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TECHNICAL ACHIEVEMENTS IN
COMMUNIST CHINA'S ELECTRICAL EQUIPMENT INDUSTRY

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TECHNICAL ACHIEVEMENTS IN COMMUNIST CHINA'S ELECTRICAL EQUIPMENT INDUSTRY

Following are full translations, in addition to excerpts, of articles taken from the Chinese-language periodical Tien-chi Kung-yeh (Electrical Equipment Industry). Titles, publication data, and names of authors are given below.

<u>Table of Contents</u>	<u>Page</u>
I. China's Electrical Industry During the Last Decade	1
II. Shanghai Produces an Experimental Model of an 865-kva Blocking Magnetic Amplifier	21
III. Technical Expansion of China's Steam Turbine Generator Industry and Future Trends	22
IV. Flying Leap in the Expansion of the Transformer Industry	31
V. Ten Years of the Boiler and Steam Turbine Industry	45
VI. Technical Achievements of the Chemical and Electrical Battery-Source Industry	58
VII. Ten Years' Development of the Medium and Small Electrical Equipment Industry	65
VIII. A Decade of Significant Events in the Technical Development of the Electrical Equipment Industry	71
IX. The High Tide of Production Rolls Forward, Production and Economy Increases	90
X. Ten Years of Glorious Achievements in the Low-Tension Electrical Equipment Industry	92
XI. Ten Years of Technical Achievements in the High-Tension Switch Industry and Future Prospects	100
XII. Flying Leap in the Expansion of the Electric Welding Equipment Industry	107

	<u>Page</u>
XIII. 1959 Generating-Equipment Plan Fulfilled 45 Days Early	113
XIV. Communist China's Electrical Equipment Industry <u>Excerpts</u>	116
XV. <u>Extracts Pertaining to Communist China's</u> <u>Electrical Industry</u>	118

1. CHINA'S ELECTRICAL INDUSTRY DURING THE LAST DECADE

Tien-chi Kung-yeh

Peiping. No. 18, 25 September 1959
Pages 12-19

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1. THE GROWTH AND EXPANSION OF OUR ELECTRICAL EQUIPMENT INDUSTRY

The electrical equipment industry is the technical basis in the national economy for the creation of materials for use with electricity. It manufactures whole sets of power generation, transmission, and distribution equipment for the electrical industry. In close cooperation with other departments of the machine building industry, it supplies whole sets of electromotive, electrometallurgical, thermoelectric, electrolytic, and electric traction equipment for the metallurgical, mining, chemical, communication and transportation, light, and textile industries. It also furnishes equipment for the electrification of agriculture.

Prior to the liberation, under the economic oppression of the imperialists and the rule of the Kuomintang, the foundation of our electrical equipment industry was extremely weak and the technical level backward. In the highest productive year of 1947, the total number of generators produced was only equivalent to 25,224 kilovolt-amperes; the total number of motors was equivalent to 68,391 horsepower; and the number of transformers, merely 146,680 kilovolt-amperes. The total number of workers in the industry (including radio) was less than 20,000. The largest generator produced had only a generating capacity of 200 kilowatts; the largest motor, not more than 180 horsepower, and transformer, not over 2,000 kilovolt-amperes. Other products, such as switches, wire, porcelain, and electric meters, were all of the small type. Under these circumstances, the industry's scientific research work could not be carried out.

Ten years ago, under the eminent leadership of the Chinese Communist Party, the Chinese people achieved a great victory in their democratic revolution, overthrowing the government of the Kuomintang, abolishing the special privileges previously enjoyed by the imperialists, and confiscating all bureaucratic capital.

Privately-owned and other enterprises were given a socialist reform, and a series of mass movements, later resulted in a rapid increase in their production power.

During the past 10 years, as a result of the correct leadership and deep concern of the party's central committee, Chairman Mao, and the unselfish aid rendered by Soviet Russia and other brotherly nations, our electrical equipment industry, after going through a 3-year rehabilitation period and the First Five-Year Reconstruction Plan, built and expanded numerous large enterprises, using the latest technical equipment to replace the originally backward production facilities. Along with the continuous daily progress in production, a responsibility-sharing system was adopted in the industry throughout the country. The advanced experiences of Soviet Russia and other socialist countries were studied, and the technical standards and production series of the industry throughout the entire country were unified. A large number of technical and administrative cadres and technical workers was cultivated, enabling them to master advanced production technology for electrical products. In 1957, the total value of the products produced by the electrical equipment industry was over 4 times that of 1952. In the period of the First Five-Year Plan, the average rate of annual increase exceeded 30 percent. In 1958, the main principle of "exerting vigorous efforts and striving for an upper hand in socialist construction by producing more, producing rapidly, producing good-quality products and practising economy" and the policy of "advancing with both feet" brought out by the party, created the positive initiative of the masses. At the same time, an all-out great leap forward movement was launched. The electrical equipment industry, like any other industry in the country, resolutely carried out the party principles by strengthening party leadership within all its enterprises, using political ideology as an advanced element, and carrying out a mass movement for technical reforms and revolution, which resulted in unprecedented progress. During that year the total output of the industry was more than double that of 1957. The total output of generating equipment was raised from a generating capacity of 198,000 kilowatts in 1957 to 800,000, an increase of more than 3 times; those of transformers and motors were increased from 2 to 3 times. The production of other main electrical products also had a multiple increase. In 1959 the electrical equipment industry continued its development with high speed. The total output of power-generating equipment is scheduled to reach 1,800,000 kilowatts, which will be an increase of 1,000,000 kilowatts or 125 percent as compared to that of 1958; this will surpass the quota planned for 1962 (1,400,000 to 1,500,000 kilowatts). Within less than 2 years, the quota mapped out in the Second Five-Year Plan will be over-fulfilled. It is believed that such a speed of development can never be made by any of the capitalist countries.

The continuous development of new products has been an important task of the electrical equipment industry. During the past decade, such products have been rapidly developed and thousands of different items are being presently produced. The entire administration and workers of the industry not only have been able to master the designing and manufacturing technology of a series of medium and small types of electrical products, they also are exerting vigorous effort and manifesting joint wisdom in producing large, high-tension, and precision industrial equipment, gradually supplying whole sets of these advanced products to insure that the various departments of the national economy advance on the path of mechanization and automation. Since the great leap forward year of 1958, we have already produced whole sets of 72,500-kilowatt water turbine generators and 50,000-kilowatt steam turbine generators. Sets of 25,000-kilowatt steam turbine generators have also been produced in series. As regards high-tension electrical equipment and materials, we have mastered the production of whole sets of a 220-kilovolt-ampere transformer and a 5,000-megavolt-ampere high-tension circuit breaker, as well as cables and porcelain products. As regards electromotive equipment, we have also fully mastered the technology of manufacturing DC and AC motors with a capacity of not more than 4,000 kilowatts and low-tension control equipment. Other items which have been test-manufactured include tightly-sealed mercury rectifiers, large-capacity traction motors, main automatic electromagnetic parts, and various types of high-grade insulating materials. All this has greatly raised the technical level of the electrical industry. Today the electrical equipment industry, through the correct leadership of the party, the joint efforts of the masses, and the unselfish aid of Soviet Russia and other brotherly nations, has already established a complete technical system.

2. THE DEVELOPMENT OF SCIENTIFIC RESEARCH WORK IN THE ELECTRICAL INDUSTRY

The work of scientific research in our electrical industry was originally without a foundation. It was not until the period of the First Five-Year Plan that a small number of independent scientific research agencies was first established. Under the guidance of the party's policy of combining theory with practice and scientific research with production work, the scientific and technical personnel of the industry, along with the tremendous increase of production and the rapid development of new products, conscientiously studied the advanced technology of Soviet Russia and other socialist countries, continuously accumulated theoretical knowledge of product designing and quality determination, and in the course of their practical work learned numerous types of operational methods. Due to the fact that electrical products are

frequently affected by the environment, weather, raw materials, and various factors of use, the need for the designing work to be carried out by the manufacturers themselves gradually became evident, which resulted in the plants' central laboratories and testing stations being established to carry out testing and research work.

In the spring of 1956, the party called upon the scientific workers throughout the country to draw up a 12-year (1956-1967) long-range plan for the development of science and technology in coordination with the nation's capital construction work. Under the guidance of this plan, work for an over-all concrete plan for the development of electrical engineering research was launched. The year 1958 was one with a "great-leap-forward" development of our science and technology. During that year, various electrical industry agencies, on the basis of the research work carried out at the plants, expanded and strengthened the Peiping Electrical Equipment Scientific-Research Institute and the Shanghai Electrical Equipment Scientific-Research Agency, enabling them to become two comprehensive electrical industrial scientific-research organizations. With close cooperation and the sharing of their respective responsibilities, these organizations carried out the study of electrophysics, the technology of automatic control, electrical materials, main electromagnetic parts, intermediate and small generators, low-tension electrical equipment, electric-welding and electrothermal equipment. At the same time, agencies for the study of and research on high-tension electrical equipment, large generators, transformers, electric cables, and porcelain products were also established. These agencies are mainly located in the vicinity of or within the manufacturing plants so that a much better coordination between theory and practice can be realized. The Electrical Industry Research Agency of the Chinese Academy of Sciences, designed to carry out a study of the basic theory for the development of the electrical industry, the theory of electric power systems, and the complex new technology for the production of electrical machinery and equipment, was also established that year. All these scientific research organizations are presently building their respective research and testing centers. Among the principal ones are those designed for testing high-tension electric current of more than 330 kilovolts with a current-breaking capacity of 15,000 megavolt-amperes, low-tension electrical equipment with a current-breaking capacity of 100 kiloamperes, rotary motors of steam turbine generators of a capacity of more than 100,000 kilowatts, high-tension electric transformers of more than 330 kilovolts, as well as electric cables, high-tension porcelain, electric condensers, and mercury rectifiers. The scientific research organizations, by virtue of the unselfish aid of Soviet Russia, have begun to equip themselves with the

latest technology. Following the establishment of the testing centers, our electrical engineering research work will be facilitated by strong and substantial material foundations.

Conscientiously carrying out the party's instructions and closely coordinating with the needs for national construction, the electrical engineering research task in 1958 was executed jointly by the masses of workers with a view to eliminating the old method of relying solely on a small number of technicians working in the laboratories. As a result, the total number of scientific research personnel in the various scientific research agencies, higher educational institutions, and enterprises was increased by 30 times as compared to that before the liberation. In this rapidly growing force of technicians, the younger members, especially by following the party's instructions and exerting their vigorous efforts, repeatedly made achievements. Despite the various materially disadvantageous conditions, they were able to devise ways and means for self-preservation. The following is an outline of the principal achievements made in our electrical engineering research work and in the work presently being carried out.

a. Electrical Generating Equipment

As a result of carrying out the party's policy of giving priority to the development of heavy industry as well as the electrical industry, our electrical generating equipment industry has made rapid progress. Due to the fact that our country has abundant water resources, the long-range plan for the development of our electrical industry foresees the use of hydroelectric power as the main target and thermoelectric power as an auxiliary target. As regards hydroelectric power generating equipment, an 800-kilowatt vertical-type water turbine generator set was first test-manufactured in 1951 through the technical assistance of Soviet Russia. During the period of the First Five-Year Plan, generators of a capacity of 6,000, 10,000 and 15,000 kilowatts, respectively, were made one after another. Since the great-leap-forward year 1958, the 16,000-kilowatt propeller-type and the 72,000-kilowatt diametrical axial flow generator sets have been produced. Since the past 8 or 9 years, the generating capacity of the average water turbine generator set has been raised by 90 times, which at the same time indicates that our technical level has also risen. In making the 10,000-kilowatt 187.5-rpm water turbine generator set in 1955, advanced designs and automatic facilities were used. The advanced designs included the welded shell of the water turbine, water-lubricated bearings, a sectional-type generator support, and a modern air-cooled system. The entire operation from starting to stopping the generator set is controlled by automatic equipment. The test manufacture of the 72,000-kilowatt generator set marked a further advance in the

technical level of our production of hydroelectric power generating equipment. This generator set weighs a total of 670 tons, with numerous principal parts made by the welding method. The diameter of the water turbine rotor is 4.1 meters. The generator is of the suspension type, and the outer diameter of the stator core is 8.54 meters. The generator set is also equipped with an advanced closed-type air circulating system as well as rigid-support thrust bearings. Because it was made with advanced designs and by modern techniques, the generator set possesses a high technical and economical value, with an average weight of not more than 7.6 kilograms per kilovolt-ampere.

At the same time that hydroelectric power equipment was being developed, the production of thermoelectric power equipment also experienced rapid progress. In 1954, through the technical assistance of Czechoslovakia, the first 6,000-kilowatt steam turbine generator was test-manufactured. During the period of the First Five-Year Plan, technical achievements were made in the manufacture of products of the 2,500- to 12,000-kilowatt series. In 1958 the 25,000-kilowatt air-cooled steam turbine generator set was test-manufactured. The 50,000-kilowatt surface hydrogen-cooled steam turbine generator (Hydrogen pressure = 1.05 atm absolute), which was recently test-manufactured, is scheduled to be put into operation within the end of the year.

The fact that it has been possible to rapidly increase the capacity of generators is due to the research and testing work done within the past several years. In developing the air-cooled system, on-the-spot measuring work in test operations was carried out. This resulted in the technicians mastering the air-circulation calculating method for water turbine generators and acquiring ways and means of furthering the improvement and developing the potentialities of air capacity, which, in the course of new designing work carried out later, contributed much to increasing the load capacity of generators, lowering raw-material consumption, and reducing the size of the equipment. In studying and testing air distribution in high-speed steam turbine generators, model structures are being used. This will produce numerous useful data for the new designing work on a series of products under a capacity of 25,000 kilowatts, enabling these products to acquire a higher technical and economic value. The use of a similar theory for studying the generator cooling problem is presently in stage of preliminary planning. It is proposed that first the modulus of the cooling effect be obtained and then a concrete method for designing model structures be devised. In 1958, study and testing work on a direct cooling method was started by using high-pressure hydrogen in the interior of the conductor of a generator rotor and other liquid substances in that of a stator rotor. This brought about a new phase in the study of and research on the

generator cooling system. The result of all this research and testing work has opened up a path for the future development of modern and large-capacity generators. In the determination of parameters, different testing methods were used on running generator sets, which resulted in developing a reliable determining system. In the development of the excitation system, compound exciters and automatic excitation regulating installations equipped with voltage adjusters were test-manufactured in 1956. In 1958 several research units simultaneously began model testing on ion exciting installations. Some of them used the automatic-type ion exciting system equipped with a series transformer and the structural method with an isostatic reactor. When the exciting system functions, the vertex voltage value is formed at the same time by relying on the change of the grid angular displacement and the compound excitation of the series transformer. These characteristics enable the angular displacement, under normal condition, to become less selective, with the resultant effect of lightening the burden of the regulator and improving the operation of the rectifying installations. As a result of the various different types of model tests made, the work of designing exciting installations for large water and steam turbine generators was completed. It is to be followed by future industrial testing work.

b. High-Tension Power-Transmission Facilities

Along with the expansion of the electric power system and the capacity increase of generators, a corresponding development of high-tension electric-power transmission facilities is needed. In the period of the First Five-Year Plan, transformers of the 20,000-kilovolt-ampere, 220-kilovolt series were produced. Since 1958, large transformers of the 40,000-kilovolt-ampere, 220-kilovolt and the 75,000-kilovolt-ampere, 66-kilovolt series have been test-manufactured, with the modern oil-immersed force air-cooled system used in the latter series. Carrier voltage regulating tap switches have already been used on large transformers. The output of a unified series of transformers (less than 3,500-kilovolt-amperes, 110-kilovolts) was carried out as early as in the period of the First Five-Year Plan. At present, test and research work is being done to improve the quality of these products by lightening the weight by 11 to 21 percent. The scientific research work on transformers has been carried out mainly by utilizing electromagnetic models to determine the ballistic resistibility and the main and auxiliary insulating power of the insulating structure of transformers of a 110-kilovolt capacity or less, in an effort to gain an economic and reliable insulating distance for improving the designing work and lowering the material consumption quota. For the purpose of

studying the lightning resistibility of transformers, full wave and cut-off wave ballistic tests were carried out on large test-manufactured transformers. The accomplished method of finding defects in ballistic tests of high-tension transformers can be used for accurately locating damaged positions. During the past 2 years, 220- and 330-kilovolt electric condenser type sockets and 330-kilovolt electric current mutual inductors were studied and test-manufactured. At present, large-scale testing and research work is being carried out on the insulating structure, as well as on the oil immersed force air-cooled and water-cooled heat dispersion installations of transformers of the 330-kilovolt series. On voltage and current mutual inductors for control and measurement use, a systematic analysis was carried out which led to the acquisition of a theory to be used as a base for the designing work on mutual inductors. Instruments for measuring the errors of mutual inductors have already been produced and are being effectively used in industries. Fruitful results have also been acquired in the study of epoxy-resin coated mutual inductors.

As regards high-tension circuit breakers, production technology for the 110-kilovolt series oil and air circuit breakers was acquired in the period of the First Five-Year Plan. Since 1958, 220-kilovolt, 5,000-megavolt-ampere oil circuit breakers have also been test-manufactured. In test-manufacturing the 22-kilovolt air circuit breakers, tests of their mechanical function have been completed. This type of circuit breaker is scheduled to be put into formal production within the end of the year. As regards scientific research work on circuit breakers, the main course taken was to carry out tests on the insulating rejuvenation and arc extermination power of various types of gases under flowing conditions. Model testing work on 33-kilovolt air circuit breakers has also been started by examining the accuracy of the function of air motion and measuring a series of necessary air motion parameters as well as by studying the functional stability of the enclosed valve in the arc extermination chamber. The result of the tests proved that the originally designed air motion functional system of the circuit breakers is reliable. The structure of the air motion system possesses ample mechanical power, capable of withstanding strong vibration and multiple operation. The problem of the enclosed valve's functional characteristics can be solved, and the principal time parameter of circuit breaking agrees with the design requirements. For the purpose of coordinating with the establishment of strong electric current testing grounds, electric power agencies, high-tension switch manufacturing plants, and the electrical equipment study and research laboratories of higher educational institutions, during the past 2 years, carried out research and testing work on oscillatory return circuit installations by utilizing the open-current capacity supplied by power

networks for testing electric power. They also speeded up the installation of impulse generators (a 100-megavolt-ampere and a 25-megavolt-ampere generator have already been installed) as a technical preparation for testing the capacity of open current. At the same time, research work was carried out on high-tension and large-capacity circuit breakers used for protecting generators, the cooling and structural problems of break switches, the use of alternate current function, the test manufacture and use of ground switches and quick break switches, and the expansion of the current breaking power of load switches and fuses by increasing the voltage.

Regarding high-tension lightning arresters, a series of the 220-kilovolt (and less) valve type have been produced. In order to develop the 330-kilovolt super high tension transmission facilities, the lowering of the voltage charge in the interior of the system has been the principal subject of study and research. This in turn led to the launching of scientific research work on magnetic blowout arresters. In 1958 research and testing work was carried out by enterprises, schools, and research agencies on various types of magnetic blowout gap arc extermination structures and valves, attaining primary achievements in the structural designing and functional requirements of magnetic blowout arresters. After going through model testing, this type of lightning arrester will be put into test operation on high-tension transmission lines.

Along with the technical improvement of our high-tension power transmission lines and high-tension electrical equipment, a complete series of high-tension porcelain products has also been developed, including long rod type insulating porcelains and a new series of line porcelains. In 1958, oil sockets for 330-kilovolt transformers were test-manufactured; this marked great technical progress in our production of high-tension porcelains. The main course taken in our scientific research work on porcelains is to use domestic raw materials, to study requirements and operations, to determine the nature of the porcelain substance itself, as well as to sum up the results of the new technical processes of crushing, mixing, blank making, drying, and the speed operation of the kiln, so that a primary foundation for our porcelain industry can be attained. During the past 2 years, satisfactory results have been achieved in the study of high-intensity porcelains. At present, porcelains that double the intensity of feldspar-porcelains can be produced. Our electric porcelain scientific research work, in close cooperation with the great-leap-forward development of the porcelain enterprises, is now aimed at the creation of high intensity, high insulating, and small-size high-tension porcelain products.

During the past 10 years, our electric cable industry has already test-manufactured the 110- and 220-kilovolt electric

cables and mastered the manufacturing technology of lead-covered oil-immersed paper-insulated cables of 35 kilovolts and less, rubber-sheathed cables of 6,000 volts and less, and aluminum core cables. Regarding telecommunication cables, tests have been completed on city telephone cables, 60-line carrier wave telecommunication cables, special shield grid long distance carrier wave telecommunication cables used for the electrification of railroads, small coaxial telecommunication cables, and the symmetrical type high-frequency cables. The manufacturing technology of high intensity lacquered wires and electro-magnetic wires has been acquired. Scientific research work has been carried out in close coordination with the test manufacture of thousands of electric cable and wire products, systematically mastering the structural theory and production process of a series of products relating to high-tension electric cables and high-frequency communication cables. Systematic analyses and studies have also been carried out on the electrical, chemical, and physical nature of the paper and oil used in the manufacture of cables; this resulted in acquiring various different forms of processing. Primary achievements have been made in determining the rise in the temperature and current-carrying capacity of electric cables. At present, a study is being done on the new theory of the thermal equilibrium of super high tension electric cables and high electric potential gradient insulating structures in an effort to lay down a foundation for the designing work on 330-kilovolt super high tension electric cables. The study of the shielding theory and the production method of communication cables resulted in the creation of the low shielding coefficient long distance carrier wave communication cables used for the electrification of railroads. The success of testing the aluminum wire welding method has brought about the use of aluminum instead of copper in the manufacture of conducting wires. Based upon the foundation acquired in the lacquer coating process of high intensity lacquered wires, study on the test manufacture of heat resistance lacquered wires has been pursued. Primary achievements have also been made in the testing of aluminum oxide wires.

Due to the rapid progress in the development of our electrical industry, new lines have to be designed for high voltage transmission and the voltage of old transmission lines must be stepped up. During recent years, a number of high voltage testing laboratories have been established by the various agencies concerned. In close coordination with the needs for the construction of high tension power networks and the manufacture of high voltage electrical equipment, a series of basic research projects has been carried out. On the subject of dielectric puncture phenomenon in an air gap while under the effect of working frequency voltage and impulse voltage, and on the electric

discharge characteristics of an air gap and insulating structure while under the effect of an operational voltage wave, by carrying out tests on electrodes, wave forms, and dielectrics of different surface conditions and the puncture and lightning mesh of different types of insulating structures, and by studying the electric discharge process of long gaps. Regarding electric arc characteristics, research work was carried out on the arc blow-out and reactance intensity of gases. In regard to the tests made on different types and models of new high-voltage electrical equipment, finished products, and on the maintenance and repair of operational equipment within the electric power system, satisfactory results have been obtained by the high-voltage testing laboratories of the various agencies concerned. In the course of their work, they have mastered the techniques of designing and manufacturing power frequency voltage testing transformers, impulse voltage generators, impulse current generators, and the relative high-voltage testing condensers, as well as the installation and usage of high-voltage measuring instruments. They have also made positive preparations for the establishment of a unified system for the testing of power frequency voltage and impulse voltage. We have already been successful in the design and test manufacture of the 1,800-kilovolt impulse voltage generator, 250-kiloampere impulse current generator, 600-kilovolt high-voltage testing transformer and transient analysis instruments. The small-type oscillating return circuit testing equipment, which was manufactured jointly by several scientific research units, is now being used for testing small circuit breakers, fuses, and lightning arresters. Along with the development of the high-voltage electric power system, our research and test-manufacturing work for high-voltage testing equipment is also heading toward flying-leap progress. The 5,000-kilovolt impulse voltage generator, the manufacture of which is presently under study and planning, is a model example of these rapid developments.

c. Electric Power Traction Systems and Equipment

The progress of our electric power traction technology shows that our machine-building industry is also advancing on the path of modernization. Generator-amplifier controlled DC generators, the generator system including a whole set of electrical equipment, have been extensively used in domestically manufactured blast furnaces, rolling mills, lathes, mining, hoisting, and transportation equipment, and paper-making machines. By virtue of the accumulated operational experiences and the increase of the performance capability and capacity of magnetic amplifiers, testing and research work in recent years has been completed, using magnetic amplifiers to serve as exciting equipment for intermediate

and small DC generators to substitute for the generator-amplifiers. These magnetic amplifiers have also been put into test use in the automatic control system of electric arc furnaces and lathes.

The use of static control ionic tubes (ignition guiding tube or exciting tube) or semiconductor rectifiers to substitute for rotary converters is the direction toward which electric power traction has been developing in recent years. In the course of studying the principle of test-manufacturing a traction installation for the thyatron of the jig-boring machine, an ionic traction installation with a capacity of over 2,500 kilowatts and a speed error of less than 0.2 percent was designed. In coordinating with the needs for the development of ionic traction and the ionic excitation system of synchronous generators, various types of grid controlled installations have been studied and test-manufactured. These grid controlled installations include those for use in static phase shifting bridges and peak reactors, half wave magnetic amplifiers, and small crystall triodes.

To improve and extend the use of AC power traction is an important phase in the over-all development of the electric power traction system. At present, industrial tests are being carried out on bridge cranes; spinning, weaving, printing, and dyeing machines; and electric arc steel refining furnaces, by using saturated reactors to regulate the speed of the induction motors. Laboratory research work on ionic frequency changing and speed regulating has also been started.

In studying the joint rotation of multiple generators, primary achievements have been made by utilizing the AC axis synchronous DC generator (motor) system in conjunction with the model testing results of ship-hoisting machines. On the use of the compound regulating theory and the following action system, more research work is scheduled to be carried out.

In developing the use of the control system of electronic calculators, control installations have been primarily test-manufactured for the operational use of milling machines and electric arc steel refining furnaces. On the logical control system formed by the composition of noncontacting magnetic parts, laboratory testing work has been completed. This system will first be put into use in the control installations of automatic production lines and lathes for further industrial tests.

The development of the automatic action formed by electric power traction and of electromagnetic equipment are complements of each other. As a result of studying advanced Soviet technical experiences in the production of magnetic amplifiers, motor amplifiers, servomotors, self-set angular motors, and different types of ouncer motors (including ouncer synchronous motors and speed measuring motors), along with the additional work carried out on analysis, testing, and research, we are now capable of

designing numerous different types of electromagnetic equipment. Among this equipment, that which has been designed and test-manufactured includes highly sensitive magnetic amplifiers with a control power of 10^{-12} watts, 500- to several thousand-cycle high-frequency magnetic amplifiers, and 21-kilovolt-ampere saturated reactors, as well as AC speed measuring motors and 25-kilowatt motor amplifiers. Also, in accordance with our country's present conditions, research work has been started on a series of magnetic amplifiers and self-set angular motors.

During recent years, great improvements have been made on medium and small motors and low-voltage electrical equipment; this contributed greatly to the development of electric power traction. After carrying out research and testing work, as well as an analysis of technical and economic aspects, the production series of these types of motors were improved, and products that compare with the standard of these being produced by other socialist countries were designed. At present, samples of these motors are being test-manufactured using high-grade insulating materials and silicon steel sheets with the hope of reaching a higher quality level both in weight and performance capability. As regards low-voltage electrical equipment, enclosed-type fuses with a rated current of 100 to 1,000 amperes and a current breaking power of 50,000 amperes were manufactured. Also, a new series of the universal type 4,500-ampere automatic air circuit breaker with a current breaking capacity of 100,000 amperes, modern type contactors, and intermediate relays were designed and test-manufactured, with the size and weight reduced by one half as compared to the old series.

d. Insulating Materials

The insulating-materials industry in our country started to develop after the liberation. Since then, such products as immersed paper, winding paper, electric cable paper, and electric condenser paper have been produced one after another. Because of the amount of research work being carried out, the quality and output of these products were rapidly raised. During recent years, technical progress was made on the production of long-fiber paper after solving the problem of fiber setting, increasing the strength of the paper, and reducing the thickness, with primary solution also being made of the difficulties of producing special mica tape paper.

Glass fiber products are a principal basic material used in the manufacture of modern insulating materials. As a result of mastering the technical process of non-alkali glass, fiber glass can now be drawn to as thin as 5 microns in diameter. At present, glass fiber of a diameter of 3.5 to 4.5 microns and glass cloth of a thickness of 0.025 millimeter are being test-manufactured, and extensive scientific research work has been started in an effort to

produce a still thinner type of glass cloth. Also, a study is being made on the technical process of glass fiber paper and glass diaphragms.

Regarding the use of mica as an insulating material, investigations were conducted on the products of several well-known mica mines within the country and a plan was mapped out for the development of the mines and the rough processing and sheeting processing of mica. Powdered mica paper and its products represent new developments in recent years. As a result of studying advanced Soviet experiences, primary achievements were made regarding the heating temperature of mica, the acid and alkali process, and the method of paste making. For the purpose of acquiring suitable materials for making powdered mica products, a study was made on a number of richer mica mines within the country, as a result of which a method for the processing of several types of mica was created. Recently a method was employed for increasing the mechanical strength of powdered mica paper to 2.5 to 3 kilograms per square millimeter, observing the rigid selection of raw materials mixed with colloidal substances to increase the pressure resistance. The improvement of the quality of this type of product has opened up a new supply source to meet the enormous demand of the electrical-machine industry.

Synthetic high molecular materials are basic materials used in the manufacture of modern high-quality insulating materials. In the development of these materials much depends upon the foundation of the low molecular single unit heavy synthetic organic industry. Due to the present enormous output of phthalic anhydride, the hydroxyl-carboxylic acid resin varnish, which is also presently being produced, can be put to much wider industrial use.

In the development of enamels used in the manufacture of high-strength enamelled wires, study was first made of both the gas and liquid synthetic process of polyethylene acetal enamel and on a change in the molecular weight of polyethylene acetic acid to simplify the process of manufacturing the enamel and improve its quality. At present, progress has been made with the formaldehyde and methyl acetaldehyde enamels, the latter of which has reached the E-grade technical standard. Secondly, in the study of polyamine enamel, the synthetic process and the quality-control problem of polyester resins have been solved. At present the quality of the polyamino ester enamel and the wires coated with it has reached the required technical standard. Thirdly, as a result of the achievements made in the suitable linking of the molecular structures by certain organic chemical compounds, polyester resin enamel of high mechanical strength and excellent heat-resistance capability has been produced.

Following the accomplishments made in the technical process of epoxy resins, small quantities of this product are being produced and at the same time efforts are being made to bring about an overall production stability and to improve the quality to meet the standard requirements. At present, epoxy resins are being used for coating mutual inductors and gluing porcelains.

As a result of achievements made in the study of forming a silicone organic polymeric compound into a single substance by means of the direct processing method, this item is presently being produced in small quantities in various workshops. The efficiency of the single substance synthesis has reached the normal industrial standard. Also, because of the progress made in the study of the hot and cold condensation methods, many types of silicone organic resins and insulating varnishes of an excellent heat-resistance capability have been test-manufactured. Production of an experimental type of silicone rubber is presently underway, and at the same time further study is being carried out to improve the purity of the single substance and various polymeric processing methods. It is expected that in the near future large quantities of these types of new insulating materials will be made available for use by the electrical-machine industry.

3. OUTLOOK OF THE ELECTRICAL INDUSTRY'S RESEARCH WORK

The rapid progress made in the development of our electrical-machine industry during the past 10 years brought about a considerable advancement of our electrical engineering research work. The new achievements made in this field are now being used to lay the foundations for the rapid development of large and complex products, the improvement of their technical and economic aspects, and a speedy increase of output.

Our electrical engineering research work has an enormous and bright future. Our total water power resources, which rank first among the nations in the world, have a generating capacity of over 500,000,000 kilowatts. The total capacity of the generators to be installed in the first stage of construction work on the hydroelectric power project at San-men Gorge on the Yangtze River is expected to exceed 15,000,000 kilowatts. With the numerous precipitous slopes and narrow valleys in the country convenient for the concentration of waterfalls and the construction of dams, the cost of the construction of hydroelectric power stations will be greatly lowered. Coal resources are extremely rich in our country and are scattered in a great number of localities. The policy of the Central Committee as regards the long-range development of our electrical power industry aims primarily at the development of hydroelectric power with thermoelectric power as a secondary objective. Within the next several

years, work on thermoelectric power plant construction must be rapidly carried out. Under these circumstances, we are required to speedily carry out study and planning for the production of giant water turbine generators and steam generators, and at the same time rapidly improve the technical and economic aspects of the manufacture of large and medium products, enabling production to be carried out in series and to become standardized. The industrial progress made throughout the country during the past decade, along with the recent great-leap-forward development, expedited the construction of local electric power networks. Consequently, the next step to be taken is to build an over-all power system for the unification of these networks. The establishment of a nationally unified power system with the San-men Gorge project as the pivot, which was recently suggested by the various agencies concerned, will greatly accelerate the development of super high tension power transmission installations. Electrical engineering research work must be carried out in an effort to strive for the lowering of the insulation level of the entire system of high and super high tension power installations, reducing production costs and increasing their production power. With the present high-speed industrial and agricultural development which is unparalleled in history, the production potentiality of every enterprise must be fully activated, and new enterprises must be equipped with advanced technical facilities. Consequently, in all the industrial departments, especially in the fields of metallurgy and mining, production must be mechanized and automatized. In this connection, the electrical-machine industry must supply thousands of products of different types and specifications to serve as a material foundation for the realization of these objectives. The rapid progress made in the electrification of industry has opened up a new path for the development of the national economy. The achievements made in scientific and technical progress have raised the standard of efficiency of the electrical refining and electrochemical enterprises. The electrification of railroads brought about a basic technical reform in transportation, enabling efficiency to become tremendously increased within a short period of time. All the foregoing requires the electrical-machine industry to supply the latest equipment to meet the increasing demands. It also requires electrical engineering research work to be carried out rapidly to serve for the continuous great-leap-forward development of the electrical-machine industry.

The fact that our electrical engineering research work was able to develop at such great speed was the result of the strengthening of the leadership of the party and the resolute carrying out of the party's policy of relying on the masses and combining theory with practice. In order to continue this great speed of development, our policy is to apply the advanced

experiences of Soviet Russia and other brotherly countries to our own achievements made since the great-leap-forward development, the physical features of our country, the characteristics and usage of our resources, and the developmental condition of the electrical-machine industry throughout the country. Consequently, it is expedient and necessary that the following tasks be carried out:

a. To master and develop modern technology in the design and manufacture of giant water turbine generator sets and steam turbine generators of a capacity of 500,000 kilowatts or more.

b. To master and develop modern technology in the design and manufacture of electrical installations with a voltage of 330 kilovolts or more.

c. To use high-grade electrical materials and to sum up the testing results of the cooling method for electrical machines and equipment with a view to raising the technical and economic aspects of all electrical products.

d. To solve the problem of the shortage of certain materials, primarily nickel, chromium, and copper, by economizing in their consumption and using substitutes. To carry out an over-all production development of high-grade electrical materials.

e. To fully utilize the new achievements made in electronic, semiconductor, and automatic technology, and to carry out a revolutionary reform in the structure of whole sets of electrical installations and certain items of equipment with a view to bringing about a greater improvement of the technical level.

f. To fully utilize the advanced production processes of the machine-building industry and other industries, and to combine native with modern methods to enable operations in the electrical-machine industry to become mechanized and automatic and the labor production rate and output to become increased.

In order to bring about the rapid fulfillment of the above tasks, it is proposed that the following scientific research projects be carried out:

(1) In the case of large steam turbine generators, a direct cooling method for the coils of the stator and rotor either by means of liquid or evaporated gas is to be studied. In order to carry out planning and testing work on the production of a series of steam turbine generators, electromagnetism, heat, and vibration calculating methods must be established. The problem of forging and detecting the damages of large rotors and their guard rings must be solved.

(2) In the case of giant water turbine generators, the necessary research work on examining, testing, and planning must be carried out. Along with the strengthening of the cooling system, the principal and component parts, as well as the structure of the over-all installation, are to be improved with a view to lightening the weight and reducing the outer dimensions of the machines.

Improvements also must be made on the thrust bearings, the magnetic pole structure, and the exciting system.

(3) In the case of rotary electrical machines in general, a step further must be taken to improve the economic aspects in accordance with the existing manufacturing conditions and operational costs, and also to improve dependability and durability. Study must be made on the use of modern magnetic and insulating materials, the increase of cooling efficiency, the improvement of the structures so that a unified series of various types of AC and DC electrical machines can be produced.

(4) As regards the building of transformers, cold-rolled silicon steel sheets must be used to improve the structure. Over-all improvements must be made in the insulation of giant high-voltage transformers. Study must be made of the excessive loss of electromagnetic field and the mechanical stress and intensity of coils, as well as on the establishment of a highly efficient oil-immersed force cooling system, to enable planning work to be carried out on the building of ultimate-capacity transformers. Study must also be carried out on the use of aluminum wires to substitute for copper wire in the manufacture of coils, and on the basic change in the manufacturing process of transformers. In carrying out planning work on transformers, the electronic calculating system must be used.

(5) As regards high-voltage electrical equipment, study must be carried out on the manufacture of large-capacity and high-speed circuit breakers to meet modern requirements, on the production of air and oil circuit breakers in series, and on the direct and indirect method of testing large-capacity circuit breakers. Due to the continuous increase in long-distance power transmission lines and their voltages, study must be made on the manufacture of modern lightning arresters to be used for protecting these facilities so that they will not be affected by atmospheric overvoltage and overvoltage caused within the system. Study must be carried out on the overvoltage created within high and super high tension AC and DC lines, and the data accumulated as a result of the study must be employed to determine the insulating level of the facilities to be used. Research and testing work must also be carried out on the structure and production process of the high-intensity porcelain bushings needed for these high-tension power transmission facilities.

(6) Regarding electric power cables, study must be made on the new structural formation and manufacturing process of high and super high tension power cables and on the test manufacture of cables to be used for high water drops. New insulating materials, cables, and wires are to be used and their temperature is to be raised within reasonable operational limits. A step forward is to be taken to expand the use of aluminum in the manufacture of cables

and wires to substitute for copper and lead. The use of plastics as insulating layers is also to be widely expanded. Regarding the manufacture of communication cables, study is to be made of the use of plastics as insulating and protective layers to substitute for aluminum and lead.

(7) As regards low-voltage electrical equipment, study is to be made of the manufacture of products in series (including automatic circuit breakers, fuses, and contactors), which are in demand by the various departments of the national economy. These products must be small in size, light in weight, long-lived, and highly dependable. Parts and accessories produced are to be standard and universal, suitable for mass production. Study is also to be made on the use of the most advanced production processes.

(8) As regards electrical materials, study is to be carried out on the manufacture of sets of modern high-temperature, humidity-resistant, and antiseptic insulating materials and modern arc resistance materials. The use of tungsten as a basic material in the manufacture of contacting materials is to be developed, and the production of modern permanent magnetic materials, cold rolled silicon steel sheets of high conducting magnetism, and super high conducting materials is also to be studied.

(9) In order to coordinate with the operation of a comprehensive automatic system needed by such an installation as a highly efficient rolling mill, and with that of an entire set of electrical installations, study is necessary on the use of an ion and a calculated gear. In order to meet the requirement for the automatic operation of hydroelectric power installations, an automatic control system equipped with a calculated gear for use by large hydroelectric power stations and a fast ion exciting installation are to be studied. Test-manufactured, and put in use. In order to enable production processes to become mechanized and automatic, study on the over-all development of the production of a series of electromagnetic parts and whole sets must be carried out.

(10) Regarding the development of rectifiers, study and test manufacture carried out on water- and air-cooled tightly-sealed mercury rectifiers with a single capacity of 1,000 amperes, and semiconductor rectifiers with a single capacity of over 200 amperes and 150 volts. Study must also be made on various types of whole sets of current changing installations equipped with tightly-sealed mercury rectifiers or semiconductor rectifiers.

With the present high-speed progress in the development of our national economy, the scientific research work undertaken by the electrical industry is indeed extremely burdensome but glorious. With the eminent leadership of the party and Chairman Mao, the magnificence of the party policy, the tremendous

scientific and technical achievements made since the great-leap-forward development, the rapidly growing force of the electrical machine industry, and the scientific and technical cooperation between our country and Soviet Russia and other socialist countries, our continuous advance toward the accomplishment of our mission can hardly be obstructed by whatever difficulty may arise. It is firmly believed that in the not too distant future, our electrical engineering technology will be able to surpass Great Britain and reach the advanced international level.

II. SHANGHAI PRODUCES AN EXPERIMENTAL MODEL OF AN 865 KILOVOLT- AMPERE BLOCKING MAGNETIC AMPLIFIER

Tien-chi Kung-yeh,
Peiping, No. 19, 10 October 1959,
Page 3

Unsigned article

An 865 kilovolt-ampere blocking magnetic amplifier, to be used for the operational control of electric furnaces for emery production, was recently test-manufactured at the Shanghai Hsien-feng Electrical Machine Plant. The amplifier, the quality of which meets entirely the standard requirements, was the first of its kind designed by Chinese technicians. The successful manufacture of this equipment will broaden the use of magnetic amplifiers in the automatic regulating and control system in our electrical-machine industry.

The structure of this large blocking magnetic amplifier, as compared to that of the normal control equipment used in emery-producing electric furnaces, is much more simplified, its greatest advantage being that it is capable of maintaining constant temperature and the power factor of these furnaces.

The planning and test-manufacturing work of the amplifier was started at the plant in mid-April 1959. Within a short period of 8 days, a sample was produced. Testing of the sample was then carried out for another 20-day period, during which important data concerning the curve characteristics of the equipment suitable for use with emery-producing electric furnaces were acquired. Following this, the planning and test-manufacturing work for models, as well as for the actual product, began. In the process of test manufacturing, repeated meetings were called by the plant's and the workshop's party committees to carry out discussions on overcoming various difficulties and to improve the blueprints already made, with the result that within a period of 16 days one tenth of the model manufacturing work was accomplished. In the 20 days that followed, which was on the eve of the tenth anniversary of the founding of the new nation, the entire product was test-manufactured. After going through a test operation in an emery-producing electric furnace, the quality of the equipment produced was found to have entirely met with the standard requirements.

The successful test manufacture of the amplifier was the result of the communist spirit manifested by the plant's technicians and workers, who, under the leadership of the party, carried out their work with daring efforts. At present these technicians and workers, by strictly adhering to the anti-rightist principle, are continuing their efforts to insure another success in the formal production of a 1,730 kilovolt-ampere blocking magnetic amplifier for use by the Shanghai Grinding Wheel Plant in November.

III. TECHNICAL EXPANSION OF CHINA'S STEAM TURBINE GENERATOR INDUSTRY AND FUTURE TRENDS

Tien-chi Kung-yeh,
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Pages 10-13

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Beginning with Bare Hands

The manufacture of steam turbine generators in Communist China was started in the period of the First Five-Year Plan, that is, after the year 1953. In only the short period of 6 to 7 years, tremendous achievements have been made and the speed of development is unparalleled in history.

Prior to the liberation, there was only a small number of generator plants in our electric generator industry. These plants mainly carried out repair tasks and the manufacturing of small generators by copying available models. Production was not carried out with formal planning or blueprints, but on the basis of certain specifications, such as the measurements and channel patterns of silicon steel sheets and the winding of coils. Mechanical structures were formed by relying on the experience of the older workers and by copying available products and sample products. Although the industry had a history of 30 years, its foundation was extremely weak. The AC generators produced were all under the capacity of 200 kilovolt-amperes, not to mention the capability of manufacturing steam turbine generators.

Under the leadership of the party and the government following the liberation, and by virtue of the assistance rendered by Soviet Russia and Czechoslovakia, the first 6,000-kilowatt steam turbine generator was manufactured in 1954, following which the technology for the manufacture of this type of generator was rapidly acquired. At present, a series of steam turbine generators of a capacity of 25,000 kilowatts or less is being produced, and 50,000-kilowatt hydrogen cooled steam turbine generators have been test manufactured. The production of a similar type of product of a still larger capacity is being developed. As a result of strictly adhering to the party's socialist construction principles and carrying out its "advance by both feet" policy since the great-leap-forward year of 1958, the technical level of the masses of workers of the electric generator industry has been raised, and a great number of intermediate plants have been able to master the technology. This has resulted in a complete change from the old condition of solely relying on a small number of plants for production.

Promoting Test Manufacturing and Copying Work with Leap-Forward Speed

During the period of the First Five-Year Plan, the Shanghai Electric Generator Plant was the only plant capable of manufacturing steam turbine generators. In accordance with Czechoslovakian blueprints and other technical data which were acquired through the Sino-Czechoslovakian Technical Cooperation Program, and under the supervision of Czechoslovakian experts, test manufacturing work by copying the Czechoslovakian 4H series of 6,000-kilowatt 6,300-volt, 3,000-rpm steam turbine generators was started in 1953 and completed in September 1954. Following this, in February 1955 and August 1957, continuous test manufacturing work by copying the Czechoslovakian 4H series of 2,500-kilowatt and 12,000-kilowatt 6,300-volt, 3,000-rpm steam turbine generators was successful. In June to September 1956, while the copying work of the Czechoslovakian products was in process, test manufacturing work by copying the Soviet T2 series of 6,000 kilowatt and 12,000-kilowatt 6,300-volt, 3,000-rpm steam turbine generators was completed. These generators, which were test manufactured, were put into operation successively in 1955, 1956, and 1957. In January 1957, test manufacturing work was again carried out by copying the Czechoslovakian 5H series of 25,000-kilowatt 6,300-volt, 3,000-rpm steam turbine generators. This work was completed in 1958.

The first 6,000-kilowatt generator, which was test manufactured by copying the Czechoslovakian model, was installed at the Huai-nan Power Plant in Anhwei Province and put into production in February 1956. As a result of comprehensive testing (which covered a total of 42 items including loading, temperature, brief overloading, and tests under the condition of 105 percent of the rated voltage and a sudden short circuit caused by the stator's three-phase wire terminals), carried out in the second quarter of 1956 by the national Inspection Committee, which was formed by the Ministry of Electric Power and the First Machine Building Ministry, it was found that the over-all functioning of the generators met the Czechoslovakian and Soviet national standards, except that the efficiency of the cooling system, the voltage increase rate of the exciter, and the ultimate voltage were comparatively lower. In November 1956, another over-all test was made by the same Committee on a 12,000-kilowatt steam turbine generator (copied after a Soviet model) with the result that all the specifications were found to meet the Soviet national standard. This test which covered a total of 41 items, included temperature rising by means of an indirect method and a sudden short circuit.

The test manufacturing and copying work carried out during this period brought about the cultivation of our first group of technical personnel capable of designing and manufacturing steam turbine generators. In the work of designing, they have become

familiar with the structure of the machines, calculations, and various other requirements. After studying the model-selecting plans mapped out for the copying work and analyzing the advantages as well as the disadvantages of the various structural designs of the generators, concrete knowledge on the selection of the desired principal technical data was acquired. In manufacturing work, they have mastered the technical operation of the various principal parts and accessories and the use of the equipment; and regarding the task of inspection, they have completely mastered the testing of raw materials, coils, and various other component parts.

At the same time that the test-manufacturing and copying work was being carried out, the Shanghai Electric Generator Plant also assumed the task of repairing steam turbine generators of a capacity of 1,250 and 15,000 kilowatts and a voltage of 3,150 to 10,500 volts for the various power plants within the country. The repair work, which included a certain amount of designing, enabled the plant to later accumulate a great deal of designing and manufacturing experience.

In 1958, the Harbin Electric Generator Plant, under the supervision of Soviet experts, test-manufactured a model of the Soviet T2-series 25,000-kilowatt, 10,500-volt, 3,000-rpm air-cooled steam turbine generator. The series of 25,000-kilowatt steam turbine generators produced by the Shanghai and Harbin Electric Generator Plants were put into operation after being inspected by the National Inspection Committee.

From Copying to Self-Designing

In accordance with the national plan of assuring that our scientific technology reaches the international standard within a period of 12 years, and with the approval of the ministries and bureaus concerned, the Shanghai Electric Generator Plant in July 1956 started designing work on a series of the "China" model steam turbine generator. The work plan called for the application of the latest steam turbine generator manufacturing experience and the achievements of various countries in the world, relating them to the actual conditions in our country. This series of generators was to be air-cooled, with 3,000-rpm and four different capacities of 2,500, 6,000, 12,000, and 25,000 kilowatts. The voltage of the 2,500- and 6,000-kilowatt generators was to be 6,300 and 3,150 volts; that of the 12,000 and 25,000-kilowatt ones, 10,500 and 6,300 volts. Consumption of main raw materials, such as copper wire and silicon steel sheets, was planned to be more economical as compared to the present standard, and structure were to be designed for convenience as regards maintenance and repair. In addition to the plant personnel concerned, those who participated in the work included professors from Chiao-tung University, Chekiang

University, the Central China Institute of Technology, Tsinghua University, and Harbin University, as well as comrades from the Electrical Equipment Scientific Research Institute, each sharing responsibility within his own specialized field. Assistance was also rendered by Chiao-tung University and Soviet experts on the subjects of insulation and short circuit ratio, and by the Nanking Aviation Institute on the designing work on the turbine propeller. Opinions on the draft plan for the over-all structure of the machine were obtained from technical personnel and older workers of the Yang-shu-p'u Power Plant in Shanghai. By October 1957, an over-all technical plan for the machine was finally submitted for examination at a joint session attended by representatives of the Electric Power Ministry's Institute of Planning and the various universities concerned. After this designing work, the technical level of the Shanghai Generator Plant was again improved, and a good foundation was thus created for the future development of steam turbine generators of still larger capacity.

In the course of the test manufacturing and copying work, along with the tasks accomplished for the production of some of our new structural designs, the studying and testing of the following subjects was carried out, with satisfactory results in some cases being acquired:

1. Formulas on the calculation of the magnet, ventilation, temperature rise, coil design, and mechanical function of the steam turbine generators.
2. Formulas on calculating the stress of a sudden short circuit of involute and basket-type stator coils.
3. The fanning effect and air distribution of the rotor copper-wire direct-cooling structure.
4. The heat-dispersion effect of various types of cooling pipes and plates of the air-cooled equipment.
5. The mechanical function of the softening colloidal substance used in stator coils under low temperature.

Studies and tests were also made on new production processes and structures acquired in the course of the test-manufacturing and copying work.

Leap Forward Toward Greater and More Complex Objectives

In 1958 the electric power industry played a leading role in the over-all development of agriculture and industry, when increasing demands for the production of more electric power station equipment were made. In order to meet these demands, the Shanghai and Harbin Electric Generator Plants quickly undertook a greater portion of the production work. In that year the Shanghai Electric Generator Plant produced over 4 times as much as in 1957, completing the test-manufacturing work on a 25,000-kilowatt

generator set within a period of 3 months. The Harbin Generator Plant also test-manufactured a generator set of the same capacity ahead of schedule. At the same time, a great number of medium generator plants were established in the principal provinces and cities, test-manufacturing and producing numerous steam turbine generators under a capacity of 6,000 kilowatts. The speed of development of the power station equipment manufacturing industry in that year, like all other industries, was the greatest ever.

In carrying out the test-manufacturing work on new products in 1958, the workers of the Shanghai Electric Generator Plant, in close collaboration with the technical personnel, advanced toward more complex technical objectives. Thanks to the concern and active support of the party, they were finally able to test-manufacture the first 12,000-kilowatt, 3,000-rpm steam turbine generator equipped with a modern cooling system, using the same quantity and quality of materials to double the generating capacity. This greatly raised the economic aspect of the production. At the same time that this generator was being test-manufactured, a tremendous amount of testing and research work was carried out in cooperation with the various higher educational and research institutions. In early 1959, generators of this type were put into operation in various power stations. In the course of actual operations, numerous invaluable experiences were gained and technical data so far unknown to the world were accumulated. This enabled us to fully realize the kind of achievements we can make as a result of resolutely carrying out the party's principles.

In the second quarter of 1959, an inspection committee, formed by representatives of the First Ministry of Machine Building and the Ministries of Water Conservancy and Electric Power, and directed by the party committee members concerned, conducted an over-all inspection of the 25,000-kilowatt steam turbine generators produced by the Harbin and Shanghai Steam Turbine Generator Plants. These generators were found to have met the national standard. The inspection included the testing of the three-phase sudden short circuit. At the same time, the cooperation between the power plants and manufacturing plants was also examined, and a final decision was made on the blueprints and technical processes to be followed in the course of production. The result of this work laid the foundation for the future production of this type of generator in series and accelerated the continuous great leap forward in 1959.

Apart from the above, one of the most significant developments in 1959 is the gradual supply of rotors and guard rings by our own steel plants. At present, quite a large number of generators made of domestically forged parts and guard rings are in operation at various power plants, and the function of these generators is basically satisfactory. This shows that the supply

of power station equipment in our country has gradually become self-sufficient and that greater advantages have been created for future production development.

For Strengthening Scientific-Research Work and Developing More Varieties of New Products to Satisfy the Needs of National Construction

Prior to the liberation, the foundation of our electric generator manufacturing industry was extremely weak, with no capacity at all of manufacturing steam turbine generators. Because of the technical complexity and high precision of this type of product, it took the capitalist countries a period of 60-70 years to acquire their present manufacturing level. Following the liberation, however, under the leadership of the party and the government and with the technical assistance rendered by Soviet Russia and Czechoslovakia, we have been able to quickly master the manufacturing technology. This explains our great achievements of the past 10 years, and especially since the leap-forward year of 1958. Despite these achievements, our technical standard in this field of production is presently still far from the international level, due to the original backwardness of our foundation. Consequently our future development must be assured by studying and analyzing the advanced experiences of other countries, especially Soviet Russia and Czechoslovakia, relating them to the conditions and requirements within our country. We should exert our greatest efforts and manifest our communist spirit in creating new models and large capacity generators. In accordance with our present leap-forward plans, it is expected that in the near future we shall be able to reach and surpass the level of various capitalist countries. In the light of the present trends in the various countries regarding the development of steam turbine generators, we should, on the one hand, employ new technology and use new materials in the manufacture of large-capacity generator sets; and on the other, we should look into the current material-supply conditions and technical possibilities within the country and carry out the manufacture of small capacity two-pole steam turbine generators by using the composite-type rotors, so that production can be conveniently and widely carried out by the medium electric generator plants in the various localities. Consequently, every effort must be made toward the following five directions:

1. To quickly test-manufacture 50,000- and 100,000-kilowatt steam turbine generators to satisfy the rapidly increasing demand for the development of the national economy. Since the establishment of high-voltage power networks, the trend in the development of the power system has been to plan for the construction of large power

stations and the acquisition of large-capacity generator sets. One of the key problems in the production of large-capacity generators is the cooling system. However, since the great-leap-forward development and under the direct leadership of the party, we have been able to create a modern cooling system which, when used in a generator, produces highly effective results. In manufacturing generators equipped with this modern cooling system, comparatively smaller forged parts are used, and therefore the consumption of nonferrous metal and silicon steel sheets can be cut down greatly. In the manufacturing process, a great amount of machine work can be saved with the burden on larger machine lathes lightened, although an additional amount of electrical engineering work is required. Regarding the performance capability, the efficiency is not lower than the average type of generator, and if ways and means can be devised to reclaim the heat capacity, a higher efficiency can well be expected. In summing up the structural and operational characteristics, the manufacturers and the users felt that a series of the coolers should be made for use in generators of a capacity of 12,000 to 100,000 kilowatts. At present, an over-all inspection of the operational condition of the equipment is required so that production in series can be carried out at an earlier date for the benefit of the future development of generators of a capacity of 200,000 kilowatts or more.

During the past several years, the development of the hydrogen internal cooling system has been exploited by various countries in the world. Since 1958, the Harbin Electric Generator Plant has done a tremendous amount of work on the testing and study of this system. At the same time, it has accumulated a great deal of experience, with hydrogen internal cooled 50,000-kilowatt steam turbine generators now being included in its new-products test-manufacturing plan. The plant, on the eve of the tenth anniversary of the founding of the new nation, produced a hydrogen external cooled 50,000-kilowatt steam turbine generator. It is to be sent to a power station, pending final inspection to be carried out by a national committee.

2. To test-manufacture improved models of the 6,000- to 25,000-kilowatt steam turbine generators, using domestic materials.

Within the next several years, 6,000- to 25,000-kilowatt air-cooled steam turbine generators will represent a great majority of the total output, since the direct air cooling system is evidently highly efficient for the function of high-speed steam turbine generators. In this connection, plans must now be made for the improvement of this type of generator by using the direct air cooling method, thus enabling us to reach the advanced international level. At the same time, plans must also be made to use domestic materials for the production.

3. To quickly test-manufacture and produce two-pole 1,500- to 3,000-kilowatt steam turbine generators, using the simplified composite-type rotors. Since the great-leap-forward year of 1958, numerous 750- to 1,500-kilowatt four-pole projecting pole type steam turbine generators have been produced. But this type of generator can be coupled with the steam turbine without the use of a gear box. The two-pole composite-type rotor generators which are scheduled to be produced can be directly coupled with the steam turbine, which will eliminate the use of the gear box and thus simplify the production process.

4. To speed up testing and research work on new types of materials.

The development of the manufacture of steam turbine generators necessitates the use of new types of materials. In order to facilitate the production process of a modern direct cooling system, the various electrical wire manufacturing enterprises should first be called upon to solve the problem of supplying good-quality hollow conductors capable of withstanding high voltage without leakage. Secondly, testing and research work should be carried out on high-voltage insulation so as to increase the insulating level of coils and the operational dependability of generators. Thirdly, study is to be made on the use and processing of hot-rolled silicon steel sheets with a view to improving the magnetization and lowering the rate of depreciation. Plans should also be made for the use of cold-rolled silicon steel sheets in the manufacture of large-capacity generators with a view to improving their efficiency. In regard to the supply of other types of materials, such as insulating tubes and silicone organic rubber, and large forged parts and guard rings, which are indispensable for the development of modern and large steam turbine generators, the chemical and other manufacturing enterprises concerned should be called upon to make them available at the earliest possible date.

5. To carry out careful testing and study on generator parameters, exciting methods, and other subjects.

In modern and large-capacity steam turbine generators, the short circuit ratio is comparatively lower. After the direct cooling system is used (with a smaller measurement of the forged parts), study should be rapidly carried out on parametrical variations in regard to their effect upon the stability of the power network. Regarding the use of large-capacity generators, the degree of excitation increases and the function of the direct self-exciting system is deemed impossible. After the direct cooling system is used, the average rotor current greatly increases and cannot be controlled by the ordinary exciting system. Therefore, among the principal subjects to be studied, the ion and other exciting system was once tested on a modern 12,000-kilowatt steam turbine generator and found to be satisfactory.

We Must Reach and Surpass the Level of Great Britain

At the eighth session of the Eighth Central Committee Plenary Meeting, it was decided that the total amount of generating equipment to be produced in 1959 was to be equivalent to a capacity of 1,800,000 kilowatts. This figure is more than double that of 1958 and exceeds the quota mapped out in the Second Five-Year Plan. The equipments to be produced include a great many for thermoelectric power generation. We firmly believe that under the leadership of the party and with the efforts of the workers of all the enterprises, we shall be able to fulfill this difficult but glorious task. In 1947, with approximately 60 years of manufacturing experience, Great Britain's output of generators only reached an equivalent capacity of 1,640,000 kilowatts. And yet, our country, with no experience at all in the early liberation days, is now able to have an annual production equivalent to a total capacity of 1,800,000 kilowatts. Britain has an average annual increase of output of less than 7 percent, but since the great-leap-forward development we have had an increase greatly exceeding this figure. Therefore it is assured that our output will soon reach and surpass the British level. In regard to the technical level, Britain, with 70 years of manufacturing experience, completed its first 100,000-kilowatt, 3,000-rpm steam turbine generator only in 1957. But we, within the short period of 6 years, are now heading toward the development of 50,000- and 100,000-kilowatt, 3,000-rpm steam turbine generators. With the concern and support of the party, and especially since the great-leap-forward development of 1958, we have been advancing from copying work to self-designing. We believe that with the foundations created in the past and by continuously exerting our efforts, our technical level will be rapidly raised, and in the not too distant future we shall be far ahead of the capitalist countries.

IV. FLYING LEAP IN THE EXPANSION OF THE TRANSFORMER INDUSTRY

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During the past 10 years, our transformer industry had had a great development. The output and variety of new products were rapidly increased; the quality and the technical and economic aspects were continuously improved, with remarkable achievements made in scientific research work. Since the great-leap-forward year of 1958, the rapid speed of our advancement has been tremendous. All this has been the result of the eminent leadership of the party and Chairman Mao, and the vigorous and daring efforts of the masses of workers, who resolutely carried out the party principle of striving for an upsurge in socialist construction by increasing production, improving the quality of the products, and practising economy and the policy of "advancing by both feet."

A Tremendous Speed of Advancement Unparalleled in History

Our transformer industry has had a history of over 30 years, but, due to the aggression of the imperialists and the corruption of the Kuomintang prior to the liberation, it did not have the opportunity to develop. In 1947, which was the highest productive year, the transformers that were produced were only equivalent to a total capacity of 140,000 kilovolt-amperes. During that period, the largest single transformer produced was of a capacity of 2,000 kilovolt-amperes; the largest electric furnace transformer, not more than 1,000 kilovolt-amperes; and the highest voltage of a mutual inductor, not over 33 kilovolts. The quality of these products was inferior; the supply of materials depended upon imports, and the technical level constantly remained backward.

Within less than 2 years after the liberation, the annual output of the transformer industry was quickly restored to the highest pre-liberation level. Thereafter, large transformer manufacturing plants were established, a number of transformer workshops at various generator plants being expanded and reconstructed and medium and small transformer plants established during the First Five-Year Plan period. If the total output of 1958 is compared with the highest productive year prior to the liberation, it will show an increase of 85 times. In the Shenyang Transformer Plant alone, the average annual increase of output from 1952 to 1958 reached 69 percent, with a 123 percent increase in 1958 over

that of 1957. The plant's total transformer output in 1958 is equivalent to 44 years of the production carried out in the old China days. Such a speed of development is beyond the power of the various capitalist countries in the world to overtake. Great Britain, with more than 80 years of transformer manufacturing history, has had an average annual increase of less than 5.5 percent in recent years. The rapid progress made in our transformer industry clearly shows the incomparable superiority of a socialist economy, and it is anticipated that within the next several years our transformer output will reach and surpass that of Great Britain.

A Rapid Increase of a Variety of Products Basically Satisfying the Needs of the Nation

From 1949 to 1952, when the national economy was being restored, planning work was carried out on a series of three-phase 100- to 500-kilovolt-ampere intermediate-type distribution transformers, and technical reforms were made on pole-type distribution transformers under a capacity of 50 kilovolt-amperes, enabling them to be put into mass production. During that period, the Shanghai Generator Plant produced a 66-kilovolt, 15,000-kilovolt-ampere power transformer, while the Shenyang Transformer Plant manufactured a similar type of product with a voltage of 44 kilovolts and a capacity of 5,000 kilovolt-amperes. In 1953, under the leadership of the Ministry and Bureau concerned, transformer production units throughout the country were organized, and an over-all plan was mapped out at the Shenyang Transformer Plant to bring about a unification of the products, eliminating entirely the past confusion regarding specifications and models. The products for which a unified plan was made were three-phase oil-immersed power transformers of a capacity of 10,000 to 20,000 kilovolt-amperes and a maximum voltage of 66 kilovolts. As a result of conforming with advanced Soviet experience, the technical and economic aspects of these products were able to reach the advanced level, and in the course of actual operation they proved to be convenient and of excellent quality. With the assistance rendered by Soviet experts and the technical data furnished by Soviet Russia, the Shenyang Transformer Plant in 1953 test-manufactured a 15,000-kilovolt-ampere, 110-kilovolt single-phase three-coil power transformer. This was the beginning of large and high-voltage power transformer manufacturing in our country. From 1954 to 1957, developments were made regarding the design and large-quantity output of a series of large and high-voltage power transformers of a capacity of 7,500 to 40,500 kilovolt-amperes and a voltage of 110 kilovolts, satisfying the needs of the power stations in various localities. From then on, the supply of transformers under a voltage of 110 kilovolts no

longer has relied on imports. In 1957 a 154-kilovolt, 40,500-kilovolt-ampere three-phase three-coil power transformer, the structural design of which is comparatively more complex, and a 220-kilovolt, 20,000-kilovolt-ampere single phase high voltage power transformer were also test-manufactured. These products, which were designed by Chinese technicians, were among the most important achievements made in the period of the First Five-Year plan.

In the technical-reform and revolution campaign which was launched in the great-leap-forward year of 1958, remodelling work was first carried out on power transformers of the 1,000- to 5,600-kilovolt-ampere series. This important technical reform was started by mapping out the production processes in accordance with our country's conditions, lowering the coil and oil surface temperature by 5° C, cutting down on the use of copper and iron, and increasing the efficiency of the products. Past manufacturing experiences were drawn upon with a view to improving the structural design of the products and reducing the consumption of principal materials. At the same time, a considerable number of transformer plants test-manufactured 1,000- to 1,800-kilovolt-ampere transformers by using aluminum wire coils, saving a large amount of copper. The large and high-voltage items which were test-manufactured that year included the 110-kilovolt, 60,000-kilovolt-ampere three-phase three-coil power transformer and the 220-kilovolt, 40,000-kilovolt-ampere single-phase power transformer, with developments also being made on such complex products as the 110-kilovolt, 31,500-kilovolt-ampere three-phase three-coil loading switch transformer and the 40,000-kilovolt-ampere line-series voltage regulator. In 1959, the 31,500- and 75,000-kilovolt-ampere oil-immersed force-air-cooled transformers were test-manufactured, with the 60,000-to 120,000-kilovolt-ampere, 220-kilovolt giant transformers being in the process of test manufacturing. Up to this point, it is evident that we have already mastered the technology of designing and manufacturing large power transformers under a voltage of 220 kilovolts.

During the past 10 years tremendous achievements were also made in the manufacture of special types of transformers for the metallurgical, chemical, and mining industries. The largest electric furnace transformer manufactured reached a capacity of 21,000 kilovolt-amperes, with numerous 320- to 12,800-kilovolt-ampere transformers for use with mercury rectifiers being produced and large quantities of 50- to 320-kilovolt-ampere transformers for mining use and 2.5- to 4-kilovolt-ampere anti-blast transformers also being produced. A supply of whole sets of transformer station installations consisting of 100- to 1,000-kilovolt-ampere pole-type transformers has now been made available, and 5,600-kilovolt-ampere, 35-kilovolt transformers for use in electric locomotives are being formally produced.

Regarding voltage and current mutual inductors for use in an electric power system, production in large quantities is being carried out according to 650 different specifications with voltages ranging from 0.5 to 220 kilovolts. The output of these products can now satisfy the needs of all consumers, and their technical aspects are being continuously improved. Plastic current mutual inductors with a voltage of 10 kilovolts and less were test-manufactured in 1958, and 220-kilovolt cable-type current mutual inductors, the weight of which is 60 percent lighter than their old counterparts, were also test-manufactured by means of the "three combined efforts." Mutual inductors of a voltage of 3,300-kilovolts are now in the stage of study and test-manufacturing.

Current reactors of 200 to 3,000 amperes are being produced in series, and at the same time, aluminum instead of copper cables are being used in some of these products.

Regarding high-voltage testing equipment, in addition to 1,800-kilovolt impulse voltage generators, 25-kiloampere impulse current generators, 20-kilovolt anode oscillographs, and two-meter spherical pole and transient analytical instruments, which were test-manufactured in 1958, 600-kilovolt single-unit power frequency testing transformers were also made in early 1959.

In 1959 achievements were made in the test manufacture of condenser-type bushings of four different specifications -- 110, 154, 220, and 330 kilovolts. The weight of these products is lighter by one half as compared to the oil bushings.

Standardization and Systematization of Products to Create the Necessary Conditions for Series Production

Due to the fact that old China's industry was of a semi-colonial nature, the principal characteristics of transformer production under such conditions were such that although the total amount of output was small, the various types and different specifications were complex, and although neither the capacity was large nor the voltage high, varieties of grades were numerous with production being carried out by many different methods. This confusing situation was indeed extremely disadvantageous to the development of the transformer industry. Following the liberation, the adoption of the party policy of applying advanced Soviet scientific and technical experience eliminated various obstructions. At the All-China Electric Generator Industry Conference, held in 1952, it was decided that a provisional plan be mapped out for the designing and usage of transformers in accordance with the Soviet national standard. Based upon this decision, study was subsequently carried out on the structural design of products of the Moscow Transformer Plant, dividing transformers of different capacities and voltages into four categories, enabling the products to become

systematized. At the same time, the production of three-phase products was carried out to substitute for single-phase ones. All this, in the period that followed, not only brought about a remarkable improvement in the products' performance capability, saving a tremendous amount of raw material, but also created excellent factors for large-quantity production, satisfying the increasing demands of the various industries.

As a result of the expanded use of transformers in the latter part of the First Five-Year Plan period and of the new demands of consumers, a Chinese standard of transformer development was drawn up in 1957 and completed in 1958 in accordance with the conditions within the country, including the climate and natural resources. The use of this new standard was subsequently tested in the remodelling work on transformers of the third category, and also in the new designing work on a number of large-type products of the fourth category. It yielded satisfactory technical and economic results. Following this, plans for a high-voltage testing standard, a mutual inductor standard, and special types of transformer standards were drafted in accordance with the demand of consumers and the abundant experiences acquired in the 1958 technical revolution. These development plans show that our transformer industry has already advanced from copying to self-designing.

Since 1953, a tremendous amount of routine work has been carried out on the standardization of material specifications for the transformer industry. Taking into consideration the materials to be used in production, and the quality of various types of materials manufactured domestically, a standard for the consumption of materials of various types and specifications was reached. In doing this, material output can be consolidated to a reasonable limit, the quality of products can be assured, and at the same time production can be carried out gradually by using domestically manufactured materials. Another important achievement in this connection was the adoption of the metric system for tightening parts in 1952, which resulted in the full utilization of the standard products made by screw plants instead of relying on the production of the transformer plants themselves. Since 1953, consolidated planning has been done in connection with transformer parts and accessories to promote the universality and increase the output of these products.

The electrical specifications of transformers are extremely complex, yet we are capable of producing large amounts of products of numerous different specifications. The quantities produced exceed by far those produced by the transformer plants of the various capitalist countries. These great achievements are inseparably connected with our standardization and systematization of products.

For Strengthening Technological Control and Employing New
Technology to Continuously Improve the Quality of Products and
Raise Labor Productivity

The most important factor in production is the technological process. In order to carry out planned production in a modern socialist enterprise and to continuously improve the quality of products and raise the labor productivity, a technological working procedure must be established and resolutely carried out to provide guidance for the workers and to organize the work methods. The appropriate arrangement of the production line, the use of machines, the assurance of operational safety, and the systematic passing on of parts depend entirely upon the work of strengthening technological control. In 1953, under the supervision of Soviet experts and applying Soviet technological experience to the actual conditions in our plants, work was started on the establishment of a technological control system. Taking into consideration various basic requirements, plans for establishing over-all technological procedures and organizing preparatory work for the test manufacture of small numbers of products were drawn up, with different types of technological documents being mapped out. Due to the great complexity of the work and the broadness of the fields involved, the technological system was not formally completed and the confusing situation in production operations was not totally eliminated until 1956. At that time, instructions were given by the ministries and bureaus concerned to have the enterprises reorganized with special emphasis placed on the elimination of the repair work carried out in the course of manufacturing, with a view to strengthening and firmly establishing regular production operations and enabling the masses of workers to resolutely observe the new technological procedures. By 1957 progress had reached the stage where technological documents became available to the various workshops in accordance with their fields of production. Numerous technological procedures were standardized, which advantageously effected the technical level of new workers. As a result of resolutely carrying out the standard technological procedures, e.g., in the varnish coating of coils, the vacuum drying of oil-immersed equipment, the painting of silicon steel sheets, and the electroplating of parts, the quality of products gradually became stabilized, and such problems as the inferior baking and immersing of coils, the lowering of insulation resistance, the overconsumption of iron, and the leaking of oil tanks, were overcome. In the last part of 1959, as a result of carrying out the instructions of the ministry and bureau concerned regarding the reorganization of production procedures and the improvement of the quality of products by adhering to the principle of unified leadership with the appropriate sharing of responsibilities,

new technological progress was made, with the result that the quality of the transformers produced was remarkably improved.

The extension of the new technology has brought about satisfactory results in production operations. In welding work, for example, automatic air cutting, as well as automatic and semiautomatic welding methods, were employed. Also, short arc welding was extended, spot welding bolts were used, and the twisting of cooling pipes was done by means of machines. In the process of insulating materials, circulating hot air baking ovens and the vacuum drying process were used, with cardboard parts made by presses, silicon steel sheets processed by means of electric tempering, and painting done by mechanical equipment. Combined punching and shearing machines were used in various other processes. In assembling work, the copper welding method and pneumatic tools were used, which resulted not only in improvement of the quality of products but also in an increase in labor productivity. The innovations and technological reforms carried out by the masses are the principal resources for the improvement of the technological standard. The achievements made in the technological reforms and revolution of 1958 were especially splendid. In that year the Shenyang Transformer Plant alone carried out reforms in the case of 4,144 items, with 68 different types of native equipment being created by the workers. Of the number of reformed items, 2,036 were connected with technological installations, which finally brought about an increase in labor productivity of 104 percent as compared with 1957.

Scientific Research Work to Promote the Production Development

In 1952, when transformer production was carried out mainly by studying advanced Soviet experience, physical and chemical analysis of such principal materials as silicon steel sheets, transformer oil, and insulating varnish was begun. According to the need for a gradual increase in output and the development of new types of products, the initial step was taken in 1955 to strengthen the various testing and research organizations, with a view to promoting the study of new materials and technological processes. The achievements made in this connection were represented by the mastering of the hot processing technology of silicon steel sheets, followed by the successful test-manufacturing of silicon aluminum alloy, phosphorus copper welding rods, and low magnet cast iron. In 1956, extensive testing work was carried out on the silicon steel sheets produced by various countries of the world, with a systematic study being made on the iron cores of current mutual inductors, which provided a scientific basis for our designing work and the expansion of different types of mutual inductors. At the same time, laboratory tests and practical

studies were carried out on the mixed changes of various types of transformer oil, and also on the stability of domestically manufactured oil, which eliminated dependence on foreign imports and paved the way for the use of domestically made oil. In 1958, instructions were given by the ministry and bureau concerned to the Shenyang Transformer Plant to establish a transformer research office. During this period, colloidal substances for glass fiber materials were test-manufactured, with achievements being made in the trial use of epoxy-resin, the process of the vacuum drying and sealing of oil boxes, and preventing iron cores from rusting while the transformers are being dried. At the same time, error bridges for voltage and current mutual inductors, coil winding testers, and hygrometers were also test-manufactured. Production progress was made as a result of the daring efforts exerted by the masses of workers.

The rapid development of transformer products toward the high-voltage categories urgently required that scientific research work be carried out on such categories. In 1957, a high-voltage testing laboratory was constructed at the Shenyang Transformer Plant. Within a period of less than 2 years, a series of full wave and cut-off wave impulse high-voltage tests was carried out on 35 to 110-kilovolt transformers and a comprehensive impulse test was made on 220-kilovolt, 40,000-kilovolt-ampere transformers, the results of which proved that our transformers possess sufficient lightning-resistant and insulating power. A careful study and test was also made on the insulating structure of transformers of the 110-kilovolt series, and it was found that a reasonable insulation allowance existed. These findings created a foundation for future remodelling and designing work. At present, tests are being carried out on the insulating structure of a 330-kilovolt series of products. For the purpose of accurately determining the punctured position of a transformer, an inspection method for ballistic tests was acquired. Again, for the purpose of studying the overvoltage transient period of transformers, two special types of transient analytical instruments -- a gradient oscillograph and a long-period scale analytical instrument -- were test-manufactured.

The use of a modern cooling method for transformers is a step toward increasing their capacity and economizing on the use of materials in their manufacture. During the great-leap-forward development in 1958, quite a number of transformer plants carried out a study of oil internally-cooled transformers by test-manufacturing samples. Due to the fact that the work requires a long period of scientific study and in order to satisfy the needs for the immediate reform of products, detailed testing and study was recently carried out by the transformer research office on various types of oil-immersed force-cooled transformers. This

brought about fairly good results, which will be felt in the future development of extra large transformers.

Powerful Practice and Rich Experience

During the past decade the achievements made in our socialist construction have been magnificent. The rapid progress made in the development of the transformer industry is one of the many wonders of our country. In carrying out practical work in production, especially during the 1958 great-leap-forward development, valuable experiences were acquired. These experiences, after being absorbed, summed up, and developed, will create a firm foundation for the continuous leap-forward development of the transformer industry.

1. To rely on party leadership, to use politics as a leading element, and to carry out the ideological revolution are the leading factors in the continuous improvement of our production technology.

Experience has proven that only continuous revolution can bring about continuous development, and ideological revolution is the foundation for continuous revolution and development. Lacking the ideological revolution is the same as lacking the technological revolution and other related developments. In 1953, for example, when the party called for the study of advanced Soviet experience, a number of technicians were in doubt of the Soviet technological standards and data and were reluctant to make full utilization of them. They were unwilling to give up the arbitrary and fragmentary British and American technology, which obstructed the over-all improvement of the technological standards of our transformer production. However, in 1954, as a result of the party's appeal for the study of advanced Soviet scientific technological experience, the masses of technicians, in close cooperation with the workers, criticizing the technological viewpoints of the various capitalist countries, carried out a campaign for the study of advanced Soviet experience. During this period, Soviet technological data and the suggestions of Soviet experts were resolutely complied with, with the result that the quality of the transformers produced was greatly improved, the number of different types of products was rapidly increased, and the technological standard of transformers was significantly raised. In 1958, as a result of strengthening the collective leadership of party committee members and fully mobilizing the masses in the use of various methods to battle against rightist ideology, eliminate superstition, and liberate their thinking, each and every individual, from the leading cadre members to the workers, carried out his work by adhering to the socialist principle of exerting vigorous effort and striving to produce

more, produce rapidly, produce good-quality products, and practice economy. A great majority of the technicians also accelerated the speed of their ideological reform, having given special attention to overcoming their dogmatic view of technological operations and their ideas of ignoring the creative power of the masses. All this brought about enormous achievements in the technological reform and revolution, with constant progress made in production.

2. We must resolutely carry out the party policy of "advancing with both feet" so that achievements can be made in the course of production development. In the various enterprises, it is felt that special attention must be given to the following:

a. The study of advanced Soviet experience must be linked to our own individual creations. During the past several years, our work in designing and manufacturing has been greatly benefited by Soviet technological aid. By studying advanced Soviet experience, we have saved a tremendous amount of unnecessary effort and have been able to find the direct path toward the development of our technology. Consequently, we believe that in the future our study should be conscientiously continued. Based upon the foundations acquired in our study, we should at the same time exert our efforts to create our own designs in accordance with the conditions in our country. This is proven by the example of remodelling the 10 to 5,600-kilovolt-ampere standard series of transformers in accordance with our technological requirements, such as those connected with temperature, retaining the advantageous points of the Soviet model. The result was that, besides being able to raise the electrical performance capability of the products, we also saved approximately 15 percent in material expenditure in their manufacture. Such a method of study should henceforth be firmly established and continuously improved. Only by linking the study of Soviet experience to our creative work can our technological standard be raised to a still higher degree.

b. A display of revolutionary enthusiasm must be made simultaneously with the steady promotion of scientific study, and, likewise, the exertion of daring effort with the verification of the facts. Positive support must be given to the reforms proposed by the masses, even though not all of these reforms may be extended to production. Thorough scientific research work must be carried out regarding the technological reform of important products and series of products before they can be put into formal manufacture and use. The policy of increasing the amount and accelerating the speed of production, improving the quality of products, and practising economy must be used as a foundation in the test-manufacture of new products, as well as in the development of new technology. In 1958, for example, in test-manufacturing an internally cooled transformer, a certain

amount of basic material was saved, but the over-all loss was great, the number of working hours spent in the manufacturing process was in excess of that scheduled, and the operational efficiency of the product could not be assured. Although a certain amount of experience was acquired in the course of the test manufacture, we are still far from being able to put the product into formal production, and such a wide gap can only be bridged by carrying out the necessary research work. All in all, in advancing in technological development, superstition must be eradicated, ideology must be liberated, facts must be verified, and the truth of science must be respected. The lofty ideal of communism is primarily to recognize and aim for objective standards. In solving each and every scientific and technological problem, satisfactory results can finally be attained through perseverance, the exertion of painstaking efforts, and the carrying out of repeated tests. Chairman Mao has instructed us that in strategy we must treat difficulties with contempt, and in tactics, with esteem. Since there are daring efforts, there must be a spirit of scientific study. This is the reflection of the objective development standard and is also the principle which we should follow in the course of our work.

c. Long-range technological development should be carried out together with the present production reform. In this connection, we must have long-range objectives as well as short-period operational plans, aiming at the technological reform of key production problems. In 1955 technological reform plans were mapped out, and in 1956 and 1957 procedures for the reform of enterprises were drawn up. In these plans and procedures, technological inspections and operations were strengthened, which exerted an enormous effect upon the employment of new technology and the establishment of normal and modern production procedures. In the beginning of 1958 and 1959, plans for overtaking the technological progress of Great Britain and for developing the technological revolution within the country were also made. On this basis, along with the production work that was being carried out, quarterly and monthly technological arrangements in each and every department were made for carrying out short-term plans to assure the developments of the long-range objectives. Also, at the same time, the masses were called upon to study and solve every technological problem arising from the various stages of their production work. By doing this, the technological reform and development work will have the basic support of the masses. Long-range technological development plans provide clear and definite objectives for technological reform and revolution, enabling each and every individual to ambitiously work for these objectives. Short-term plans call for everyone to exert the utmost effort in every phase of work, so that production work can be efficiently carried out.

d. Major technological reforms should be carried out simultaneously with general technological improvements; and special technological studies, with the technological reforms proposed by the masses. Apart from calling upon the masses to study the major problems arising from technological development, technical personnel should also be organized to carry out a systematic study of such problems. This is one of the leading factors in the development of technological work; it should be of a long-range nature and exert a tremendous effect upon economic achievements. In the reform of the designing work on a series of products and the test-manufacturing preparation of new "heavy, large, refined, and superior" products, comprehensive research and testing work must be carried out. At the same time, adequate attention must be given to every phase of production, because even a minor degree of improvement can result in greater production efficiency. Technology develops from a lower degree to a higher degree, from simplicity to complexity, and from variation in quantity to change in quality. Only by calling upon the masses to ceaselessly exert their efforts can over-all achievements be made in technological reform and revolution.

e. The control exercised by the masses must be linked with the control exercised by the agency supervising a specialized field of work. While fully depending upon the masses, the work of a unified leadership must be strengthened. The working method of "participation by two elements and cooperation between three," which was created in the 1958 great-leap-forward development, should be secured and its use expanded. Designing and production plans should use the "cooperation between three" method, but practical work must be carried out under unified leadership with appropriate responsibilities shared by the respective departments concerned. The reform of blueprints for production, for example, cannot possibly be accomplished by a single production unit, but must be put under unified control. Key technological procedures must also be put under unified control, but the general types of operational processes can be directly assigned to the various workshops. Major and long-range scientific research work must be put under unified control. In every production unit, such as a workshop, cooperation among the masses should be organized to carry out the work of technological reforms. The achievements made in this connection should be summed up and propagated by the agencies specialized in a particular field of work.

3. In the course of carrying out technological reform and revolution and accelerating the development of production and technology, constant research and study must be carried out on various production characteristics, with absolute understanding of the direction of development and the overcoming of various key problems.

The characteristics of transformer production are such that the types and specifications of products are varied, but the structures of a series of products are unified and their parts can be more universally used. Products are of the large, medium, and small types, the large type of products being produced individually and the small ones in series. The quality of the products must be superior, since an operational defect can affect the power supply of an entire locality. The percentage of the use of nonstandard equipment in production, such as in machining, electrical and electrochemical work, and heat treatment, is high, and the different types of materials, including metal and nonmetal, are numerous. Consequently, in carrying out the technological reform and revolution, the following should be observed:

a. The policy of increasing the amount and speed of production, improving the quality of products, and practising economy must be followed. The structure of products should be continuously studied and reformed.

b. New types of products should be created, enabling them to be developed according to the "heavy, large, refined, and superior" levels. "Heavy" indicates high voltage, such as 220, 330, and 500 kilovolts, and "large" means large capacity, such as 120,000 to 240,000 kilovolt-amperes or more. High-voltage and large-capacity power transformers are presently urgently needed in our country for the construction of large power systems. "Refined" refers to the fineness of products light in weight and small in size, entailing less consumption of materials and lower cost. "Superior" refers to the employment of new technology and production processes in the manufacture of new types of products that will surpass the international standard.

c. The quality of products is to be improved and assured, with the production of good-quality products to be increased.

d. The work of technological reform should be aimed at the standardization and systematization of products, parts, and accessories.

e. Advanced technological methods should be employed to improve the equipment so that labor productivity can be continuously raised. Such major processes as riveting and fitting and finishing work on insulating parts, which are presently being done by hand, should be gradually mechanized. Tools and native equipment should be created so that production can eventually become totally mechanized.

f. Seventy to eighty percent of the cost of transformer production is for material consumption; therefore economizing on the use of materials is a factor which cannot be overlooked.

4. The continuous improvement of the educational and technological level of the masses is an important factor for speeding up production development.

Progress in production technology is the result of everyone's continuous comprehension and mastering of production procedures. Therefore every worker should raise his technological and cultural level by continuously attending "night schools of technology" and "lectures on technological problems" and by participating in the "cooperation-between-the-three-elements" and "display-of-technological-skill study groups," which have been so effective in the past. The cultural and technological revolutions must be closely linked and we must help one another in the process of development. The technological revolution demands improvement of the workers' cultural standard. Study can develop their wisdom and faculty of understanding and can also speed up the process of technological revolution. In the course of a great-leap-forward production development, the technological reform and revolution must be carried out together with the cultural revolution. Only through this can the work of the technological reform and revolution be improved and production developed.

The rapid progress in the development of the transformer industry during the past 10 years clearly proves the incomparable superiority of the socialist system and the accuracy of the party policy in regard to socialist economic construction. At present, our technological level in production is still unable to meet the needs for the development of our national economy. We must bear in mind the spirit displayed at the Eighth Session of the Eighth Central Committee Plenary Meeting, adhering to the main party policy, continuously opposing the rightists, exerting our vigorous efforts, and embarking on a campaign to increase production, practise economy, and strive for the completion of the 1959 production plan ahead of schedule, the fulfillment of the Second Five-Year Plan within a period of 2 years, and the overtaking of Great Britain in approximately 10 years.

V. TEN YEARS OF THE BOILER AND STEAM TURBINE INDUSTRY

Tien-chi Kung-yeh,
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Pages 4-9

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During the past 10 years, the course taken by our boiler and steam turbine manufacturing industry has been a victorious course magnificently lit by Marxism and Mao Tse-tung's ideology. In this period of 10 years, the unprecedented development made by the industry in changing its previous backward level clearly shows the incomparable superiority of the socialist system. The brilliant achievements made are the results of the resolute following of the party's principal policies, the strengthening of party leadership, the carrying out of mass movements and the technological revolution, and the enthusiasm and creative power displayed by the masses of workers of the industry. These achievements are also inseparably connected with the unselfish aid given us by Soviet Russia and other socialist countries.

The Inheritance from Old China

In old semifeudal and semicolonial China, ruled by reactionaries and plundered by imperialists, our heavy industry could not possibly be developed. At that time, the boiler and steam turbine manufacturing industry had only a number of manually-operated workshops repairing, manufacturing, and copying small-type steam and marine boilers. In 1949, when the Chinese People's Republic was established, the total number of small boilers produced in the entire country was approximately 200, with a total evaporating capacity of not more than 250 tons/hour. There were only one to two thousand technicians and workers. In regard to steam turbines, not even a repair shop existed. Damaged parts had to be replaced by imports from foreign countries. This was characteristic of the backward level of old China's boiler and steam turbine manufacturing industry. Old China was incapable of producing power station facilities. All the boilers and steam turbines installed at that time at the power plants, which had a total capacity of not more than 1,300,000 kilowatts, were imported from Japan, Great Britain, the U.S.A., and Germany.

Restoration of Production and Positive Reorganization

Immediately after the establishment of New China, a great number of boiler workers were organized under the leadership of the party. Cooperative plants were established, abolishing the old feudal system within plants and liberating the masses from oppression and the derivation of political and economic rights. Production efficiency at that time was greatly raised, and the workers, exerting vigorous effort and applying their rich experience, created a large quantity of simple tools and designed and manufactured a great number of boilers. Although most of the work was carried out by hand, the quality of the products was comparable with those made by machine. In the twisting of pipes and riveting work, they were able to reach the standard of work done by mechanical means.

The second step was to carry out the reform of the run-down plants left over from old China, turning them into plants suitable for the manufacture of boilers and the repair of steam turbines. In An-shan and Chin-chou in Northeast China, for example, old farm-implement and nail plants were converted into boiler assembly and repair plants subsequent to the liberation. Also, in Shanghai, the Shanghai Boiler Plant and the Shanghai Steam Turbine Plant were organized to undertake the task of repairing a 15,000-kilowatt steam turbine in 1950, gradually mastering the technology of manufacturing boilers and steam turbines and laying the foundation for the continuous production of these products in the future.

During the period of the restoration of our national economy, plans for the construction of the boiler and steam turbine manufacturing industry were mapped out by the party. As early as 1950 and 1952, Soviet experts were engaged to aid in the inspection of the construction site of the Harbin Boiler Plant and Steam Turbine Plant. In the construction work that followed, Soviet aid was also rendered. In 1952, with the aid of Czechoslovakia, the P'u-chiang Machine Works and the T'ung-yung Machine Works in Shanghai were converted into the present Shanghai Boiler Plant and Shanghai Steam Turbine Plant, respectively.

The establishment of the two boiler and steam turbine production centers in Harbin and Shanghai was one of the important measures taken by the party in the development of our motive power industry. As a result of applying advanced Soviet and Czechoslovakian experience and utilizing some of the foundations of the old plants, and with the support of the entire country, some 100 plants were organized for the production of whole sets of boilers and steam turbines. The test-manufacture of samples was quickly carried out, followed by production in series and the training of technical workers and cadres by the thousands, furnishing effective aid to many an enterprise.

As a result of the eminent leadership of the party and the enthusiasm displayed by the workers, the 1952 output of boilers was 4 times that of 1949, surpassing the highest productive year in old China.

During the period of the First Five-Year Plan, our boiler and steam turbine manufacturing industry underwent a basic change. Within this short period, it was developed from repair and assembling to individual manufacturing, from copying to individual designing and manufacturing, and from test-manufacturing to production in series.

From Repair and Assembling to Individual Manufacturing

In 1952, with the technical assistance rendered by Czechoslovakia, the decision was made by the party to utilize the already-existing foundations in Shanghai to carry out the test-manufacture of our first boiler and steam turbine at the earliest possible moment. At that time, different opinions existed as to what type and model of boiler and steam turbine should be test-manufactured. Some comrades thought that since we were lacking experience in the manufacture of power station boilers and steam turbines, we should begin with the small type, which was between the capacity of 1,000 and 2,000 kilowatts. However, others believed that since technical assistance was available, we should start with the comparatively larger type so that we would be able to quickly master the manufacturing technology, creating the conditions for the future production of still larger type products. After careful study, the party finally supported the latter opinion, deciding to commence test-manufacturing products of a capacity of 6,000 kilowatts.

At that time, the two plants in Shanghai were reconstructed with the aid of Czechoslovakia. The plan for starting the test-manufacturing of 6,000-kilowatt products won the full support of the Czechoslovakian government, which at the same time rendered us every possible assistance. In 1953, technological data on the manufacture of medium-pressure 6,000-kilowatt steam turbines, boilers of 40 tons/hour, and auxiliary equipment were furnished. Experts and technicians were dispatched to supervise the process of cold machining, welding, heat treatment, technological and product design, plant design, and the installation, test operation, and inspection of machines. At the same time, parts of such materials as steel alloy, large forged parts, speed regulators, and high pressure valves, which we were still unable to produce, were supplied. Displaying their unyielding spirit, utilizing all ways and means, and with the strong support of the party and government and the supervision of the Czechoslovakian experts, the workers of the Shanghai Steam Turbine Plant and the Boiler Plant were able

to overcome the various difficulties caused by the backwardness of our technical installations, the lack of special equipment, the weakness of our technological power, and the incapability of mastering numerous new and special technical operations such as the casting of tube plates and coal economizers and the welding of steel alloy. Finally, in the second quarter of 1955, the test-manufacturing work on our first 6,000-kilowatt steam turbine set was completed. With the close cooperation of five industrial departments and 122 different enterprises, this steam turbine set, which was made by Chinese workers, was installed in the Huai-nan Power Plant. After this, our boiler and steam turbine manufacturing industry advanced from repair and assembling to individual manufacturing.

Establishment of the Two Large Production Centers at Harbin and Shanghai

After the beginning of the First Five-Year Plan, construction work was speeded up at the Harbin and Shanghai boiler and steam turbine production centers. For the purpose of assisting in the design of the Harbin Boiler Plant and Steam Turbine Plant, a chief designer was dispatched from Soviet Russia to gather data and supervise the task. In the course of the work, advanced technology was used. This technology included the vertical-type slag welding of boilers and the pattern rolling of turbine blades. Apart from assisting in the designing work, Soviet Russia also furnished us sets of blueprints for the manufacture of various types of products, accepted some 100 of our trainees, and supplied us numerous modern special equipment, such as four-barrel plate rolling machines, large hydraulic presses, large tube-bending machines, and large heaters. Within a period of several years, it continued sending several tens of experts to supervise us in mastering production technology. As a result of the all-out support given to us by Soviet Russia and the efforts made by our workers, these two large plants were completed and put in operation more than 2 years ahead of schedule. The speed of the construction work was extraordinary, which fully manifested the great determination of the Chinese working class and the deep friendship between us and Soviet Russia.

From the Manufacture of Small Products to the Manufacture of Large Products; from Copying to Individual Designing; from Test-Manufacturing to Production in Series

With the success made in the test-manufacture of our first 6,000-kilowatt steam turbine generator set and the establishment of the Harbin and Shanghai production centers, our designing and

manufacturing capability in regard to boilers and steam turbines was rapidly improved. The Shanghai Steam Turbine Plant, while test-manufacturing a medium-pressure 6,000-kilowatt steam turbine, carried out the designing work on a medium-pressure 12,000-kilowatt steam turbine under the supervision of Czechoslovakian experts. Even before the plant was put into production the Harbin Steam Turbine Plant carried out the designing work on a 50,000-kilowatt steam turbine in accordance with Soviet blueprints. As to the manufacture of boilers, due to the fact that there were variations in the use of different types of coal, the majority of the products were calculated and adjusted to a certain degree in accordance with our existing conditions. The work done in this respect enabled us to train a group of cadre designers, giving a tremendous amount of encouragement to all the designing workers in our country and the workers in the entire boiler and steam turbine manufacturing industry, and enabling them to realize that it was not beyond their power to carry out the designing work connected with such complex products.

Following the test-manufacture of our first generator set comprised of a 6,000-kilowatt steam turbine and a boiler of a capacity of 40-tons/hour in 1955, a total of six similar sets was manufactured in that year. Subsequent to this, 2,500- and 12,000-kilowatt steam turbines were produced at the Shanghai Steam Turbine Plant; 20-ton/hour medium-pressure boilers were manufactured at the Shanghai Boiler Plant, and 35-ton/hour and 75-ton/hour medium-pressure boilers were made at the Harbin Boiler Plant. In 1956 and 1957, generator sets of a total capacity of one hundred and several tens of thousands of kilowatts were produced annually for our power stations.

The Splendor of Our Party Principle

In 1958, under the magnificence of our party's socialist construction policy of increasing and speeding up production, improving the quality of products, and practising economy, a large-scale mass movement unprecedented in history was launched and an over-all great-leap-forward development of our agriculture and industry was initiated. Along with the enthusiasm displayed in the establishment of the commune system and the all-out steel-refining campaign, production in the boiler and steam turbine manufacturing industry was also carried out with high spirits. At the same time, as a result of the movement aimed at the industrialization of every province and city throughout the country, progress in industry was made with much greater speed.

In 1958, the amount of basic construction work carried out in the two production centers at Harbin and Shanghai was doubled, with the speed of building new plants accelerated. The first

stage of construction work at the Wuhan Boiler Plant was completed in September 1959, 3 months ahead of schedule. The Wuhan Steam Turbine Plant is presently under large-scale construction. At the Peiping Steam Turbine Generator Plant, the construction work on which was started in the middle of June 1958, plant buildings covering a total area of several tens of thousands of square meters were completed at the end of November of the same year. Apart from the old plants, new construction and reconstruction work on a number of large, intermediate, and small steam turbine and boiler plants is presently being carried out. After completion, our steam turbine and boiler manufacturing industry will have a much more splendid appearance.

In the great-leap-forward year of 1958, the Harbin Boiler Plant completed a 230-ton/hour, 100-atmosphere-pressure boiler. Subsequent to this, the Harbin Steam Turbine Plant produced two 25,000-kilowatt 90-atmosphere-pressure steam turbines. The completion of this large and high-pressure equipment showed that our steam turbine and boiler manufacturing technology had advanced a step forward, having advanced from mastering the production of medium-pressure to high-temperature and high-pressure products. In the same year, the Shanghai Steam Turbine Plant, acting in accordance with our existing supply of materials, designed and manufactured a 1,500-kilowatt low-pressure and a 25,000-kilowatt medium-pressure steam turbine. The Shanghai Boiler Plant also produced a 35-ton/hour single-steam-drum medium-pressure boiler and a 65-ton/hour medium pressure boiler equipped with a coal-buffing machine. In this second great-leap-forward development year of 1959, the Harbin Boiler Plant, in accordance with its own design, manufactured a 120-ton/hour and a 240-ton/hour boiler. The Harbin Steam Turbine Plant, using Soviet blueprints as a reference, manufactured a 50,000-kilowatt high-pressure steam turbine; and, copying Soviet blueprints, test-manufactured a 25,000-kilowatt double steam drawing steam turbine. At present, the workers of these four leading plants are vigorously exerting their efforts, utilizing all ways and means, and manifesting their wisdom in the creation of more and newer-type products.

Apart from the above-mentioned four leading plants, several tens of other plants, including the Wuhan Boiler Plant, Wuhan Steam Turbine Plant, Peiping Boiler Plant, and Peiping Steam Turbine Generator Plant, and numerous machine-manufacturing plants, such as the Chungking Machine Works and the Dairen Shipyard, are undertaking the task of test-manufacturing boilers and steam turbines. These plants, after applying the experience of the old plants, quickly reorganized their production. Some of them are presently carrying out test-manufacturing work, while the test-manufactured products of others are now being put into formal operation. In April 1959, the Wuhan Boiler Plant completed

the test-manufacture of a 35-ton/hour medium-pressure boiler. Other plants, after engaging in close cooperation, produced 1,500-kilowatt steam turbines and 10-ton/hour low-pressure boilers.

In the course of the great-leap-forward development, the thinking of the Chinese boiler and steam turbine workers was fully liberated. In striving to overtake Great Britain ahead of schedule, in the manufacturing technology of power station boilers and steam turbines they have manifested great wisdom as a result of applying advanced Soviet experience. Also, great progress has been made in the design and manufacture of similar types of products, such as gas turbines, turbine-compressors, marine engines, and high-efficiency small-type steam engines.

Regarding gas turbines, the Office of Dynamics of the Academy of Sciences has designed a small radial-flow gas turbine for the 75-horsepower free-piston air compressor. Through the joint efforts of the former Shanghai Research Institute of Dynamics, the Shanghai Chiao-t'ung University, the Shanghai Diesel Engine Plant, and the Shanghai Steam Turbine Plant, an axial-flow gas turbine for the 120-horsepower free-piston air compressor was designed and manufactured. The test operation of these two types of gas turbines has already been carried out. Also, in accordance with Soviet technological data, a total of 12 agencies, including the Office of Dynamics, jointly designed a 900-horsepower gas turbine. At present, several agencies are carrying out in close cooperation designing and test-manufacturing work on a 300- and a 1,500-horsepower gas turbine, and also on one to fit the 1,000-kilowatt power generator.

Regarding the set-type gas turbine, amendment of the design has been carried out by the Steam Turbine and Boiler Research Institute in accordance with Soviet technological data and the steel-supply conditions in our country. At present, this type of turbine is being test-manufactured at the Shanghai Steam Turbine Plant. A series of research projects on several amendments is also being carried out.

On account of the great demand of the metallurgical and chemical industries, turbine compressors have now become one of the most important types of machines. Also, due to the fact that gas turbines require highly efficient turbine-compressors to supply air, the latter have become an inseparable component of the former. The Shanghai Steam Turbine Plant has already test-manufactured and produced 25,000-cubic-meter/hour turbine compressors and a series of blowers for blast furnaces and coking furnaces. At present, testing platforms for air compressors are being built at several plants.

Although the production of small-type engines has been carried out in our country for quite a considerable length of time, their structure and material supply still do not meet the

the increasing needs of our agriculture and industry. Consequently, new designs have been created by several of the agencies. The production of the 1-ton/hour angle tubular type boiler designed by the Steam Turbine and Boiler Institute, for example, requires 2 tons of metal. A test made on this type of boiler gave satisfactory results. In the production of steam engines, numerous improvements have also been made. The 100-horsepower steam engine made by the Shanghai Chien-shih Machine Works, for example, can be increased to 130 to 150 horsepower after improvements are made.

Flying-Leap Development in Science and Technology

During the past 10 years, unprecedented scientific and technological developments were made in our boiler and steam turbine technology.

In production operations, we carried out repair and assembly work mainly by hand 10 years ago, but now we have mastered the most advanced technology, such as the use of a 1,500-ton hydraulic press for the manufacture of the top of a boiler steam drum, the adoption of the slag welding method, and the employment of pneumatic tools for the cutting of steel plates. In the manufacture of steel turbines, we are now capable of machining turbine blades of a precision of several hundredths of a millimeter, casting guard plates of a precision of several tenths of a millimeter, welding steel alloy valves and steam chambers, carrying out the heat treatment of large shafts several meters in length, and producing precision cast and drawn turbine blades. We have also begun mastering numerous other technological operations. In the design of products, nothing was done 10 years ago. Although a certain number of small boilers were manufactured, they were all copied from other models. Along with the manufacturing of large-type steam turbines and boilers by copying in the period of the First Five-Year Plan, designing work on these products was also launched. Some of those new products which were designed have already been produced. Due to the fact that these designs were made for the use of our domestically-produced steel materials and in accordance with our fuel-supply conditions and the technical facilities at the various plants, in the future they will be used in the manufacture of our main standard types of products. At present, designing work is being carried out on a 100,000-kilowatt high-pressure steam turbine and a 410-ton/hour boiler, preparations for the test-manufacture of these equipment having been made.

The supply of raw materials is one of the key factors determining whether our boiler and steam turbine industry can be rapidly developed. These materials include steel plates for the manufacture of boilers (especially thick steel plates for steam

drums), various types of structural steel materials, seamless steel tubes, copper tubes, steel alloy (especially high-intensity and high-temperature-resistant steel alloy), spring steel and forged blanks for the manufacture of the main shafts and blades of steam turbines. As a result of the speedy development of the material-manufacturing industry during the past several years and especially in 1958, apart from a small number of metal elements and extremely large types of steel materials, the majority of the material supply has been sufficient. This has created numerous advantages for the continuous development of our boiler and steam turbine manufacturing industry.

The supply of auxiliary machines and instruments is also one of the decisive factors in the development of the boiler and steam turbine industry. In the past several years a certain amount of instruments still had to be imported, but now the supply is gradually becoming sufficient. Plants intended solely for the manufacture of thermological instruments and auxiliary machines, and research institutes have been established one after another, which has resulted in giving greater assurance to the development of the boiler and steam turbine manufacturing industry.

To initiate scientific research work; to widely pursue study in laboratories and in semiindustrial testing stations; to design, manufacture, and master the first series of test-manufactured products; to extend the use of various types of equipment which have been successfully tested; to summarize and propagate the experience of the masses in the course of their production work -- these are the correct methods of assuring the technological improvement and the continuous great-leap-forward development of the boiler and steam turbine manufacturing industry. Since the mapping out of a 12-year scientific development plan by the party in 1955, the Chinese Academy of Sciences, together with various higher educational institutions and plants, has positively carried out work in accordance with the policy of the Central Committee of the Communist Party of China of closely incorporating scientific research with production work. At that time, the First Ministry of Machine Building decided to establish an institute of dynamics, the study of boilers and steam turbines being one of its main projects. In 1958, due to the changed conditions, a decision was made by the Ministry to create the independent Steam Turbine and Boiler Research Institute.

Since 1956, scientific research projects on boilers and steam turbines have been coordinated and organized yearly. As regards major products and technological problems, organized discussions were carried out and plans drawn up. Numerous problems were solved through the joint effort of several agencies. The Steam Turbine and Boiler Research Institute, for example, in close cooperation with Chekiang University, built a "whirlwind" boiler

testing platform, having acquired a large quantity of testing data. The Steam Turbine and Boiler Research Institute and the Shanghai Boiler Plant jointly designed a 65-ton/hour coal-buffing machine type chain boiler, several of which have already been put into operation. The Harbin Steam Turbine Plant and the Harbin Industrial University are presently carrying out model testing of water pumps in an effort to obtain the necessary data for the design of large-type water pumps. The Chiao-t'ung University, Tsinghua University, and the Technological Improvement Bureau of the Ministry for the Hydroelectric Power Industry are also individually cooperating with the various plants concerned in carrying out the study of numerous other subjects.

While the great-leap-forward movement was in progress, a great number of agencies strengthened their scientific research work on boilers and steam turbines. In order to solve certain complex technological problems, many testing platforms were built. The Steam Turbine and Boiler Research Institute, the Harbin Steam Turbine Plant, and the Office of Dynamics of the Academy of Sciences are now carrying out scientific research work on steam and gas turbines, successful results having been obtained on air motive power, intensity and vibration, regulating, and the combustion of gas turbines. The Steam Turbine and Boiler Research Institute is also engaging in study on boilers. At present, study is being made on "whirlwind" boilers, direct-flow boilers, water treatment, boiler automatic control, and the parting of steam and water within boilers. Test platforms for direct-flow boilers, "whirlwind" boilers, water treatment, and the parting of steam from water are being installed. For the purpose of acquiring high-temperature and high-intensity steel alloy materials suitable in relation to the conditions in our country, preparations are being made by the Steam Turbine and Boiler Research Institute, the Technological Institute, and the Materials Research Institute for the construction of a large testing and research center.

The Struggle to Overtake Great Britain Within 10 Years

In order to enact a reasonable long-range plan and to have a sufficient scientific basis for the selection of new models and structures for new equipment, we must carry out a technological and economic study pertaining to the manufacture of boilers and steam and gas turbines.

Large and high parametric type boilers are the aim of all industrial countries in the world. We must give special attention to this. Research and test-manufacturing work on direct-flow boilers and boilers that use natural gas and are equipped with liquid slag discharging installations should be carried out at the earliest date.

The object of the technological reform of our boiler and steam turbine production within the next several years is to strive for self-sufficiency regarding material supply; to simultaneously develop large, medium, and small products; and to correctly and resolutely carry out the party policy of "advancing with both feet." Due to the present inadequate supply of steel alloy, the production work within this period is to be mainly carried out on medium-temperature and medium-pressure generator sets, with high-temperature and high-pressure sets to be developed at the same time. Although the efficiency of medium-pressure sets is comparatively lower, a tremendous amount of steel alloy can be saved, which means that the manufacture of boilers and steam turbines can be carried out with high speed without being jeopardized by the shortage of material. According to the findings of a comprehensive technological and economic analysis, the manufacture of medium-pressure sets of a capacity of 25,000 kilowatts or less is considered economically sound. The use of medium pressure in some of the 50,000-kilowatt sets is presently still necessary. As to those of a capacity of 100,000 kilowatts or more, development should hereafter be aimed at the high parametric brackets in striving to reach the international level within a short period of time. By doing this, we shall be able to assure a high speed of development on the one hand, and to master complex technology on the other. Regarding the capacity of generator sets, we should not only produce large and medium types, we should also manufacture the small type in large quantities. In designing small-type generator sets, the structure should be made as simple as possible with less consumption of steel alloy so that they may be conveniently manufactured. At present 1,500-kilowatt, 3,000-rpm steam turbines equipped with a carbon steel shaft but without a gear box are being test-manufactured and are soon to be inspected. A 3,000-kilowatt steam turbine to be made up of forged carbon steel parts and not equipped with a gear box has been designed. The manufacture of these sets will be mastered by many medium and small enterprises which, after fully manifesting their potentialities, will become an important part of our steam turbine and boiler manufacturing industry.

Along with the continuous development of boilers and steam turbines for use by power plants, and in order to satisfy the needs by the various branches of our national economy, production, research, and testing work should also be carried out on boilers, steam turbines, gas turbines, and various types of turbine machines (turbine compressors and turbine blowers) for other industrial uses.

Gas turbines have already been used in mobile power plants and natural gas power plants and also as a source of motive power in boats and vessels. Therefore, regardless of the standpoint of national defense or civil usage, scientific research work on this

type of equipment should be carried out with the greatest concern and without delay.

Turbine compressors are indispensable to many industrial departments and are a major component in the installation of gas turbines. Consequently, similar attention should be given to this item.

The policy of carrying out the simultaneous development of large, medium, and small enterprises and combining modern and native methods in production is an important means of assuring the speedy development of the boiler and steam turbine manufacturing industry. Therefore the creation of small standard-type motive power facilities which can save both materials and fuel is one of our current tasks which must be executed with the utmost urgency.

To understand correctly and in time the production problems arising in the course of adjustments and operations is an important step toward the future improvement of the quality of products. Consequently, a great amount of adjusting and industrial testing work on boilers and steam turbine sets should be carried out.

In regard to heat-resistant and high-intensity steel alloy, refining work has already been carried out in accordance with certain chemical formulas. However, a series of research projects has yet to be carried out to determine and create new types of steel that can be made within the limits of our domestic material resources, and also to determine the nature of these materials under different conditions, especially their intensity and deterioration under conditions of a period of prolonged high temperature. If this delicate research work is not immediately carried out, we shall be unable to solve the problem of manufacturing high parametric turbine sets within a short period of time.

Boilers and steam turbines are types of equipment which directly serve the electric power, communication, and transportation agencies. The continuous development of their production technology requires the cooperation of various industrial agencies. It requires a supply of fuel by various enterprises of the Ministries of Petroleum and Coal Industry, raw materials produced by the plants of the Ministry of Metallurgy and other ministries, and auxiliary machines, instruments, parts, and accessories made by several hundred machine and electrical machine works. Therefore, all these agencies, plants, and enterprises should carry out their production in accordance with a comprehensive plan and appropriate coordination. In scientific research work, there should be mutual assistance and development. Only by doing this can a high-speed development of the boiler and steam turbine manufacturing industry be assured.

Although in the period of the great-leap-forward movement a number of newly-established medium and small boiler and steam

turbine plants mastered the manufacturing technology of new products, there are still some which are still in the process of learning such technology. Consequently, work on exchange of experience, technological organizations, and on determining the quality of products is presently extremely important and must be carried out to the fullest extent.

In this past brilliant decade, the eminent leadership of the party and Chairman Mao has guided us from one victory to another. The energetic masses of workers of the boiler and steam turbine industry have in the past and are now carrying out their creative work with the utmost concern. The advanced experiences of Soviet Russia, Czechoslovakia, and other socialist countries have provided a pattern in our learning. Along with the magnificent progress of our party's socialist-construction policy, greater and more splendid achievements are anticipated. It is firmly believed that within the 10 years to come, our technological level will reach and surpass that of Great Britain.

VI. TECHNICAL ACHIEVEMENTS OF THE CHEMICAL AND ELECTRICAL BATTERY-SOURCE INDUSTRY

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Pages 10-12

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Institute

1. Prior to the year 1949, when the country was liberated, our chemical and electrical battery-source industry had already had a history of 30 to 40 years. The production of dry cells and storage batteries was first carried out in 1911 and 1921 respectively. However, under the oppression of the reactionary regime in those days, plus the competition of the foreign products which poured into the country, the technical progress of the industry was extremely slow. Production facilities were simple and inferior, and much work had to be done by hand. The output was low, the types of products were scarce, and the quality was poor. The raw-material supply had to rely on imports.

Following the establishment of the Chinese People's Republic and under the leadership of the party, the chemical and electrical battery-source industry, like all other industries, underwent a considerable amount of progress. As early as 1951, the total output already exceeded that of the highest productive year prior to the liberation. In the great-leap-forward year of 1958, brilliant achievements were again made. The total output in that year was 837,000 storage batteries, equivalent to 404,500 kilovolt-amperes hour, and 100,000,000 dry cells, which, compared with the highest productive year prior to the liberation, represented an increase of 48 times in storage-battery production and 12 times in dry-cell production. Compared with 1949, there was a growth of 65.3 times in the former and 28 times in the latter. The total output of the entire chemical and electrical battery-source industry in 1958 was 34 times that of 1949, which represented an average annual increase of 48 percent, with a 98 and a 39.5 percent increase in storage-battery and dry-cell production respectively. Production in 1959 is scheduled to be much higher than 1958. Such a speed of development is beyond the power of the capitalist countries. The total output of storage batteries in Great Britain in 1957 was only 3 percent over that of 1956. Production of the same type of products in the USA from 1947 to 1957 showed an increase of only 2.3 percent. Although, following World War II, Japan had a speedier development, her average annual

increase in the 8-year period from 1949 to 1956 was only 18 percent. These comparisons clearly show the incomparable superiority of the socialist system.

2. Along with the high-speed development in production, the technical standard of the industry was also rapidly raised. During the past 10 years, production of dry cells and storage batteries has been developed into eight great series and more than 300 different types. These products can now basically satisfy the needs of the rapidly-progressing national economy and national-defense construction. Such items as alkaline storage batteries and laminated dry cells, which could not be made in the country and had to be imported in the old days, are now not only being produced but also exported.

In old China, pasted plates could only be made available for the manufacture of lead acid storage batteries. However, following the liberation, semi-pasted type light batteries for use in locomotives and much more durable than the pasted type, were produced. In 1950, light-weight, small-size, and large-capacity storage batteries for use by the aviation industry were test-manufactured by copying Soviet models. These batteries, which were formally produced in 1951, are capable of normal functioning at a temperature of minus or plus 50 degrees Centigrade. In 1952, the manufacturing technology of solid and set type storage batteries was acquired. In this type of batteries, which are estimated to have a durability of 20 years, casted lead plates instead of pasted plates are used. Rubber-tube type storage batteries were made at the Fu-shun Mining Lamp Plant in 1951, following which a similar type of battery for traction and locomotive use was also test-manufactured. This type of battery is not only light in weight but is also 3 times more durable than the pasted plate type, and can be charged and recharged as many as 100 times. In 1955, in accordance with Soviet data, dry sealed and electricity loaded type storage batteries were manufactured and put into formal production. These types of batteries, when leaving the factory, are dry sealed. In 1956 storage batteries for use in beacons were test-manufactured. In the course of the great-leap-forward movement in 1958, glass fiber tube storage batteries were manufactured. This type of battery, as compared to the rubber tube battery, is more durable and has a large capacity. Other items which were also test-manufactured included three-layer insulating storage batteries in which glass wire and plywood plates were used, and large type storage batteries which are 100 percent more durable and greater in capacity and 20 to 30 times larger in outer dimensions and heavier in weight than the ordinary types of such batteries.

Prior to the liberation, we were incapable of producing alkaline storage batteries. However, in 1955, nickel-cadmium

storage batteries of the GH-10 and GH-8-1 types were test-manufactured in accordance with Soviet data and were put into mass production in 1956. By 1958, an entire series of these products was established. As a result of conscientiously carrying out the study of advanced Soviet experience, high-quality mechanical equipment was used in the production line in raw material preparation, steel band binding, nickel plating, powder application, and plate making. During the past several years, this brought about a 20-fold production increase as well as the stability of the quality of products. The durability of nickel-cadmium storage batteries can reach 750 revolving stages. Their capacity at a low temperature of minus 40 degrees Centigrade is equivalent to 25 percent of that at the normal temperature. Also, they are small in size, have excellent mechanical functioning, and have wide usage in the national economy and national defense. In 1959, small tightly-sealed nickel-cadmium storage batteries and sintering type nickel-cadmium storage batteries not equipped with a plate box were manufactured; this opened up a new path for the development of these types of batteries. At the same time these batteries were being made, nickel-iron storage batteries were also test-manufactured in 1957, and in 1958 an entire series of these products was established, followed by the initiation of mass production.

Silver-zinc storage batteries are a modern type of battery having a high unit ratio and capable of withstanding a heavy load. Consequently they are presently being studied and developed by various countries of the world. The study of this type of battery in our country was first started in 1956, followed by small-quantity production in 1958 and a gradual increase of output and improvement of quality thereafter. At present, through the cooperation of various agencies, a study of prolonging their durability is being carried out. In 1950 research work was started on zinc-mercury cells for use in special types of instruments and radio, with achievements being made in 1953. This type of cell is smaller in size and larger in capacity, with a more stable discharge voltage and a greater high-temperature resistance than dry cells. They are still effective after being kept at a temperature of 54 degrees Centigrade continuously for a period of 3 months. When being discharged under a current density of 15.5 milliamperes/millimeter², their ratio capacity is 85 watt-hours/kilogram. In 1958, while the great-leap-forward development was being carried out, this type of cell was put into formal production. For the purpose of satisfying the needs of radio communication and certain special types of instruments, research and test-manufacturing work on zinc-manganese laminated cells was carried out in 1953. In 1955 the production of this type of cell was initiated. The capacity of these cells, as compared to that of cylindrical cells of a similar size, is 100 percent greater, and at the same time

the utilization rate of zinc sheets is 50 percent higher. At present, this type of cell put out in a total of 37 different models, is being produced in large quantities to basically satisfy the various consumers that require a supply of small type high-voltage batteries. Also, they are being exported to foreign countries, thus gaining a large amount of foreign exchange for the nation. In 1953, in order to meet the needs of special communication in high-altitude meteorological research work, zinc-lead wet cells, which can be used at a temperature of plus or minus 60 degrees Centigrade, were test-manufactured. These cells, which were put into formal production in 1955, are small in size and light in weight and possess a high voltage. In the great-leap-forward development year of 1958, workers of the chemical and electrical battery-source industry, exerting vigorous effort, produced alkaline air wet cells and alkaline zinc-carbon dry cells. Also, in accordance with Soviet data, alkaline air dry cells and iron-carbon cells were test-manufactured. Air dry cells, as compared to manganese powder A-cells, are 30 percent lighter in weight but 50 percent greater in capacity. Active carbon, which is used as a material for the manufacture of this type of cell, can be made from ground nut shells, cotton-seed hulls, and saw dust, which are plentiful everywhere. In 1958 the manufacture of air dry cells became universal throughout the country. Alkaline air wet cells are also manufactured by using active carbon. When the capacity of these cells reaches 1,000 amperes, the unit ratio is 50 watt-hours/kilogram. The study of the possibility of manufacturing iron-carbon cells was indeed a daring attempt. The anode of the cells is active carbon while the negative pole is active iron, with the use of potassium hydroxide as electrolyte. The cells are entirely free of nonferrous metals, which means that a new path has been opened for their manufacture by means of ferrous metals. At present, this type of dry cell is being test-manufactured in small series. The open-circuit voltage of the cells is 0.9 volt. Under a load of 3.5 milliamperes/millimeter², the closed circuit is 0.7 volt. When the continuous discharge reaches 0.5 volt, the unit ratio capacity is approximately 65 watt-hours/kilogram. Alkaline zinc-carbon dry cells are also a type of product daringly made in the course of the great-leap-forward movement. The production of alkaline air wet cells has the advantage of increasing the utilization rate of zinc, but because the size of the cells is too large and the electrolyte is in fluid form, they are inconvenient as regards transportation. In the course of the great-leap-forward movement, these problems were studied and overcome, and dry cells are being test-manufactured instead. The open circuit voltage of this type of cell is 1.3 volts. Under a load of 2.5 milliamperes/millimeter², the closed circuit voltage is 1.16 volts. When the continuous discharge reaches 0.9 volt, the

unit ratio capacity is 150 watt-hours kilogram. Under not too large a discharging rate, the capacity is equivalent to 3 times that of zinc-manganese dry cells. Consequently this type of product is considered to have a bright future.

3. Another factor which led to the rise in the production level of our chemical and electrical battery-source industry was the continuous improvement of mechanical operation. As a result of the correct leadership of the party and the joint efforts exerted by the workers and technicians in carrying out the study and use of Soviet data, coupled with our production experience and the creation of various new types of mechanical equipment, working conditions were greatly improved and labor productivity was raised, which completely changed the erstwhile backward condition of relying solely on hand operation.

In the production of flashlight batteries, for example, the main processes from powder mixing, carbon wrapping, thread winding, paste applying to sealing, are carried out by semi-automatic and automatic machines. The transportation of raw materials, semi-finished products, and finished products is mainly done by conveyor belts. The use of mechanical and automatic equipment in the production process has brought about a multiple increase of output. The use of automatic carbon wrapping machines is 3 to 4 times more efficient than hand-operated machines and 10 times more efficient than hand operation. The use of semiautomatic thread winding machines is 4 times quicker than hand operation. At present, several major dry cell plants in our country have already set up a mechanized production line for flashlight batteries.

Regarding equipment used in the production of lead storage batteries, that which was manufactured and widely extended included lead ball casting machines, lead ball automatic conveyors, tightly sealed lead powdering machines, automatic plate casting machines, automatic plate coating machines, rubber tube cutters, and rubber tube powder filling machines, which greatly improved working conditions, lowering the possibility of lead poisoning. After 1953, when the technical reform and revolution was carried out by the masses, numerous special types of equipment were created. At present, plans are being made at the various plants for the establishment of a mechanized production system for certain special series of products, and it is anticipated that these plans will soon be put into practice.

4. Along with the production expansion, testing and research work was also continuously strengthened. Advanced technical experiences acquired from within and without the country were widely propagated, which served a great purpose in solving various key problems pertaining to the quality of products, as well as in raising the production rate and increasing the number of different types of products. In the early stage of the liberation,

laboratories were set up in the various major battery plants for the purpose of undertaking the tasks of analyzing and testing raw materials and studying and testing various technological operations. In 1956 and thereafter, central laboratories were universally established at various plants. Testing equipment was added and the number of personnel was increased. These laboratories stood firmly behind the plants, studying and solving numerous complex problems arising in the course of production. Regarding zinc-manganese dry cells, for example, a problem which affected greatly their durability was the corrosion of zinc sheets, which had never been solved prior to the liberation. However, in 1956, under the leadership of higher authorities and through the cooperation of various central laboratories, small groups were organized to carry out tests and research on anticorrosion for dry cells. After approximately one year's work, a primary conclusion on the improvement of the quality of zinc sheets was reached and the following means of bringing about such an improvement were brought forward:

- a. In the manufacture of zinc sheets, lead and cadmium should be added, and the content of copper, iron, and other miscellaneous substances should be reduced.
- b. In the rolling process of zinc sheets, special attention must be paid to the evenness of the surface. When a sheet is welded into a cylindrical shape, an extra polishing process should be carried out.
- c. The structure of the cells should be made humidity-resistant and tightly sealed.

After these measures were carried out, the corrosion of cells was greatly reduced.

In summer, dry cells easily become air inflated and lose their effectiveness. During the past several years, various plants continuously carried out study on this problem and found the following solutions:

- a. In the process of cell manufacturing, the cell must be allowed to cool off before it is sealed up.
- b. The bottom of the cells and welded seams should be insulated from electrolyte.
- c. Softer and higher intensity sealing lacquer should be used, or the sealing must be done by means of a buttoned top.

Various types of special facilities used in the dry cell manufacturing industry were mainly created by the workers in the course of their production work. At present, based upon these facilities, a step forward is being taken to organize their production line so as to enable it to become totally mechanized. As a result of applying Soviet experience in the production of storage batteries, graphite was used as a substitute for red and yellow lead oxide, which reduced the number of production processes and protected the workers against lead poisoning. In the

process of plate casting and coating, such advanced methods as using diaphragm coating substances, pre-manufactured alloy, and inflating substances were used. Some plants also manufactured automatic machines for plate casting and plate coating, enabling these two processes to become mechanized. In the drying process, the multi-layer drying method was used, which resulted in lowering the waste of plates from 4.84 to 0.4 percent. As a result of improving the structure and welding method in the case of plates and rubber containers, the standard of a series of automobile storage batteries was raised, the production control was simplified, and a great amount of lead and raw rubber was saved. By using humus acid as an inflating substance in automobile storage batteries, the starting capacity at a temperature of minus 18 degrees Centigrade will be increased by 50 percent.

The supply of the principal materials, such as lead, zinc sheets, manganese powder, graphite, ammonium chloride, and zinc chloride, used in our chemical and electrical battery-source industry prior to the liberation mainly relied on imports. Following the liberation, much research work was carried out on the use of domestically manufactured materials. According to incomplete statistics, the necessary materials used in the production of lead storage batteries are presently available to an extent of 95.3 percent; those used in the production of dry cells, to an extent of 94.2 percent.

Since the establishment of the Chemical and Electrical Battery-Source Research Institute in 1958, research work in the chemical and electrical battery-source industry has become more active. Along with the great-leap-forward industrial and agricultural development, scientific research work was also carried out with full vigor. A series of new technical processes were used in production and a series of such new products as iron-carbon dry cells, air wet cells, alkaline zinc-carbon dry cells, paper pulp separators, and tightly closed anti-blast cells were manufactured. Testing and research work on such delicate products as solar energy cells and fuel cells is being carried out.

5. The progress in the development of the technical level of our chemical and electrical battery-source industry in the past 10 years has clearly shown the unlimited wisdom and vigor of our working class in carrying out their tasks under the eminent leadership of the party. At present, with indefatigable zeal and energy these workers are continuing to strive for the fulfillment of the Second Five-Year Plan 3 years ahead of schedule and for the attainment of the international technical level.

VII. TEN YEARS' DEVELOPMENT OF THE MEDIUM AND SMALL ELECTRICAL EQUIPMENT INDUSTRY

Tien-chi Kung-yeh,
Peiping, No. 20, 25 October 1959,
Pages 13-15

Medium and Small Electrical
Equipment Research Office,
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This year of 1959 is the tenth year since the founding of the Chinese People's Republic. Under the eminent leadership of the Chinese Communist Party and Chairman Mao, during these past 10 years and following the victory achieved in the new democratic revolution, the Chinese people, representing one fourth of the world's population, won another victory in socialist revolution and construction. Since 1958, especially as a result of following the party's socialist construction principle, an unprecedented "one day is equivalent to 20 years" progress was made in all fields of industry, agriculture, communications, transportation, trade, and culture. The medium and small electrical equipment manufacturing industry, like all other industries, also achieved great success, completely eliminating its past backward condition and becoming a modern industry capable of individually carrying out mass production.

Medium and small electric motors include asynchronous, synchronous, and DC motors of a capacity from 0.6 to 1,500 kilowatts. Their output is the largest among the various types of products produced by the electrical equipment industry. Due to their low production cost and their convenient operation and maintenance, these motors are being widely used as a source of power in the various sectors of the national economy, e.g., in water pump and cement manufacturing, coke washing and iron refining, and chemical, textile, paper, and food production. The consumption of power produced by the medium and small motors occupies 40 to 50 percent of the total power generating capacity; therefore we can see their importance in relation to the development of our national economy.

1. The medium and small electrical equipment manufacturing industry of old China had a history of over 30 years. However, up to the time of the liberation, there existed only a small number of plants in the major coastal cities, such as Shanghai and Tientsin. These plants were small in scale, equipped with simple and inferior facilities, and were only capable of manufacturing certain types of small and electric fan motors. The largest product produced was the 180 horsepower asynchronous motor. Some of these plants were completely incapable of carrying out manufacturing and did only repair work. During that period, the motors that were used in the country were mainly imported. According to statistics published by the National Resources Commission of the Kuomintang government

in a 1946 quarterly magazine, the total output of motors and generators in the 7-year period from 1937 to 1945 was only equivalent to a capacity of 32,464 and 2,489 kilowatts, respectively, which, compared to the present standard, is less than the total monthly output of a large workshop. Even the most common materials, such as silicon steel sheets, electromagnetic wire, yellow wax cloth, insulating paper, and ball bearings, which were used in production in those days, could not be supplied domestically. The development of new China's electrical equipment industry was started on these backward foundations.

2. The period from 1949 to 1952 was the rehabilitation period of our national economy. Under the leadership of the party and the government, the damage done during the war was quickly repaired. After carrying out major construction work and the democratic reform of the production control system in the medium and small electrical equipment manufacturing industry, those plants which originally could only manufacture small motors gradually became more comprehensive and capable of producing larger motors, DC motors, and synchronous generators. In this period of approximately 3 years, a number of state-operated plants, such as the Shanghai, Hsiang-t'an, Dairen, and Po-shan Electrical Equipment Plants, emerged. Those plants, which could only carry out repair work in the past, gradually turned to manufacturing work. At the same time, such new products as DC motors for use in street cars, 750-kilowatt motors, and 375-kilowatt synchronous motors were test-manufactured. In 1952 the annual output was 26.7 times that of 1949.

3. During the period of the First Five-Year Plan, large-scale systematic construction work was carried out in the medium and small electrical equipment manufacturing industry. The originally existing plants were expanded into modern and comprehensive ones capable of manufacturing various types of new products. New plants were built and expanded in Northeast, Southwest, Central-South, and East China, which resulted in a complete change in the disposition of the industry. Democratic reform was carried out and a new production system was established in privately-owned electrical equipment enterprises, which later were included in the national economic plans.

During this period, a series of enterprise and technical reforms was carried out in the medium and small electrical equipment industry. After studying advanced Soviet experience, the enterprise and technical control standard of the industry was improved. A unified design of the basic series of asynchronous and DC motors was established in accordance with the Soviet standard, which completely eliminated the confused situation of the past and provided a good foundation for the future development of these products. During the period of the First Five-Year Plan, tremendous progress was made in the production of medium and small electrical equipment by

copying Soviet models. The number of different types and series of products that were test-manufactured and produced totalled more than 100. A series of 0.3-to 100-kilowatt and 100-to 1,500-kilowatt asynchronous motors and 0.3-to 200-kilowatt and 200-to 1,500-kilowatt DC motors, for example, were designed, test-manufactured, and produced in series. From then on, our manufacturing level has advanced from the design and manufacture of individual products to production in series. Furthermore, motors for use in tropical climates, marine motors, high-speed DC and AC motors, as well as various special types of motors, such as those used for battery charging and electro-plating, were test-manufactured. While learning and operating in accordance with Soviet technology, individual designing work was also carried out, improving the design of the T-series synchronous motors and the J-and JO-series asynchronous motors. In the process of production, such advanced technical methods as rotor aluminum casting, the vacuum immersing of rubber and varnish, and the treatment of commutators and oxidized diaphragm iron cores were employed. The technical level of insulation treatment and the manufacture of commutators and iron cores was raised. Regarding the use of raw materials, the supply of insulating varnish, yellow wax cloth, silicon steel sheets, electromagnetic wire, and ball bearings has been basically self-sufficient. Also, by applying advanced Soviet experience, a standard of material specifications was set up, which greatly simplified the number of structural parts and promoted their usage, enabling their production to be reduced and efficiency to be raised.

As a result of the continuous rise in labor productivity and in the ideological level of the workers, as well as the expansion of old and the completion of new plants, production has been greatly increased. In 1957 the total output was 55.52 times that of 1949; the total value of the output increased 40 times. The total amount of medium and small electrical equipment produced can now meet 70 to 80 percent of the needs for the development of our national economy, with still a portion of the products being exported to aid our brotherly countries.

4. The year of 1958 was one in which a high-speed development of "one day is equivalent to 20 years" was made. Under the guidance of the party principle, the medium and small electrical equipment industry also made unprecedented progress. The number of manufacturing plants in the country increased from the original 10 or so to more than 300; the labor strength tripled and the output quadrupled (4.1 times) that of 1957. The structure of the industry was completely changed. This type of progress could only be made by the Chinese people, who, under the leadership of the party, eliminated all superstition, liberated their ideology, and manifested their Communist spirit. This is the type of progress which the capitalist countries can hardly imagine.

In the course of the great-leap-forward development, a great number of electrical equipment manufacturing plants was added, with the originally existing plant again being expanded. The area of the Shanghai Electrical Equipment Plant, for example, was expanded almost 100 percent. The majority of the new plants, in this short period of one year, quickly mastered the manufacturing technology of medium and small electrical equipment and became an important newborn source of strength for the industry, enabling the old plants to have more opportunity to carry out the manufacture of more complex products. In 1958 and 1959, apart from those products which were being produced by the old plants and those which were gradually being mastered by the new plants, others which were test-manufactured included motors for use under water and in mine shafts, transmission motors, solonium rectifier generators, mechanical rectifier exciting generators, 60-kilowatt DC generators, and numerous other types of new products suitable for use in special fields. The technical level of the entire electrical equipment manufacturing industry at that time was greatly raised.

Since the launching of the great-leap-forward development in 1958, a technical revolution was carried out by the workers of the electrical equipment manufacturing industry. In every workshop, central laboratory, and research institute, a series of studies were made on the new technology, new design, new materials, and new production methods in an effort to speed up the development of medium and small electrical equipment toward acquiring a higher insulating power. As a result of these studies, improvements were made in the design of a number of products, enabling them to become unified with the standard series of other socialist countries. Among these products were the 0.6-to 100-kilowatt J₂JO₂-series asynchronous motors (using E and F grade insulation), the 0.3-to 200-kilowatt Z₂-series DC motors (using A, B, and E grade insulation), the 100-to 1,000-kilowatt J-series asynchronous motors (using B grade insulation), and the T-series water turbine generators for use on farms. At present, samples of these products are being made for further testing. Regarding new materials, those which have already been test-manufactured include high conductance silicon steel sheets, powdered mica products, polyethylene formaldehyde-acetaldehyde, polyamine and epoxy high-intensity varnish-coated wires, various types of heat-resistant glass fiber coated electromagnetic wires, epoxy resins, silicone organic varnishes, and other types of insulating varnishes. These new materials have been or are now being tested for use in the manufacture of various types of medium and small electrical equipment of different insulation grades. Regarding new equipment to be used for production, research and test-manufacturing work is being carried out on machines that can convert the entire production line process and the process of insulating testing, material immersing and drying into automatic

operations; the process of shearing, punching, selecting, and assembling, and the wrapping of coils, into mechanical operation; and the wiring of stators into semiautomatic operation. Some of these machines are already being used in the production line. Also, studies relating to aluminum wire motors, water-cooled motors, and air-cooled installations are being carried out. All these have created various types of material foundations for the future development of medium and small electrical equipment.

The carrying out of the technical revolution and scientific research work resulted in a rapid increase in output and a great improvement in design and manufacturing technology. In the production of the newly-designed T-series generator, for example, copper consumption was decreased by 39 percent; the consumption of silicon steel sheets by 7.5 percent. The weight of the equipment was reduced by 10 percent. In the manufacture of the J₂J0₂ -series asynchronous motor, copper consumption was cut by 8 to 23 percent; the consumption of silicon steel sheets, by 10 to 22 percent. The weight was reduced by 17 to 30 percent, and the size by 12 to 36 percent. Regarding the Z₂-series DC motor, copper consumption is estimated to have decreased by 25 percent; silicon steel sheet consumption by 24 percent. The weight was reduced by 20 percent. Regarding H-grade insulating motors, a 14-kilowatt four-pole closed type was test-manufactured, which, as compared to an A-grade one, can save 43.4 percent on copper, 23 percent on silicon steel sheets, and 58.2 percent on other structural materials. The weight is 33 percent lighter; the size, 40 percent smaller. In regard to the remarkable improvement of manufacturing technology, the time required for the production of a J-series 2.8-kilowatt motor at the Dairen Electrical Equipment Plant, for example, was reduced from 21.69 hours in 1954 to 6.86 hours in 1958, with an average annual reduction of 66 to 82 percent. In the production of rotors at the same Dairen Electrical Equipment Plant, the daily output is equivalent to 3.5 per square meter, calculated in accordance with the area of the unit carrying out the production. The total number of motors, equipped with a No. 3 base, assembled per day is equivalent to 110 per worker.

5. Under the eminent leadership of the party in the past 10 years, our medium and small electrical equipment manufacturing industry has developed from a small to a large industry, from producing simple to complex products, gradually advancing toward the path of modernization. The disposition of plants has also been changed from being concentrated in the coastal cities to being widespread throughout the country. In the number of plants and workers, production scale, types of products, designing and manufacturing standards, new materials, and the study of new technology, enormous achievements have been made. At present, a series of new designs have been made. The insulating power of

low-voltage asynchronous motors has reached the E and F grade, while that of high-voltage asynchronous motors has been raised to the B grade. New materials of various insulating grades have been test-manufactured.

While we are being called upon by the Central Committee of the party to strive for overtaking the output of Great Britain within a period of approximately 10 years, enabling our country to become one with a modern industrial, agricultural, scientific, and cultural level, the task to be undertaken by the medium and small electrical equipment manufacturing industry will be difficult but glorious. By following the principle of the party and the guidance of Chairman Mao, it is believed that with the progress already made, we shall be able to make still greater achievements and bring about the realization of our objectives ahead of schedule.

VIII. A DECADE OF SIGNIFICANT EVENTS IN THE TECHNICAL
DEVELOPMENT OF THE ELECTRICAL EQUIPMENT INDUSTRY

Tien-chi Kung-yeh

Unsigned article

Peiping, No. 20, 25 October 1959,
Pages 30-33

1 October 1949:

People's Republic of China founded.

1949:

A temporary standard for induction motors, transformers, switches, and electrical wires drafted by the East China District.

1950:

The First All-China Electrical Equipment Industry Conference, called by the Ministry of Heavy Industry, was held in Peiping.

A decision was made on the development of the electric-generator industry in the Northeast China District. At the same time, the temporary standard drafted by the East China District was approved and issued to the various districts for adoption.

1950:

Based on the foundation of the four originally existing electrical-engineering plants and machine works, more than 10 generator, transformer, electrical wire, light bulb, porcelain, and battery plants were established one after another in the Northeast China District.

1950:

The first group of Soviet electrical-engineering experts arrived to assist us in construction work.

End of 1950:

A number of electrical-engineering plants constructed at Harbin, Chia-mu-ssu, and A-ch'eng.

January 1951:

Tung-pei Tien-kung, a comprehensive magazine concerning electric-generator manufacturing published for the first time in the Northeast China District.

Second quarter, 1951:

Stator coils for 13,800-volt electric generators manufactured by Electrical Engineering Plant No. 5 (the present Shenyang Transformer Plant).

June 1951:

The first Chinese-designed electric-generator manufacturing Plant -- the Harbin Electric-Generator Plant -- started construction. Four factory buildings, including those for manufacturing transformers, were built at Electrical Engineering Plant No. 5, with large and modern facilities added.

1951:

Remodelling work on medium and small induction motors was carried out for the first time, followed by the launching of formal production.

December 1951:

First Soviet electrical-engineering data acquired.

End of 1951:

A complete set of 800-kilowatt vertical-type water turbine generators manufactured for the first time in our country by Electrical Engineering Plant No. 5 for the Hsia-t'ung Hydroelectric Power Plant on the Lung-ch'i River in Szechwan Province.

June 1952:

A factory building for the manufacture of intermediate-type generators built at the Harbin Electric Generator Plant and opened for production.

1952:

At the second All-China Electrical Equipment Industry Conference held in Peiping, it was decided that before a national standard was enacted, the Soviet national standard for the manufacture of electrical products was to be adopted temporarily. At the same time, a proposal, together with explanations concerning an electric-voltage standard in China, was made.

On the eve of National Day, 1952:

A complete set of 3,000-kilowatt water turbine generators manufactured at Electrical Engineering Plant No. 5.

March 1953:

Tien-ch'i Kung-yeh, the first national magazine concerning electrical engineering, was published in Peiping.

October 1953:

The unification of electrical-product planning work was carried out by the Electrical Equipment Industry Control Bureau. Planning work was completed on six different categories of generators, four categories of transformers, and 10 categories of switches.

1953:

Reorganization of state-operated and several state and privately-operated electrical-engineering plants was carried out by the Electrical Equipment Industry Control Bureau. Also, operational plans for these plants were mapped out, which later resulted in the establishment of a number of such modern plants as the Shanghai Electric Welding Machine Plant and the Shenyang Low-Voltage Switch Plant.

1953:

Chinese-made electrical products were displayed for the first time at an international exhibition (Leipzig).

1953:

Production of graphite brushes, carbon brushes, and metal brushes was started at the Harbin Battery Plant.

1953:

A mica workshop was built at the Harbin Insulating-Materials Plant.

1953:

A single-phase 13,500-kilovolt-ampere 110-kilovolt electric transformer was manufactured for the first time in Communist China at the Shenyang Transformer Plant.

1953:

A complete 6,000-kilowatt water turbine generator, the first of its kind made in Communist China, was produced by the Harbin Electric-Generator Plant for the Ku-t'ien Hydroelectric Power Station in Fukien Province.

1953:

A 10-kilovolt oil circuit breaker was manufactured by the Shenyang High-Voltage Switch Plant.

1953:

Test-manufacture of electric condensers was started at the Shanghai Electric Generator Plant.

1953:

Rubber tube storage batteries were made at the Po-shan Battery Plant.

February 1954:

Instructions for the development of different types and models of electrical products to meet the needs of the national

economy were issued by the Electrical Equipment Industry Control Bureau.

April 1954:

Construction work was started at the Harbin Electric Meters and Instruments Plant, which was one of the principal projects built with Soviet assistance.

June 1954:

Expansion work began at the steam turbine generator shop of the Shanghai Electric Generator Plant.

September 1954:

Reconstruction work commenced at the Shanghai Steam Turbine Plant.

November 1954:

Construction work in the Shanghai Boiler Plant's steam drum and boiler tube shops was started.

December 1954:

The large water turbine generator plant building of the Harbin Electric Generator Plant was constructed and production was started.

Fourth Quarter, 1954:

The Harbin Boiler Plant started construction work.

Second Quarter, 1954:

Copper graphite brushes test-manufactured at the Harbin Battery Plant.

July 1954:

A 3-ton electric furnace was produced for the first time in Communist China at the Hsiang-t'an Electric Generator Plant.

September 1954:

A 6,000-kilowatt Czechoslovakian-type steam turbine generator, the first of its kind made in Communist China, was produced with the technical assistance of Czechoslovakia by the Shanghai Electric Generator Plant for the Huai-nan Power Station.

1954:

A single-phase 20,000-kilovolt-ampere 154-kilovolt electric transformer was manufactured by the Shenyang Transformer Plant.

1954:

Spark plugs for use in automobiles and tractors were made by the Nanking Electric Porcelain Plant.

1954:

60-kilovolt (G-50) bushings were manufactured at the Fu-shun Electric Porcelain Plant.

1954:

A power motive system was designed for 4-meter planers.

1954:

The A-ch'eng Relay Plant started manufacturing P₃ -70, P₃ -100, and P₃ -180 type DC relays, P₃ -2100 type AC relays, and P₃ -218 clock-type time relays.

February 1955:

The Peiping Electrical Equipment Industry Research Institute established.

1955:

The A-ch'eng Relay Plant, the first of its kind in Communist China, was completed.

August 1955:

Valuable suggestions concerning the development of our electrical industry were offered by Soviet electrical-engineering expert Koschenko, a member of the Soviet Academy of Sciences delegation visiting our country, after he had inspected our electrical equipment plants in various localities.

1955:

Chemical and electrical battery-source specialists were dispatched to North Korea to assist in the construction of its battery industry.

October 1955:

Soviet FMHB-500 multi-anode iron shell mercury rectifiers manufactured by the Shanghai Electric Generator Plant.

1955:

The Electrical Equipment Industry Control Bureau started compiling standard models of various products.

1955:

Plants of the Electrical Equipment Industry Control Bureau compiled technological documents for various products.

1955:

A 10,000-kilowatt automatic water turbine generator set was manufactured for the first time in Communist China by the Harbin Electric Generator Plant for the Kuan-t'ing Hydroelectric Power Station.

1955:

Communist China's first 6,000-kilowatt steam turbine and medium-pressure 40-ton boiler was produced by the Shanghai Steam Turbine Plant and the Shanghai Boiler Plant for the Huai-nan Power Station. Thereafter, Communist China was capable of manufacturing 6,000-kilowatt thermoelectric power generating equipment in series.

1955:

10-, 35-, and 110-kilovolt oil blast circuit breakers were manufactured by the Shenyang High-Voltage Switch Plant. The 10-kilovolt circuit breakers have a circuit-breaking capacity of 2,500 kilovolt-amperes. At the same time, 10-, 20-, and 35-kilovolt oil circuit breakers with a circuit-breaking capacity of 200 to 2,500 megavolt-amperes were also manufactured.

1955:

Electric motive equipment for intermediate-type ϕ 500 and small-type ϕ 430/500 rolling mills were manufactured, with a generator amplifier control system and a simultaneous automatic exciting system used.

1955:

Seven-ton and 10-ton overhead cable type mining electric locomotives were manufactured by the Hsiang-t'an Electric Machine Plant.

1955:

Storage batteries for aviation use were manufactured by the Shenyang Storage Battery Plant.

1955:

Nickel cadmium storage batteries were made at the Planning Center for the construction of the Hsin-hsiang Storage Battery Plant.

February 1956:

The Hsin-hsiang Storage Battery Plant started construction.

March 1956:

The Wuhan Boiler Plant started construction.

Second Quarter, 1956:

The Sian Switch and Rectifier Plant started construction.

May 1956:

The Peiping Electrical Equipment Industry Research Institute was expanded to become the Peiping Electrical Equipment Scientific Research Institute, and at the same time two branch institutions were established at Shanghai and Canton.

June 1956:

The Technological Research Institute was established in Shenyang.

July 1956:

The modern Harbin Electric Meters and Instruments Plant, the first of its kind in Communist China and built with Soviet assistance, was completed and put into production.

August 1956:

The Shenyang Electric-Cable Plant, the largest of its kind in Asia and among the best in the world, built with Soviet assistance, was completed and put into production.

August 1956:

A unified electrical-products technological standard was issued to all plants and became effective on 1 August 1956.

August 1956:

Two motive power research institutes were established in Peiping and Shanghai, respectively. Later merged, these two organizations formally became the Steam Turbine and Boiler Research Institute, located in Shanghai.

December 1956:

Harbin Boiler Plant constructed.

1956:

The Tientsin Electric-Cable Plant was expanded with the assistance of East Germany.

End of 1956:

The Sian High-Voltage Electric Porcelain Plant under construction.

1956:

The Shanghai Electric-Generator Plant, the Shanghai Steam Turbine Plant, and the Shanghai Boiler Plant were completed.

1956:

The Harbin Steam Turbine Plant started operations.

1956:

12,500-kilowatt steam turbine generators were manufactured by the Shanghai Electric-Generator Plant and the Harbin Electric-Generator Plant.

December 1956:

12,000-kilowatt steam turbines were made by the Shanghai Steam Turbine Plant.

1956:

35-kilovolt AC and 110-kilovolt DC cables for X-ray use and cables for mine prospecting use were test-manufactured by the Shanghai Electric Cable Plant and the Shenyang Electric Cable Plant.

December 1956:

35-kilovolt super high tension paper insulating power cables were manufactured by the Shanghai Electric Cable Plant and the Shenyang Electric Cable Plant.

1956:

Communist China's first 15,000-kilovolt-ampere oil-immersed force water cooled electric furnace transformer, 5,600-kilovolt-ampere rectifier transformer, and 220-kilovolt voltage mutual inductor were manufactured.

1956:

The Harbin Battery Plant mastered the technological process of electrochemical graphite brushes.

1956:

Designing work was carried out on a series of steam turbine generators under a capacity of 25,000 kilowatts, which were suitable to the conditions within Communist China.

1956:

Designing work on a 800-kilowatt DC electric power system for windlasses was completed.

1956:

MMHM-100 mercury rectifiers were test-manufactured at the Shanghai Generator Plant. Production of these rectifiers in series followed.

1956:

A DC sectional power motive system for printing and dyeing machines was manufactured.

1956:

Multiple-layer dry batteries manufactured by the Hankow Battery Plant.

1956:

Designing work completed on a power motive system for paper-making machines with a daily output of 25 and 50 tons, respectively.

1956:

Storage batteries for use in beacons were manufactured by the Po-shan Battery Plant.

January 1957:

The magazine Tien-ch'i Kung-yeh /Electrical Equipment Industry/ was redesignated Tien-chi Kung-yeh /Electric Generator Industry/. It became an organizational publication of the Ministry for the Electric-Generator Manufacturing Industry.

April 1957:

The Hsiang-t'an Electric Generator Plant started expansion.

October 1957:

The Shanghai Electric-Cable Research Institute and the Sian Electric-Porcelain Research Institute were established.

December 1957:

The Shenyang Transformer Plant completed expansion and started production.

February 1957:

Medium-pressure coal powder type 35-ton boilers test-manufactured at the Harbin Boiler Plant.

November 1957:

A plan for the development of new products was mapped out by the First Ministry of Machine Building.

1957:

Several delegations, specialized in the fields of anti-blast, electric generator, and hydroelectric power generating equipment; electric wire and cable; electric locomotives; steam turbines; and boiler manufacturing made inspection trips in Soviet Russia and other brotherly countries.

1957:

Three-phase three-coil 40,500-kilovolt-ampere 154-kilovolt and single-phase 20,000-kilovolt-ampere 220-kilovolt electric transformers were manufactured at the Shenyang Transformer Plant.

1957:

Medium-pressure coal powder type 75-ton and medium-pressure 130-ton boilers were manufactured at the Harbin Boiler Plant.

1957:

Twenty-four-line carrier wave long-distance communication cables were made at the Shanghai Electric Cable Plant and the Sheyyang Electric Cable Plant.

1957:

A series of radio frequency coaxial cables were manufactured at the Tientsin Electric Cable Plant.

1957:

High-intensity enamelled copper wires were made at the Shenyang Electric Cable Plant, the Shanghai Electric Cable Plant, and the Harbin Electric Wire Plant.

1957:

Five-ton electric arc furnaces were produced at the Hsiang-t'an Electric Generator Plant.

1957:

7,500-kilovolt-ampere simultaneous phase accelerators were made at the Harbin Electric Generator Plant.

1957:

110-kilovolt 4,000-kilovolt-ampere compressed air circuit breakers and 110-kilovolt 3,500-kilovolt-ampere oil blast circuit breakers were manufactured at the Shenyang High-Voltage Switch Plant.

1957:

The Sian Electrical Condenser Plant started test-manufacturing series, pulsating, coupled, and phase shifting condensers.

1957:

Electric motive equipment for 3-cubic-meter electric shovels and chain-type wood-grinding machines, each capable of producing 25 tons of wood pulp daily, were designed and manufactured.

1957:

Designing work on new-model low-voltage electrical equipment was underway. Those completed were automatic air circuit breakers under 4,000 amperes, AC contactors under 600 amperes, thermorelays under 150 amperes, fuses under 1,000 amperes, knife fuses under 600 amperes, and magnetic starters under 150 amperes.

January 1958:

The magazine Tien-chi Kung-yeh [Electric Generator Industry] was redesignated Tien-kung Chi-shu [Electrical Engineering Technology], and became a technological publication of the Eighth Bureau of the First Ministry of Machine Building.

February 1958:

The Te-yang Hydroelectric Power Generating Equipment Plant in Szechwan Province started operations.

24 March 1958:

An agreement on jointly carrying out testing and research work on electrical equipment under humid and hot climatic conditions in Communist China was signed in Peiping by Communist China, Soviet Russia, Hungary, Poland, Czechoslovakia, and East Germany.

May 1958:

Scientific research organizations for large electric generators, high-voltage electrical equipment, electromotive equipment designing, transformers, power traction equipment, medium and small generators, electrical instruments, electric meters, relays and explosion-proof generators were established.

May 1958:

The Sian Switch Rectifier Plant went into production.

June 1958:

The Harbin Electrocarbon Plant, the first electrocarbon plant in Communist China, commenced formal production.

June 1958:

The Harbin Boiler Plant started its second stage of expansion.

June 1958:

The Cheng-tu Electric Generator Plant under construction.

July 1958:

The Sian Electrical Condenser Plant commenced formal production.

July 1958:

The Peking Steam Turbine Generator Plant under construction.

July 1958:

The Harbin Insulating-Materials Plant, the first large and modern comprehensive-type insulating-materials manufacturing plant in Communist China, was completed.

July 1958:

Representatives were dispatched to Sweden to participate in the Annual International Electrical-Engineering Conference.

Fourth Quarter, 1958:

The Peking Heavy Electrical Machinery Plant under construction.

December 1958:

The modern Harbin Steam Turbine Plant was constructed and started production 2 years ahead of schedule.

December 1958:

The Sian High-Voltage Electric Porcelain Plant commenced test operation.

1958:

The Harbin Electrical Engineering College, the first higher educational institution in Communist China for the study of electrical engineering, was established.

June 1958:

A high-pressure boiler, the first of its kind in Communist China with an hourly evaporating capacity of 230 tons, was test-manufactured at the Harbin Boiler Plant. At the same time, a high-pressure container of 320-atmosphere pressure for use in a chemical fertilizer plant was also manufactured.

June 1958:

An 80-ton mining electric locomotive, the first of its kind made in Communist China, was manufactured at the Hsiang-t'an Electric Generator Plant.

June 1958:

A 120-kilowatt DC steam turbine generator for use in ships was designed and manufactured.

June 1958:

Synchronous motors with a capacity of 2,800 kilowatts for use in chemical fertilizer plants were manufactured at the Shanghai Electric Generator Plant.

Second Quarter, 1958:

Silicone organic glass mica bands, silicone organic mica plate linings, and silicone organic glass colloidal bands for use in the manufacture of 25,000-kilowatt steam turbine generators, and a small-type water soluble formaldehyde resin synthetic adhesive for use in the making of veneer for the aviation industry were produced at the Harbin Insulating-Materials Plant.

National Day, 1958:

25,000-kilowatt steam turbine generators were made at the Harbin and Shanghai Electric Generator Plants.

September 1958:

A 60,000-kilowatt water turbine generator was manufactured by the Harbin Electric Generator Plant for the Feng-man Hydro-electric Power Station.

September 1958:

A 10,000-kilowatt radial axial flow type water turbine was test-manufactured at the Harbin Electric Generator Plant. The turbine, the structure of which is welded together, has a rotor 2,000 millimeters in diameter.

September 1958:

Intermediate-type steam turbine generators of 500 or more kilowatts were manufactured in the provinces of Kiangsu, Chekiang, Shantung, Kiangsi, Szechwan, Kwangtung, Hopeh, and Honan.

September 1958:

Communist China's first 2,000-kilowatt high-speed induction motor was test-manufactured at the Shanghai Electric Generator Plant.

September 1958:

220-kilovolt 600-ampere 5,000-megavolt-ampere oil blast circuit breakers, 35- and 60-kilovolt 600-ampere light-weight break switches, 25-kilovolt 300-ampere 150-megavolt-ampere air circuit breakers for use in locomotives, 20-kilovolt 6,000-ampere break switches, and 10-kilovolt 600-ampere 200-megavolt-ampere insulation oil box oil circuit breakers were manufactured at the Shenyang High Tension Switch Plant.

September 1958:

110-kilovolt super high tension electric cable and 252-kilocycle 60-line carrier wave long-distance communication cable were manufactured at the Shenyang and Shanghai Electric Cable Plants.

September 1958:

Communist China's first 40,000-kilovolt-ampere 220-kilovolt oil-immersed air-cooled power transformer and 60,000-kilovolt-ampere three-phase three-coil air-cooled lightning-resistant transformer were manufactured at the Shenyang Transformer Plant.

October 1958:

Comrade Liu Shao-ch'i, vice chairman of the party Central Committee and Chairman of the Standing Committee of the People's Congress, inspected the Shanghai Electric Generator Plant.

December 1958:

Comrade Chu Te, vice chairman of the party Central Committee and the Chinese People's Republic, and Comrade Lin Po-chu, vice chairman of the Standing Committee of the People's Congress, inspected the Wuhan Boiler Plant.

Latter part of 1958:

Inspections were made by Ch'en Yun at the Shanghai Hua-t'ung Switch Plant; Teng Hsiao-p'ing and Li Fu-ch'un at three power generating equipment plants in Harbin; and Tung Pi-wu, Nieh Yung-chen, and Lo Yung-huan at the Hsiang-t'an Electric Generator Plant. All these persons were party and government leaders.

November 1958:

Bushings for 220-kilovolt electrical condensers were manufactured at the Li-ling Electric Porcelain Plant.

December 1958:

A 72,500-kilowatt water turbine generator, the largest in Communist China, was manufactured by the Harbin Electric Generator Plant for the Hsin-an Chiang Hydroelectric Power Station.

December 1958:

Medium-pressure 280-ton boilers were made at the Harbin Boiler Plant.

December 1958:

220-kilovolt super high tension paper insulating electric cables were produced at the Shenyang Electric Cable Plant.

1958:

Communist China's first 138-ton AC electric locomotive was test-manufactured at the Hsiang-t'an Electric Generator Plant. Test operation of the locomotive was underway.

1958:

A 30-kilowatt high-temperature box-type electric furnace was test-manufactured at the Shanghai Hsin-yeh Electrical Machine Plant.

1958:

220-kilovolt super high tension valve-type lightning arresters were made at the Fu-shun Electric Porcelain Plant.

1958:

Large bushings for 330-kilovolt magnetic blow-out lightning arresters were manufactured at the Sian Electric Porcelain Plant.

1958:

Communist China's first comprehensive television cable was made at the Tientsin Electric Cable Plant.

1958:

A 20,000-volt high-voltage oscillograph, which is an important testing instrument for the development of high-voltage electrical equipment, was manufactured at the Shenyang High Tension Switch Plant.

1958:

PMHB-500 x 6 and PMHB-500 x 12 single-anode mercury rectifiers were made at the Sian Switch and Rectifier Plant.

1958:

1,800-kilovolt impulse voltage generators, 25-kilovolt impulse current generators, and 600-kilovolt power frequency high-voltage testing transformers were manufactured at the Shenyang Transformer Plant.

1958:

A series of 10 to 5,600-kilovolt-ampere medium and small transformers suitable for our climatic conditions was established.

1958:

Model ZSJK-12800/10 large-type rectifying transformers (equipped with carrier voltage regulating autotransformers) with a capacity 9,620 kilovolt-amperes were made and produced in series at the Shenyang Transformer Plant.

1958:

Designing work on a series of transformers for steel-refining arc furnaces of 20 tons and less was completed at the Shenyang Transformer Plant.

End of 1958:

Communist China's first ZDP-5,600/25 rectifying transformer, used in electric locomotives, was manufactured at the Shenyang Transformer Plant.

End of 1958:

Aluminum cable cement reactors were produced in large quantities at the Shenyang Transformer Plant.

1958:

10-kilovolt plastic current mutual inductors and a model LCLWD-220 220-kilovolt electric cable capacitance type current mutual inductor were made at the Shenyang Transformer Plant.

1958:

Designing work on a 330-kilovolt electric cable capacitance type current mutual inductor was completed at the Shenyang Transformer Plant.

1958:

Designing work on Communist China's first electromotive equipment for primary rolling mills with a diameter of 700/500, 850/650, and 1,150 millimeters, and for blast furnaces with a volume of 1,513 cubic meters, was completed.

1958:

Electromotive equipment for 25- and 50-ton paper-manufacturing machines were made.

1958:

Communist China's first Soviet-model electromotive equipment for milling machines was made by using the tracking system of an electronic tube amplifier.

1958:

Long-distance protective shields and high-frequency phase differential protective shields for use in 11-220-kilovolt power networks were manufactured at the A-ch'eng Relay Plant.

1958:

Semi-conductor directional impedance, rectifying-type full impedance, and power directional relays; full impedance and time magnetic amplifying relays; and reclosing, intermediate, and time relays for alternating-current operation were made at the A-ch'eng Relay Plant.

1958:

A number of modern low-voltage parts, magnetic amplifiers, magnetic logical parts, saturated reactors, and noncontacting control parts were test-manufactured at various places in the country.

1958:

Semi-automatic electric slag-welding machines capable of welding steel plates of a thickness of 60 to 250 millimeters, steel pipe welding machines capable of welding 8,000 tons of steel pipes of a 76-millimeter diameter annually, gas protective arc welders for welding nonferrous and rare metals, and arc welders that use carbon dioxide as protective gas, were manufactured at the Shanghai Electric-Welding Machine Plant.

1958:

Electric meters of the 0.2 grade were test-manufactured at the Harbin Electric Meter and Instrument Plant.

1958:

Glass wire tube storage batteries were manufactured at the Po-shan Battery Plant.

1958:

Three-layer insulating storage batteries were made at the Shenyang Storage Battery Plant.

1958:

Samples of silver-zinc storage batteries were test-manufactured at the Peking Electrical-Equipment Scientific Research Institute.

1958:

Samples of underwater tone frequency communication cable were made at the Shanghai Electric Cable Plant.

January 1959:

Communist China's first high-voltage high-temperature 50,000-kilowatt steam turbine was manufactured at the Harbin Steam Turbine Plant.

January 1959:

The magazine Tien-kung Chi-shu /Electrical Engineering Technology/ was redesignated Tien-chi Kung-veh /Electrical Machine Industry/, and became an organizational publication of the Eighth Bureau of the First Ministry of Machine Building.

May 1959:

National inspection was carried out on the 25,000-kilowatt steam turbine generators produced by the three large power-generating equipment plants in Harbin and three similar types of plants in Shanghai.

May 1959:

Communist China's first 72,500-kilowatt water turbine generator was manufactured at the Harbin Electric Generator Plant.

July 1959:

A high-voltage high-temperature double air pumping 25,000-kilowatt steam turbine was made at the Harbin Steam Turbine Plant.

1959:

The State Council approved the National Standard GB156-59, "Rated Voltage and Frequency for Electrical Equipment," and 330 kilovolts as being the maximum voltage classification.

1959:

A 150-kilogram vacuum induction type electric furnace was made at the Shanghai Hsin-yeh Electrical-Machine Plant.

1959:

A 10-ton and a 40-ton electric arc furnace were made at the Hsiang-t'an Electric Generator Plant.

1959:

Electric meters of the 0.1 grade were made at the Harbin Electric Meter and Instrument Plant.

September 1959:

GCH-2 high-frequency differential protective shields for super high tension 330-kilovolt lines, JH-12 distance protective shields, and BCH-3 transformer differential protective installations were manufactured at the A-ch'eng Relay Plant.

26 September 1959:

Communist China's first hydrogen-cooled 50,000-kilowatt steam turbine generator was produced at the Harbin Electric Generator Plant.

28 September 1959:

A 2,500-kilowatt mobile railroad power station was built by the Pao-ting Railroad Electrification Bureau.

September 1959:

The first stage of construction of the Wuhan Boiler Plant was completed and the plant started operations $3\frac{1}{2}$ months ahead of schedule.

September 1959:

The large transformer plant building of the Shenyang Transformer Plant was completed.

September 1959:

A single-phase three-coil 220-kilovolt 30,000-kilovolt-ampere power transformer was made at the Shanghai Electric Generator Plant.

September 1959:

A single-phase, three-coil, oil-immersed, air-cooled, 220-kilovolt, 60,000-kilovolt-ampere power transformer was manufactured at the Shenyang Transformer Plant.

September 1959:

A 1,500-kilowatt, 3,000-rpm steam turbine generator was made at the Shanghai Hsien-feng Electrical Equipment Plant. At the same time, a 865-kilovolt-ampere blocking magnetic amplifier, to be used for the operational control of an electric furnace for emery production, was also designed and manufactured.

September 1959:

Forty-core color television cable for long-distance cameras was manufactured at the Tientsin Electric Cable Plant.

September 1959:

High shielding comprehensive trunk line cable for use in the electrification of railroads was made at the Shenyang Electric Cable Plant.

1959:

A 4,00-kilowatt, tightly-sealed, water-cooled, single-anode mercury rectifier for use in trunk-line locomotives was made at the Shanghai Electrical Equipment Scientific Research Institute.

IX. THE HIGH TIDE OF PRODUCTION ROLLS FORWARD,
PRODUCTION AND ECONOMY INCREASE

Tien-chi Kung-yeh,
Peiping, No. 21, 10 November 1959,
Page 1

Unsigned article

The electrical equipment manufacturing industry is presently continuing its great-leap-forward campaign, with progress being made in increasing production and practising economy.

In September 1959, the production of power generating equipment reached the 1962 level 3 years and 3 months ahead of schedule. Of the 33 types of electrical products, the quotas of eight planned for the year were fulfilled. These eight types of products are mutual inductors, mercury rectifiers, power condensers, electric arc furnaces, electric welders, battery cars, electrical instruments and meters, and electrocarbon products. In October of the same year, inspired by the outcome of the meeting of progressive workers throughout the country, a new order for production development was established in a great number of plants. During this period, power generating equipment equivalent to a total capacity of 303,000 kilowatts was produced. This figure, as compared to that of September, represents an increase of 1.7 percent. The total output of power-generating equipment in the first 10-month period of 1959 reached a capacity of 1,757,000 kilowatts, so that the target planned for the year could be attained at any time. In the past, the production of sets of electrical equipment was a weak link in the over-all operation. However, after appropriate measures had been taken, this situation gradually improved. The output of large electrical equipment in October, for example, was equivalent to a total capacity of 146,000 kilowatts, which, as compared to that of September, was an increase of 22 percent. Likewise, the total amount of high-voltage electric porcelain produced in the former period, which was 5,742 tons, was 33.3 percent over that of the latter period. In October, some of the plants completed the year's national plan, while the output of a number of others reached the production value planned for the end of the year. Plans for the creation of different types of new products were partially fulfilled.

In the course of the October increased-production and economization campaign, new developments were made in labor competition and technical reforms. At the Shenyang Transformer Plant, High-Voltage Switch Plant, and Electric Cable Plant, a series of technical-reform competitions were enthusiastically carried out. At the Transformer Plant, more than 2,000 workers participated in 800 different technical exhibitions and competitions within several days. At the bare-wire workshop of the Electric Cable Plant, some 222 workers

took part in exhibition competitions in connection with single products and sets of products at a rate of 450 times per person. The workshop, within the first half of the month, completed 64 percent of the month's total production quota, while the plant, on the 20th day of the month (October), overfulfilled the total production quota planned for the entire year. On the 11th and 12th (of October), the workers of the Hua-t'ung Switch Plant proposed a total of 188 technical reform items. At the Shanghai Boiler Plant, the technical revolution campaign was enthusiastically carried out. In the plant's metal workshop, 438 technical reform items were suggested within a period of 19 days. Of these items, 309 were accepted. Progressive worker LI Fu-hsiang suggested a total of seven items, which, after being applied, raised the working efficiency by 2 to 7 times, bringing about the completion of the month's quota within a period of only 7 days. A great number of other plants also carried out large-scale competitions, enabling their production to become increased day after day. In early October, the output of relays per shift at the A-ch'eng Relay Plant was increased from 600 to 800. Over 70 percent of the workers in the standard-parts workshop set up a new record regarding the quantity of output and quality of products.

At the same time that the mass movement was being launched, the control work in every plant was also strengthened, guaranteeing a systematic production operation to be carried out daily, every 10 days, and every month. At the Shanghai Electrical Equipment Plant, inspection was carried out every 5 and 10 days to strengthen the preparation and adjustment work for production and to promptly solve the various key problems that arise in the course of production. At the Harbin Boiler Plant, a "four-point inspection" campaign was launched by the workers. This campaign, which includes "the inspection of contracts, sets of products, production targets, and deficiencies," was designed to enable every production unit and individual worker to set up working objectives and the leaders to study the existing problems so that appropriate measures can be taken and special personnel assigned to solve these problems within a prescribed period.

X. TEN YEARS OF GLORIOUS ACHIEVEMENTS IN THE
LOW-TENSION ELECTRICAL EQUIPMENT INDUSTRY

Tien-chi Kung-yeh,

Peiping, No. 21, 10 November 1959, Research Office,

Pages 6-8

Low-Tension Electrical Equipment

Shanghai Electrical Equipment

Scientific Research Institute

During the 10 years since the founding of the republic, our scientific technology and industrial and agricultural production have made tremendous progress. In the fields of manufacturing, mining, farm irrigation, communications, and transportation, automatic power-operated equipment has been increasingly used. The process of automation must depend upon various types of return circuits organically composed of numerous different types of low-tension electrical equipment, which reliably carry out protective and control functions. According to statistics, over 80 percent of the electric energy passes through low-tension electrical equipment. In those nations where production is highly electrified, the figure reaches over 90 percent. In producing every unit of generating equipment that has a capacity of 10,000 kilowatts, a total of 12,000 low-tension electrical items (automatic air circuit breakers, contactors, controllers, etc.), excluding such simple items as knife switches and push buttons, is needed. Consequently, along with the continuous development of the various sectors of our national economy and the broad use of power-operated equipment, the low-tension electrical equipment manufacturing industry will have a wide development in the future. Its mission will be important and glorious.

As a result of the economic invasion of the imperialist countries prior to the liberation, the supply of power-operated equipment depended upon importation. The electrical equipment industry of old China could mainly carry out only repair and assembling work. Although a number of products were produced, they were all copies of foreign models and the quality was inferior. Low-tension electrical equipment plants were nonexistent and products that were produced in certain electrical equipment plants were treated as accessory items. They were not produced in series and the technical and economic aspects were extremely backward. A great majority of the materials used in production, such as silicon steel sheets, resistance wire, and bimetal sheets, were imported from foreign countries. Due to the enormous amount of foreign products that poured into the market, the Chinese products were unable to withstand the competition and the plants finally lost confidence in manufacturing. Under such circumstances, the low-tension electrical equipment manufacturing industry could not possibly make any progress.

Following the liberation, the party and the government carried out reorganization work on the existing enterprises to develop their production capabilities. Such plants engaged in the production of low-tension electrical equipment as the Shenyang Low-Tension Switch Plant and the joint state and privately-operated Hua-t'ung Switch Plant were then established. A low-tension electrical equipment workshop was also added to the Hsiang-t'an Electrical Equipment Plant. Adjustments were made in numerous small privately-operated plants, enabling them to devote a part of their time to the production of small switches. By 1952, the production of low-tension electrical equipment, both in number of types and in quantity, showed a remarkable increase, satisfying to a great extent the requirements of the various sectors of the national economy during the rehabilitation period. However, due to the fact that there were numerous different types of products, the specifications of these products at that time were very confusing, and their quality unstable, they were still unable to meet the over-all requirements for the development of the national economy.

In 1953, in response to the appeal of the party and as a result of conscientiously pursuing the study of Soviet technology, the progress of the development of the low-tension electrical equipment industry was greatly accelerated. The Electrical Equipment Industry Control Bureau of the First Ministry of Machine Building, on three different occasions, carried out work on unifying the designs of the products produced throughout the country. The designs of several tens of products then became unified, which finally completely eliminated the confused situation of the past. In the designing work carried out at the plants, the Soviet three-phase designing method was adopted, with a designing and test-manufacturing system being established. As a result of these measures, products made after Soviet models were continuously test-manufactured. By 1957, the test-manufacturing work on then major categories of new products, namely, knife switches, composite switches, automatic air circuit breakers, controllers, contactors, starters, relays, manipulators, resistors, and rheostats, which consisted of more than 100 different series and over 200 different types, as well as a small number of special electrical items, was completed. Due to the fact that these products were of a high standard and universal usage, they were basically able to meet with the requirements for the production of sets of control equipment for large hydroelectric and thermoelectric power generating facilities, transformer stations, heavy machines, and communication and transportation facilities. The practical work done in these several years also accumulated a large number of low-tension electrical equipment workers.

For the purpose of continuously improving the technological standard of the industry, a low-tension electrical equipment research office was established at the Shanghai Electrical Equipment Scientific Research Institute in 1957. Central laboratories were also formed in the various plants, carrying out a series of studies and tests on the performance capability of products, material usage, and manufacturing technology.

Along with production expansion, the manufacturing technology was also improved, with rapid progress being made toward an advanced level. In the scope of technical installations available for manufacturing work, for example, over 50 percent of the goal was reached. Regarding AC contactors, which were in comparatively great demand, test-manufacturing work was started in 1953, but already in 1956 they were being made on a production line at the Hua-t'ung Switch Plant. As a result of this, the output was rapidly increased and production control was greatly simplified and continuously improved. As regards the manufacture of tools and patterns, the mechanization of bench work began in 1957, with special emphasis placed on the grinding of blanks, enabling the junior technicians to become familiar with the mechanical operations replacing the hand operations carried out by the senior technicians. Regarding the supply of materials, the great majority of them were in sufficient supply; plastics were widely substituted for metals, and electroplating for painting. In manufacturing technology, die casting and powder metallurgy were employed in the manufacture of contactors. Spot welding was also widely used, bringing about numerous advantageous factors in the large-scale production of excellent-quality low-tension electrical equipment had completely changed. In the early stages of the liberation, only a few repair and assembly plants existed, but in 1957 a total of 33 fairly large plants were established. The total number of workers increased to more than 20,000. The annual production value exceeded 224,000,000 yuan, and as regards low-tension electrical equipment, explosion-proof equipment, and complete sets of equipment, the number of units produced reached 1,500,000, which basically satisfied the increasing demands of the various sectors of the national economy.

The year 1958 was the first year of the Second Five-Year Plan in which the masses enthusiastically followed the party principle of "exerting vigorous effort and striving for progress in socialist construction by increasing and speeding up production, producing good-quality products, and practising economy." Consequently, in the field of agriculture and industry unprecedented progress was made. In such a great leap forward, the output of power generating equipment in 1958 was 4 times that of 1957, and production in 1959 is expected to be more than double that of 1958. The increase in the output of this equipment created a great demand for the production of a new series of low-tension electrical

products, and at the same time created a keen interest on the part of the low-tension electrical equipment workers in the development of new types of products, the use of new materials, the employment of modern technology, and the expansion of production. As a result of carrying out a mass movement and technical revolution, remarkable developments were made in production, research, and designing work. The power and wisdom of the workers of the industry were also fully displayed.

First, a series of new products, including the 4,000-ampere DW0-series universal-type automatic air circuit breakers, were test-manufactured. These circuit breakers, as compared to their old counterparts, have a circuit breaking capacity that is larger by 1.5 to 3.7 times. The area required for their installation has been reduced by 60 percent; the size is smaller by 45 percent, and the weight is lighter by 75 percent. Taking the 200-ampere circuit breakers as an example, the manufacture of every 10,000 of these products can save 300 tons of steel material, 25 tons of nonferrous metals, and 150 tons of insulating materials. Among this series of products, the 1,500-ampere and 200-ampere grade are already being produced. Secondly, regarding the 1,000-ampere RTO-series enclosed-type fuses, their current breaking power is 4 to 5 times greater than their old counterparts. The breaking power of the various grades of 400 amperes and less has reached 50 kiloamperes (effective value), which is greater than the maximum 46 kiloamperes specified for the AC5 grade fuses of the British B. S. 88 national standard. In the case of other items, such as the 600-ampere and less CJO-series AC contactors, the main technical characteristics are that the mechanical durability is 5,000,000 times; the electrical durability, 250,000 times; the working frequency, 1,200 times/hour; and the inversion power, 20 times that of a tenfold rated current. Modern thermal relays possess the advantageous characteristics of current adjusting, temperature reciprocating, and high thermal stability. A modern relay and a contactor of the new series can be made into a modern magnetic starter. Designing work on a new series of star-delta starters, electromagnetic relays, and DC contactors is also being carried out at full speed through the joint efforts of various manufacturing plants. Modern explosion-proof magnetic starters and push buttons for use in coal mines are being produced at the Shenyang Low-Tension Switch Plant. All these new products are durable, small in size, and light in weight, and a great amount of raw materials can be saved in their manufacture. Also, such advanced products of great complexity as magnetic controllers for 750/550 rolling mills, and control panels for coal washing machines, dressing machines, and large blast furnaces of a capacity of 1,513 cubic meters, were manufactured.

At the same time that new types of products were being developed, work on improving the design of the old products was also carried out. At the Shenyang Low-Tension Switch Plant, for example, □ -type magnetic starters were put into greater usage, which greatly raised the economic aspects of the products. At the Hua-t'ung Switch Plant in Shanghai, the design of the A-3000 series air circuit breakers was improved, which resulted in broadening the usage of these products. The plant also completed the designing of a new series of AC contactors. At the Hsiang-t'an Electrical Equipment Plant, a new design of the 6,000-ampere DC automatic air circuit breaker was made. At other plants, such as the Shanghai Electrical Machine Plant and the Chung-nan Electrical Equipment Plant, modern contactors and fuses were designed and test-manufactured. Both technically and economically, all these new products are one to 5 times better than the old ones.

With the continuous increase in the number of new products and their output, enormous quantities of new materials were used. Apart from using aluminum as a substitute for copper and plastics for metals, graphite bakelite powder was used in manufacturing bearings and asbestos bakelite powder was used in making heat-resistant parts. New domestically manufactured materials, such as vinyl chloride plastics, epoxy resins, various types of insulating varnishes, glass fiber, silicone rubber, high-intensity enamelled wire, birch veneer, glass fiber veneer, clay, talc ceramics, semiconductors, and bimetal sheets, were also used broadly and in large quantities. As a result, small and superior-quality electrical equipment was produced and miniature-type switches were test-manufactured.

In manufacturing technology, the rate of progress was even more remarkable. The proportion of the punching and pressing of parts has reached 80 to 90 percent. Highly efficient automatic and semiautomatic machine lathes and automatic punch presses were introduced during the period of the technical revolution. According to statistics, the total number of improved equipments used, and suggestions on new technology applied, by the Shanghai Hua-t'ung Switch Plant within a period of one year reached over 1,000. As a result of the technical revolution launched by the masses of workers and the enormous quantities of products being produced by means of production lines, the output was rapidly increased. At the Hua-t'ung Switch Plant, for example, the output of relays in 1959 alone totalled over 300,000, which was 6 times that of 1958. The Shanghai Hsing-chung Electrical Equipment Plant, which started test-manufacturing the KT series AC contactors in the first quarter of 1959, had a labor force of only 200 workers. However, after carrying out their work with the aid of production lines and fully exerting their revolutionary efforts, they were able to produce these products in large amounts by the third quarter of the same year. The total monthly output in that period was approximately 10,000.

At the Shenyang Low-Tension Switch Plant, a total of seven automatic assembly lines was set up in the first 6 months of 1959. Also, as a result of mastering numerous special technical methods, such as using paraffin wax for precision casting, the pattern making of delicate parts was greatly speeded up. The use of a high-voltage electrostatic field in paint spraying greatly raised the utilization efficiency of paints. The adoption of the supersonic-wave welding method solved the conductor welding problem of using aluminum as a substitute for copper. All this has opened up a broad path for the production development of low-tension electrical equipment both quantitatively and qualitatively.

In the past, the production of low-tension electrical products was concentrated in only a few localities. By 1958, however, as a result of resolutely carrying out the policy of "advancing with both feet," a great number of plants was established in various places throughout the country. The annual output of each type of product in some of the newly-established plants was designed to reach several tens of thousands. Their scope of operation is much larger than some of the old plants. At the conference on Low-Tension Electrical Equipment Control Facilities held in Shanghai in November 1958, the total number of new and old plants represented was more than 100, which was triple the number of plants existing in the final period of the First Five-Year Plan. These new plants were established and developed by simultaneously carrying out construction, test-manufacturing, and production, as well as by combining the native with the modern method, launching a mass movement campaign, and developing special equipment. According to statistics, the total number of types of special equipment created in 1958 exceeded 200, of which 90 were basic ones that have been widely used. Due to the fact that the manufacturing plants are scattered all over the country, they benefit by the local supply of materials and by the manufacturing and disposing of their products locally, which will ultimately eliminate the difficulties of supplying sets of products to remote areas and assure a continuous leap forward.

During the 10 years since the liberation, the low-tension electrical equipment manufacturing industry has made glorious achievements. Several hundred new products were produced and developed from a low to high standards. The majority of the materials used in production were manufactured domestically. New types of materials were fully utilized and advanced manufacturing methods were employed. The great majority of the products can now satisfy the nation's needs, while some of them are being exported to aid in the construction of our brotherly countries. However, in order to assure the further progress of our technical level and to meet the requirements for the continuous development of our national economy, large and superior testing and research centers are

required. Consequently, since the beginning of 1958, the testing centers at various large old plants have been strengthened and study on the improvement of products has been pursued. A testing center of a national scale for electrical products for use in tropical areas was also established. At the Shanghai Electrical Equipment Scientific Research Institute, preparation for the establishment of a large-scale testing center is underway. When completed, various types of testing equipment, including those for testing DC and AC current breaking capacity up to 100,000 amperes and the durability of electrical products, will become available. At present, equipment for testing current breaking capacity up to 50,000 amperes (effective value) is in operation, serving the various manufacturing plants in improving and developing low-tension electrical products.

For the purpose of increasing the output and improving the quality of low-tension electrical equipment, work on the unification of the specifications of products throughout the country is being carried out so that a national standard can be ultimately established. Also, efforts are being made to standardize and universalize all parts so as to lower the costs of production and raise the efficiency of their utilization. Along with the rapid development of the industry throughout the country, a technical cooperation and information network was organized in 1958 for exchanging and propagating advanced production experiences within the country. At the same time, technical cooperation with Soviet Russia and other brotherly nations was strengthened and advanced Soviet experiences were studied, which resulted in the continuous improvement of our technical level.

Along with the great-leap-forward development in the various sectors of our national economy and the establishment of people's communes, the automation of our industry and the electrification of our agriculture have been included in our daily discussions. In order to bring about greater developments in this glorious and vital task, the low-tension electrical products manufacturing industry must continue adhering to the spirit of Eighth Session of the Eighth Plenum of the Central Committee, carrying out the anti-rightist campaign, exerting vigorous effort, assuring the technical revolution, speeding up the development of new and the improvement of old products, and raising the technical and economic level of both new and old products. It must accelerate the test-manufacturing, production, and extension work on a new series of products so as to rapidly acquire satisfactory economic results. Regarding the production of sets of products, it must use "weak current" equipment so as to reduce the dimensions of the products and increase their stability. It must exert positive efforts in training new technicians, expanding the areas of production, propagating advanced technical experiences, and organizing production lines to

increase the extent of mechanical operations. It must use and develop to the utmost extent new types of materials; it must continue study on plant designing and manufacturing technology, as well as laboratory study, so as to increase the output and improve the quality of products. It must speed up the establishment and strengthening of research testing centers, recruiting experienced workers specialized in the fields of physics, chemistry, electrical engineering, mechanics, metallurgy, and mathematics, with a view to strengthening the industry's research and testing work. It must continue to promote technical intelligence work, giving attention to new achievements and trends in the development of the industry and ceaselessly studying the advanced experiences of Soviet Russia and other brotherly nations. It must summarize and propagate the rich production experiences acquired by the masses of workers in the course of their practical work. All this will enable the research, testing, designing, and production work to become organized, and the low-tension electrical equipment manufacturing industry to satisfy to the utmost the requirements for the development of our national economy.

At present, the workers of the low-tension electrical equipment manufacturing industry are confidently and positively responding to the resolutions of the Eighth Session of the Eighth Plenum of the Central Committee, striving for the completion of the principal targets of the Second Five-Year Plan before the end of the year (1959) and for overtaking Great Britain in the output of principal products within a period of approximately 10 years.

XI. TEN YEARS OF TECHNICAL ACHIEVEMENTS IN THE HIGH-TENSION SWITCH INDUSTRY AND FUTURE PROSPECTS

Tien-chi Kung-yeh,

Peiping, No. 21, 10 November 1959,
Pages 9-11

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High-tension switches are key equipment for power generation, transmission, and distribution lines. They carry out control and protective functions in an electric power system. The main high-tension switches are circuit breakers and isolating switches. Loading switches are also a type of high-tension switch, which, when equipped with a fuse, can be used as a part of a circuit breaker. High-tension switches are of numerous different types; the mechanical structures have their respective individual characteristics. Taking the weight of the equipment as an example, the high-tension circuit breakers produced in the country vary from several tens of kilograms to nearly 100 tons. Along with the daily increase in the scope of power networks and the capacity of individual generators and power stations, high-tension switches of a higher voltage, larger capacity, and speedier function are in increasing demand. The use of high-tension switches has a set standard in relation to the capacity of power-generating equipment. Generally, in every set of generating equipment which has a capacity of 10,000 kilowatts, 100 to 120 high-tension circuit breakers and 400 to 480 high-tension isolating switches are required. Consequently, the development of the high-tension switch manufacturing industry has a direct effect upon that of the electric power industry.

Prior to the liberation, the supply of high-tension switches almost totally relied on import. The Chinese national industry produced only a number of simple and small products, which were never inspected or tested. The largest circuit breakers, manufactured by copying foreign models, were indoor oil circuit breakers with a voltage of 33 kilovolts. The electrical equipment plants, which were established in K'un-ming and other localities with Kuomintang bureaucratic capital, produced only 7.5- and 13.2-kilovolt indoor oil circuit breakers with a current breaking capacity of not more than 100 megavolt-amperes. The design of these products was old and backward and the total number produced was only around 100.

In 1949, following the founding of the Chinese People's Republic, the high-tension switch manufacturing industry, like all other industries in the country, which were developed under the leadership of the party, following the party principle, with the unselfish aid of Soviet Russia and the untiring effort of the masses

of workers, made tremendous progress. In production capability, it progressed from its incapability to produce a series of products prior to the liberation, to preparing for the establishment of the first production center in 1952, and then to its present establishment of plants throughout the country. The supply of products can now satisfy the needs of national construction, completely changing the past situation of mainly relying on import. In the output of different types of products, it has advanced from the copying of individual products of a backward design in the pre-liberation days, to systematic production by copying a series of modern Soviet products starting in 1953, to gradually carrying out its own design of products suitable for use in the country. The industry has now become fully familiar with the technology of manufacturing 220-kilovolt high-tension switches and is test-manufacturing still higher tension and larger capacity products to meet the requirements for the future unification of the nation's power networks into a single large network. The speed of all these developments is unprecedented in the history of the world.

Following the liberation, the party gave considerable attention to the high-tension switch manufacturing industry. In accordance with the policy of "making self-sufficiency the primary objective and foreign aid a secondary one," which was adopted in the development of our industries, a number of experienced workers in the industry were transferred from Northeast China and organized into a planning group in 1950, carrying out designing and test-manufacturing work. In the beginning of 1952, oil circuit breakers of a rated voltage of 15 kilovolts and a current breaking capacity of 50 megavolt-amperes, as well as isolating switches and fuses of a similar voltage, were test-manufactured in Harbin. In the same year, the Shenyang High-Tension Switch Plant and the Shanghai Hua-t'ung Switch Plant were established, both producing 60-kilovolt oil circuit breakers. However, because these types of products were of old design and small capacity, and because the various types of materials used in the production were numerous, the manufacturing technology complex, and the steel consumption large, they were unable to meet the requirements of the nation's anticipated large-scale economic development. At that time, the party adopted the policy of resolutely carrying out the study of Soviet experience, which was subsequently followed by the masses of workers. Engineers and technicians criticized the superstitions about British technical materials and the idea of blindly worshipping Britain and the USA, creating a firm understanding as regards resolutely learning from Soviet Russia. In 1953, work on unifying designs and remodelling high-tension switches was launched. Production was carried out according to plan by copying modern Soviet products and the Soviet technical standard was used. This finally completely eliminated the past backward and confused situation resulting from copying products of the capitalist countries.

The unselfish aid of Soviet Russia has exerted a great effect upon the speedy progress of our high-tension switch manufacturing industry. Soviet Russia, which possesses rich experiences and first class technology, not only furnished us with complete sets of technical data and helped us in training technical personnel, but also dispatched specialists to our country to supervise our work at the plants, enabling us to quickly master the manufacturing technology of Soviet products. From 1953 to 1955, Soviet model 10-, 35-, and 110-kilovolt oil blast circuit breakers (the 110-kilovolt ones were with a current breaking capacity of 2,500 megavolt-amperes) and 10-, 20-, and 35-kilovolt oil circuit breakers (with a current breaking capacity of 200 to 2,500 megavolt-amperes) were test-manufactured. In 1957, Soviet model 110-kilovolt 3,500-megavolt-ampere oil blast circuit breakers and 4,000-megavolt-ampere compressed air circuit breakers were also test-manufactured.

During the period of the First Five-Year Plan, apart from reconstructing and expanding various old plants, including the Shenyang High-Tension Switch Plant and the Shanghai Hua-t'ung Switch Plant, strengthening the technical reforms in the tool and machine shops, and establishing and strengthening various central laboratories, the modern Sian High-Tension Switch Plant and a high and medium tension current-testing center were built and a special research institute was established with Soviet assistance. After mastering the Soviet manufacturing technology and accumulating several years of designing experience, work on the improvement of the structure of products, enabling them to become suitable for use in the country, was carried out in the final period of the First Five-Year Plan.

In the great-leap-forward year of 1958, the workers of the high-tension switch manufacturing industry carried out a mass movement and technical revolution. Cadre members themselves engaged in labor, while workers also participated in control work. The past irregular systems and procedures were totally reformed. In each and every manufacturing plant, new products were rapidly developed. In the Shenyang High-Tension Switch Plant alone, a total of 20 new products was test-manufactured in that year. As a result of simplifying the complex test-manufacturing procedures and fully relying on the masses, the period required for the test manufacture of a product was greatly reduced. The test manufacture of a power-operated installation, which in the past required several months to complete, now takes a period of only 7 days. Since the beginning of the great-leap-forward movement, the major products which were test-manufactured included 220-kilovolt 5,000-megavolt-ampere oil blast circuit breakers by the Shenyang High-Tension Switch Plant and the Hua-t'ung Switch Plant, and compressed air circuit breakers of a similar voltage and current breaking capacity by the Sian High-Tension Switch Plant. The completion of these 220-kilovolt oil blast and compressed air circuit breakers shows that our high-

tension switch manufacturing technology has advanced a large step toward the international level. The progress in the test manufacture of circuit breakers in the 15- to 220-kilovolt series took us a period of only 7 years, yet it took a total of 37 years for the U.S.A. to advance from manufacturing the 22-kilovolt series in 1901 to producing the 220-kilovolt series in 1938. The speed of our development has not been experienced by any capitalist country. It fully confirms the superiority of the socialist system.

During the past few years, 10-kilovolt light-weight oil circuit breakers, 35- and 60-kilovolt light-weight isolating switches, 110-kilovolt ground switches that can be used as a part of a circuit breaker, and quick break switches were test-manufactured in accordance with improved designs and new materials. At present, the test manufacture of the 60-kilovolt column-type oil circuit breaker is scheduled to be completed soon, while the test manufacture of the 330-kilovolt compressed air circuit breakers and isolating switches is still in progress.

In distinguishing high-tension circuit breakers in accordance with their arc blow-out dielectric function, a total of three types, namely, oil blast, oil, and compressed air, can be widely used. An oil blast circuit breaker has a larger capacity and is capable of speedy functioning; however, its manufacture requires the use of more steel materials and transformer oil. An oil circuit breaker has comparatively slower functioning and a smaller capacity, but its manufacture involves less consumption of materials and is low in cost. A compressed air circuit breaker is capable of reaching an extremely large capacity and a high speed of functioning, and can be tested by means of the distribution method without requiring large-capacity current breaking testing equipment. However, its structure is complex and the cost of its manufacture is comparatively higher. Due to the fact that these types of circuit breakers have individual characteristics, their development in various countries depends upon the existing material and economic resources. In accordance with the conditions of our country, several tasks should be emphasized:

1. To carry out the development of oil circuit breakers in accordance with the great demands. The 220-kilovolt oil blast circuit breaker which was test-manufactured in our country has a net weight of 14.3 tons and requires 16 tons of oil, in comparison with which the oil circuit breaker of a similar voltage which is now being test-manufactured is a little over 3 tons and uses only 700 kilograms of oil. Due to the fact that the majority of the circuit breakers presently required in our country need not necessarily have a large capacity, and for the purpose of economizing on steel materials and transformer oil, the large-

quantity production of oil circuit breakers is essential. The development of the same type of products of the 35- to 220-kilovolt series or a still higher voltage is desired.

2. To develop simple equipment, such as loading switches, to substitute for the structurally complicated circuit breakers. A ground knife switch, together with a quick break switch, can be used in a step-down transformer station in substitution for a circuit breaker. A fuse can break overloading and shortcircuit current and can also serve as an automatic reclosing gate. When used in conjunction with a loading switch, it is capable of functioning as a circuit breaker. An isolating switch with a powerful arc blow-out capability can be used in a transformer station as a substitute for a circuit breaker. All this equipment is simple in structure, easy to manufacture, and low in cost, and therefore should be widely developed.

3. In manufacturing power distribution circuit breakers, new materials should be used and new designs and manufacturing technology should be employed so as to simplify the structure, reduce the size, economize on material consumption, and save manhours. Power distribution circuit breakers of 10 kilovolts and less account for approximately 90 percent of the entire demand for circuit breakers. If their structure can be simplified and new materials used, the costs of production can be greatly lowered. In 1958, the Shenyang High-Tension Switch Plant test-manufactured the 10-kilovolt oil circuit breaker, using glass cloth and epoxy resins instead of insulating cardboards in the manufacture of the arc blow-out equipment and cast aluminum alloy as a substitute for a greater part of the copper conductance materials, enabling the weight of the equipment to be reduced from 170 to 100 kilograms. This not only cut down greatly the consumption of steel materials and copper and the manhours spent in the machining work, but also reduced the size of the products and the area required for their installation. Also, the use of the punching, pressing, and casting methods to substitute for the cutting process, and conveyor belts or rails in the assembly line, will serve to cut down manhours and material consumption, as well as to increase the output and improve the quality of the products.

4. To improve the structure and raise the capacity of oil blast circuit breakers. The oil blast circuit breakers that are presently produced have reached a voltage of 220 kilovolts. Due to the fact that the production of this type of equipment requires a larger consumption of metals and transformer oil, it is not feasible to give them a higher voltage. The essential work to be done at present is to raise their current breaking capacity, speed up their functioning, and improve the performance capability of the reclosing gate, so that they may be able to meet requirements wherever oil circuit breakers are unable to. Also, air functioning

installations should be used to substitute for DC power sources to cut down investments in storage batteries.

5. To develop super high-tension, large-capacity, and speedily-functioning circuit breakers to satisfy the needs of the rapid development of large power networks. After the enormous hydro-electric power stations on the San-men Gorge, the Liu-chia Gorge, and the three gorges on the Yangtze River are put into operation, super high-tension and large-capacity power networks will emerge. The 220-kilovolt circuit breakers presently being produced cannot possibly meet the requirements of these networks. Instead, circuit breakers of 330 and 500 kilovolts or of a still higher voltage and larger capacity are desired. Due to the fact that large-capacity air circuit breakers have more advantages, priority should be given to their development. The maximum current-breaking capacity of the 330-kilovolt air charging circuit breakers presently being test-manufactured will reach 12,000 and 20,000 megavolt-amperes. At the same time that air charging circuit breakers are being produced, super high-tension and large-capacity oil circuit breakers should be studied and developed.

In order to meet certain special requirements, circuit breakers for use in generators, high tension DC power transmission circuit breakers, SF₆ circuit breakers, and circuit breakers for use with electric furnaces should also be developed.

New types of isolating switches should be developed according to need. The design of these switches should be simplified. The three-column type isolating switches presently being produced should be gradually replaced by the double-or single-column type. After the 330-kilovolt 2,000-ampere isolating switches are produced, the development of this type of equipment should proceed in the direction of a higher voltage and larger capacity.

The design and manufacture of high-tension switches requires that a tremendous amount of high-voltage and strong-current testing work be carried out. Only by repeatedly testing and studying the high-tension physical phenomena and the strong-current arc blow-out structure can new types of products be created. Since the birth of New China, the party and the government have been very much concerned about the testing and research work on high voltage and strong current. With the assistance of Soviet Russia, a high-voltage and strong-current testing center was constructed at Sian according to the international standard. This testing center is equipped with two sets of impulse synchronous generators, each with a short circuit capacity of 2,500 megavolt-amperes. large-capacity oscillating return circuits, 6,000-kilovolt impulse voltage generators, 250-kiloampere/200-kilovolt impulse current generators, 2,250-kilovolt working frequency testing transformers, and 1,500-kilovolt DC high-tension installations. The presence of this modern testing center has created a number of conditions for

strengthening the testing and research work on high voltage and strong current and for gradually improving the performance capability and the design parameters of the products. This year (1959), after completing the test manufacture of the new 330-kilovolt series of products, model testing work on super high-tension insulating structures, strong-current arc blow-out structures, and cooling systems will be initiated to prepare for the future design and test manufacture of higher-voltage and larger-capacity high-tension switches.

With the rapid progress of our electric power industry and the daily increase in the capacity of individual generators, power plants, and power networks, the task of the high-tension switch manufacturing industry will be difficult but glorious. It is firmly believed that through the achievements already made in the great-leap-forward development and by continuously following the party principle and exerting our effort, the industry will be able to make still speedier progress and in the not too distant future we shall be able to surpass the capitalist countries.

XII. FLYING LEAP IN THE EXPANSION OF THE ELECTRIC WELDING EQUIPMENT INDUSTRY

Tien-chi Kung-yeh,
Peiping, No. 21, 10 November 1959,
Pages 12-14

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Electric welding equipment is one of the important types of equipment used in the electrical equipment manufacturing industry. It is important because electric welding has now become an important technical process in many modern industries, especially in the machine-manufacturing and building industries. The process of electric welding not only can firmly bind metals together, but also can cut down metal consumption, raise labor productivity, and improve the quality of products.

Today, electric welding is being extensively used. The output, the number of different types of products, and the degree of automation of this type of equipment in a country clearly show the level of industrial development of that country.

In old China there was no electric-welding equipment industry. Electric welding was seldom used. In repairing machine parts, only simple hand-operated arc welders were used. These welders were all imported from Britain and the U.S.A.

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In 1949 the China mainland was liberated; the appearance of the entire country was completely changed. The electric-welding equipment industry entered its development stage.

With the restoration of the national economy, the output of iron and steel rapidly increased and the use of electric welding became more widespread everyday. The electric welding equipment originally possessed by the various industries could not meet the increasing need. At that time, however, there were still no plants specializing in the manufacture of this type of equipment. Production was carried out at some of the electrical equipment manufacturing plants, such as the Shanghai Electrical Equipment Plant, which produced a number of DC hand-operated arc welding generators, and the Shenyang Transformer Plant, which manufactured AC hand-operated arc welding transformers. This was the beginning of our production of electric welding equipment.

For the purpose of continuing to satisfy the needs of the progressing national economy, the Shanghai Electric-Welding Equipment Plant, the first of its kind in the country, was established in Shanghai in 1953 through the merger of numerous

small electrical equipment manufacturing plants. In the beginning, the plant could only produce, by copying Soviet models, a small amount of hand-operated arc welding equipment and simple and small contactor arc welding equipment, such as the BS-330 type AC hand-operated arc welding transformers. Thereafter, production advanced toward comparatively more complex products, such as the AT-320 type DC hand-operated arc welding generators and the NP-25 type foot-pedalled spot welders.

The development of automobile manufacturing and ship building in our country requires large quantities of automatic electric welding equipment, such as automatic arc welders that are capable of welding under the layer of flux, and automatic contacting arc welders that are equipped with electronic and ionic starting and regulating installations. Before starting to manufacture these types of complicated equipment, we must first become familiar with the theories pertaining to the automatic adjustment in the arc welding process and the automatic control in the contact welding process. In this connection, a series of research projects must be carried out.

In the early part of 1955, the Electric-Welding Equipment Research Office of the Shanghai Electrical Equipment Scientific Research Institute, the Machine and Electrical Equipment Research Institute of the Chinese Academy of Sciences, and the Shanghai Electric Welding Equipment Plant jointly pursued the study of theories pertaining to automatic adjustment in the arc welding process and the use of electronic and ionic instruments in contact welders. As a result of carrying out extensive testing work, comprehensive examination, and complete analysis, the EA-1000 type automatic arc welders, which were equipped with an arc and voltage regulating system and were capable of maintaining the stability of the voltage and the length of the arc in the course of the welding process, and the XQ-100 type simultaneous igniting tube interrupters, which were capable of regulating the closed circuit time in contact welding within 0.02 to 0.18 second, and could also regulate the wave form of every cycle in AC current so as to gain accurate control over the heat capacity of the welded object, were manufactured in the early part of 1956. The production of these types of equipment has laid down an excellent foundation for the future development of various other types of automatic welding equipment.

At the end of September 1956, the resolutions made at the Eighth Congress of the party, held in connection with the launching of the Second Five-Year Plan, pointed out: "As far as conditions permit, advanced technical equipment should be employed, the latest scientific achievements utilized, and vigorous efforts made to master this new technology so that our industry can be raised to the modern technical level...." These important

instructions of the party gave a decisive impetus to the development of the electric welding equipment industry. It was due to these instructions that electric welding, an advanced and highly efficient method of machining metals in the modern era, finally attracted the people's attention. Consequently, much attention was given to the equipment used for such a process. Numerous industrial concerns, which formerly seldom employed the electric welding process, were now ceaselessly expanding the scope of its usage, while others, which had originally only adopted the hand-operated arc welding method, also started using the automatic arc welding and contact welding processes. Under such circumstances, the output and number of different types of electric welding equipment, especially automatic arc welding and automatic contact welding equipment, had to be rapidly increased. By 1957 we were already capable of producing in large quantities numerous types of universal electric welding equipment. This equipment included various types of AC hand-operated arc welding transformers, automatic arc welding transformers, and multi-station type arc welding transformers; various types of DC arc welding generators, including multi-station type DC arc welding generators, automatic and semiautomatic arc welders, and various types of medium and small capacity spot and seam contact welders, together with their necessary matching electronic and ionic control instruments, such as time regulators that were used for control in proper sequence, non-simultaneous-ignition tube contactors, and simultaneous-ignition tube interrupters.

For the purpose of coordinating with the development of the scientific-instrument and heavy-machinery manufacturing industries, modern capacitance retaining spot welders that are capable of welding thin metals, and slag welders that are of the highest international technical level and are capable of automatically regulating and maintaining the stability of the depth of the melting pond in a welding process, were test-manufactured in 1957.

II

Since the great-leap-forward year of 1958, as a result of following the party principle of exerting vigorous effort and striving for progress in socialist construction by increasing and speeding up production, producing good-quality products, and practising economy, the workers of the entire electric welding equipment manufacturing industry, under the leadership of the party, eliminated all superstition, liberated their thinking, and carried out a technical reform and revolution. As a result, the total output of electric welding equipment in 1958 was double that of 1957. The total number of sets of equipment produced in that year reached over 9,000, excluding a great number of those produced

by the various medium and small electrical-equipment plants and those manufactured by the users themselves. In 1958, for the purpose of coordinating with the great-leap-forward development of the heavy machinery, aircraft, automobile, and tractor manufacturing industries, as well as the iron and steel industry, modern electric welding equipment, such as slag welders, was put into formal production. At the same time, several types of large and high-grade electric welding equipment, the manufacture of which had never been previously endeavored, were also produced. This equipment included 300-kilovolt-ampere rectifying impulse wave spot welders, used in the aircraft manufacturing industry and capable of spot welding aluminum alloy of a thickness of 0.8 + 0.8 to 2 + 2 millimeters; thin plate butt welders, equipped with burr removing installations and capable of removing burr from the surface of the welded object and also capable of automatically butt welding low carbon steel bands of a thickness of 0.8 to 3.5 millimeters and a width of 30 to 250 millimeters; and automatic butt welders of a capacity of 750 kilovolt-amperes, used for welding the wheels of automobiles and tractors.

In carrying out research work, the party's policy of "scientific research work serves production and should begin with socialist construction" was followed. In the great-leap-forward development in 1958, research work on modern electric welding equipment, which has great bearing on socialist construction work, was continued. Among the special subjects studied in connection with the equipment used was protective gas arc welding. In consequence, such modern equipment as carbon dioxide arc welders and argon arc welders were manufactured.

In the continuous great-leap-forward development in 1959, the electric welding equipment manufacturing industry again made new achievements. This was due not only to the experiences gained in the great-leap-forward year of 1958 and the doubling of efforts on the part of the workers in commemoration of the tenth anniversary of the founding of the republic, but also to the fact that the supply of various types of raw materials and parts was now adequate and the fact that the work of expanding various plant buildings, which began in 1958, was completed and the new buildings gradually put to use. Furthermore, due to the fact that a number of medium and small electrical equipment plants, which were built up in 1958, were now capable of producing numerous types of hand-operated arc welding equipment, those major plants which originally produced these types of equipment could concentrate on the manufacture of automatic electric welding equipment as well as large, modern, and high-grade equipment.

In connection with the successful results obtained and the tremendous increase in the output of the products previously test-manufactured, also manufactured were 600-kilovolt-ampere rectifying

impulse wave spot welders; universal type slag welders; console type automatic seam welders, used in electrical equipment production lines for welding shells and oil tanks; and simultaneous-ignition tube interrupters, equipped with welding current automatic amplitude modulating and stabilizing installations so as to satisfy the pre-heating and temper requirements of the welded object, and capable of insuring the quality of the welding work. At present, preparations are being made for carrying out the manufacture of highly productive automatic steel roll lap welders, 500-kilovolt-ampere steel rail butt welders, and 650-kilovolt-ampere rotary transformers for use in welding the longitudinal seams of steel pipes in production lines.

III

During the past 10 years, Soviet Russia and other brotherly nations furnished us with unselfish aid. Soviet Russia, especially, supplied us with a large amount of advanced technical data and dispatched specialists to our country to supervise our work. With the assistance of these specialists, the first group of our electric welding equipment technical personnel was trained. These individuals are now skillful workers, having advanced from copying work to designing numerous types of products. This is a good example of proletarian internationalism. We shall continue to apply the advanced experiences of Soviet Russia and other brotherly nations.

IV

Ten years have passed. Our electric welding equipment manufacturing industry not only has developed from its previous low level to its present high level, but also has manufactured numerous types of advanced, modern, high-grade, and automatic products, having become one of the principal sectors of our electrical equipment industry.

At present, large-scale expansion work is underway at various manufacturing plants. A large testing center is scheduled to be built within the Shanghai Electrical Equipment Scientific Research Institute. Also, preparations for the construction of large electric welding equipment manufacturing plants are being made. Numerous medium and small electrical equipment plants, which were built up during the great-leap-forward development in 1958, are gradually advancing from manufacturing only AC arc welding transformers to also producing such more complex products as DC arc welding generators and semiautomatic arc welders. The electric welding equipment manufacturing industry, after resolutely carrying out the party's policy of "advancing with both feet," is now comprised

not only of large and concentrated plants capable of manufacturing high-grade products, but also of small and scattered plants that can produce simple equipment.

In the near future, our electric welding equipment industry is prepared to embark on the following major developments:

1. To design and manufacture new types of arc welding electricity sources with advanced technical and economic characteristics to be used primarily as new electricity sources for protective gas arc welding.

2. To design and produce in series new types of automatic and semiautomatic arc welders. These arc welders not only are required to have higher technical and economic characteristics than the present ones, but must also meet the different requirements of the various industries.

3. In accordance with the needs of the various industrial sectors, to design various types of special automatic arc welders. These arc welders should be capable of raising the production rate and improving the quality of the welded objects. Due to the fact that lap welding possesses a great economic value, adequate attention should be given to equipment of this type. Also, different models of this equipment should be designed so that they can be extensively used by the various industrial sectors.

4. Regarding contact welders, further development in the direction of larger and more complex types should be made.

Various types of highly automatic small contact welders for use by the scientific-instrument manufacturing industry should be produced, as well as various high-grade and large types of this equipment, such as steel pipe welders, multi-spot welders, pulsating welders for welding light metals, and thin plate butt welders.

5. With the increase in the capacity of contact welders, the three-phase -- single phase electricity source lines of this equipment should be studied. Also, the accumulating and rotary transformer method should be used to increase the motive power of this equipment.

The resolutions made at the Eighth Session of the Eighth Plenum of the party, appealing to the masses to strive to overtake and surpass Great Britain within a period of approximately 10 years, have increased the enthusiasm of the workers of the electric welding equipment manufacturing industry. These workers, under the leadership of the party, will continue to advance the course of socialist construction and the great-leap-forward development, opposing rightist ideology and exerting vigorous effort in striving for still greater progress in the production and technology of the electric welding equipment manufacturing industry.

XIII. 1959 GENERATING-EQUIPMENT PLAN FULFILLED 45 DAYS EARLY

Tien-chi Kung-yeh,
Peiping, No. 22, 25 November 1959,
Inside front cover

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As of 17 November 1959, following the great achievements made in the previous 3 months of August, September, and October, the workers of the electrical equipment manufacturing industry produced power generating equipment equivalent to a total capacity of 1,808, 110 kilowatts, thereby completing the year's national plan 45 days ahead of schedule. This figure, as compared to the 800,000 kilowatts produced in the great-leap-forward year of 1958, represents an increase of 125 percent. The plans for other products, such as transformers, electric wires and cables, AC motors, high-voltage circuit breakers, switch panels, mutual inductors, mercury rectifiers, power condensers, high voltage fuses, and electrical instruments and meters, were also overfulfilled earlier than scheduled.

In the first half year of 1958, the total output of power generating equipment already exceeded that of the entire year of 1958 by a capacity of 81,600 kilowatts. This was a victory for the party principle and was also the result of using politics as an advanced element and carrying out a mass movement under the leadership of the party committees of the various echelons. In August and thereafter, as a result of responding to the appeal of the Eighth Session of the Eighth Plenum of the Central Committee of the party, in launching an anti-rightist campaign for exerting vigorous effort, increasing production, and practising economy, production was continuously raised. The output of August was 2.9 percent over that of July; the output of September was 41.2 percent more than that of August. Production in October also surpassed that of September. The total output of August, September, and October exceeded that of the entire year of 1958.

In the course of the anti-rightist campaign of exerting vigorous effort, increasing production, and practising economy, an inter-plant competition among the power generating equipment manufacturing plants was organized jointly by the First Ministry of Machine Building and the Ministry's Labor Union Committee. Numerous new and interesting methods were created and used, resulting in widely developing the technical reform and revolution, improving the enterprise control work, and raising production efficiency. Adhering to the slogan of "battling throughout the winter, changing the previous conditions, and overtaking the Shanghai Electrical Equipment Plant and the Harbin Boiler Plant in the effort to make great achievements by the end of the year," the Harbin Electrical Equipment Plant criticized some of the cadre members'

conservative thinking as regards "potentialities having already reached the fullest extent and being willing to remain at the bottom," thereby promoting total development in its technical reform. Within a 25-day period in October, the plant applied a total of 93 items of advanced experience and 71 items of technical reform, raising its operation efficiency by 1 to 1,430 times. The October production plan of the plant was overfulfilled by 28 percent, which, as compared to that of September, was an increase of 56 percent, and, as compared to the average monthly output of the first 7 months of 1959, was an increase of 250 percent. As a result of expanding the use of various types of advanced machine tools, the plant's steam turbine generator shop raised its production efficiency and solved various key problems. In September and October, it reached and maintained a production capacity of 125,000 kilowatts, which, as compared to the average monthly output of the first 8 months of the year, was an increase of 4 times. The Harbin Boiler Plant, as a result of carrying out various types of competitions and applying advanced experiences, completed its national quota for power station boilers and the annual production plan 100 and 67 days ahead of schedule, respectively. In the course of the campaign to increase production and practise economy, carried out since the beginning of the year, the Shanghai Electrical Equipment Plant mapped out 5-day short-term plans as well as hourly plans for major products. A total of four teams were organized to assist the small production groups in carrying out technical reforms and solving key problems. The supply of black mica bands was a key problem. However, after devising ways and means and testing more than 2,000 times, a final solution was reached by using powder mica bands as a substitute for sheet mica bands. Also, in converting the inner layer of a cupola furnace from a neutral to an alkalai nature, the decision was made to cast 50 percent of the white pig iron into gray pig iron, thereby overcoming the shortage of pig iron and improving the quality of the castings. As a result of these improvements, production was increased month after month. In the production of steam turbine generators, for example, the output of August was 234 percent over that of July; that of September exceeded by 12 percent that of August, and that of October was again 27 percent over that of September. The year's production plans for transformers, DC motors, and AC motors were fulfilled 126, 64, and 54 days ahead of schedule, respectively.

In the course of the inter-plant competitions, the Communist spirit of "sacrificing one's self for others and learning while assisting" was fully displayed. In September, the Shanghai Boiler Plant received from the Harbin Boiler Plant a supply of steam drums equivalent to 40 percent of the year's plan, which was overfulfilled by the latter plant. The supply of these drums was one of the important factors which enabled the Shanghai plant to complete

its annual national plan 53 days ahead of schedule. Since the beginning of the year, the workers of the Shanghai Electrical Equipment Plant have visited several plants, including the Hsien-feng Electrical Equipment Plant, accumulating than 100 items of advanced experience and solving numerous key production problems. At the same time, they also helped these plants master the test-manufacturing technology of various new products.

The medium and small power generating equipment manufacturing plants have now become an important part of the industry. During the first 9-month period of the year, these plants, together with a number of machine works, produced power-generating equipment equivalent to a total capacity of 437,000 kilowatts, overfulfilling the year's national plan by 14 percent. The production of power-generating equipment in the period of the First Five-Year Plan was mainly carried out in Shanghai and Harbin, but now a small number of products are also being produced in 15 different provinces, cities, and autonomous regions.

At present, the workers of the electrical equipment manufacturing industry are striving to increase production by 15 percent, fulfill the over-all national plan ahead of schedule, aid in the technological reform of the agricultural industry, and prepare for continuous progress in the coming year.

XIV. COMMUNIST CHINA'S ELECTRICAL EQUIPMENT INDUSTRY [Excerpts]

Tien-chi Kung-yeh,
Peiping, No. 18, 25 September 1959,
Pages 1-2

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In the old days, China's electrical equipment industry was extremely backward. In the highest productive year of 1947, the total number of generators produced, all of the AC type, was equivalent to a total generating capacity of approximately 20,000 kilowatts; the number of motors, to 50,000 kilowatts; and the number of transformers, to not more than 150,000 kilovolt-amperes. But, in 1959, 10 years after the founding of the republic, the total number of generators produced is scheduled to exceed 9,000,000 kilowatts, 180 times that of 1947; and the number of transformers will reach a capacity of more than 16,000,000 kilovolt-amperes, 110 times that of 1947. The total annual output of whole sets of generating equipment (excluding the common type of AC generators) increased from 198,000 kilowatts in 1957 to 800,000 kilowatts in 1958, and again to 1,800,000 kilowatts in 1959, compared with which the capitalist country of Great Britain is hopelessly behind since, from 1946 to 1958, its average annual increase in generator output was equivalent to only 200,000 kilowatts.

The technical level of old China's electrical equipment industry was extremely backward. The largest generator produced had a generating capacity of only 200 kilowatts, the largest motor was one with 180 horsepower, and the largest transformer had a capacity of not more than 2,000 kilovolt-amperes. However, during the last decade, we have manufactured, one after another, numerous sets and products, many of a higher technical level. Among these products are complete sets of 72,500-kilowatt water turbine generators, 50,000-kilowatt steam turbine generators, large 4,000-kilowatt motors, 60,000-kilovolt-ampere 220,000-volt transformers, 110,000-volt 4,000-megavolt-ampere compressed air circuit breakers, 220,000-volt 5,000-megavolt-ampere oil circuit breakers, 220,000-volt electric cables, 60-circuit carrier wave long-distance communications cables, trunk line electric locomotives with a power of 4,000 kilowatts, 3,500-cubic-meter large turbine air pumps, 2,800-kilowatt DC motors, and whole sets of related control equipment for use in operating the 750/500 steel rolling mills, as well as numerous modern types of electric welding machines, electric arc furnaces, mercury rectifiers, storage batteries, precision measuring instruments, insulating materials electrocarbon products, and electro-alloys. All these products have been supplied in sets to the various sectors, which has resulted in greatly increasing the degree of our self-sufficiency and eliminating the former backward condition of relying solely

on import. The electrical equipment industry not only has supplied different types of electrical equipment to the communication and transportation departments of various other industries, at the same time it has also furnished countless numbers of electrical products to the farms. In 1958 alone, the total amount of electricity-generating equipment on the farms throughout the nation was increased by a capacity of several tens of thousands of kilowatts; the total number of motors used for irrigation purposes was increased by the equivalent of 368,000 horsepower, which indeed accelerated the development of agricultural and industrial production on the farms.

The disposition of the electrical equipment industry in the old days was extremely inappropriate. The majority of the plants were located along the coast, a minor number being located in the inland and practically none in the border regions. During the past 10 years, in accordance with the national economic principle of the appropriate disposition of plants, those enterprises located along the coast were expanded and reconstructed along with technical reforms to enable them to fully manifest their potentialities, and new plants were established in Northeast and Northwest China. At the same time, the construct-work of other new plants was initiated in North, Central, and Southwest China. Since the leap-forward year of 1958, as a result of complying with the party's socialist construction principle and the policy of "advancing with both feet," the electrical equipment industry has made unprecedented progress. Large, medium, and small plants are scattered throughout the country like stars of chessmen, greatly improving the old system of plant disposition.

Along with the continuous leap-forward progress of the electrical equipment industry, the number of workers has also rapidly increased. Before the liberation, the entire industry had a labor force of a little over 10,000 persons, but now it has developed a labor force of more than 400,000. As a result of the education provided for them by the party, these workers have now become part of a strong labor force whose political ideology has improved and whose technical and educational level has risen.

XV. EXTRACTS PERTAINING TO COMMUNIST CHINA'S ELECTRICAL INDUSTRY⁷

Tien-chi Kung-yeh,
Peiping, No. 20, 25 October 1959,
Pages 1-2

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Since the launching of the anti-rightist campaign of exerting vigorous effort, increasing production, and practising economy, the output of the Sung-chiang Electrical-Machine Plant has been steadily increasing. As of 20 October 1959, the plant completed 72 days ahead of schedule its national plan for the production of AC motors (equivalent to a total capacity of 415,000 kilowatts). At present, the workers are aiming at the production of more AC motors, motors to be used with cranes, and overfulfillment of the quota for the production of large-type electrical products in the fourth quarter of 1959.

Inspired by the outcome of the Eighth Session of the Eighth Plenum of the Central Committee of the party, the workers of the Nanking Steam Turbine Generator Plant completed four 1,500-kilowatt steam turbine generator sets 62 days ahead of schedule. A large-type 500-kilowatt electric motor was also test-manufactured 10 days ahead of schedule. At present, they are striving to complete 10 large-type electric motors 15 days ahead of schedule. They are also aiming at an additional output of five of these motors to prepare for a still greater leap-forward development in the coming year.

In October 1959, the Harbin Electrical-Machine Plant completed its production quota for power-generating equipment (equivalent to a total capacity of 210,000 kilowatts) and large electric motors of a total capacity of 44,200 kilowatts. As compared to the output of September, this is a remarkable increase.

Since the beginning of October, the workers of the entire plant have continued their activities in connection with the technological reform and revolution. This has accelerated the speed of production. The process of cutting mica sheets in Workshop No. 14, previously carried out by hand, is now being done by machine and has resulted in increasing operational efficiency by more than 1,300 times. Likewise, in Workshop No. 6, the finishing work on sealing tiles is now being done by grinders instead of hand operation, which has raised production efficiency by 239 times. Among the workshops of the plant, six of them completed their respective monthly plans 5 to 10 days ahead of schedule.

Workers of the Shanghai Electrical-Machine Plant completed their quota for October by producing power-generating equipment equivalent to a total capacity of 85,000 kilowatts and large electric motors of a total capacity of 85,800 kilowatts.

Since the beginning of October 1959, when the workers of the Shanghai Boiler Plant entered a production competition, they have overfulfilled their assigned quotas and established new output records. As of October 26, the plant completed its production plan for the month 5 days ahead of schedule, having produced six 65-ton, eight 35-ton, five 20-ton, and one 10-ton boiler. The workers have stated that they will strive for the completion of the year's national plan 15 to 20 days ahead of schedule and will also make preparations for a still greater leap-forward development in the coming year.

On 28 October, in response to the appeal of the Central Committee of the party and the Shanghai party committee, the 115,000 workers of the Shanghai Electrical-Machine Plant pledged to complete their national plan within the coming 48 days, which will be 15 to 20 days ahead of schedule, fulfilling all the orders placed with the plant. They also pledged that the production level of the first quarter of next year would not be lower than that of the fourth quarter of this year, and that, at the same time, they would strive for an increase in the production of power-generating equipment of a total capacity of 150,000 kilowatts by the end of this year, AC motors of a capacity of 400,000 kilowatts, transformers of 1,650,000 kilovolt-amperes, and DC motors of 35,000 kilowatts. They also pledged to provide large quantities of high- and low-voltage switch panels and power cables to help agriculture gradually become mechanized and electrified, and to provide it with more irrigation facilities and chemical fertilizers. They further pledged to aid the industrial development of various localities within the country.

A 1,500-kilowatt non-salient pole steam turbine generator, the first of its kind designed in our country, was recently test-manufactured at the Shanghai Hsien-feng Electrical-Machine Plant. The success of the test-manufacture of this type of steam turbine generator has created the conditions for the universal establishment of medium and small power stations near our farm villages.

On 29 October, in the fourth quarter of 1959, as a result of having adequately prepared for the fulfillment of the production and material-supply plans and having mastered the new production technology, the workers of the Wu-han Boiler Plant fulfilled the month's output quota, in addition to completing three boilers of a capacity of 35 tons/hour for use in power stations. They have pledged to fulfill the annual production quota one half to one month ahead of schedule. They have also pledged to speed up the second stage of construction work in the valve, iron casting, and steel casting shops in preparation for the national inspection to be made at the end of the year, and to establish the material and technological foundation for a continuous great-leap-forward development in the coming year.