in meetings of technical committees, subcommittees and working groups which are now called into session quite frequently. Soviet organizations perform work in the elaboration of international standard and recommendation proposals directly in secretariats of those technical ISO committees, which are assigned to the USSR.

To this, we should add that the subject field of technical committees in which the USSR participates is quite varied and touches upon a very wide range of scientific, technological and production problems of many branches of the national economy. Representatives of Soviet organizations perform systematic work as permanent members of commissions which work systematically on individual problems of international standardization. This method of work has justified itself, since it has not only made possible to rapidly prepare objective comments and suggestions about ISO documentation, but has also made it possible to keep interested specialists fully informed about international standardization. Simultaneously, the exchange of experience and information about latest achievements of science and technology has also improved.

International standardization increasingly develops with every passing year.

Participation in ISO work widens the horizons of Soviet specialists and make it possible for them to critically evaluate the state of individual technical problems in many countries of the world. This work is of substantial significance also with respect to methodology, since it develops new organizational forms, in particular, it adapts to Soviet standardization practices the method of analyzing a problem in specialized commissions (teams), composed of highly-skilled representatives of different organizations.

The development of international standardization is also of great significance in ensuring coordination of USSR standards with standards of People's Democracies and of other countries, which buy industrial equipment in the USSR and which use technical assistance of our country. The interaction between standards should also be ensured in connection with coordination of the industries of Socialist countries. This necessitates not only proper development of regional standardization, but also elaborating appropriate principles and methods for its implementation.

7. PROBLEMS OF THE METRIC AND INCH [ENGLISH] SYSTEMS OF MEASUREMENT

Two systems of measurements are extensively used in the world at present - the metric and the inch [English]. The metric system is used in the USSR, all People's Democracies, GDR, FRG, France, Italy, Sweden and Switzerland and many other countries. India, has recently converted to the use of the metric system. The English system is used in the USA, England, Canada, Australia, Holland, etc. The advantages of the metric system do not require proof and, therefore, the Soviet Union firmly insists on the use of this system and decisively supports it in the ISO as the basic system of measurement.

Characteristic is the fact that the metric system of weights and measures was legally recognized in the USA as early as in 1866 and in in England in 1873, but was not properly developed in these countries up to now. These countries even now object to establishing the metric system as basic. By request of the majority of ISO members, the metric system should be regarded as basic in all countries where this is the state system.

This topic serves as grounds of heated discussions which took and are taking place in the ISO, giving rise to numerous and, sometimes, considerable difficulties. It is necessary to find a way out which would to some degree reconcile these principal differences.

It may be assumed that the English system will be in use for a considerable period of time. A transition from series of dimensions to another, or from one system of measurements to another, can be achieved only gradually, as new designs are being produced, when the technical and economic advantages of this transition become evident.

Considerable work on the problem of compatibility between the metric and English system was performed in India. Its results are reflected in the Indian standard JS 787-1956.

8. REGIONAL STANDARDIZATION

Regional standardization is an effective variety of international standardization. Its prevalence is limited by the interests of the given group of nations.

The first regional standardization system was called "ABC" (which are the Latin initials of countries participating in this regional system: America - Britain - Canada). It has, as its basic goal, the unification of armaments and of all which is connected with the armaments production of the USA, England and Canada. For this reason, the ABC system should be characterized as militaristic, since all the remaining

economic, scientific and technological and other problems are subordinate in characters.

The regional standardization system embracing the Socialist countries, has an explicit economic character. Its goal is promoting the economic and scientific and technological flowering of Socialist countries, the specialization and coordination of their industries and the development of commercial relations.

With this purpose, for many years now, systematic work is performed for unification of national standards and preparation of general recommendations which harmoniously take into account the interests of each country.

Up to September of 1960, about 100 recommendations were approved about unification of standards for the more important kinds of machine building, electrical equipment, metallurgical and other products. Of great significance, is unification of threads, tolerances and fits and other general technical norms. A considerable part of these recommendations is already adapted into standards of the Socialist countries and is successfully used in the national economy of the USSR. Recommendations on unification were, toward the beginning of 1962, reflected in 109 state standards of the Soviet Union. These standards are specially designated by a five-cornered star in front of the standard's designation.

Starting with June 1962, the Council of Mutual Assistance took charge of regional standardization. With this purpose, a constant SEV standardization commission and also a SEV [Council of Mutual Assistance] Standardization Institute were established.

Each conference of representatives of interested countries is preceded by meticulous preparation of recommendations, obtaining industrial consent for them and comprehensive consideration. In the recent past,

this work was performed in the following fields: steel brands, profiles and dimensions of rolled stock, mechanical tests and chemical analysis of metals, tolerances and fits, machine building drawings, fastening components and welding. All this work is performed according to plans approved at annual conferences of representatives of the countries.

9. THE NEW INTERNATIONAL SYSTEM (SI) OF UNITS

A single system of measurements is the basis for development of international and regional standardization. The new international single universal system of SI units was introduced in the Soviet Union for preferred use starting with 1 January 1963, thus replacing the previously used MKS, CGS and MKGCS systems. The SI units are given in Table 72.

TABLE 72

Units of the International System (SI) of Measurements

Designation of quantities	Units of measurement	Abbreviations
	Basic units	
Length	Meter	m
Mass	Kilogram	kg
Time	Second	sec
Electric current	Ampere	amp
Temperature, thermodynamic	Degree Kelvin	^{o}K
Luminous intensity	Candle	-
	Supplementary units	
Plane angle	Radian	rad
Solid angle	Steradian	sterad
	Temperature scales and units	
Thermodynamic temperature in degrees Celsius	Thermodynamic degree Celsius	^{o}C (therm.)

Temperature difference or interval	Thermodynamic degree	deg (therm.)
Practical temperature	The 1948 international degree Celsius	°C (inter. 1948)

Derived units of space and time

Area	Square meter	m^2
Volume	Cubic meter	m^3
Frequency	Cycles per second	cps
Linear velocity	Meter per second	m/sec
Angular velocity	Radian per second	rad/sec
Linear acceleration	Meter per second square	m/sec^2
Angular acceleration	Radian per second square	rad/sec^2

Mechanical units

Density (volumetric mass)	Kilogram per cubic meter	kg/m^3
Force	Newton	n
Moment of force, force couple	Newton-meter	n-m
Pressure (mechanical stress)	Newton per meter squared	n/m^2
Dynamic viscosity	Newton-second per meter squared	$n\text{-}sec/m^2$
Kinematic viscosity	Square meter per second	m^2/sec
Work and energy	Joule	-
Power	Watt	w
Specific weight	Newton per cubic meter	n/m^3
Moment of inertia (dynamic)	Kilogram-meter squared	$kg\text{-}m^2$

Thermal units

Amount of heat; thermodynamic potential (internal energy)	Joule	-

Specific heat, specific thermodynamic potential	Joule per kilogram	joule/kg
Specific heat of a system	Joule per degree	joule/deg
Specific heat	Joule per kilogram-degree	joule/(kg. deg)
Thermal flux	Watt	w
Surface density of thermal flux	Watt per square meter	w/m^2
Heat exchange coefficient; heat transfer coefficient	Watt per square meter-degree	$w/(m^2\text{-deg})$
Thermal conductivity coefficient	Watt per meter-degree	w/(m-deg)
Thermal diffusivity coefficient	Square meter per second	m^2/sec
Temperature gradient	Degree per meter	deg/m
Thermal resistance	Second-degree per joule	sec-deg/joule

Electrical and magnetic units

Amount of electricity; electric charge	Coulomb (ampere-second)	-
Current density	Ampere per square meter	amp/m^2
Volume electrical current density	Coulomb per cubic meter	$coulomb/m^3$
Surface electrical current density	Coulomb per square meter	$coulomb/m^2$
Electrical displacement (electrical induction)	Coulomb per meter squared	$coulomb/m^2$
Electrical displacement flux	Coulomb	-
Electromotive force, electrical voltage	Volt	v
Electrical field strength	Volt per meter	v/m
Electrical capacitance	Farad	f

Electrical resistance	Ohm	-
Specific electrical resistance	Ohm-meter	ohm-m
Electrical conductance	Siemens	-
Specific electrical conductance	Siemens per meter	-
Magnetic flux	Weber	-
Magnetic induction	Tesla (Weber per meter squared)	$weber/m^2$
Magnetomotive force	Ampere (ampere-turn)	amp (amp-t)
Magnetic field strength	Ampere per meter (ampere-turn per meter)	amp/m (amp-t/m)
Inductance	Henry	hy
Magnetic constant, absolute magnetic permeability	Henry per meter	hy/m
Intensity of magnetization	Ampere per meter	amp/m
Reluctance	Ampere per weber	amp/weber
Magnetic permeance	Weber per ampere	weber/amp
Electrical energy	Joule	-
Angular frequency of electric current	Radian per second	rad/sec
Frequency of electrical vibrations	Cycles per second	cps
	<u>Acoustic units</u>	
Sound pressure	Newton per meter squared	n/m^2
Acoustical resistance	Newton-second per meter to the fifth power	$n\text{-}sec/m^5$
Sound intensity	Watt per meter squared	w/m^2
	<u>Photometric units</u>	
Luminous flux	Lumen	lm

Luminous energy	Lumen-second	lm-sec
Surface brightness	Lumen per meter squared	lm/m^2
Illumination	Candle-second	candle-sec
Luminance	Nit	-
Illuminance	Lux	-
Amount of illumination	Lux-second	lux-sec

CONCLUSION

The November Plenary Session of the Central Committee of the CPSU has made major decisions with respect to improving the management of the industry and accelerating the elaboration and adaption of new equipment. It is natural to ask: what can be considered as promising in the field of standardization, taking into account its role and significance in mordern machine building?

1. Evaluating the results of standardization. It is commonly known that results of standardization should be valued not by the number of approved standards and normal standards, but by the effect they had on the national economy. However, up to now, the quantitative evaluation still rules. For example, the results of standardization during the last three years are characterized as follows: 1600 standards and 4000 machine building normal standards were approved. But what is this, is it too much or too little? Which specific problems were solved by the industry as a result of the use of these standards and normal standards? An answer cannot be obtained. Taking into account the necessity of obtaining a more specific idea about the results achieved, it is necessary to ensure systematic accumulation of factual data about the use of standards and normal standards. Base organizations are in a position to evaluate the results of their adaption by its own branch of indus-

try and sovnarkhozes can evaluate the results in their economic region. Then the role of standardization in creating the material and economic basis of Communism and the results of its utilization can be actually evaluated on its merits, but in order to do this, the indicators of standardization effectiveness should be reliable and positively comparable.

The existing methods for evaluating the results of standardization are based on laborious calculations and require the selection of many recorded data and also of certain starting information which is not contained in plant documentation. This introduces an element of subjectivity into the calculations, with the result that the reliability of effectiveness indicators is lost and they are no longer comparable.

The required comparability and reliability of calculations can be achieved only in the case when workers of different plants, design and production organizations will use a single system of indicators, comparing the increased scale of manufacture of goods which is achieved and the corresponding lowering of the labor input required for their manufacture (of the type of Table 65, presented in Chapter 13). These indicators can be established on the basis of factual data of plants of various machine building branches and, on the basis of their statistical analysis. Analogous correlation relationships can also be established with respect to indicators of increasing the productivity of labor and of possible lowering of the net cost of products for various scales of production centralization.

For practical purposes, it is advantageous to have tables, systematic revision of which will allow to timely reflect the achievements of technology and production organization. Indicators which are peculiar to common machine subassemblies and components, can be uniform for the entire machine building. Indicators pertaining to finished products

and also to subassemblies and components characteristic of individual kinds of machines and equipment, can be of branch character.

Performance of this work, which involves the elaboration of technical and economic indicators, is one of prospective tasks of base standardization and normalization organizations.

2. Developing a theoretical basis for unification of machine components. The methods of unification of components and subassemblies, evolved by the industry, are based on their local or branch classification by production engineering, functional, overall size and other features. As a result of this, general machine building unification of components and subassemblies has not been achieved and organization of their centralized manufacture at specialized plants is not, as yet, ensured.

The theoretical basis of general machine building unification is a single system for classification of machines and equipment, their subassemblies and components and also a single system of preference numbers. The time is ripe for replacing the existing disconnected local classification systems and the systems of component designations related to them by a single state-wide system of numerical designations, pertaining to the following three characteristic groups of components: 1) of similar design; 2) differing in design but similar in production engineering; 3) differing in both design and production engineering.

Unity of numerical symbols characterizing the design, functional, dimensional, production engineering and other features, will create the necessary conditions for expedient subdivision of components within each of the above groups, in conformance with requirements of mechanized and automated production. This subdivision of components will result in the formation of dimensional series of standard dimensions, which in several successive stages can be brought close to ordered di-

mensional series.

3. Unification of production engineering requirements to machine components. The purpose of any unification is increasing the production scale for adapting more effective production processes and increasing the productivity of labor. However, adaption of integrated mechanization and, especially, of automation of component manufacture requires to solve not only the quantitative, but also the qualitative problem.

It is frequently found that components with the same purpose and of analogous design and corresponding dimensions, cannot be produced on the same automatic line even if it is adjustable. This is due to the difference in production engineering bases and technical requirements put to blanks, the precision with which they were machined and the surface roughness and, also, of metal platings, preservation or packing conditions, etc. For this reason, it is necessary to extensively unify all these requirements.

The importance of solving production engineering unification of components is due to the additional fact that subsequently increasingly new components can appear with new production engineering requirements, which will unnecessarily complicate the use of automatic production units being organized. It is expedient to record the results of unification of production engineering requirements, in corresponding standards and normal standards.

4. Unification of materials brands. The currently existing nomenclature of brands of metallic and nonmetallic materials has evolved historically. The variety of requirements put to materials in the as-supplied state in reference to individual components, additionally complicates unification of components for the purpose of increasing their production scale. A need exists for extensive unification of varieties

of materials, elimination of parallel brands, unification of requirements put to materials in the as-supplied state. All this work can be performed on the basis of a single system of classification and numerical designations of materials, which would reflect all their features.

5. Major problems of standardization. Quite recently, it was considered that the most important task of standardization is elaboration of parametric series of machines, equipment and other machine building products which are needed by the national economy, taking into account the promises of its development. This work was organized and is conducted on a large scale by the State Committee for Automation and Machine Building. At the present time, the following two problems are significant and urgent.

One of them pertains to ensuring high quality of machine and equipment being produced. Establishing quality indicators is one of the tasks of standardization. While the problems of proper stable quality with respect to kinds of materials and certain products were properly reflected in state standards, this problem still remains the No.1 problem with respect to the machines and equipment produced. The significance of solving it cannot be overestimated and the feasibility of its successful solution is beyond doubt. Expedient indicators of reliability and service life of machines and equipment can be established and this is now the task of standardization organs and scientific research institutes.

As second major task of standardization organs, we should consider the elaboration of a single state-wide system of numerical designations of all kinds of raw and processed materials, semifinished and finished products, their components and subassemblies and also the corresponding drawings or other technical documentation. The absence of such a sys-

ten affects the development of automating production planning and management, recording and accounting work.

6. Organization of technical committees. The methodology of the elaboration of standard and normal standard proposals, their consenting and approval which is used at the present time has evolved about 30 years ago. It is characteristic by profuse correspondence with interested organizations, laborious compilation of summaries of disagreements, a slow process of creating new standards and normal standards and by the second order role of operating personnel. Under new conditions of machine building development, with the large scale mechanization and automation of production, a more effective system would be that providing for elaboration of standards and normal standards by technical committees (TK), specializing in specific kinds of machines and other products and their subcommittees (PTK), narrowly specializing in individual pertinent problems, pertaining to the subject field of the given technical committee. For example, the TK for tractors should cover all kinds of tractors and self-propelled chassis. One of its PTK can concentrate its efforts on problems of defining and substantiating the indicators of service life and operational reliability of tractors, which are being standardized. Another TPK could work in the field of establishing expedient service lives for frequently replaced tractor components, etc. The TK and PTK should be composed of competent design engineers, production engineers, economists and must also have testing personnel.

Standards and normal standards elaborated by TK will become better substantiated and more stable. The standardization and normalization front will expand sharply. Base organizations will become actual branch scientific and technical centers of standardization and specialization of production.

7. Unity of standards. Parallel existence of standards and normal standards was expedient when the development of machine building was departmentalized. At the present time, when interbranch and branch normal standards are just as mandatory as state standards and when the contents of many standards and normal standards duplicate one another, the retention of two different names of documents serving the same purpose is no longer necessary. A measure has become ripe, directed toward regulating this problem. The term "standard" is more expedient of the two and the term "normal standard" should be retained only for plant and other local normal standards.

8. Role of branch standardization (normalization). Soviet standardization, as this follows from the classification chart of state standards, has a branch structure which is now even more strengthened by the activity of base organizations. But the branch normalization related to standardization was not properly developed. In the meantime, implementation of assembly and component specialization in machine building is already negatively affected by the lagging branch normalization, which can be shown by the following examples. Tractors of the Volgograd and Khar'kov plants, which are identical by their basic parameters, have different running gears, tracks and even cabs. These tractors have an engine of the same design, but the engine supports are different. New models of GAZ and ZIL trucks have even such components as valves of different design. The picture is more or less the same in other machine building branches. This is a result of the lagging branch normalization.

9. The place of standardization in the industry. The role and significance of standardization work in machine building progress make it necessary to raise the question about upgrading the authority of standardization organs in the industry. Modern standardization embraces all elements of creating and adapting new equipment, of production organi-

zation and its economics. For this reason, it is expedient that the chiefs of standardization departments in all design organizations and at the majority of plants, should be given the status of chief deputy engineer and in individual TsKB and NII - the status of deputy director. It is also expedient to reorganize base organizations into Central Design Offices for Standardization.

10. The representative character of standardization organs. All standardization organs work together with many industrial organizations. The representative character of their activity follows from the substance of their work. This is the reason why the system of technical committees and subcommittees is commonly accepted in the majority of countries. This is the system which has evolved in the practice of the International Organization for Standardization (ISO). The necessity is ripe for further democratization of standardization organs, more extensive participation in their work by representatives of users and for the creation of representative committees.

11. Scientific research in the field of standardization. Not a single field of creative activity exists in the present time in which some, or other, scientific investigations are not performed. The exception is only standardization, since not a single of the scientific research institutes in the standardization system occupies itself by these investigations. This cannot be considered a normal situation. Many problems exist in the field of standardization, certain of which are illuminated in this book.

A union between practice and theory is of especial importance to standardization.

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