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RADC-TDR-64-202
Final Report

STUDY AND INVESTIGATION OF GRAPHIC MATERIALS HANDLING

TECHNICAL DOCUMENTARY REPORT NO. RADC-TDR-64-202

July 1964

Information Processing Branch
Rome Air Development Center
Research and Technology Division
Air Force Systems Command
Griffiss Air Force Base, New York

Project No. 4594, Task No. 459402

(Prepared under Contract No. AF 30(602)-3154 by D.P. Waite, R.D. Morrison, Jr., and J.A. Jaffe of Information Dynamics Corporation, Wakefield, Mass.)

FOREWORD

This report summarizes the results of the effort associated with the study and investigation of graphic materials handling performed under Contract AF30(602)-3154 for Rome Air Development Command by Information Dynamics Corporation.

Information Dynamics Corporation wishes particularly to express its appreciation to Mr. Gino Frate, RADC Project Engineer, who has provided most helpful direction and guidance in the performance of this study. Information Dynamics Corporation also wishes to express its appreciation to those manufacturers who supplied representative equipments for evaluation and to the many people who gave of their time freely to permit the establishment of operating background data on many of the equipments, techniques, and approaches considered in this study program.

David P. Waite, President of Information Dynamics Corporation, and principal investigator on this study program, and his co-authors Roderick D. Morrison, Jr., Project Manager, and James A. Jaffe, Systems Engineer, were assisted in the study by William W. Tunnicliffe, Manager of Systems Engineering, David E. Sparks, Systems Engineer, Joseph E. Poirier, Systems Engineer, and Dr. George K. Lewis, Photo-Interpretation Consultant.

Secondary Report No.: R-3001-4

AIR FORCE, GAFB, N.Y., 30 Nov 64-44

Key Words: Data Storage Systems; Photo Interpretation; Aerial Photography; Data Processing Systems

ABSTRACT

The purpose of this study was to identify various state-of-the-art techniques and approaches which could be integrated to provide a system suitable for the storage, retrieval, and handling of a wide variety of graphic materials proposed as a data base for a Reconnaissance Technical Squadron.

The study was performed by detailing the definition of the problem; reviewing current practices in organizations concerned with graphic materials; surveying available equipments having potential application; reviewing techniques and approaches as revealed in current literature; testing representative types of storage equipment; analyzing factors related to indexing and organization as they affect material storage; and synthesizing a representative solution for the types and volumes of graphic materials assumed - all with simplicity of design and manual handling as study objectives.

The results obtained included rating information on different techniques of storage; selection of representative equipment types; layout of a storage area to accommodate the estimated volume; and selection of a material storage addressing method.

PUBLICATION REVIEW

This report has been reviewed and is approved. For further technical information on this project, contact Mr. Gino Frate, RADC (EMIIO), GAFB, NY.

Approved: GINO J. FRATE
Project Engineer

Approved: FRANK J. TOMAINI
Chief, Information Processing Branch

FOR THE COMMANDER: **IRVING J. GABELMAN**
Chief, Advanced Studies Group

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EVALUATION

1. The Graphic Materials Handling Study was initiated to support the in-the-house program of OSR 406. It has specifically been concerned with improving the techniques for manipulating and storing the graphic materials that are expected to be used in a Reconnaissance Technical Squadron. Among these materials are maps, charts, photographic prints, mosaics, rollfilm and collateral information.

2. The OSR 406 program has been involved with exploiting the current state-of-the-art to provide an optimum reconnaissance data handling and reduction complex. As a consequence, improved devices and techniques have evolved in the process of achieving the program objectives. In conjunction with these it was realized that further improvements in graphic materials handling would further promote more effective system performance. Therefore, the Graphic Materials Handling Study was undertaken to provide these improvements.

3. This study has considered in detail the characteristics of the RTS operational environment. It has provided recommendations which indicate by manual means how the manipulation of graphic materials can be facilitated. These recommendations, involving both equipments and techniques, will be further evaluated by personnel of the OSR 406 program before they are considered for future implementation in a Reconnaissance Technical Squadron.

4. Although these recommendations were directed for RTS use, they are concerned with many principles and characteristics which are considered basic in the handling and storage of graphic materials. Consequently, the results of this study are applicable in all situations where the manipulation and storage of graphic materials is of concern.

Gino J. Frate

GINO J. FRATE
Project Engineer
Systems Planning Office

SECTION ONE. INTRODUCTION

The purpose of this study was the identification of state-of-the-art techniques which when integrated — with simplicity of design and manual handling as principal objectives — would yield a set of techniques and methods satisfactory for storage, retrieval, and handling of the wide variety of graphic materials which constitute the data base anticipated for a Reconnaissance Technical Squadron. These graphic materials vary in substance from a single sheet map 57 1/4 x 41 1/2 inches weighing only ounces to a 9 1/2-inch x 500-foot roll of aerial film weighing some 20 pounds. These materials vary in estimated total quantity from 150 PI Keys to 54,000 reels of aerial roll rilm — a nominal six-month accumulation of basic interpretable material, gathered at a rate of 300 rolls per day.

The study — conducted within the period from June 1963 to April 1964 — was approached by investigations, essentially in parallel, of the actual operational requirements, of current practices of organizations concerned with appreciable collections of graphic materials, of equipments currently or predictably available, and of techniques and methods as revealed in current literature.

The requirements were studied to allow detailing. For example, what were the estimated quantities involved; what was the distribution among sizes falling within the range of sizes established; what were the constraints on modification of any item of graphic material which might be required by a potential technique of storage, handling, or retrieval — e.g., permanent attachment of holding devices or simply folding; how would these materials be used and what effect would this have on techniques selected — i.e., what would the size and composition of a typical user request be; would the intellectual content of the material in association with the methods of management of this content by the users pose any implicit or explicit guidelines for the constitution of the graphic materials store and the techniques, methods, and equipments used within the store?

Current practices were investigated to determine not only the methods and techniques currently in use but also to ascertain the judgments of typical users — throughout a range of collection sizes and types — regarding methods and techniques of more recent origin. In assessments of this kind it is important to recognize that when an organization has a large collection, it has a large standing investment in a given equipment approach. The force of existing investment and the familiarity of personnel with an existing physical arrangement and associated set of operational practices inevitably conditions their judgment concerning and inclinations toward different methods, techniques, and equipments. The practices determined and the judgments obtained were weighed, with these factors in mind, against the needs of the present system — simplicity, manual operation, and, implicitly, speed of retrieval. It may be pointed out in passing that this latter — speed of retrieval — is a determining factor not commonly found. Organizations contacted were selected from four broad sectors of our technology — military, government, university/private institution, and commercial —

to gain representative data concerning the storage, retrieval, and handling of three broad types of graphic materials -- cylindrical solids, rectangular solids, and sheet meterials. Roll film collections — representative of cylindrical solids — which were considered ranged in size from the small vault of a commercial aerial survey company to the multi-room vault of a large military agency. Book collections — representative of rectangular solids -- which were considered ranged from the implicit observations and experiences of uses (from home-sized library to Widener-sized library) and of a library scientist on the staff to observations concerning an actual photographic interpretation library of a large national agency. Map collections — representative of sheet material —which were considered ranged in size from the private collections of small aerial survey companies through medium-sized collections of universities and international organizations to the large-sized collection of a military agency. Similarly representative of sheet material, collections of photographic prints considered ranged from the small-sized private collection to the multimillion-sheet collection of a large newspaper.

Equipment variety and availability was established by a comprehensive evaluation of replies received from 152 manufacturers covering 14 categories of filing equipment and 31 categories of support equipment. Data concerning equipment types and capabilities were sought and selected on the basis of their applicability to the storage, retrieval, and handling of the three basic types of graphic materials: cylindrical solids, rectangular solids, and sheet materials.

The literature search was similarly directed toward methods and techniques potentially applicable to the three basic classes of graphic materials within the context of the present requirement.

Equipments representative of types deemed potentially applicable for the present application were sought from manufacturers. 7 manufacturers responded with equipments which were applicable to the storage of cylindrical solids, rectangular solids, and sheet materials.[1] Additionally, two different types of laboratory test shelving were constructed for specific tests comparing roll-axis horizontal and roll-axis vertical methods of storage for aerial roll film. Each equipment was tested for speed of retrieval and speed of refiling for all allowable types of graphic materials. Observations of operational factors —found, in some cases, to be even more significant than the actual times of retrieval and refiling — were made during the warm-up period which was used to avoid learning curve effects in the test data and during the actual test period. The graphic materials used in these tests to explore the basic classes of cylindrical solids, rectangular solids, and sheet material included, in cylindrical solids, roll film cans (appropriately loaded for proper weight simulation); in sheet materials, maps of several types (Geological Survey, ONC, WAC AMS, Aero. App., Jet Navigation, Aero. Planning), photo-indexes to simulate

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1/ It should be noted that the equipments received for tests are considered representative of desirable types. The statements, discussions, and evaluations herein should not be construed as praising or condemning specific manufacturers. Rather all remarks are intended as assessments related to types of equipment in the context of application to the Reconnaissance Technical Squadron. All manufacturers who provided equipment for test did so without reservation and were most cooperative in allowing assessment by test.

thin mosaics, sheets of masonite to simulate mounted mosaics, actual overlays and acetate sheets to simulate a large quantity of overlays, and photographic prints; and, in rectangular solids, a spectrum of general library materials which included PI keys, PI reference books, reports, documents, and bound hard-cover books.

The operational requirements; results of the surveys of current practice, available equipments, and current literature; and the results of the actual time and motion studies were analyzed as a foundation for synthesizing an over-all graphic materials storage, retrieval, and handling system responsive to the requirements.

The system which has been synthesized will accommodate 170,000 individual items of graphic materials covering the spectrum of: 1) roll film, 2) magnetic tape, 3) maps, 4) overlays, 5) mosaics, 6) photographic prints, 7) target folders, 8) PI keys, and 9) general library materials. The system will provide single-item access times of: 1) 3 minutes for roll film, 2) 2 minutes for magnetic tape, 3) 1 2/3 minutes for sheet material (maps, overlays, mosaics, and photographic prints), and 4) 1 1/2 minutes for general library materials (target folders, PI keys, books, periodicals, documents, reports, etc.). The system will provide an access time of 9 minutes for a 100-item package composed of 16 cans of roll film, 10 cans of magnetic tape, 59 items of sheet material, and 15 items of general library materials.

The system is based upon the concept of independence of physical array and indexing array and the physical array is ordered by functional role. physical form of the material, editorial class of the material, pattern of use, and quantity.

The details of the study effort and the considerations behind the system synthesized are reported in the nine section which follow, covering operational requirements; study effort methodology; surveys of current practice, equipment, and literature; tests performed; factors relating to the Reconnaissance Technical Squadron environment; factors relating to physical organization; and the system synthesized

The recommendations which follow the reporting focus on the desirability of a study relating the physical techniques which have been established for the storage, retrieval, and handling of graphic materials with the concept and vocabulary structure which will be required for management of the intellectual content of this store of graphic materials.

SECTIO" TWO. DEFINITION OF THE PROBLEM

2.1 SCOPE OF THE STUDY EFFORT

The study investigation was confined to problems associated with the storage and retrieval of the graphic materials from file and to the physical handling problems associated with the dissemination of the graphic materials to the various user workplaces throughout the Reconnaissance Technical Squadron Facility. The study effort has not been concerned with the problems of handling of the data base inputs from various sources prior to receipt of the data base at the input processing room of the physical storage area, nor with the user manipulative requirements, except where these might be a factor in the selection of a particular storage technique or equipment configuration in the storage area recommendations. The scope of the study is graphically illustrated in Figure 1. Indexing and coding techniques were investigated only to the extent that they had a direct effect on representative physical storage conditions or requirements. It should be pointed out, however, that indexing and coding strongly influence the organization of the materials store and must be considered in making the final choice of equipment configurations for the physical arrangement of the selected graphic materials. (This subject is briefly discussed in Section Eight of this report.)

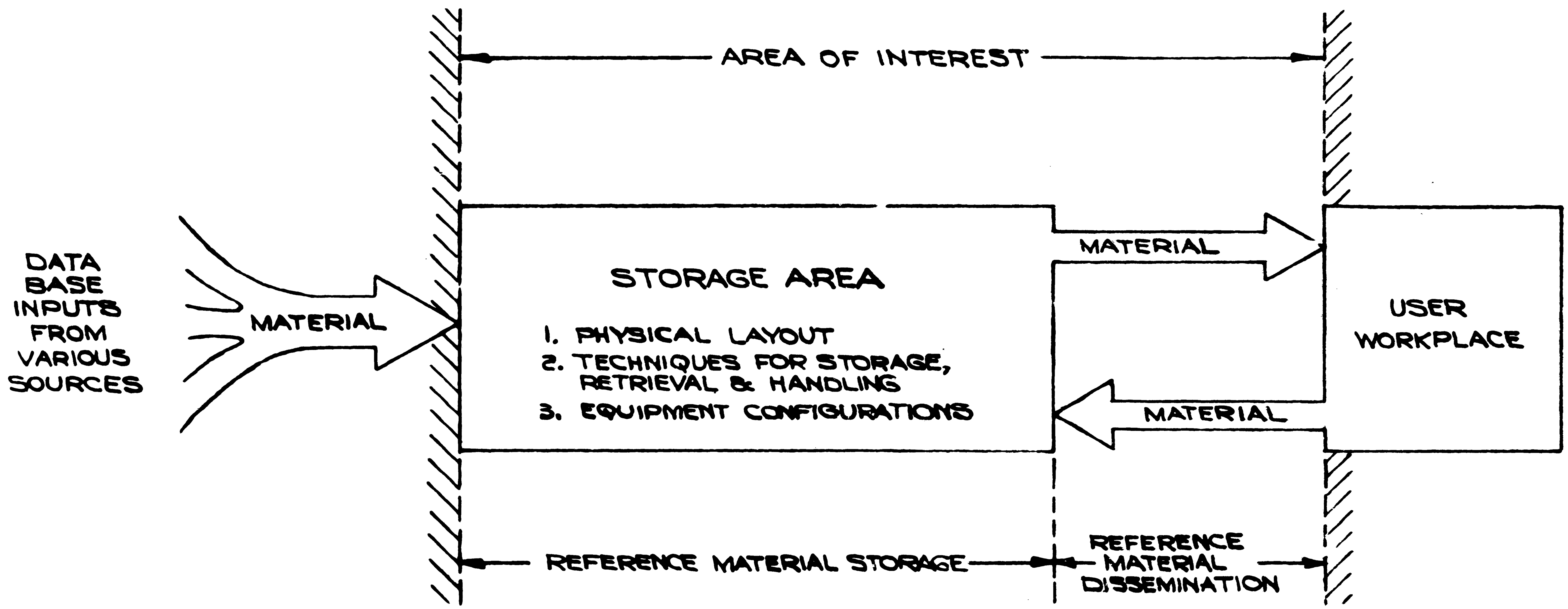

FIGURE 1

__SCOPE OF STUDY & INVESTIGATION OF GRAPHIC MATERIALS HANDLING__

2.2 RECONNAISSANCE TECHNICAL SQUADRON ENVIRONMENTAL CHARACTERISTICS

2.2.1 Physical Characteristics

Certain assumptions have been made to provide a basis upon which recommendations for physical handling techniques and equipments and storage area can be based, since, at the time of writing of this report, the final design details for the RTS Facility have not been specified. It is anticipated that the final configuration of the RTS Facility will result in a permanent building having unlimited expansion capabilities in the horizontal direction. It is also understood that the environment of the RTS Facility will be completely controlled with respect to temperature, humidity, dust-prevention provisions, etc., and that the recommendations herein need not include any special considerations for the protection of the reference materials from adverse environmental conditions. It is also assumed that the RTS building configuration will, in itself, satisfy the security requirements for this operation and that the equipment and techniques to be suggested in the report need not, in themselves, provide for internal access control.

It has also been assumed that the different work stations proposed for use in the RTS Facility will be located contiguous to the graphic materials storage area. At the present time, it is anticipated that there will be approximately 14 different work stations utilizing, generating, processing, or otherwise coming in contact with the hard-copy graphic reference material making up the data base of concern in this study. An assumed composition of user workplaces is given in Table 1.

Table 1

RTS WORKPLACES UTILIZING HARD-COPY DATA BASE

Workplace	Hard-Copy User	
	Yes	No
1. Operational control		X
2. Flight planning work station	X input	
3. Pre-receipt	X	
4. Flash and immediate stations	X	
5. Mission review work station	X input	
6. Detailed work station	X	
7. EA Reduction	X	
8. External intelligence screening station	X input	
9. Chart updating and target materials	X input	
10. TTR (Tactical Target Record) production work space	X	
11. Photoprocessing and reproduction	X	
12. Supplementary support		X
13. Computer		Not directly, but affected indirectly through coding
14. Hard-copy storage and retrieval	Owner	

2.2.2 Operational Characteristics

2.2.2.1 User Workplaces

Of the 14 assumed workplaces, six (numbers 3, 4, 6, 7, 10 and 11) are directly concerned with use of the graphic materials. Of the remaining eight, three (numbers 2, 5, and 9) are concerned with modification and/or generation of graphic materials, one (number 1) is concerned with operational control of the entire effort, one (number 8) screens the incoming materials, one (number 12) provides support, one (number 13) is directly involved in the control and use of the graphic materials though it is not a direct user, and the last (number 14) is the base of operations for all graphic materials activities.

Although each of the groups of workplaces poses a somewhat different use profile, for purposes of this study all have been considered alike in the respect that any user may require any kind of graphic material in any volume. In each case it has been assumed that a request would be received in the graphic materials storage area which would specify by accession number each of the items desired, that these would be gathered within the storage area, and that they would be delivered to the entrance door of the storage area in a suitably organized manner on a carrier appropriate to the volume and nature of the requested materials.

All of the material within the hard-copy storage area is assumed to be data base — i. e., all roll film and magnetic tape will have been interpreted, at least in a preliminary way, before it is introduced into the hard-copy storage area; all other materials — e.g., books documents, reports, maps, and overlays — are by nature data base. This assumption is mentioned to insure clarity of understanding in later paragraphs and to establish at the outset that the study of graphic materials has been approached by considering the storage, retrieval, handling, and refiling process as analogous to that of a computer memory. In the sense of material handling -- or, more precisely, information handling, there is no differentiation, in a functional process sense, between interpretable material and reference material, between initially received data base packages and currently received interpretable input. There are the same set of problems to consider as there are in the computer case — input; output; choice of memory location appropriate to size, nature, and required speed of accessibility; random access; storage address control; and updating.

2.2.2.2 Data Access Time

Within the limitations of present equipment configurations, the lowest data access times possible are desired — to meet the most demanding requirement, for which a rough approximation of one to two minutes has been given as the desired nominals. Since total access time would be a function of the proximity of the user workplace to the hard-copy storage collection, it has been assumed for the purposes of this study that access time is measured from the time of the receipt of the request by the hard-copy storage and retrieval officer to the time that the material leaves the storage area. This definition has been established to allow segmentation of the over-all problem even though, as will later develop, consideration has been given to the material dissemination and retrieval process that takes place outside the hard-copy storage area —— namely, between the portal of the storage area and each and every user workplace.

2.2.2.3 Satellite Operations

It has been assumed that preparation of data base for satellite facilities — e.g., Mobile Wing Reconnaissance Technical Squadron (MWRTS) or an Image Interpretation Cell (IIC) is to be handled in the same manner as a request for reference material for use at an "in-facility" workplace. It is not the intent of the present system design consideration to concern itself with the problems of distribution of reference materials to the actual site of the satellite nor to become involved in the material handling problems at the satellite facility. These requests for data base will be handled by delivery of the materials to the shipping department of the RTS Facility wherein normal military material shipment procedures will be followed.

2.2.2.4 Graphic Material Flow-Rate Requirement

It has been determined from discussions with photo-interpretation personnel that under certain operational conditions the reference material requested by an individual photo-interpreter may vary from 0 to 50 items within a given day. However, in a Reconnaissance Technical Squadron, having wide diversification among user workplaces, it is possible that the daily usage traffic may be in the order of 100 items per user workplace. Tc accommodate the maximum-demand situation, a figure of 100 items per user workplace has been selected for the purposes of definition of desired characteristics for the material dissemination system.

2.2.3 Physical Characteristics of the Data Base Collection

The range of sizes and forms of items contained within the data base collection was initially established as that of Table 2. Investigation of representative items which will be found in a typical data base collection yielded the figures of Table 3. Discussions throughout this report will be in terms of these 9 basic types of graphic materials. In addition to the nature and size of expected items, an assumed total quantity has been included in Table 3. The amounts of roll film are based on an assumed 300 rolls per day and the ability to store a total quantity equal to that of a six-month period of input. The library quantities are based upon a representative national photographic interpretation reference library. These, and the other values of Table 3, have been established in association with RADC not as limiting values but rather as design-center values upon which to base the study of graphic materials handling techniques and equipments and the associated preliminary hard-copy storage and retrieval system synthesis.

Tactical Target Records (TTR's) have not been included in Table 3 since it is understood that they will be stored in a separate location. Provision has been made, however, for their inclusion within the organized storage of the carrier selected for transport of the graphic materials from the two storage areas — graphic materials and TTR's — to the user workplaces.

Table 2

RANGE OF PHYSICAL CHARACTERISTICS OF PROPOSED GRAPHIC MATERIALS DATA BASE COLLECTION

HARD-COPY MATERIAL ITEM		SIZE (Inches Unless Noted)	
		Minimum	Maximum
1.	Photography (Negatives and Prints)	70-mm roll	9 x 18
2.	Maps	20 x 20	60 x 60
3.	Charts	20 x 20	60 x 60
4.	Overlaps	20 x 20	60 x 60
5.	Mosaics	12 x 12	60 x 60

Table 3

REPRESENTATIVE PHYSICAL CHARACTERISTICS OF
PROPOSED GRAPHIC DATA BASE COLLECTION

ITEMS	APPROXIMATE SIZES (Inches Unless Noted)	ASSUMED TOTAL QUANTITY
1. ROLL FILM (CANS)		
5-inch	8-1/2 (D) x 5-7/16 (H)	32,400
9-1/2-inch	8-1/8 (D) x 9-15/16 (H)	10,800
70-mm	7-3/4 (D) x 2-15/16 (H)	10,800
2. MAGNETIC TAPES	11-1/2 x 1-7/16	10,000
3. MOSAICS	60 x 60 x 0.125	1,000
4. OVERLAYS	25 x 22 x 0.005	1,000
5. MAPS		
Jet Nav.	55 x 35-1/2 x 0.005	8
Aero Plan.	46-1/2 x 31-3/4 x 0.005	15
U.S. Global	57-1/4 x 41-1/2 x 0.005	12
ONC & WAC	57-1/4 x 41-1/2 x 0.005	280
ONC & WAC	29 x 22 x 0.005	280
Pilotage Chart	29 x 22 x 0.005	1,000
Aero App.	29 x 22 x 0.005	3,800
AMS	29 x 22 x 0.005	2,000
6. PHOTOGRAPHIC PRINTS		
	9 x 9 x 0.010	1,500
	9 x 18 x 0.015	1,000
	5 x 19 x 0.015	100
7. TARGET FOLDERS	9-1/2 x 11-3/4 x 1.000	1,500
8. PI KEYS		
	8-1/2 x 11 x 0.500	75
	11 x 17 x 0.500	75
9. GENERAL LIBRARY MATERIALS		
(Books, Periodicals, NI Series, ASSOTW'S, etc.)	From Book to Folio	90,000

SECTION THREE. STUDY EFFORT METHODOLOGY

The study and investigation of graphic materials handling techniques and equipments have been conducted generally in accordance with the approach illustrated in Figure 2. The specific, detailed milestones of these 9 major avenues of consideration:

(1) Development of operational requirements,

(2) Observations of current practice,

(3) Review of off-the-shelf equipments,

(4) Review of technique literature,

(5) Technique tests,

(6) Identification of factors significant to the physical nature of the materials, the nature of the equipments, and the nature of the store,

(7) Identification of factors significant to the operational application,

(8) Synthesis of a representative system, responsive to the design center values of type, size, and quantity assumed, and

(9) Development of recommendations

are illustrated by Figure 3, the work plan developed in the first month of the study. The results of each type of consideration are reported in the sections which follow.

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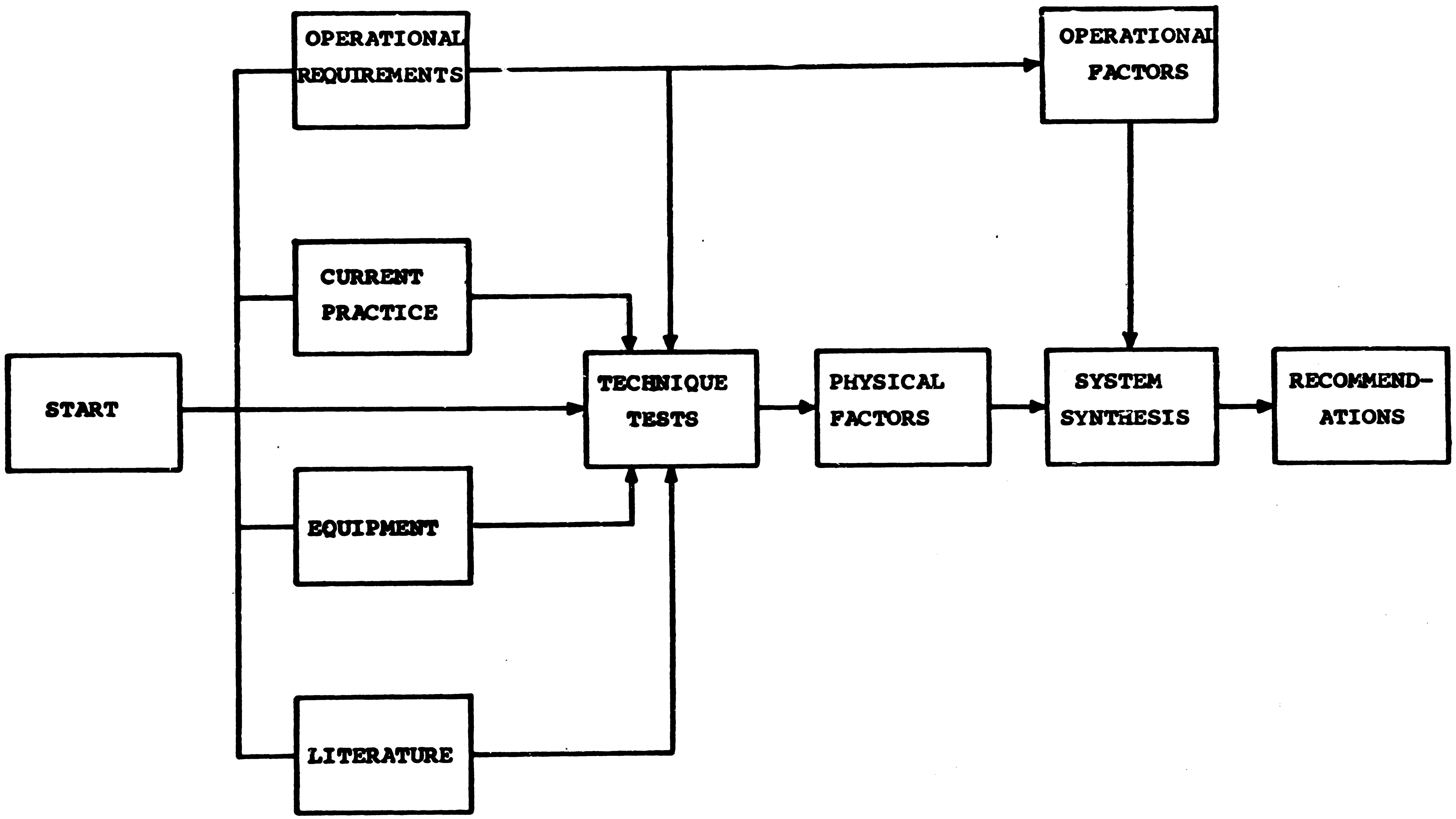
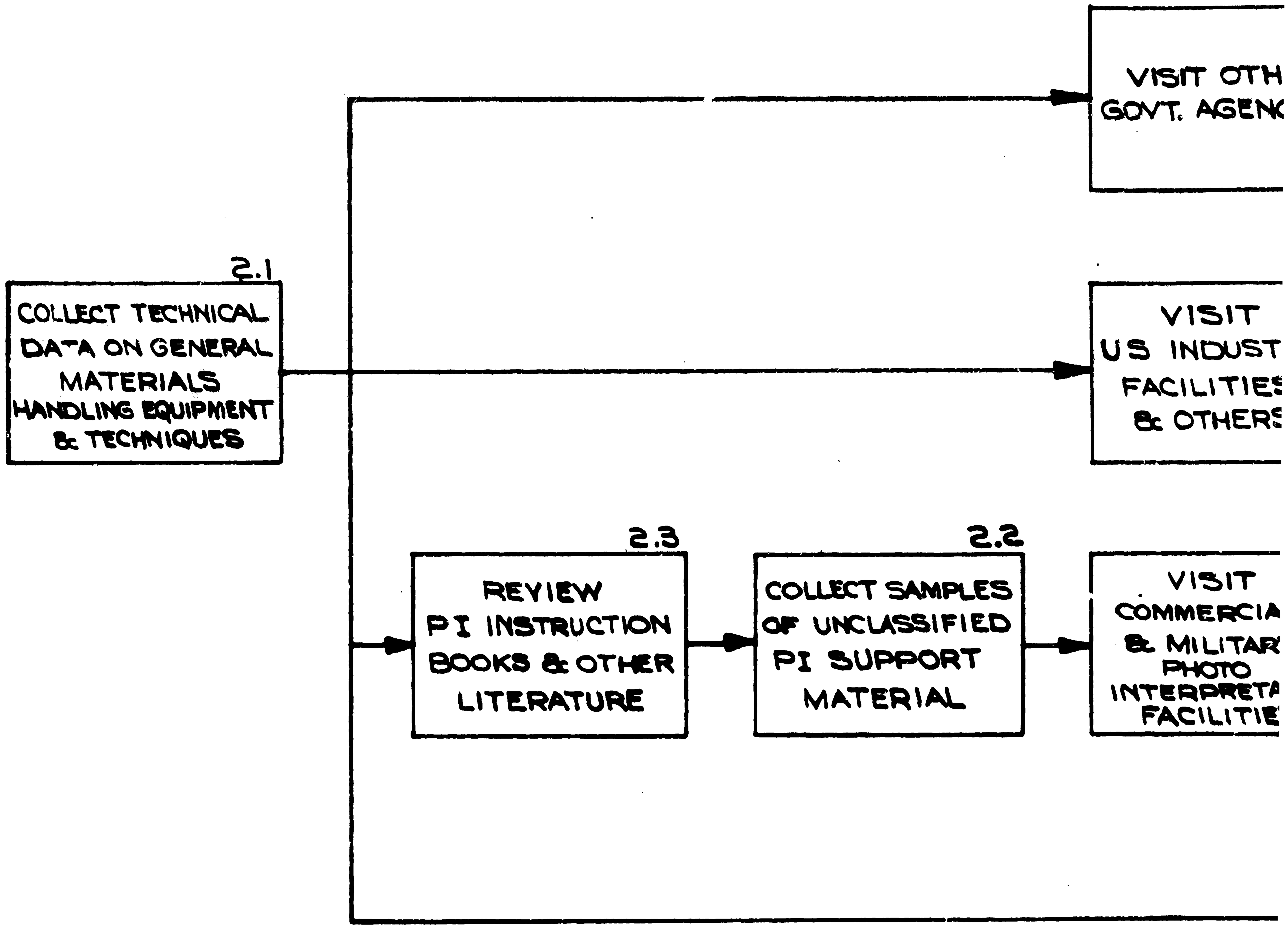


Figure 2

STUDY METHODOLOGY



NOTE: NUMBERS ADJACENT TO BLOCKS INDICATE APPROPRIATE PARAGRAPHS IN IDC WORKPLAN SUBMITTED TO RADC ON 25 JULY 1963

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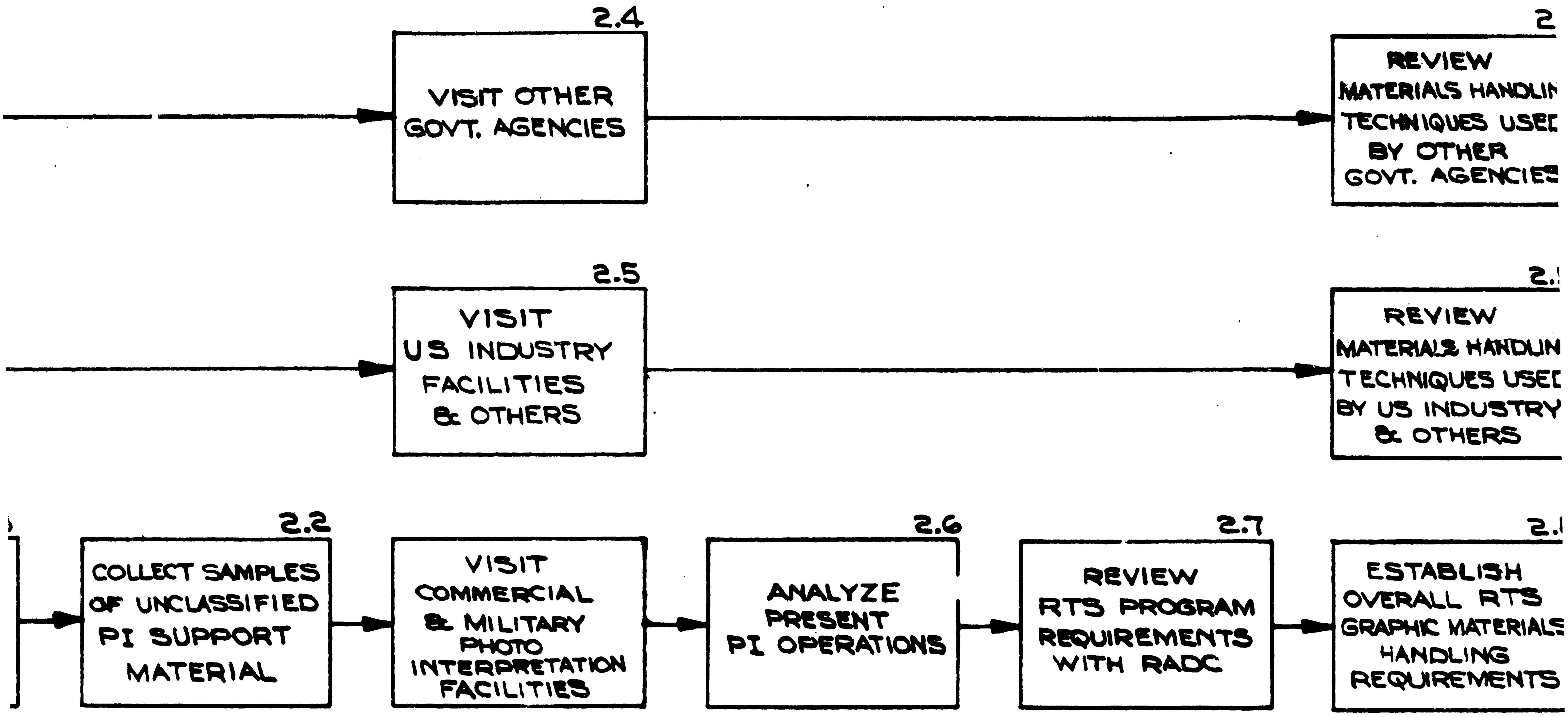

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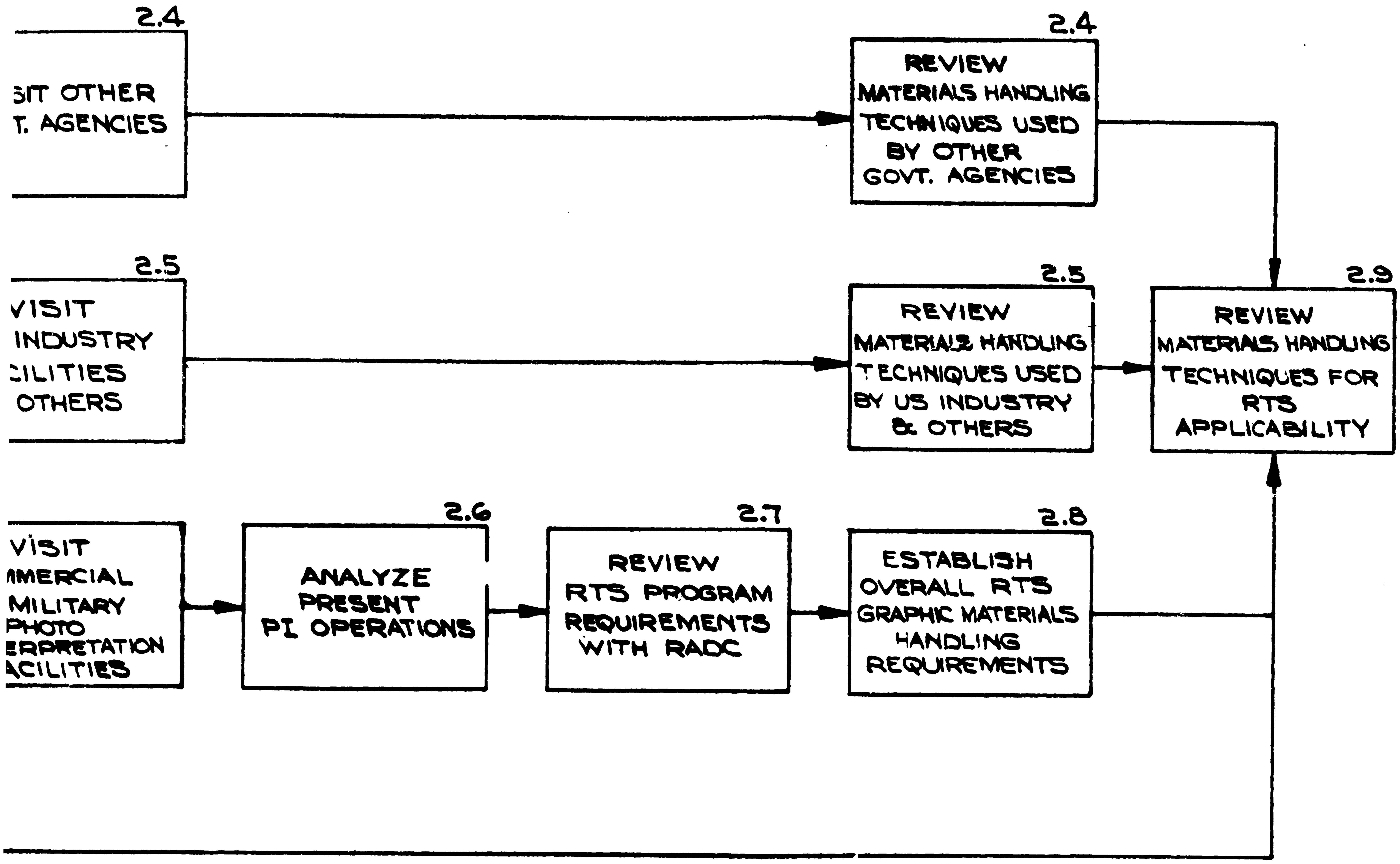

FIGURE 3

STUDY EFFORT
METHODOLOGY MILESTONES

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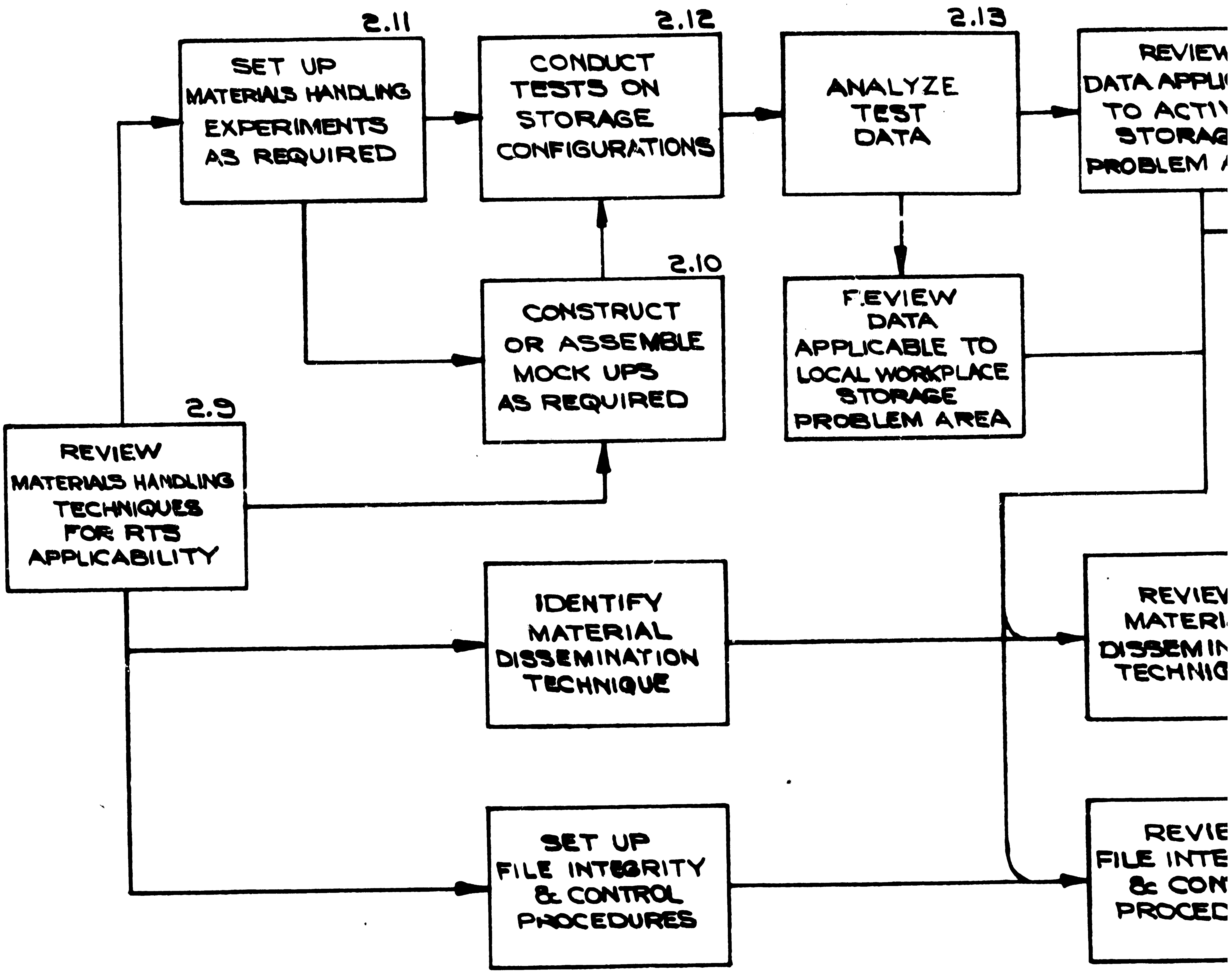

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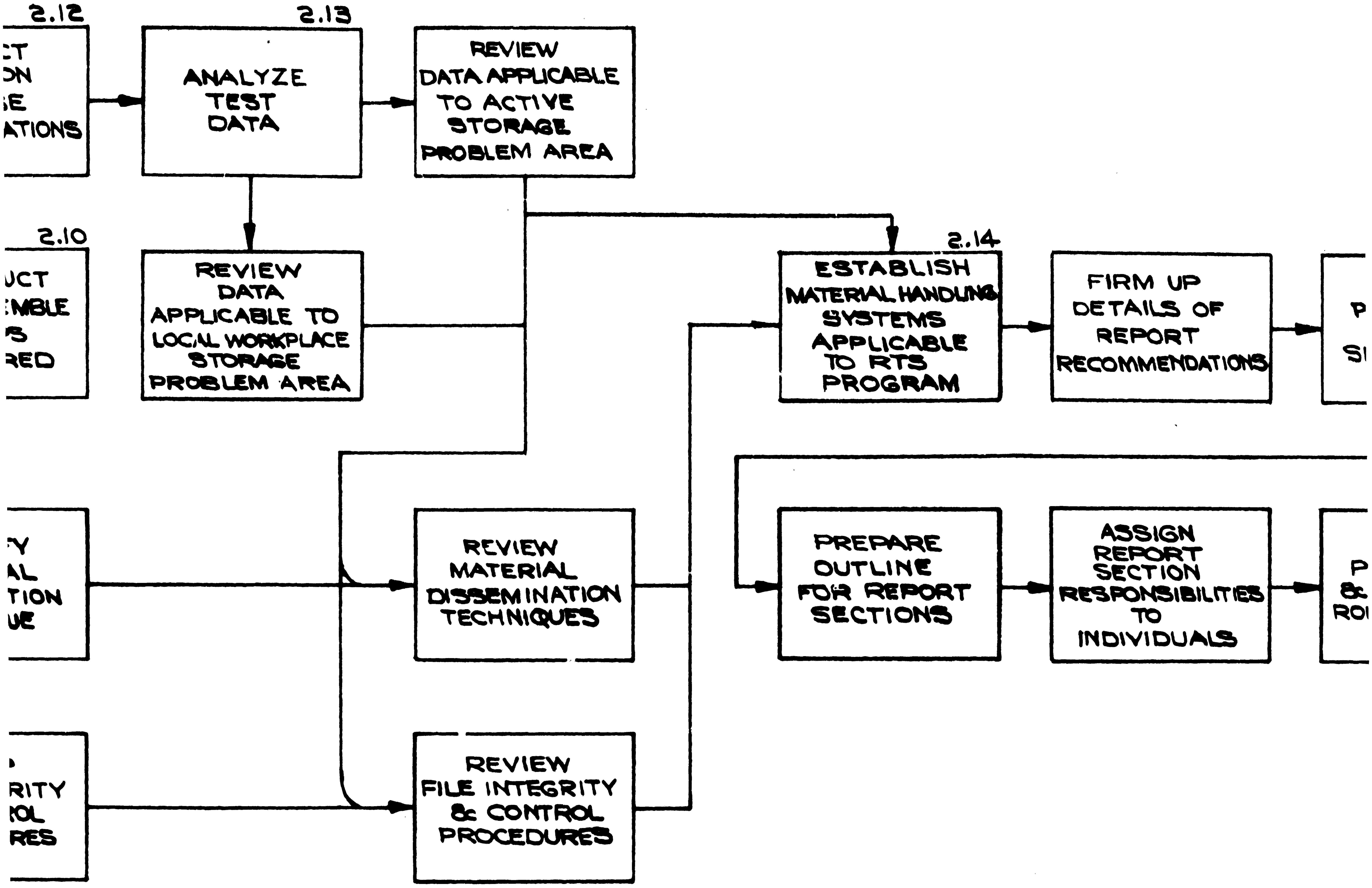

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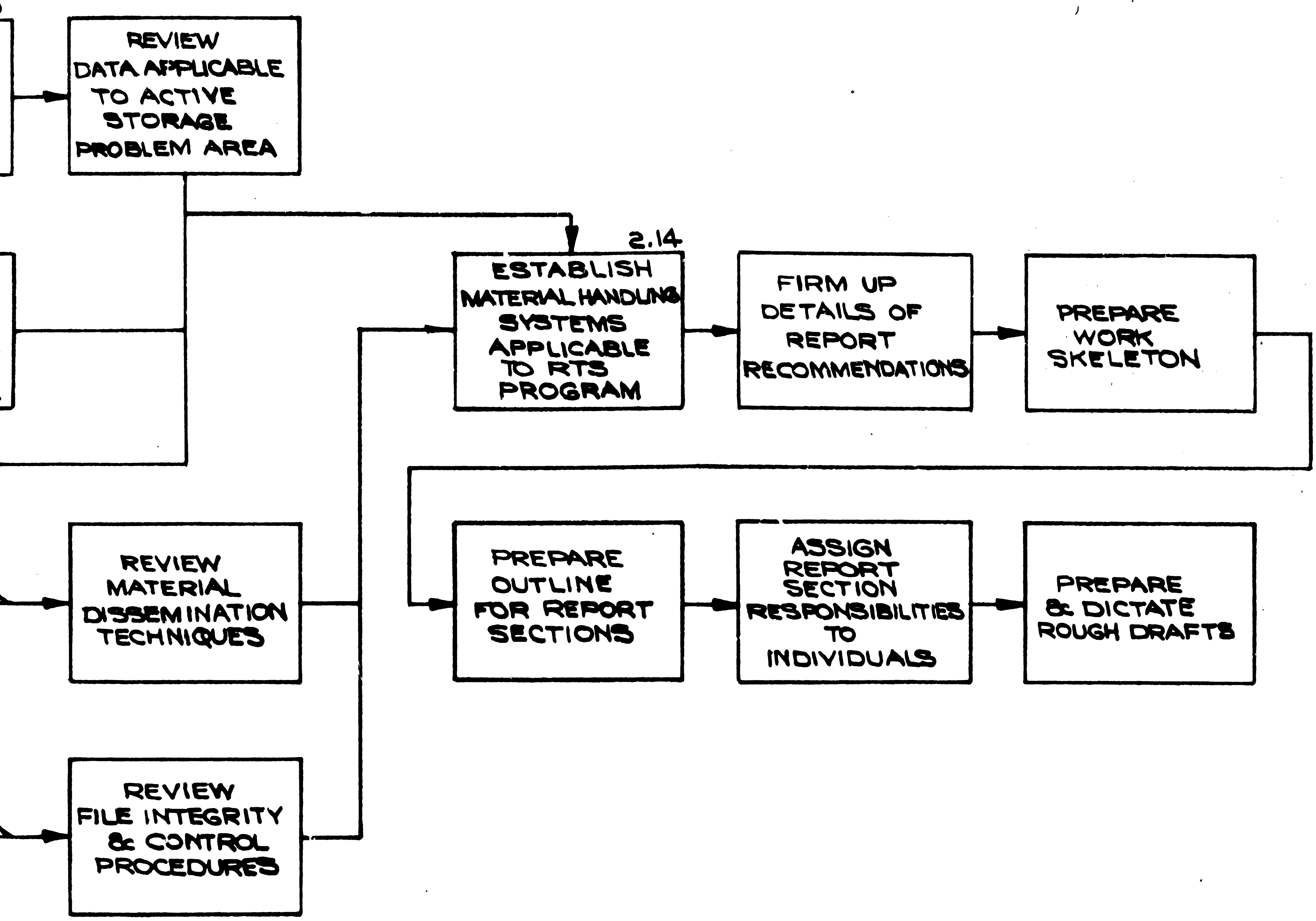

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FIGURE 3

STUDY EFFORT
METHODOLOGY MILESTONES

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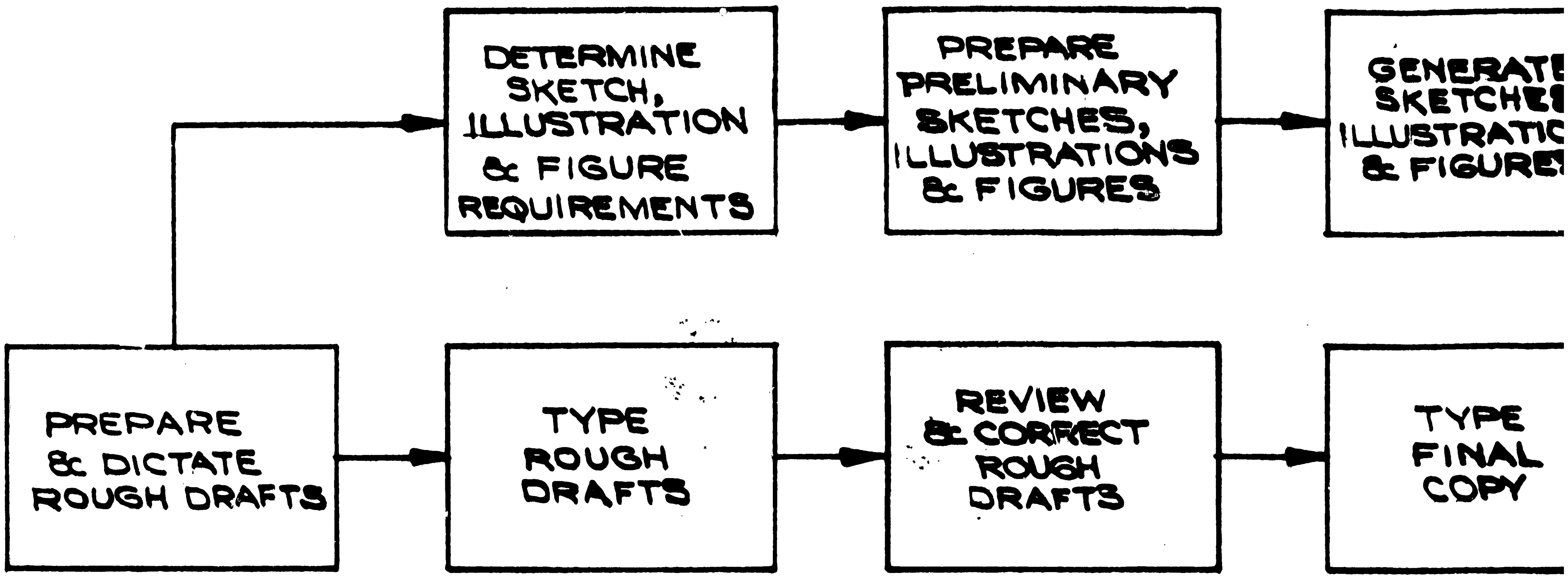

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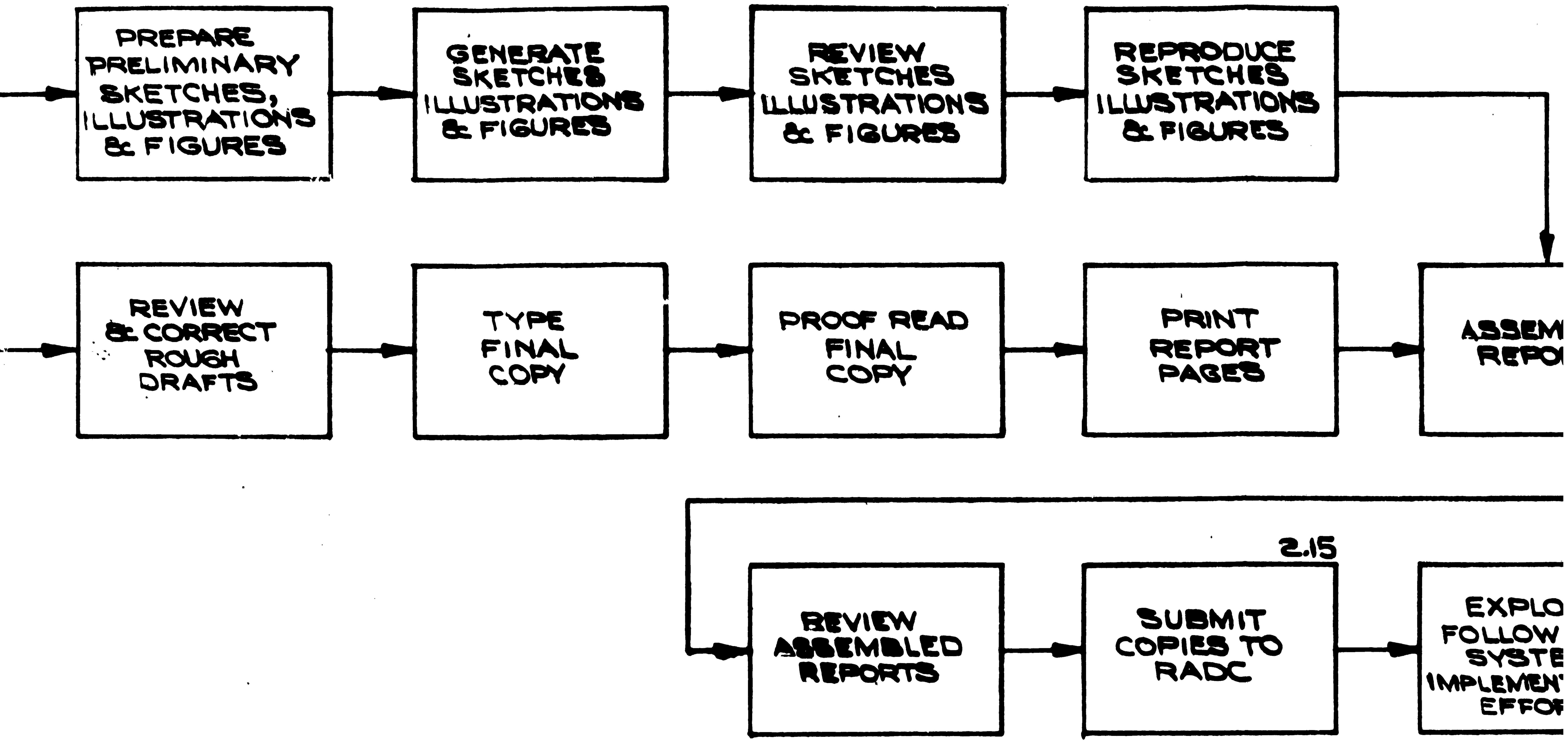

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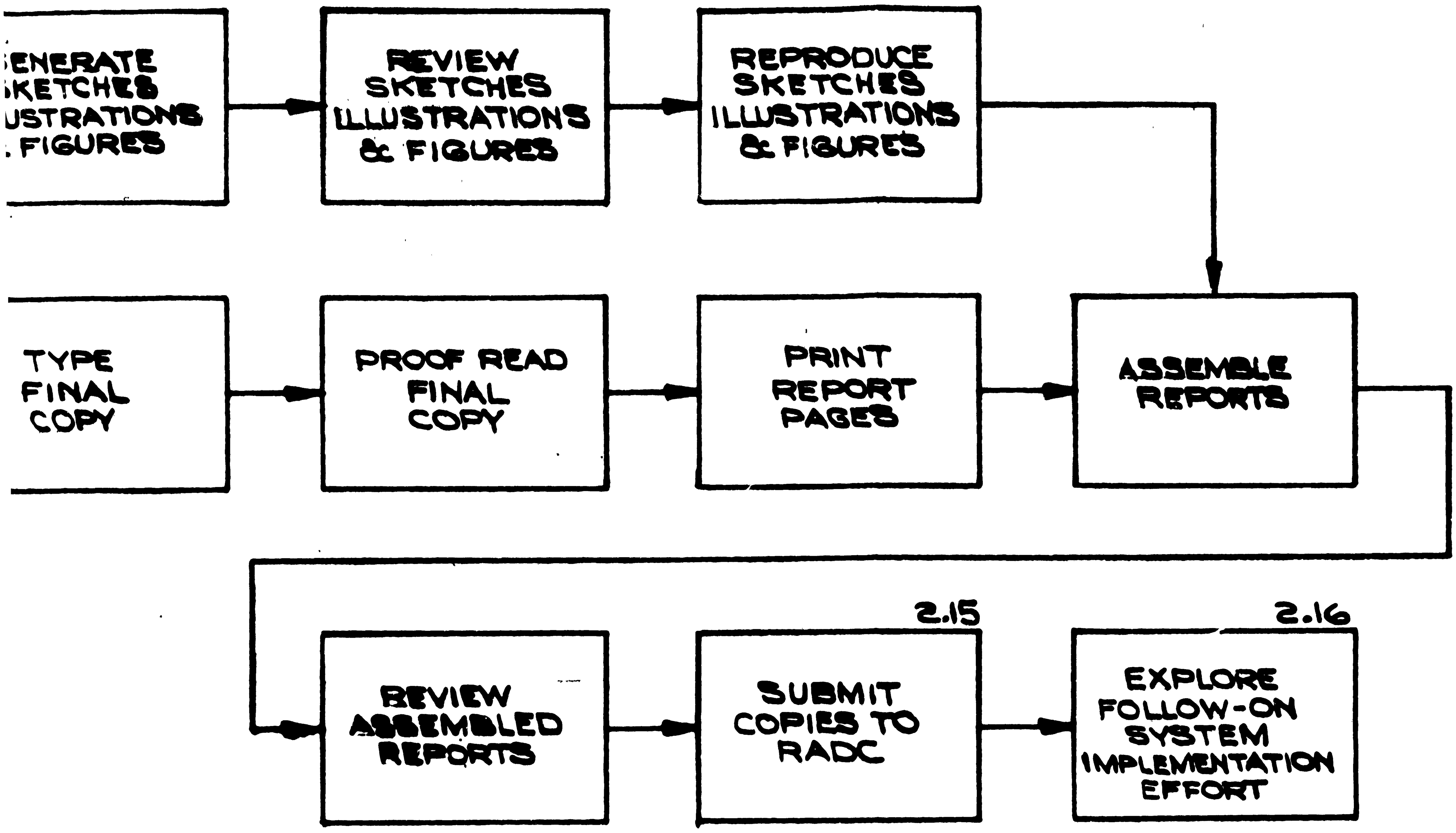

FIGURE 3

STUDY EFFORT
METHODOLOGY MILESTONES

SHEET # 3 OF 3

SECTION FOUR. REVIEW OF CURRENT TECHNIQUES

4.1 INTRODUCTION

Current practices in the physical handling of graphic materials were assessed by contacting a wide variety of representative organizations — military, governmental, and civilian — each of which was engaged in handling one or more types of graphic materials. The organizations contacted ranged from large governmental units through large university and public libraries to large civilian aerial photographic corporations. They are listed in Table 4, with identification of the data form of interest, and are described in detail in ensuing paragraphs. Table 4 is constructed to allow both a categorized organizational presentation and a rapid identification of organizational descriptions in which a given data form is discussed. For convenience, the material is presented in the organizational arrangement.

Table 4

INSTALLATIONS REPRESENTATIVE OF CURRENT TECHNIQUES

Organization	Data Form					
	Roll Film	Maps	Drawings	Sheet Film	Mosaics	Photo Prints
A. <u>MILITARY</u>						
1. Army Electronics Command			X			
2. Army Map Service		X				
3. Naval Oceanographic Office		X				
B. <u>GOVERNMENTAL</u>						
1. Agricultural Stabilization and Conservation Service	X			X	X	
2. Bureau of Public Roads		X				
3. Coast & Geodetic Survey		X				
4. Geological Survey		X				
5. Library of Congress		X				
C. <u>CIVILIAN</u>						
1. Aero Service Corporation	X			X	X	
2. American Geographical Society		X				
3. Chicago Aerial Survey Co.	X			X		X
4. Clark University		X				
5. Harvard University		X				
6. Lockwood, Kessler & Bartlett, Inc.	X			X	X	
7. Mark Hurd Aerial Survey Co.	X			X		X
8. Metropolitan Museum of Art						X
9. National Geographic Society		X		X		
10. New York Daily News						X
11. New York Public Library		X				
12. New York Times						X
13. Tri-State Transportation Committee			X			
14. United Engineering & Foundry Co.			X			
15. United Nations		X				
16. Westinghouse Electric Corporation			X			

4.2 MILITARY INSTALLATIONS

4.2.1 Army Electronics Command

The Records Management Section of the U. S. Army Electronics Command, Fort Monmouth, New Jersey, was contacted.

The Electronics Command has a very large volume of A, B, C, and D size drawings to file. There is a significant space problem in that they are limited in the amount of space which may be used for filing these drawings.

The Electronics Command is currently filing these drawings in Planfile units made by Art Metal, Inc. Previous to this, they had used flat drawers roughly 2 inches in depth for filing drawings. They had encountered many problems with these. One of the major ones was that, as a rule, the drawers were only half-filled because filling a drawer completely made the contents too cumbersome to move.

An extensive equipment survey was run by the Records Management Section and the purchase of Planfiles was implemented. These Planfiles have been in operation for some time now and marked improvements in many areas have been noted over previous flat-drawer filing. It was mentioned that many more drawings can be packed in the same amount of space than previously. The units are portable and semi-fireproof. They are water-resistant up to the top opening. Recently a water main break caused a flood in the storage area whereby water poured down from the ceiling and began to build up on the floors. Drawings in the flat-drawer units became soaked through; those in the Planfiles remained dry. Another feature of Planfiles is that rearrangement or realignment of the files is quite convenient, since they are on castors and heavy equipment is not required to move them.

Since reference to drawings is made in the actual workspace, an outstanding feature of the units is that the top of the unit adjacent to the one being used can be used as a work surface area. This feature allows more efficient utilization of space, since the reference tables previously required consumed space but did not, simultaneously, afford storage volume.

Another advantage recounted is that the use of ladders has been eliminated for drawing filing. Many problems were encountered in attempting to interfile drawings while standing on ladders. The Planfile can be reached much more easily than five-drawer, standard, flat, horizontal drawers in tiers. There is no problem with having to stoop to reach the lower sections and having to use ladders to reach the higher sections. Aisle space has been cut down substantially since the space does not have to be left to open drawers.

4.2.2 Army Map Service

The Chief of the Library Division of the United States Army Map Service in Washington, D. C., was contacted.

The Army Map Service Library contains approximately 2 million maps which are all filed in flat file drawers 48 x 52 inches. The AMS Library houses the primary topographic map collection for the Department of Defense.

Within the file drawers, maps are filed within jackets or folders for purposes of protection. Approximately 50 maps are filed per jacket and five jackets are filed within a drawer. Each file case has five drawer files; each drawer is approximately two inches high. The cases themselves are piled six or seven sections high because of space restrictions in the library. Ladders must be used to reach maps in the top two sections. Large maps are folded down to fit the one standard drawer size.

Some atlases are filed in the AMS Library. These are filed flat on roller shelves in a special atlas case.

In fulfilling its particular mission, that of supplying maps to the DOD, AMS finds that this particular use of flat file drawers, plus a punched card map classification system, permits it to send maps to its various users fairly rapidly. However, it was mentioned that, since AMS has such a huge investment in flat drawer filing, it would be very uneconomical for them to consider the use of any other filing equipment.

4.2.3 Naval Oceanographic Office

The District Distribution Office in Philadelphia, Pennsylvania, was contacted.

This office is the storage and distribution warehouse for maps and charts distributed by the U. S. Navy to ships for which the Philadelphia District Office has responsibility.

The warehouse occupies approximately 100,000 sq. ft.

Items are received in bulk, usually palletized, and are filed on open shelves in their bulk form.

Approximately 26,000 different items, each item varying in quantity from 500 to 10,000, are stored in this warehouse. There is a large turnover of all materials. No one item remains in the warehouse for any significant period of time.

Items are stored only in bulk form and items are not usually distributed on a rush basis. Ordinarily, there is sufficient lead time to permit all distribution within the normal working day. Fork-lift trucks are used to remove the palletized quantities of maps and charts from the open shelf compartments and to deliver these to the shipping point. The shelves are approximately 12 feet high.

For bulk storage, receipt, and distribution of large quantities of maps and charts, a warehouse of this configuration was judged as suitable as any for this kind of map storage.

4.3 GOVERNMENTAL INSTALLATIONS

4.3.1 Agricultural Stabilization and Conservation Service

The Chief of the Photo Section of the Agricultural Stabilization and Conservation Service in Asheville, North Carolina, was contacted.

ASCS is responsible for furnishing enlargements to the Department of Agriculture for use in accurate determination of acreage allotments. In this capacity, they store large amounts of roll aerial film and large sheets of film. The Department of Agriculture does not require immediate delivery of enlargements for film copies from ASCS.

ASCS has a store room of approximately 15,000 rolls of 9-1/2 inch aerial film. The collection of aerial film is increased at the rate of 500 to 800 rolls per year. In addition to the aerial roll film, they have a collection of approximately 15,000 sheets of 20 x 24-inch photographic film. These are the negatives for the photo indexes.

The aerial roll film is filed on open, steel shelves, with the axis of the roll horizontal, as illustrated in Figure 4. The shelf sections are approximately 12 ft. high, placed back-to-back in the storeroom. As can be seen at the left edge of Figure 4, at can locations 12013 and 12014 at the top, or 1249 at the bottom, small separators are used to prevent can rolling. Two things may be noted from the labeling: 1) each cubicle and each can top are labeled identically, and 2) the film is stored in two basic sections, upper and lower. The upper section contains older film, e.g., 12001 through 13200; the lower section contains current film, e.g., 1201 through 2400.

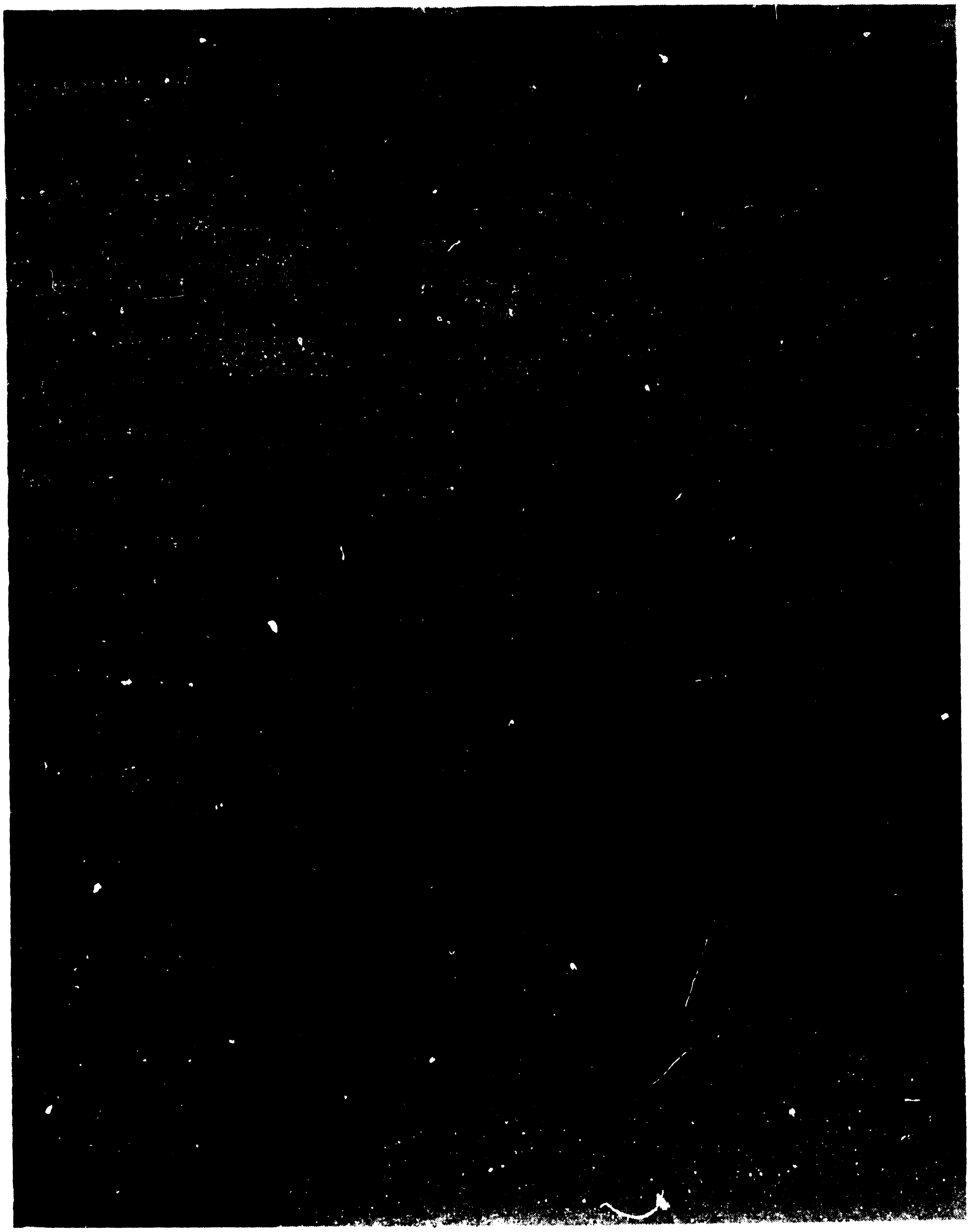

Fig. 4 Typical Roll-Film Storage

It will also be noted that a railing has been built around the top edge of the shelves and a roller ladder is used to obtain film from the upper section.

The 20 x 24 inch sheet film is filed in kraft paper envelopes with 5 or 6 sheets of film per envelope. Five or six envelopes are placed in flat, horizontal drawers which are approximately 2 inches deep and 26 x 30 inches in cross section.

Although some photo mosaics are made by ASCS, the mosaics themselves are not filed, as a general rule. In most cases, contact negative film is made of the mosaic and the film itself is stored — to avoid the problems customarily encountered in storage and handling of mosaics. The few mosaics which ASCS has, probably not more than 50, are stored in the flat, two-inch high drawers —with approximately four or five mosaics per drawer.

Before moving to their Asheville location, ASCS had been located in cramped quarters and had stored their roll film with the roll axis vertical on open steel shelves, with the cans being placed three deep. It was mentioned that there are many problems encountered in this particular storage pattern because it was always necessary to pull the front can, or two cans, off the shelf when attempting to locate a can behind. Their current filing system files cans one-deep on these open, steel shelves with dividers between each roll of film so that an individual can is readily accessible and cannot get out of position. They are quite satisfied with this system and have had no difficulty with retrieval and refiling, since theirs is not a rapid response operation.

Similarly, in the case of sheet film, the response times which are compatible with their operation allow the use of envelopes within drawers.

4.3.2 Bureau of Public Roads

The Map Curator of the Map Division of the U. S. Bureau of Public Roads in Washington, D. C., was contacted.

The Map Division has the responsibility of both storing and distributing certain quantities of all maps which are prepared by the U. S. Geological Survey. They store state and county highway planning survey maps, state and county survey maps, state and county traffic maps, city maps, and U. S. Geological Survey planimetric maps. The Map Library serves as both a distribution office for maps and a reference library. Maps must be distributed on a regular basis to various states. The Library does not require immediate access to any map or maps. Approximately 15 people per day might visit this map library but they usually do not demand immediate service.

The various maps filed in the Map Library range in size from 18 x 20 inches through 4 x 6 feet.

Maps are filed flat in horizontal drawers. The very large maps are folded and placed in standard file drawers. It was mentioned that an attempt is made to file all maps by size, although this is not always possible. When maps in the same series come in different sizes, the small maps are placed on top, and the larger maps are placed on the bottom. This means, of course, that it becomes necessary frequently to look in two different locations within a drawer, unless the size of the map is known beforehand. They are not particularly satisfied with having to fold the maps but have a problem in that there is a large investment in drawers of a given size and a limited amount of space.

It was mentioned that if it were necessary to file many different size maps together and folding was to be avoided and space was not a problem that hanging maps might be a solution to this problem. However, an adequate test of this method has not been performed.

4.3.3 Coast and Geodetic Survey

The Chief of the Chart Distribution Office of the U. S. Coast and Geodetic Survey in Washington, D. C., was contacted.

The Coast and Geodetic Survey produces charts which are used for navigational and aircraft aids. They are constantly in the process of revising various charts — some as frequently as every four weeks — some only once every five years.

Their particular mission is to take charts which are printed in another division of the Coast and Geodetic Survey and to bind, fold, punch, collate, package, and store them before delivery. In addition to the storage of large quantities of printed charts, the Office of Cartography of the Coast and Geodetic Survey is responsible for storing hydrographic and topographic survey charts.

The Chart Distribution Office is responsible for distributing to various cartographic sales offices approximately 2,000 different Coast and

Geodetic charts (of which 500 to 8,000 copies of each chart are available) and a thousand different air charts.

These items are stored on open shelves whose depth and width is specifically made for a given size chart. These shelves are roughly six inches apart and hold anywhere from 500 to 1,000 charts to a shelf. Since the Chart Distribution Office ships charts in bulk and since revisions of a given chart are always of the same size; they are able to have fixed filing space made fairly accurately to the size of the chart.

The hydrographic and topographic survey charts are stored in a vault area. This vault contains racks roughly 12 feet high and contains approximately 10,000 topographic and 9,000 hydrographic survey sheets. These are the original charts on which all data is plotted and from which cartographers make drawings, plates, etc. Since these are one-of-a-kind, they are mounted on linen. They contain survey data in the form of sounding depths and other vital information. Since some of these charts are over 100 years old and since they are one-of-a-kind charts, each one is individually stored in roll form in a 42-inch long, 2-inch diameter tin tube, placed in a 12-foot high rack. The purpose of the tube is to prevent deterioration of the chart from dust and dirt by providing essentially a sealed volume of storage.

In the Chart Distribution Section, all items are filed by size and are only shipped out in bulk. Although dust and dirt is a problem, one chart is usually used for protection purposes only and permanently kept on the top of the pile of charts. The surfaces of the charts themselves do not have an opportunity to get dirty, only the edges. Some charts are kept folded — usually the aeronautical routing charts. These are kept folded in a manner similar to road maps. They are stored and distributed in bundled form.

4.3.4 Geological Survey

The Map Distribution Officer at the U. S. Geological Survey in Washington, D. C., was contacted.

The Distribution Branch is responsible for distributing maps published by the U. S. Geological Survey. These maps are of three different sizes — 21 x 27, 21 x 17, and 22 x 32-inches. The maps are stored by area covered on open shelves. Since dust is a problem, the top one is used as a dust cover.

As a rule, there are 400 copies of each map kept as a working stock. In a backup warehouse, there are bulk packages of 400 copies of each map. The average distribution for a given map is one to five copies.

About 25,000 different maps are handled within this particular branch.

Open shelves are used because they are convenient to get at, are inexpensive to maintain, and are relatively inexpensive to purchase initially. This particular office has shelves which are adjusted to the sizes of the maps they store and, since so many maps are of this same size, no particular problem is encountered in using the shelves of roughly the same dimensions for all maps.

Speed of response within the Chart Distribution Branch is not critical.

4.3.5 Library of Congress

The Map Division of the Library of Congress in Washington, D.C., was contacted.

The Map Division is responsible for filing all maps, whether recent or ancient, having to do with the history of the United States. As such, it has many maps which go back to the 15th century. They are not concerned with rapid retrieval of maps. Rather they are concerned mostly with an archival storage of historical maps.

The maps are usually no larger than 30 x 40 inches. If maps are larger than this, they are folded down to 30 x 40-inch size. All maps are filed in flat, horizontal drawers which are approximately 2 inches high. Each drawer holds no more than 50 maps. Since there is a space problem, drawers are piled up quite high in the storage areas and it requires step ladders to reach the top drawers.

The Library of Congress appears relatively satisfied with this flat-drawer filing method for their basically historical collection. It was felt, however, that flat-drawer filing might not necessarily be the ideal filing arrangement if rapid retrieval of maps was required.

4.4 CIVILIAN INSTALLATIONS

4.4.1 Aero Service Corporation

The Chief of the Photo Laboratory of Aero Service Corporation in Philadelphia, Pennsylvania, was contacted.

Aero Service is one of the largest commercial aerial survey organizations in the United States and, as such, has the responsibility of filing large quantities of 9-1/2-inch aerial roll film, sheet film, and mosaics. Their roll film vault contains approximately 30,000 rolls of 9-1/2-inch by 200-foot aerial film. This quantity increases at the rate of approximately 1,000 rolls per year.

Roll film is stored on open steel shelving which is approximately 12 feet high. The film is stored with roll axis horizontal inside of boxes. Each box is approximately 6 inches square and 10 inches deep. They are placed on the shelves one deep. The reason boxes are used is to prevent any mishap, should the can covers come off. It is realized, however, that additional space is required for film can storage using this method.

Storage of mosaic boards presents a problem. At present, an open rack is built approximately 6 feet deep by 4 feet high and 8 feet in length. The eight foot dimension is divided into six-inch sections and mosaic boards are slid into these sections. It was mentioned that, since there is no support of the mosaics within each six-inch section, mosaic boards have a tendency to bend. The mosaics are mounted on one-quarter-inch masonite.

Because of the problems associated with their storage, it was felt that, if at all possible, mosaics should be completely eliminated, and 1:1 film negatives should be made and stored. The film could then be used for making various sized enlargements and film would present less of a problem for storage than would the mosaic itself.

4.4.2 American Geographical Society

The Map Curator Emeritus for the American Geographical Society in New York, New York, was contacted.

The American Geographical Society has approximately 350,000 maps. Their collection is growing at the rate of approximately 10,000 maps per year.

Two types of units are used for map storage. The majority is stored in cases which are similar to sliding drawers, except for the fact that, when the shelf supporting the case is pulled out, the front of the case drops down so as to permit access to the entire pile of maps within that particular case. Within this basic type, some flat horizontal drawers manufactured by The Lyon Metal Products Company are also used. The other type of map filing equipment is an Art Metal, Inc. Planfile.

The maps stored in all the different units are usually no larger than 28 x 40 inches. If larger than this, they usually must be folded down to fit either the drawers or the sliding shelves.

It was felt that a Planfile unit was of greater utility because of the greater amount of packing density per square foot of floor space than flat drawer files and because the Planfile holds maps under compression (established by spring compression), considered to be a better way to file maps than drawer or shelf filing without pressure.

In addition to maps, the AGS has a large collection of atlases, some very old. Since standing these atlases upright on shelves would have a tendency to break the bindings, they, too, are filed in roller shelf units similar to the drop front units used for map storage.

4.4.3 Chicago Aerial Survey Co.

The Film Curator of the Chicago Aerial Survey Co. in Chicago, Illinois, was contacted.

Chicago Aerial Survey has a collection of approximately 800 cans of 9-1/2-inch aerial film stored with the roll axis vertical on open steel shelves, two cans deep. The cans receive a standard label giving job number, job title, date photographed, time, strip, negative numbers, and flight scale. Label reads when roll axis is vertical.

Additionally, they have approximately 5 standard filing cabinets in which are stored sheet film and photographic prints. Approximately 500 manuscript maps are stored in tubes 2-1/2 inches in diameter and 40 inches long. All of these items are stored in a temperature and humidity controlled vault.

Large mosaics (e.g., 10 x 24 feet) are made at this establishment, but they are custom made and always considered "in process" and are not stored.

Ordinary maps, e.g., Geological Survey quadrangles, are stored in standard file configuration.

The collection is manageable in size and does not face high-speed retrieval requirements.

4.4.4 Clark University

The Map Curator of the Graduate School of Geography of Clark University in Worcester, Massachusetts, was contacted.

The map collection contains approximately 50,000 maps of varying sizes. The maps are filed in flat drawers only. These are five-drawer sections which are placed three sections high to afford easy access to the top drawers and, at the same time, provide working surfaces when maps are pulled out of the drawers. Small and large maps are interfiled and an attempt is made to keep the leading edges of all maps toward the front of the drawer so that the small maps will not become lost within the drawer.

Since this is a relatively inactive collection and is used for reference purposes only, it is not necessary to have a map filing system which will lend itself to rapid access.

It was felt that, for rapid access, if space permitted, some sort of hanging system whereby each individual map was hung on a rod, or series of rods, might afford both rapid access and permit the interfiling of large and small sizes. Although this system has not been used at Clark for map filing, it was felt that it would have possibilities if space did not present a problem.

4.4.5 Harvard University

The Custodian of the Windsor Memorial Map Room, Widener Library, Harvard University, in Cambridge, Massachusetts, was contacted.

The collection in this library contains approximately 50,000 maps. The maps are filed flat in horizontal drawers or on open shelves. In either system the maps are placed within 20 x 30-inch folders, five to twenty-five maps per folder, and an average of five folders per shelf. Since the open shelves and drawers are on one size only, all maps larger than this must be folded down to meet these size limitations.

Speed or response is not an essential requirement of this map library. The maps constitute more of an archival, historical collection, and people wishing to obtain copies of maps do not usually require them in a hurry.

Although this library recognizes that there are techniques and equipment which would permit it to protect its maps, and possibly retrieve them more rapidly than they are now doing, they have neither the need for rapid retrieval nor the money to change the particular filing equipment they are now using.

4.4.6 Lockwood, Kessler, and Bartlett, Inc.

The Photo Laboratory of Lockwood, Kessler, and Bartlett, Inc., in Syosset, Long Island, New York, was contacted.

LKB, an engineering and aerial photographic organization, has approximately 1,500 rolls of 9-1/2-inch aerial roll film in its vault and is increasing this at the rate of 100 to 125 rolls per year.

In the vault, films are stored on Art Metal, Inc., open file shelving, spacers being placed between adjacent cans to prevent rolling. The cans used are of such design so that the covers will not fall off. It was mentioned that if the film was stored inside boxes considerably more space would be required for the film storage. The method used is filing cans one deep with the roll axis horizontal. Spacers are placed approximately every six inches horizontally, and the shelves are spaced approximately every six inches vertically. The shelves themselves are roughly ten feet high.

Previously, cans had been stored with the roll axis vertical and had been filed two or three deep. . The retrieval of cans was very complicated using this method because frequently the required can was in the back or the second row, and this required moving cans out of the way and holding them while getting the proper can. In addition, they mentioned that it was impossible to see whether a can in the second or third row was out of file just be looking at the shelf space if the can in front were to block it.

To facilitate refiling of cans, LKB uses a large number, approximately four inches high, which specifies the horizontal row and vertical row of the can and is painted on the back wall of each compartment. The can itself also contains this number in smaller letters. When refiling cans, it is easy to see at a glance exactly which compartment should be used.

In addition to roll film, LKB has a few thousand sheets of negative film in two sizes: 20 x 24-inches and 40 x 48-inches. These films are made from mosaics and are stored instead of the mosaics. They have found that mosaic filing presents such a problem that it is much simpler to make a 1:1 film copy of the mosaic after it has been produced, to save the film, and to destroy the original mosaic. The mosaic negatives are filed in flat horizontal drawers, each drawer holding 40 to 50 negatives. The negatives are filed within envelopes within the drawer, each envelope containing approximately 10 negatives.

4.4.7 Mark Hurd Aerial Surveys, Inc.

The Administrative Manager for the Mark Hurd Aerial Surveys, Inc., in Minneapolis, Minnesota, was contacted.

Mark Hurd has a collection of approximately 3,000 rolls of 9-1/2-inch aerial roll film stored with the roll axis horizontal on open steel shelving in a termperature and humidity controlled fireproof vault.

Both flat negatives and photographic prints of nominal 8 x 10-inch size are stored in boxes of original receipt in specially constructed slide-in racks. 20 x 24-inch prints are stored vertically in a file configuration with vertical separators to avoid curl.

Large mosaics are made and are photographed. Original mosaics are not stored, as a general rule.

Manuscript maps are stored in tubes.

4.4.8 Metropolitan Museum of Art

The Librarian in charge of the Photo Reference Section of the Metropolitan Museum of Art in New York, New York, was contacted.

The Metropolitan Museum of Art has a large collection of photographs. These are divided into two parts: 1) color photographs, which are mounted on cardboard and which, in thickness and over-all dimension, approximate an average mosaic, and 2) black and white photographs which are mounted on thin cardboard.

There are approximately 6, 300 color prints. At present they are filed in racks approximately 6 feet high. The rack is broken horizontally into two sections: one, 2-1/2 feet high; the other, 3-1/2 feet high. There are one-quarter-inch plywood vertical spacers approximately every eight inches. Color prints are slid into these open racks by size. The largest color print is mounted on cardboard which is 30 x 45 x 0. 25 inches. Two problems are presently associated with these racks: one is dust, the other is curl. In order to view any one print, it is necessary to pull all prints in a given compartment out of the rack.

A decision has recently been made to go to the Art Metal, Inc., Planfile unit. Within this unit they anticipate filing three hardboard mounted prints in each folder, or approximately 180 per Planfile. They feel that this unit will give them freedom from dirt and dust, the ability to view individual prints without pulling out an entire group, and spring compression which will help prevent the cardboard from bending.

They anticipate buying small drawer Planfile units for prints up to 19 x 24 inches and large Planfile units of the freezer chest type for prints larger than this.

Black and white prints are mounted on thin cardboard and all are approximately 11 x 14-inches. There are approximately 275,000 black and white prints filed in open racks. At present it is necessary to pull out an entire group of prints in order to view any one. Another problem presently encountered is they are stored in two banks, the open racks being 22 inches deep and 14 inches high. This means that when requiring prints in the back row it is frequently necessary to pull out an entire front grouping. In addition, there is a problem with dust.

They have recently decided to purchase standard file drawers with a drop front to them. They feel that these file drawers will give them tight compression of all items within the drawers as well as a certain browsing ability when the drawer is opened and the prints are permitted to fan out. Since there is very little activity in this collection, in the sense of new acquisitions, each drawer, when packed, will not ordinarily require new prints to be placed in them. Although they very much liked the idea of the Art Metal, Inc. Planfile drawers with their individual spring compressors for black and white prints, they felt that they would prefer to spend their money for as many units as possible and Planfile units were more expensive than the ordinary drawer units.

4.4.9 National Geographic Society

The Chief Map Librarian of the National Geographic Society in Washington, D. C. was contacted.

The National Geographic Society has approximately 85,000 to 100,000 maps in their map library. In addition to maps, they have a few hundred sheets of color separation negative film from which the multi-colored maps are produced.

The National Geographic has recently moved into new quarters and furnished their map library with Art Metal, Inc., Planfile units for both map storage and negative film storage. It was mentioned that there had been a great amount of skepticism concerning the value of Palnfile units, since, for many years, the National Geographic had used flat horizontal drawers. They said, however, that they were most pleased over the fact that these Planfiles save a great deal of space over the flat file drawers and, in addition, they find it easier to retrieve and refile maps in them. Another feature that particularly pleased them is that since they file different sized maps in the same location, small maps, when interfiled with large maps in the Planfile, have less of a tendency to get lost, since the entire folder can be pulled up and all maps within it checked. In contrast to this, there had been a problem when retrieving maps which had crept to the back of flat file drawers. In general, the National Geographic Society is pleased with the transition to these units and have found them to be far superior to their previous filing methods using flat file drawers.

4.4.10 New York Daily News

The Library of the New York Daily News in New York, New York, was contacted.

The Daily News has in its active photograph file approximately 3,000,000 photographs pertaining to 1,000,000 different subjects.

Normal four-drawer files are used to store these photographs. No special consideration is given to the photographs, although it was mentioned that, unless the follower block on the four-drawer files is tightly compressed up against the photographs, they do have a tendency to curl.

4.4.11 <u>New York Public Library</u>

The Chief of the Map Division of the New York Public Library in New York, New York, was contacted.

The New York Public Library has approximately 350,000 sheet maps in their collection. Approximately 10,000 people come into the Map Division requesting maps each year.

Maps are filed within jackets in flat drawers. Paper is used as a dust protector. Retrieval of maps from these drawers is relatively rapid. It was felt by the New York Public Library's Map Division that maps should be filed flat and that drawers were as good a way of doing this as any. It was emphasized, however, that the drawer should be no more than 2-1/2 to 3-inches in height to facilitate the removal of maps from the bottom of a pile. The New York Public Library has standardized its drawer size to 40 x 27-inches. Whenever maps are larger than this, they must be folded down to fit within the map jackets.

4.4.12 <u>New York Times</u>

The Photo Library of the New York Times in New York, New York, was contacted.

The Photo Library contains approximately 2,000,000 8-1/2 x 11-inch photographs. Every photograph printed in the Times is filed in the Photo Library as a glossy print.

Five-drawer standard office files are used for this photograph filing. The amount of time it takes to retrieve a given photograph from the file is not of particular importance in this collection. For their general purposes, the five-drawer files appear to be quite satisfactory, although it was mentioned that photographs, if not packed tightly, do have a tendency to curl.

4.4.13 Tri-State Transportation Committee

The Tri-State Transportation Committee in New York, New York, was contacted.

Tri-State is an organization formed by New York, New Jersey, and Connecticut which is concerned with future transportation needs of the Metropolitan New York area.

Large drawings are filed in three Art Metal, Inc., Planfile units and in standard horizontal flat drawers. There are approximately 20,000 drawings in the entire collection, 6,000 in the Planfiles, and 14,000 in the horizontal drawers.

The person actually responsible for filing and refiling drawings in both of the units felt that the Palnfiles were much more rapid to use in both retrieving drawings and in refiling them. It was also mentioned that the Planfiles were superior for odd-sized material and that there was much less of a tendency to lose small sheets which might be interfiled among large sheets than there would be in a horizontal drawer. They also felt that the Planfiles save considerable space over the horizontal drawers and that they are much more accessible than are horizontal drawers.

4.4.14 United Engineering and Foundry

The Chief Engineer of United Engineering and Foundry in Pittsburgh, Pennsylvania, was contacted.

United Engineering and Foundry uses Art Metal, Inc., Planfiles exclusively for their drawing files. They began this program in 1938 when they started out with two. Previous to that, they had had horizontal drawers which were made out of wood and had found many difficulties with them. A particular problem was misfiling when the drawers were piled higher than five feet. Their Planfiles hold an average of 3,500 tracings each, and the average drawing size is 25 x 35-inches. They currently have 55 Planfiles which hold a total of approximately 280,000 drawings. It was mentioned that they originally started out on a test program with these 2 cases and now have 55. They file half-sized drawings in a large Planfile, putting two drawings side by side.

All in all, they are quite pleased with this system and feel it is far superior to horizontal drawer filing for blueprints and plans.

4.4.15 United Nations

The Chief of the Map Library Section, Dag Hammarskjold Library, United Nations, in New York, New York, was contacted.

The Map Library, which is relatively new, contains approximately 70,000 maps. The objective of the Map Library is to be able to provide a picture of any part of the world which may be required by members of the Secretariat.

The maps are contained in Hamilton Manufacturing Co. drawers piled approximately chest high.

Roughly 300 drawers are used for map storage. For the most part, these flat drawers have been satisfactory. However, there has been a small problem in that there is a tendency for the smaller maps to become lost among the larger ones. For the particular mission of the U. N. Library, the Hamilton Manufacturing Co. drawers appear to be most satisfactory.

4.4.16 Westinghouse Electric Co.

The Supervisor of Office Services for the Westinghouse Electric Company in East Pittsburgh, Pennsylvania, was contacted.

Westinghouse Electric maintains an active drawing file which runs into the hundreds of thousands of drawings. These drawings are all filed in approximately 80 Art Metal, Inc., Planfile units. Before going to Planfile units, extensive time studies were run by Westinghouse because speed of retrieval is one of the most critical items in this particular operation. After running extensive time studies, they were convinced that the Planfile units would allow for more rapid retrieval of drawings than would the horizontal flat drawers which were previously used. They began changing to the Planfile system and by 1959 had discarded their last horizontal drawers.

The flat drawers previously used had been piled four sections high. It has been their experience that despite the fact that this was a relatively manageable height for the top drawer, the Planfiles have decreased retrieval time by a factor of three. This has held up consistently over the years and they have constantly found that it is far more rapid to retrieve a drawing from the Planfile that it ever was with the horizontal drawers.

In addition, this particular organization must justify all expenditures by showing cost reductions. It was found that the Planfiles, by reason of the fact that they occupied less space and that they allow more rapid retrieval, would justify their initial purchase. In actual practice, they have been found to be economical to maintain and simple to work with.

All in all, it was felt that this system is far superior to any other for any type of drawing filing.

4.5 SUMMARY

The consensus of users contacted in their reactions to the various types of equipments and the type of material to be stored, retrieved, and refiled is summarized in the following paragraphs.

4.5.1 Roll Film

Open steel shelving is the most generally used type of storage. Experience has shown that storage with the roll axis horizontal is superior to storage with the roll axis vertical in two important respects: 1) there is individual-item, or unit-record, access without the necessity for holding the forward one (or two) film cans while retrieving the second (or third) row can, and 2) the presence or absence of a given roll film can may be visually established without physical movement of any roll film cans. There appears to be some concern over the popping off of can tops and any method to be recommended should take this into account.

4.5.2 Maps, Charts, and Drawings

There are three basic types of equipment in use: 1) the standard flat, horizontal drawer file, most often made by Hamilton Manufacturing Co., 2) the newer vertical, compression-type Planfile, made only by Art Metal, Inc., and 3) the tin tube file bank. User experience has shown advantages of the Planfile over the standard horizontal drawer type, in terms of speed of retrieval and refiling, economy, space, interfiling of large and small sheets, reference surface utility, and protection of items stored. The tin tube approach is considered to be a special case affording safe, archival storage for individual one-of-a-kind manuscript maps.

4.5.3 Sheet Film

Sheet film of size equal to or less than 8-1/2 x 11-inches is stored in standard file cabinets. Sheet film of larger size is filed in either flat, horizontal drawer units or in Planfile units, determined on the basis of whatever type of storage the given organization is using for its maps.

4.5.4 Mosaics

Mosaics are filed in two basic manners: 1) in standard flat, horizontal drawer units, and 2) in constructed "bay" structures holding small groups of mosaics, without compression, within an individual compartment of the structure. The most significant problem mentioned is that of curl. Difficulties of both curl and feathered-edge rising have contributed to the establishment of the policy — which exists in several organizations — of making contact (or reduced) negatives of the mosaic and of discarding the mosaic.

4.5.5 Photographic Prints

Photographic prints are stored in three ways: 1) standard file cabinets, 2) bay structures, and 3) boxes. One organization is shifting to the use of Planfile drawer units. The problems of single-item, or unit-record, access appear in the group handling required in bay structures and all three methods now in use evidence troubles with curl if compression is not used.

SECTION FIVE. REVIEW OF EQUIPMENT

In determining the types of off-the-shelf equipment which could be used for handling the various types and sizes of graphic materials, it was necessary first to categorize available equipments and then measure the applicability of equipments of a given category to the storage of a particular type of hard-copy. Table 5 lists the categories into which basic filing equipments were broken; Table 6 lists the categories into which related support equipment was broken.

5.1 SOURCES

Several reference sources were used to identify manufacturers of equipments falling within the categories selected (Tables 5 and 6, previously). A broad survey was made to insure general awareness of all off-the-shelf types of equipments and of the implications of these types to handling techniques and to the complexion of the over-all system of storage and retrieval of the hard-copy materials. In each publication searched, all items, either advertised or described, were evaluated for potential value to the graphic materials handling application. Whenever potential value was indicated, contact was made with the manufacturer to obtain descriptive information, product identification, and price data.

The publications listed below are representative of those which were searched.

One hundred and fifty-two manufacturers responded to inquiries generated from the searches. Detailed listings of the data obtained are

Table 5

FILING EQUIPMENT CATEGORIES

1. Electrical Files
2. Hanging Drawing Files
3. Horizontal Drawer Files & Card Cabinet Files
4. Mobile Files
5. Negative Files
6. Open Shelf Files
7. Reel Files
8. Rolled Drawing Files
9. Roller Shelf Files
10. Shelf and Bin Files
11. Tray Files
12. Vertical Drawer Files & Card Cabinet Files
13. Vertical Hardboard Files
14. Visible Files

Table 6

SUPPORT EQUIPMENT CATEGORIES

1. Benches
2. Binders (Ring and Post) and Folders
3. Book Stands and Book Cases
4. Boxes
5. Cabinets
6. Clip Boards
7. Cutters, Punches, and Scissors
8. Data Processing Supplies
9. Desks
10. Easels
11. Expanding Files
12. File Guides, Indexes, and Folders
13. Industrial Trucks
14. Labels, Tags, and Tabs
15. Ladders
16. Laminators
17. Light Boxes, Tables, and Vacuum Frames
18. List Finders
19. Machine Stands (Wheeled)
20. Rack Sorters
21. Rotary Indexes
22. Safes
23. Signals (Clip On)
24. Stamps and Numbering Machines
25. Staples and Eyeletters
26. Steel Floor Grating
27. Stencils, Rules, Lettering Guides, and Templates
28. Tables
29. Tacks, Pins, Hangers, and Clips
30. Tape, Glue, and Machines
31. Wheeled Carts

given in Appendix II in three forms: (1) an alphabetical list of all manufacturers, (2) a listing of manufacturers for each type of filing equipment, and (3) a listing of manufacturers for each type of support equipment.

5.1.1 Thomas Register

The Thomas Register of American Manufacturers, issued by the Thomas Publishing Company, 461 Eighth Avenue, New York 1, New York, is a classified reference book which lists many thousands of manufacturers both by the products which they manufacture and by company name. For purposes of this graphic materials handling study, the categories having to do generally with filing equipment were the ones used.

One hundred and fifteen manufacturers were listed under the category "Files: letter, office, etc.". Ninety-seven manufacturers were listed under the category "Cabinets and cases: filing". Forty-three manufacturers were listed under the category "Blueprint filing cabinets".

5.1.2 OFFICE Magazine

The OFFICE Magazine, subtitled A Magazine of Management Equipment and Methods, issued monthly by Office Publications, Inc., 73 Southfield Avenue, Stanford, Connecticut, was another source of equipment information. Each issue of the OFFICE magazine for the past year (averaging 250 pages) was carefully read to see whether any equipment, either advertised or described, might have application for the RTS facility.

5.1.3 REPRODUCTION METHODS Magazine

REPRODUCTION METHODS Magazine is issued monthly by Gellert-Wolfman Publishing Corporation, 33 West 60th Street, New York, N. Y. All issues for the past year were carefully read to determine whether any equipment advertised or mentioned in new-product notices would be applicable to the RTS project.

5.1.4 SYSTEMS Magazine

SYSTEMS Magazine is issued bi-monthly by United Business Publications, 200 Madison Avenue, New York, N. Y. All issues for the past year were reviewed to determine whether any equipment, either advertised or mentioned in the new-products sections, would be applicable to the RTS facility.

SECTION SIX. REVIEW OF THE LITERATURE

6.1 REPORTS PERTAINING TO EQUIPMENT

Reports and other information were received from those manufacturers identified and queried according to the pattern of equipment categorization given previously in Section Five. The literature received was categorized by subject (i.e., equipment categories of Tables 5 and 6, previously presented) rather than by manufacturer. Thus, if one manufacturer made equipment in two different categories — e.g., vertical drawer files and horizontal drawer files — the pages pertaining to vertical drawer files would be placed in the vertical subject section, those relating to horizontal drawer files in the horizontal subject section. In this way, it was possible to build a file that was completely subject-oriented. This type of file arrangement allowed methodical evaluation of the applicability of a given type of filing (or handling) in all its varied forms to the requirements of this study, rather than the alternative of evaluating the equipment of each manufacturer across the types of equipment to the types of requirements.

6.2 REPORTS PERTAINING TO TECHNIQUES

Many different sources were thoroughly searched to determine the availability of articles, books, periodicals, and other documents which might have application for various techniques to be used in the storage, retrieval, handling, and refiling of roll film cans, magnetic tape containers, maps, charts, overlays, mosaics, photographic prints, target folders, PI keys, and general library materials. The kinds of sources used were divided into two main categories. The first, a Reference Bibliography, contains lists of articles published in various periodicals. The second, an Additional Bibliography, consists of the actual card catalog files under various subject headings to be found in some of the larger libraries.

Three major periodical listings were thoroughly searched to determine whether articles of interest to the graphic materials handling storage problem were in existence. These three listings were: (1) Library Journal, published by the H. W. Wilson Company, which lists articles published in library periodicals; (2) Reader's Guide to Periodical Literature which lists articles published in general periodicals; and (3) the Business Periodicals Index which lists articles published in trade magazines. These three publications were searched for articles published within the last 20 years in the principal search categories listed in Table 7. Listings, which totaled 428, were grouped under four main headings having specific application to the storage, retrieval, handling, and refiling of graphic materials for a Reconnaissance Technical Squadron:

(1) Map Storage and Classification

(2) Files and Filing

(3) Human Engineering and Time-Motion Studies

(4) Aerial Reconnaissance, Photogrammetry, and Photo-Interpretation

Table 7

PRINCIPAL SEARCH CATEGORIES

1. Aerial Photography
2. Aerial Reconnaissance
3. Aerial Surveying
4. Display
5. Documentation
6. Files & Filing
7. Graphic Materials Handling
8. Handling
9. Human Engineering
10. Indexing
11. Information Storage and Retrieval Systems
12. Intelligence
13. Interpretation
14. Man-Machine
15. Map Storage and Classification
16. Mapping
17. Materials Handling
18. Military Intelligence
19. Military Reconnaissance
20. Motion Study
21. Office Equipment
22. Office Manuals
23. Office Methods
24. Operations
25. Optical/Target Recognition
26. Pattern Recognition
27. Photographic
28. Photographic Collections
29. Photographic Detection
30. Photographic Interpretation

Table 7 (Cont'd)

PRINCIPAL SEARCH CATEGORIES

31.	Photography, Aerial
32.	Photogrammetry
33.	Picture Collections
34.	Programming
35.	Recognition
36.	Reconnaissance
37.	Stereo
38.	Surveying, Aerial
39.	Surveying, Photographic
40.	Symposia
41.	Target Identification
42.	Target Recognition
43.	Time Study
44.	Work Measurement

In addition to the periodical listings, the card catalogs of representative libraries were searched within the same categories (Table 7) and were similarly grouped. Library catalogs examined included those of MIT, the New York Public Library, and the U. S. Defense Documentation Center, Hanscom Field Office.

The master card file so created is given in Appendix III under these same main headings. Selections were made from this list for evaluation of applicability of given techniques and approaches to this study.

SECTION SEVEN. TECHNIQUE TESTING & EVALUATION

7.1 EXPERIMENT DESIGN

The general approach to experiment design has been illustrated implicitly in Figure 2, presented previously. In the design of actual tests it has been intended to take the results of observation of current practice, the search of off-the-shelf equipment types, and the techniques and approaches revealed in the literature; to project these against concurrent consideration of operational factors (those factors influencing selection of physical handling techniques suitable for storage,retrieval, handling, and refiling of graphic materials in the environment of a Reconnaissance Technical Squadron) and physical factors (those factors influencing organization of the physical store); to develop evaluation criteria reflecting these influencing factors; and to develop test procedures allowing application of the selected evaluation criteria to equipment types and techniques which may practicably be called off-the-shelf and which will reflect simplicity of design and manual operation.

7.2 EVALUATION CRITERIA

Factors which influence the choice of equipment for the Reconnaissance Technical Squadron facility were listed in order. A weighting factor was assigned to each criterion in relative order of importance. This was done because some of the factors were more significant for the particular application at the Reconnaissance Technical Squadron facility than were others. For example, a file unit which was rated high in speed of retrieval and refiling would carry more weight than a file unit which rated high in adequate labeling surfaces.

The equipment rating criteria are given in a summary listing, with associated weighting factors, in Table 8.

A point score was developed for each equipment by summing, for each criterion, the product of the weighting factor and the rank order of the particular equipment within the particular criteria. Table 9, a copy of the recording form used, has been annotated to illustrate the manner of application in a representative application. In this example, 10 equipments have been placed in the order of their estimated availability, with the value 10 given to the equipment considered most available. The product of rank order and weighting factor for Equipment No. 1 is, therefore, 10 x 4 or 40. Similar values are established for each criterion and the "Total for Rated Equipment" is the sum. In the event that two units are deemed equal, each is given the same rank order number, say 6, and the lowest order

Table 8

EQUIPMENT EVALUATION CRITERIA AND WEIGHTING FACTORS

	Criterion	Weighting Factor
1.	Special Storage Configurations	6
2.	Retrieval and Refiling Speed	5
3.	"Wear and Tear" on Materials	4
4.	"Off-the-Shelf" Availability	4
5.	Operational Considerations	3
6.	Size and Form Versatility	3
7.	Material Conversion Requirements	3
8.	Independent Accessibility	3
9.	Unit Capacity	2
10.	Unit-Record Access	2
11.	Retrieval and Refiling Ease	2
12.	Adequate Labeling Surfaces	2
13.	Simultaneous Access	2
14.	Item Identification Without Removal from File	1
15.	File Rearrangement Ease	1
16.	Weight and Mobility	1

Table 9

EQUIPMENT COMPARISONS CHART
WITH ILLUSTRATIVE ENTRIES

Sheet ______ of ______

Date ______________

By ______________

Number	Equipment Rating Criteria For ______________	Weighting Factor	Unit Identification															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Special Storage Considerations	6																
2	Retrieval and Refiling Speed	5																
3	"Wear and Tear" on Materials	4	10	6	9	2	8	3	7	4	6	5	← RANK ORDER					
4	"Off the Shelf" Availability	4	40	24	36	8	32	12	28	16	24	20	← POINT SCORE FOR THIS CRITERION					
5	Operational Considerations	3																
6	Size and Form Versatility	3																
7	Material Conversion Requirements	3																
8	Independent Accessibility	3																
9	Unit Capacity	2																
10	Unit Record Access	2																
11	Retrieval & Refiling Ease	2																
12	Adequate Labeling Surfaces	2																
13	Simultaneous Access	2																
14	Item Identification Without Removal From File	1																
15	File Rearrangement Ease	1																
16	Weight and Mobility	1																
	Totals for Rated Equipment																	

number, 1, does not appear. This case is also illustrated in Table 9.

Each of the selected criteria is discussed below.

7.2.1 Special Storage Considerations

This was given a weighting factor of 6. It was felt that, when necessary for specific kinds of graphic materials, this might well be the most important consideration, even more important than the retrieval or refiling speed. Photographs, for example, should be held under compression to prevent their natural tendency to curl. If equipment did not do this, although all other factors might be favorable, a curled photograph which presented problems in the user workplace would render the equipment less desirable. When, however, it was not necessary for the material being tested to have these special considerations, all pieces of equipment were given the same rank order, and thus generated equal rating products.

7.2.2 Retrieval and Refiling Speed

Speed of retrieval and refiling was given a weighting factor of 5. This appears to be the second most significant item and any equipment chosen must lend itself to rapid retrieval and refiling of graphic materials to meet the established nominal for access time.

7.2.3 "Wear and Tear" on Materials

This criterion was given a weighting factor of 4. It was felt to be especially important that equipment should not in any way affect the materials which were filed within it. For example, a piece of map filing equipment which might have a tendency to rip or to tear maps would be rated lower than equipment which did not harm maps at all.

7.2.4 "Off-the-Shelf" Availability

This was assigned a weighting factor of 4. It was felt that, when a particular piece of equipment was readily available from a manufacturer as a standard item and other pieces of equipment to handle a given size material could only be ordered on a special basis, the item which was available without special consideration should be given the higher rank order value.

7.2.5 Operational Considerations

This criterion was assigned a weighting factor of 3. This factor includes consideration of safety, anthropometric considerations, and others related to operator-equipment aspects. It was felt that storage equipment should be such so that a given operator retrieving graphic materials from a given equipment, or refiling materials in the equipment, should have no interference from the equipment itself, no possibility of pieces of the equipment harming his physically in any way, that the equipment in its design should take into consideration anthropometric characteristics such as the required reach.

7.2.6 Size and Form Versatility

This was given a weighting factor of 3. It was felt that a piece of equipment should have the ability to store many sizes of the same type of materials, such as 70-mm and 9 1/2-inch aerial photographic cans, without substantially converting the equipment. In addition, it was felt that the equipment should lend itself easily to storing different sizes of other kinds of materials such as maps which might be interfiled, although being of slightly different sizes, etc. Further, it was felt that a given piece of equipment should lend itself to the storage of more than one type of graphic materials; e.g., a piece of equipment which could only file maps would be rated lower than a piece of equipment which might file maps and mosaics.

7.2.7 Material Conversion Requirements

Minimum material conversion requirements was given a weighting factor of 3. It was felt that any equipment which requires any conversion operation on the items being stored would be rated lower than any equipment which does not. This meant that a piece of equipment which requires holes to be punched in an object, covers to be placed over an object, etc. before being used in the equipment would be rated lower than equipment which did not — since these might, for example, interfere with the vacuum frame in the copy camera.

7.2.8 Independent Accessibility

This was assigned a weighting factor of three. It was felt that inherent in the equipment should be the ability to retrieve the given item without the use of ladders, tables, and the like.

7.2.9 Unit Capacity

Unit capacity per equipment type was given a weighting factor of 2. The type of equipment which can hold more of a given type of graphic materials for a given amount of floor space than a competitive type of equipment is given a higher rating. If, for example, one unit required 5 sq. ft. of floor space to hold 2,000 items and another unit required 8 sq. ft. of floor space to hold 2,000 items, higher rating would be given to the unit which required 5 sq. ft.

7.2.10 Unit-Record Access

This was given a weighting factor of 2. It was felt that it should be relatively simple to remove either one item or an entire group of items without special considerations. Equipment which permitted removal of single items easily was rated higher than equipment which required the unfastening of special devices to remove items from a bound group.

7.2.11 Retrieval and Refiling Ease

This was given a weighting factor of 2. It was felt that the physical removal of items from a piece of equipment should not cause undue hardship to the operator. Equipment which required the carrying of a large group of heavily weighted material in order to remove a given item was rated lower than equipment which did not require removal of the entire group before retrieving a single item.

7.2.12 Adequate Labeling Surface

This was given a weighting factor of 2. It was felt that all equipment should have enough labeling surface to permit whatever indexing and addressing information which might be required.

7.2.13 Simultaneous Access

Simultaneous access possibilities were given a weighting factor of 2. It was felt that the equipment should be such that it would be possible for two people to retrieve items from the same piece of equipment at the same time.

7.2.14 Item Identification Without Removal from File

This was given a weighting factor of 1. It was felt that it should not be required to pull out an entire group of materials before positively identifying the single item required.

7.2.15 File Rearrangement Ease

This was given a weighting factor of 1. It was felt that it should be a relatively simple job to take a group of items from one section of a unit and transfer these to another section of the unit.

7.2.16 Weight and Mobility

This was given a weighting factor of 1. It was felt that units which had the ability to be moved or transported relatively easily would be rated higher than those which would require special equipment for doing so.

7.3 TEST PROCEDURES

Certain of the evaluation criteria of the preceding section could be measured by data received from manufacturers — e.g., availability and weight. Others might best be measured by tests — e.g., speeds of retrieval and refiling and operational considerations. Accordingly, procedures were established for those criteria which were to be rated on the basis of test and observation. These are described below, along with identifying annotations of criteria for which no tests were performed.

7.3.1 Special Storage Considerations

These considerations were measured as the result of observation based on knowledge gained of problems attendant to the storage or handling of a particular type of graphic material — e.g., the curl of photographic prints or of mosacis.

7.3.2 Speed of Retrieval for an Individual Item

Data upon which to establish a figure for this evaluation criterion was obtained by measurement. As a by-product to the actual time tests and measurements, observations were made which provided data for:

(1) Special Storage Considerations

(2) "Wear and Tear" on Materials

(3) Operational Considerations

(4) Independent Accessibility

(5) Retrieval and Refiling Ease

(6) Simultaneous Access

(7) Item Identification Without Removal from the File

Prior to the actual time trials, each equipment was operated by personnel assigned to the test program to insure familiarity with the various operations and manipulations required and, thus, to eliminate learning time as a factor to be considered in the analysis of the test results.

Each of the equipment configurations selected was tested to determine the amount of time necessary for a single operator to retrieve an individual item from the material collection. The testing procedure, data sheets, and evaluation of the test results were based on standard time and motion study practices. Ten tests of each file condition were run initially and the test results were analyzed to determine if an additional number of observations would be required to attain a $\pm$ 10% precision and a 95% confidence level. Testing was then continued until the proper number of observations had been made. The data sheet format upon which both retrieval and refiling data were recorded is given in Table 10. Various conditions were established in the files to insure coverage of the spectrum of normal operating circumstances. These are described below.

7.3.2.1 Normal Conditions

These tests were based on the retrieval of a single item filed in a numerical sequence in a collection of 18, 50, or 100 items of the same

Sheet _____ of _____

Date __________

By __________

Table 10

RETRIEVAL & REFILING TIMES

Manufacturer __________ Material __________

Unit Tested __________ Quantity __________

Test Description __________ Size __________

__________ Subjects A __________

__________ B __________

Test No.	Specific Test Conditions	Test Code	Sub-ject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1			A												
			B												
2			A												
			B												

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport

Comments and Observations

type. The number of the item to be selected from a given collection was varied to approximate the normal distribution characteristics expected in actual use. The variation for the two larger size collections is indicated in Table 11.

The location of the collection within the storage configuration was established in accordance with normally expected distribution characteristics. The unit collection size was experimentally determined, depending upon manufacturer's specifications and test observations.

7.3.2.2 Misfiled Condition

Sample tests of this type were run to determine the general impact of misfiling. These tests were based on the retrieval of a single item filed out of normal numerical sequence in a collection of 50 or 100 items of the same type. The misfiled item was randomly located within ± 10 items from the normal filing location.

7.3.2.3 Missing Contiguous Items

A sample test of this type was run to determine the effects of missing sheets. These tests were based on the retrieval of a single item filed in numerical sequence in a collection of 50 or 100 items when the items, or item, contiguous to the subject item had been removed from the collection. Tests were conducted with contiguous single item, multiple items, and whole blocks of items removed from the file.

Table 11

ITEM NUMBER DISTRIBUTION FOR TESTS

50-Unit Collection	100-Unit Collection
5	10
10	20
20	40
22	44
24	48
26	52
28	56
30	60
40	80
45	90

7.3.3 Speed of Refiling for an Individual Item

Based on the conditions set up in the preceding paragraph, tests were conducted to determine the amount of time for a single operator to refile correctly items previously retrieved. The testing was based on the following condition:

(1) Normal Condition

These tests were based on the correct refiling of a single item in the collection under normal conditions described in paragraph 7.3.2.1.

7.3.4 "Wear and Tear" on Materials

Throughout the testing careful consideration was given to any indication of damage to the data collection in the normal operation of the storage equipment. Comments were noted on individual test sheets.

7.3.5 "Off-the-Shelf" Availability

This was established on the basis of data received from the manufacturer. Observation and measurement were not employed.

7.3.6 Operational Considerations

These considerations were established primarily by observation of safety factors, human factors, and actual operation factors during the retrieval and refiling time tests. Safety weaknesses and hazardous conditions were probed during learning times and during actual operation. Human factors considerations were qualitatively established by noting any need for excessive operator manipulation or for physically demanding manipulation — e.g., too long to reach. Any requirement for additional equipment — e.g., tables, chairs, stepstools — necessary to proper operation was also noted.

7.3.7 Size and Form Versatility

This was established on the basis of dimensional and form compatibility considerations, with qualitative observational assessment when the preceding compatibility considerations were met.

7.3.8 Material Conversion Requirements

These were established on the basis of manufacturer specifications and observation.

7.3.9 Independent Accessibility

This was established on the basis of observation and qualitative testing.

7.3.10 Unit Capacity

During the testing, a careful observational and qualitative test check was made to determine whether the manufacturer's rated storage capacity was suitable. Whenever it appeared that the manufacturer's rated capacity was not adequately established, testing was conducted with other quantities to establish proper recommendations.

7.3.11 Unit-Record Access

This was established on the basis of qualitative testing and observation.

7.3.12 Retrieval and Refiling Ease

This was established on the basis of observations made during the retrieval and refiling time tests. It also included observation of any restrictions on the interfiling of odd sizes of materials within the same editorial series.

7.3.13 Adequate Labeling Surfaces

Throughout the retrieval and refiling tests, careful qualitative and observational evaluation of the configuration of the equipment was made to insure that adequate labeling and indexing surfaces were provided.

7.3.14 Simultaneous Access Capabilities

During the retrieval and refiling tests, a qualitative test evaluation was made to determine whether or not the equipment configuration would permit simultaneous access during refiling and retrieval.

7.3.15 Item Identification Without Removal from File

This was established by qualitative testing.

7.3.16 File Rearrangement Ease

During the retrieval and refiling tests, ease of file reorganization was established on the basis of observation.

7.3.17 Weight and Mobility

This was established on the basis of manufacturer's data and visual observation during tests.

7.4 TEST MATERIALS

A variety of graphic materials was obtained to afford representative materials suitable for the tests and observations which had been planned. The test material inventory is given in Table 12. It will be noted that actual, real-life graphic materials were used in the majority of the cases. In those cases which were simulated, the acetate sheets used to simulate overlays were of the same type one would use, but had not been inked; the simulated mosaics were pieces of masonite or cardboard without the mounted photographic print segments; and the photographic prints, in the large quantity case, were simulated by cardboard.

Table 12

TEST MATERIAL INVENTORY

Material Type and Size (Inches unless noted)	Quantity	Material Nature	
		Actual	Simulated
1. ROLL FILM (CANS)			
5	3	X	
9-1/2	12	X	
70 mm	3	X	
2. MAGNETIC TAPE	0		
3. MAPS			
27 x 22	100	X	
55-1/2 x 35	1	X	
57 x 41-1/2	6	X	
29 x 22	34	X	
34 x 23-3/4	5	X	
23 x 30	1	X	
4. OVERLAYS			
25 x 22	100		X
20 x 22	9	X	
5. MOSAICS			
48 x 48	3		X
36 x 24	3		X
36 x 48	3		X
6. PHOTOGRAPHIC PRINTS			
9 x 9	100		X
8 x 10	21	X	
9-1/4 x 10-1/4	10	X	
9 x 18	1	X	
7. TARGET FOLDERS	0		
8. PI KEYS			
8-1/2 x 11	9	X	
11 x 14	2	X	
9. LIBRARY MATERIALS	40	X	

7.5 EQUIPMENT SELECTED FOR TEST

After consideration of the anticipated requirements of the Reconnaissance Technical Squadron and the data obtained concerning the various types of storage equipment, certain equipment types were selected for test. The types of equipment selected for tests with the various types of graphic materials are presented in Table 13.

Representative samples of the various types of equipment selected were sought from the manufacturers. Equipments which were received are listed in Table 14. Each of the equipments which were tested — other than the wooden laboratory shelving and album samples — was supplied for test by the manufacturer. Although the actual units tested were not necessarily of the same size as would be recommended for ultimate incorporation into the Reconnaissance Technical Squadron facility, it was felt that these equipments would not only illustrate the functional capabilities of an equipment type, but would also provide accurate quantitative data which could be extrapolated to the design-center case.

Upon receipt, the equipments were assembled and set up in an environment of the same type assumed for the Reconnaissance Technical Squadron (i.e., standard air-conditioned, office-storage type of environment).

Table 13

EQUIPMENT TYPES SELECTED FOR TEST

Material To Be Stored	File Type 1 Drawer	2 Vertical	3 Hanging	4 Open Shelf	5 Hardboard	6 Magnetic Tape
1. Roll Film				X		
2. Magnetic Tape						X
3. Maps	X	X	X			
4. Overlays	X	X	X			
5. Mosaics	X	X	X		X	
6. Photographic Prints	X	X		X		
7. Target Folders	X	X		X		
8. PI Keys		X		X		
9. Library Materials				X		

Table 14

REPRESENTATIVE EQUIPMENTS SELECTED FOR TEST

Manufacturer	Unit Title
1. Drawer Filing Units	
(1) Art Steel Company	Steelmaster Filing Cabinet
(2) Art Metal, Inc.	Planfile Drawer Unit
(3) Hamilton Manufacturing Company	Unit System File With Tracing Lifter
(4) Hamilton Manufacturing Company	Unit System File Without Tracing Lifter
2. Hanging File Units	
(1) Acco Products Company	Accoway Open Rack
(2) Globe-Wernicke Company	Cello-Clip Map and Plan File
(3) Hamilton Manufacturing Company	Vertical File
(4) Plan Hold Corporation	Wall Rack File
3. Hardboard Storage Units	
(1) Hamilton Manufacturing Company	Board Unit

Table 14 (Cont'd)

REPRESENTATIVE EQUIPMENTS SELECTED FOR TEST

Manufacturer	Unit Title
4. <u>Open Shelf Units</u>	
(1) Art Metal, Inc.	Open File Shelving
(2) TAB Products Company	Unit Spacefinder
(3) Laboratory Test Model	Wooden shelving, Roll axis vertical Multiple-can depth
(4) Laboratory Test Model	Wooden shelving, Roll axis horizontal Single-can depth
5. <u>Vertical File Units</u>	
(1) Art Metal, Inc.	Planfile

7.6 TEST OBSERVATIONS

7.6.1 General

The equipments which were obtained for test have been listed previously in Table 14. Figures 5 and 6 illustrate these equipments, with the exception of the Cello-Clip stand, the hardboard unit, and the vertical-axis roll film open wooden shelf — each of which will be separately shown later in the text.

In the material which follows, the units tested for a particular type of graphic material are tabulated and observations made during the tests of each unit are recorded. The presentation serves to identify each equipment, to illustrate graphically certain of the strengths and weaknesses, and to give observational data. Section 7.7 which follows gives the retrieval and refiling time test data and the results of this section and 7.7 are combined in the Equipment Evaluation of Section 7.8.

Fig. 5 Roll Film and Sheet Material Filing Equipment

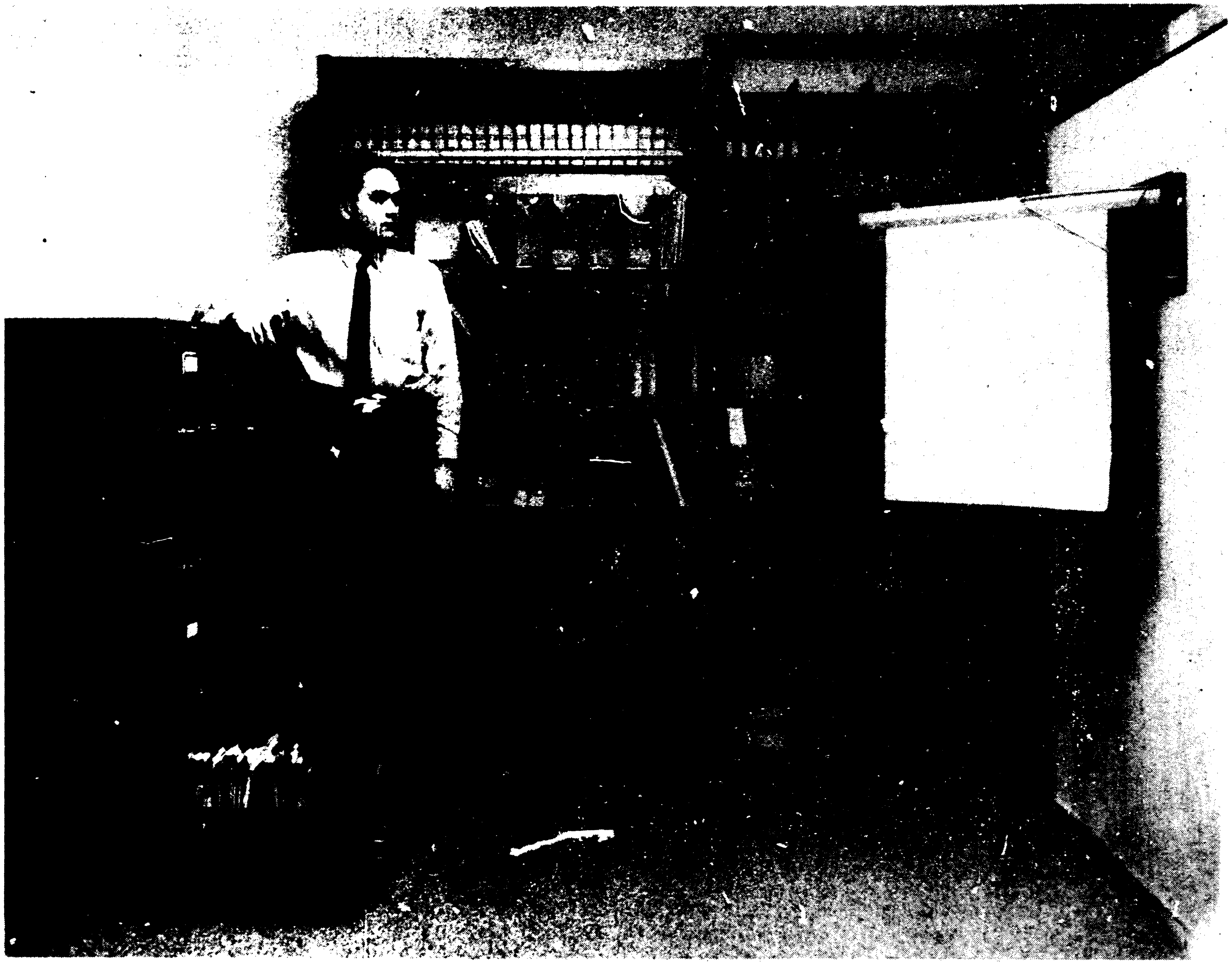

Fig. 6 Page-Size and General Library Filing Equipment

7.6.2 Roll Film Test Observations

The three sizes of roll-film cans used in the tests are illustrated in Figure 7. The storage equipments in which they were tested are listed in Table 15. Figures 8 through 10 illustrate the tests of horizontal roll axis, one-can deep tests in 7-can-high and 10-can-high configurations and illustrate can top pull-off. Figures 11 and 12 illustrate the situation with Art Metal, Inc., Open File Shelving. Figure 13 illustrates the manner in which the separators of this unit may be set to the desired dimension for roll film cans (or for other material as later presented). This adjustment can be made in terms of separators on the horizontal shelf or in terms of the separation between shelves, each in modular steps. Figures 14 and 15 illustrate the tests of vertical roll axis, two-can deep tests and show the practical difficulties of retrieval from the second row.

In the roll film retrieval and refiling tests, the cans were filled to a weight corresponding to a full roll — 20 pounds in the 9 1/2-inch case.

Specific observations include:

(1) Roll Axis Horizontal

When retrieving cans without using the handles, it was noted that cans had a tendency to slip out of the retriever's hands due to their weight and the lack of a gripping surface. The "high" cubicle from which film cans were retrieved was 58 inches from the floor. The "low" cubicle from which film cans were retrieved was 32 inches from the floor.

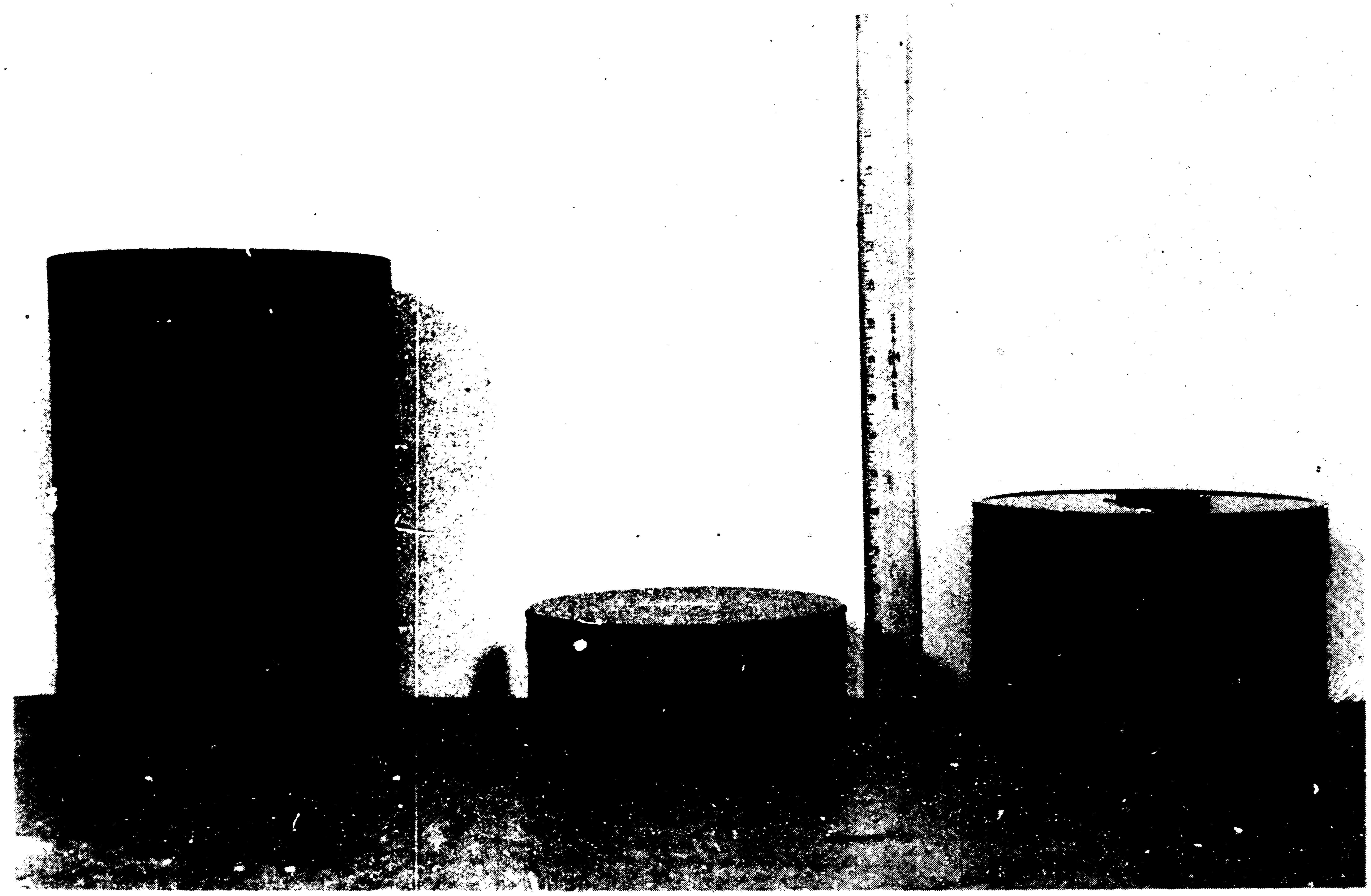

Fig. 7 Roll-Film Cans (Three Sizes)

Table 15

ROLL-FILM STORAGE EQUIPMENTS TESTED

1.	Art Metal, Inc.	Open File Shelving Roll axis horizontal Single-can depth
2.	Laboratory test model	Wooden shelving Roll axis horizontal Single-can depth
3.	Laboratory test model	Wooden shelving Roll axis vertical Multiple-can depth

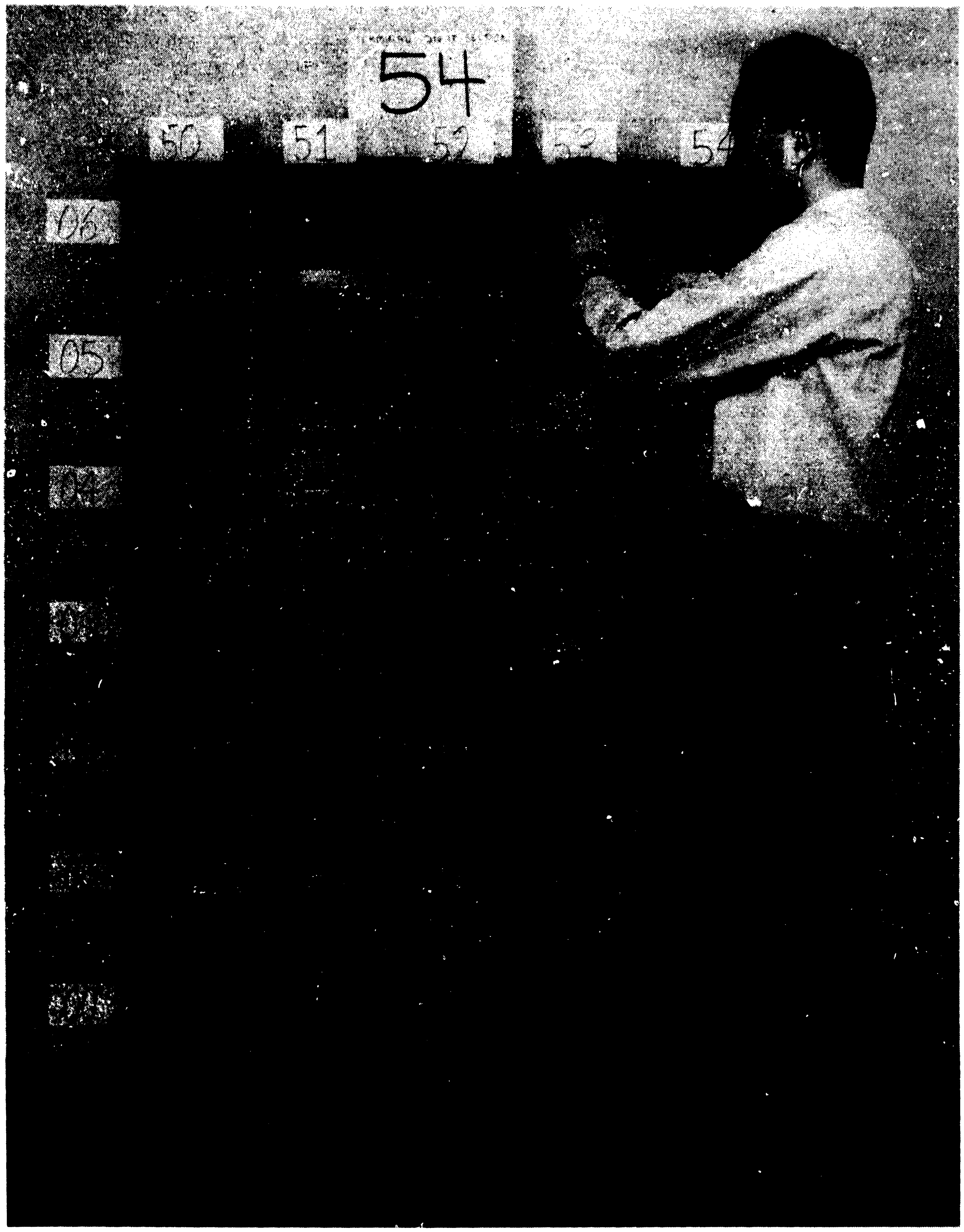

Fig. 8 Wooden Open-Shelf Roll-Film Horizontal File 7 High Configuration With Roll Axis Horizontal Illustrating Normal Reach

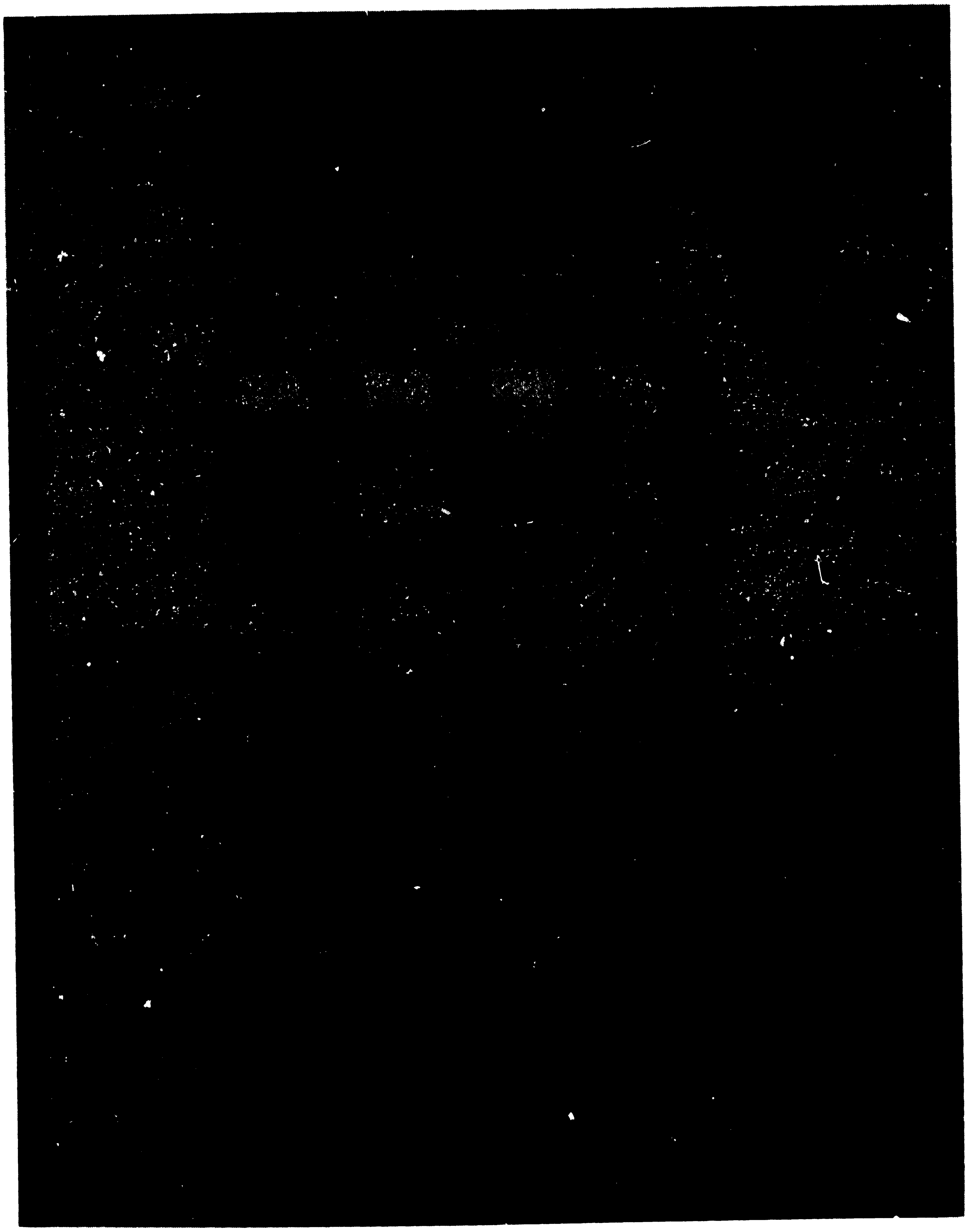

Fig. 9 Wooden Open-Shelf Roll-Film Horizontal File 10 High Configuration With Roll Axis Horizontal Illustrating Difficult Reach

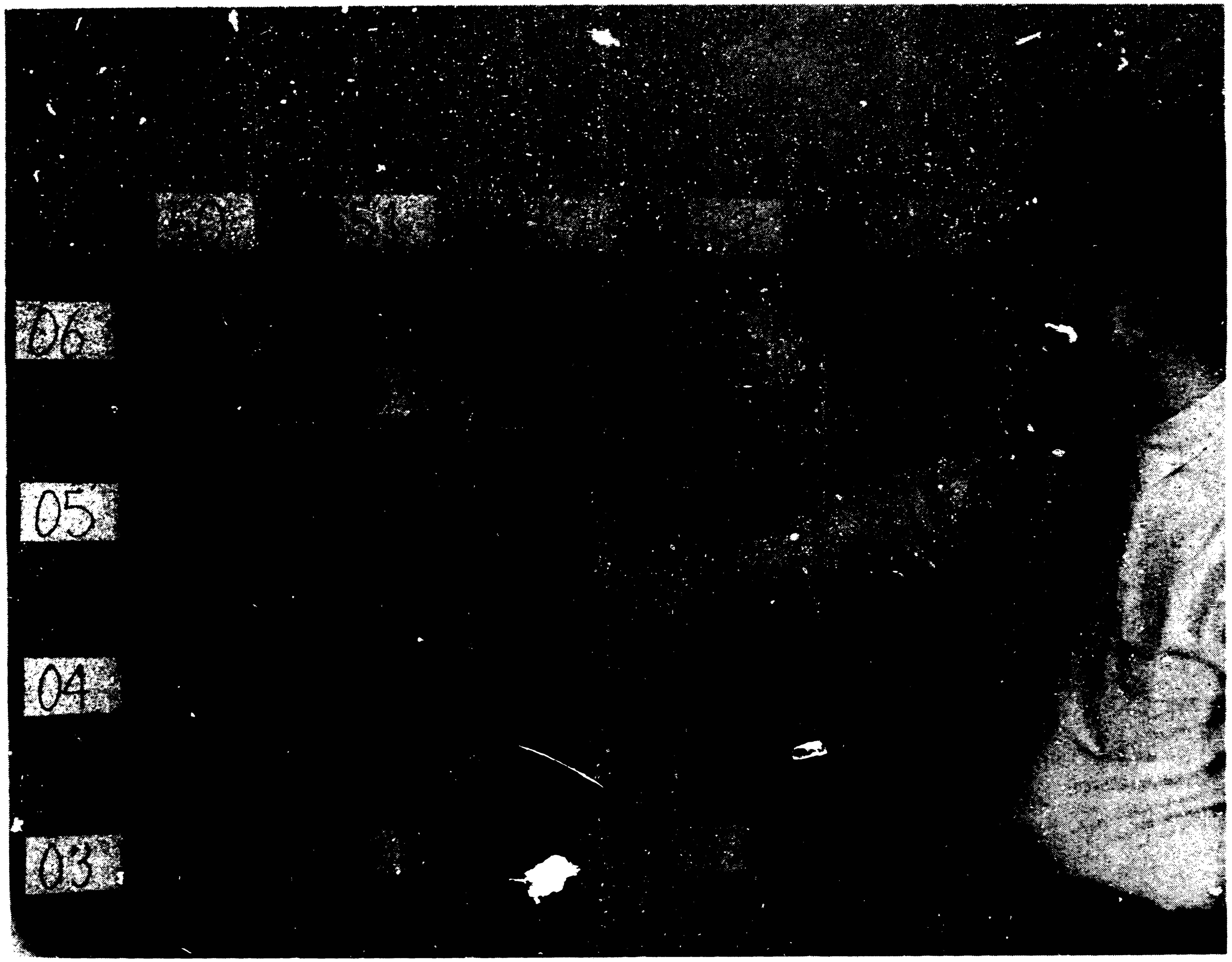

Fig. 10 Wooden Open-Shelf Roll-Film Horizontal File 7 High Configuration With Roll Axis Horizontal Illustrating Can Top Pull-Off

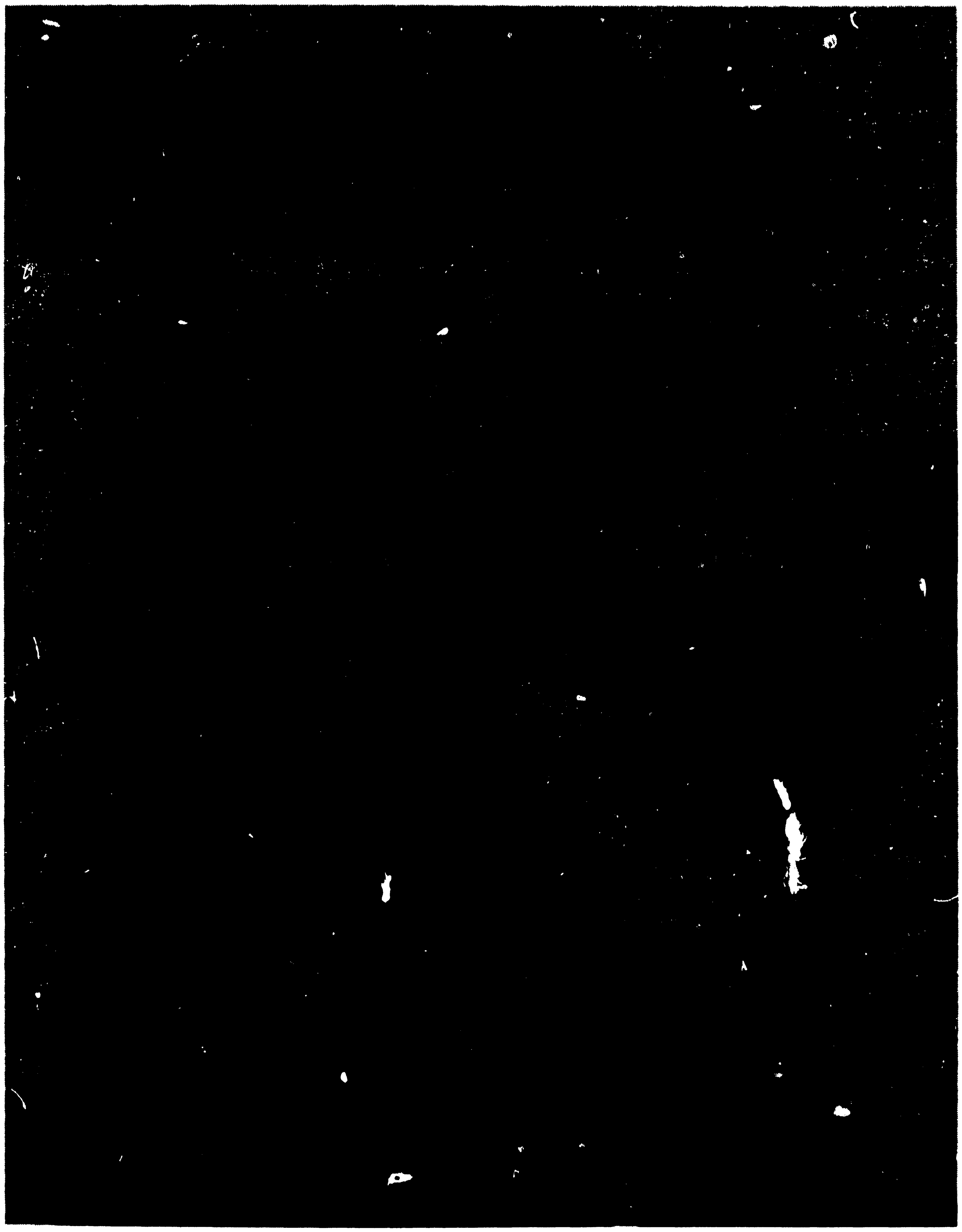

Fig. 11 Art Metal Inc. Open File Shelving With Roll Axis Horizontal Illustrating Normal Reach

Fig. 12 Art Metal, Inc. Open File Shelving With Roll Axis Horizontal Illustrating Difficult Reach

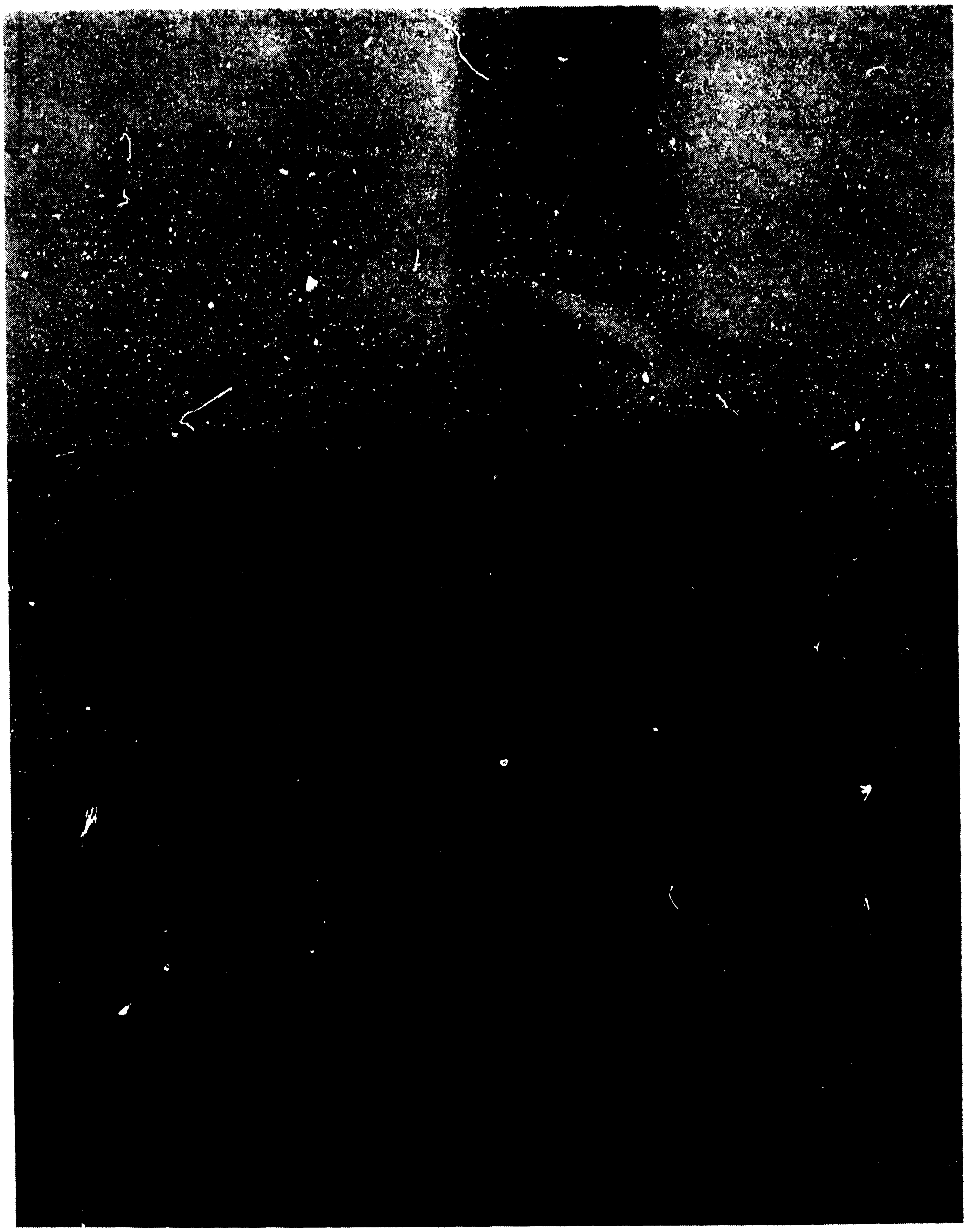

Fig 13. Art Metal, Inc. Open File Shelving — Illustrating Adjustment Method

Fig. 14 Wooden Open-Shelf Roll-Film Vertical File With Roll Axis Vertical Cans Two Deep Illustrating Front-Row Retrieval

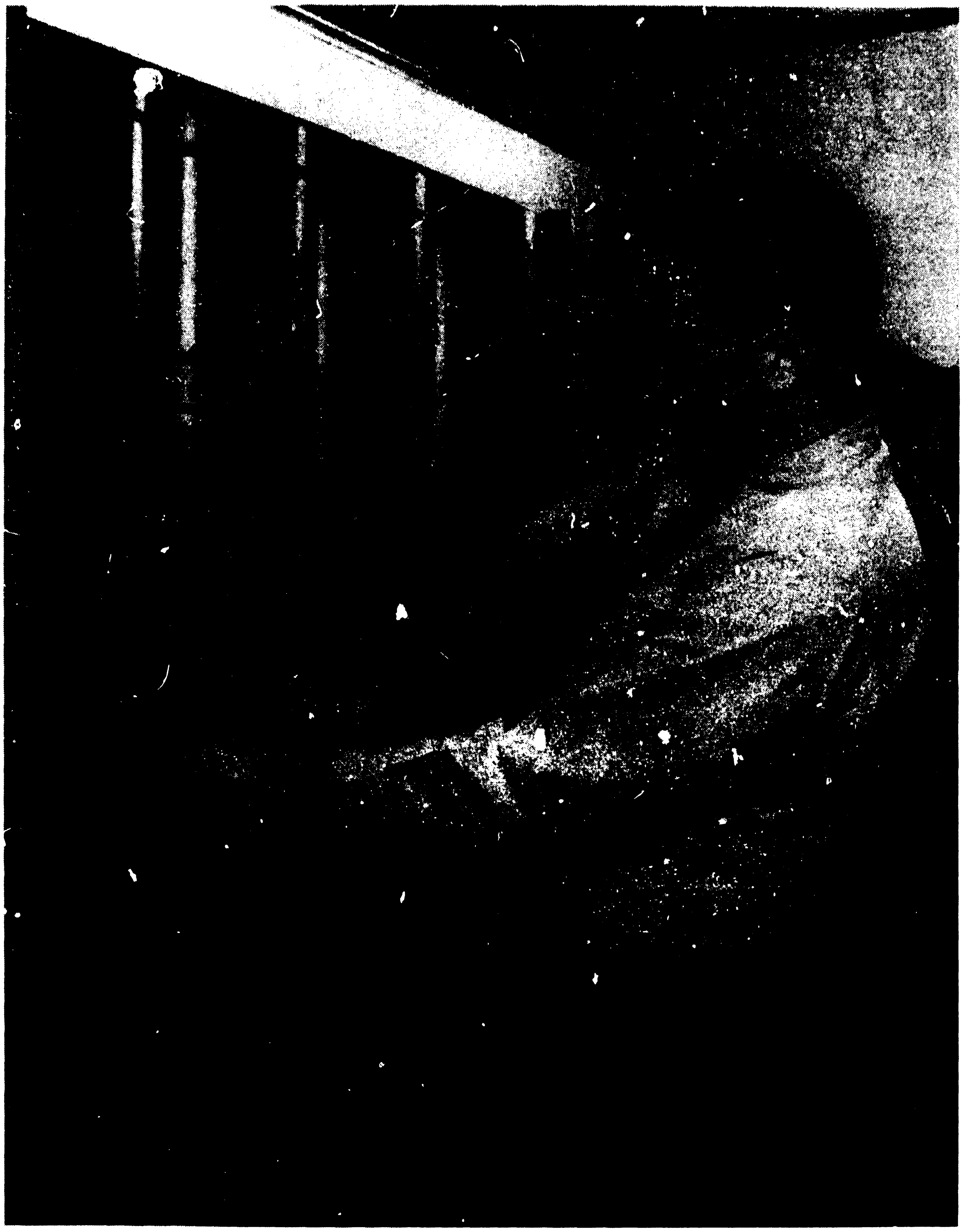

Fig. 15 Wooden Open-Shelf Roll-Film Vertical File With Roll Axis Vertical Cans Two Deep Illustrating Rear-Row Retrieval

(2) Roll Axis Vertical

Retrieving cans from the rear row was involved. The front can had to be removed and placed on the floor before attempting to retrieve the rear can. Following this, it was awkward to get one's fingers in and around the sides of the cans in order to remove the rear can (due to the clost packing of adjacent cans). Due to the lack of a gripping surface, cans had a tendency to slip out of the subject's hands because of their weight. The wooden shelves on which the roll-film cans were placed two deep were 36 inches from the floor.

7.6.3 Magnetic Tape Test Observations

Only one kind of storage equipment particularly adapted to magnetic tape (see top of TAB Products Company Unit Spacefinder previously presented in Figure 6 and later presented in Figure 56) was located. It was felt that none of the other generalized filing units (or adaptations thereof) would exceed the advantages of the individual cell wire rack method. Therefore, no comparative tests were run.

7.6.4 Map Test Observations

The various sizes of maps in the test materials inventory have been listed previously in Table 12. Selections from this inventory were used to test the equipments listed in Table 16. In the following paragraphs, each equipment is illustrated by photographs and operational observations are given.

Table 16

MAP STORAGE EQUIPMENTS TESTED

1.	Acco Products Company	Accoway Open Rack
2.	Art Metal, Inc.	Planfile
3.	Globe-Wernicke Company	Cello-Clip Map & Plan File with Wooden Holder
4.	Globe-Wernicke Company	Cell-Clip Map & Plan File with Individual Holders
5.	Hamilton Manufacturing Company	Unit System File with Tracing Lifter
6.	Hamilton Manufacturing Company	Unit System File without Tracing Lifter
7.	Hamilton Manufacturing Company	Vertical File
8.	Plan Hold Corporation	Wall Rack File

7.6.4.1 Acco Products Company

Accoway Open Rack with 50 Maps

Figure 16 illustrates the basic method of storage of 50 maps using two Acco fasteners. Figure 17 illustrates the type of tearing which can occur.

Other observations include:

(1) It is possible to cut fingers on the sharp edges of the Acco fasteners.

(2) The Acco fasteners, with repeated use, get bent due to folding and unfolding, and it is more difficult to slide the maps back onto the fasteners as they are used.

(3) With repeated removal, maps become sliced by the sharp edges of the fasteners.

(4) The maps furthest away from the top sheet became most difficult to remove and retrieve.

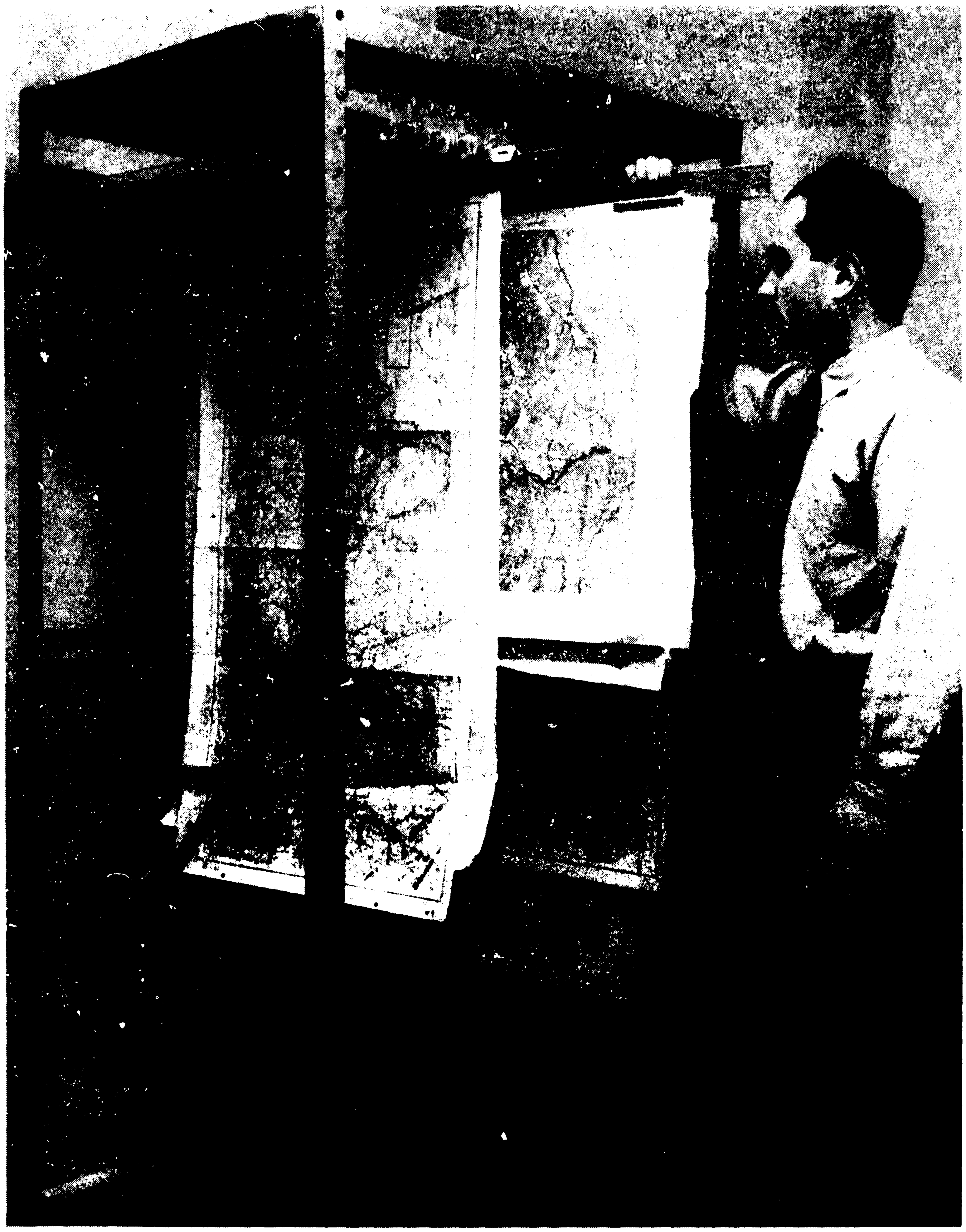

Fig. 16 Acco Products Company Accoway Open Rack With 50 Maps

Fig 17 Acco Products Company Accoway Open Rack Illustrating Tearing Due to Clips

7.6.4.2 Art Metal, Inc.

Planfile with 50 Maps

Figure 18 illustrates the basic method of storage of 50 maps. Figure 19 illustrates the spring loading structure into which the pocket folders slip to establish map compression.

Observations include:

(1) One subject caught his finger in the front shelf when closing this with one hand.

(2) Folders should be pulled out so that at least 2 inches remain in the pocket. If the folder is pulled out entirely, it is much more time-consuming to put it back into its proper location

(3) When retrieving maps from the rear pockets, it is not necessary to lift up the shelf.

(4) Maps were held by one hand after they had been located and the remainder of the folder was lowered back into the file.

(5) It is difficult to refile maps in the rear of the unit because maps are not able to fan backwards.

(6) The top of the unit is 36 inches from the floor.

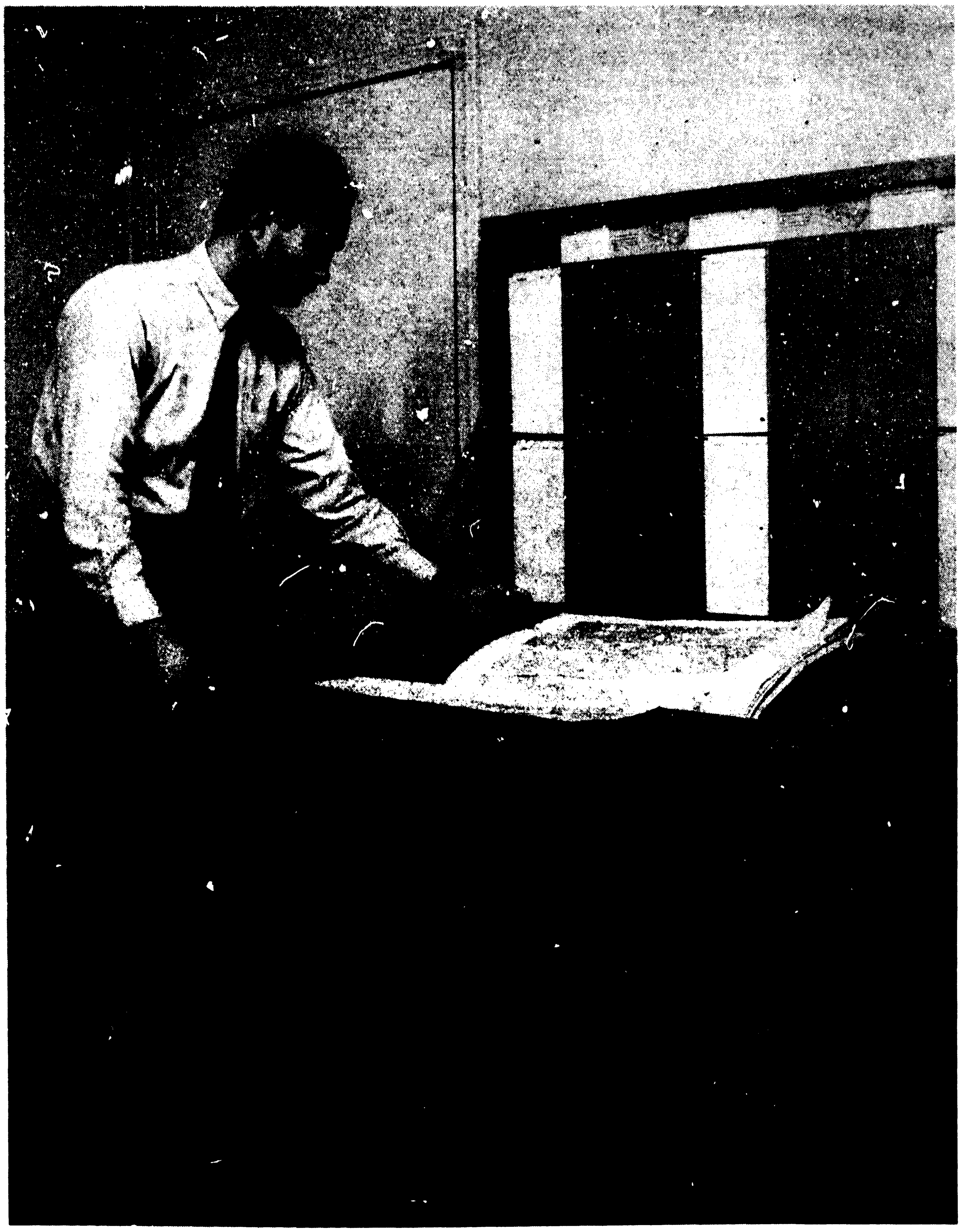

Fig. 18 Art Metal, Inc. Planfile With 50 Maps

Fig. 19 Art Metal, Inc. Planfile

Illustrating Structure and Spring Loading

7.6.4.3 Globe-Wernicke Company

Cello-Clip Map & Plan File

Using Wooden Group Holder for 50 Maps

Figure 20 illustrates the basic method by which both the wooden group holder and the individual group holders are suspended in hanging file form. Figure 21 illustrates the wooden group holder alone, in a detached condition.

Observations include:

(1) When refiling or retrieving, a table is required to lay the group-holder and maps down.

(2) There is some difficulty in pulling up maps on the threaded screws. They have a tendency to catch.

(3) It was necessary repunch the holes with a very large punch in order that maps might have freedom to slide up and down on the screw threads.

(4) Retrieval is speeded up if the maps to be removed from the pile are tightly held in one hand and lifted up as a group. The desired map is then removed and the group replaced on the unit.

(5) Frequently, however, one map will get out of alignment which will require carefully replacing small groups of maps onto their proper threaded screws.

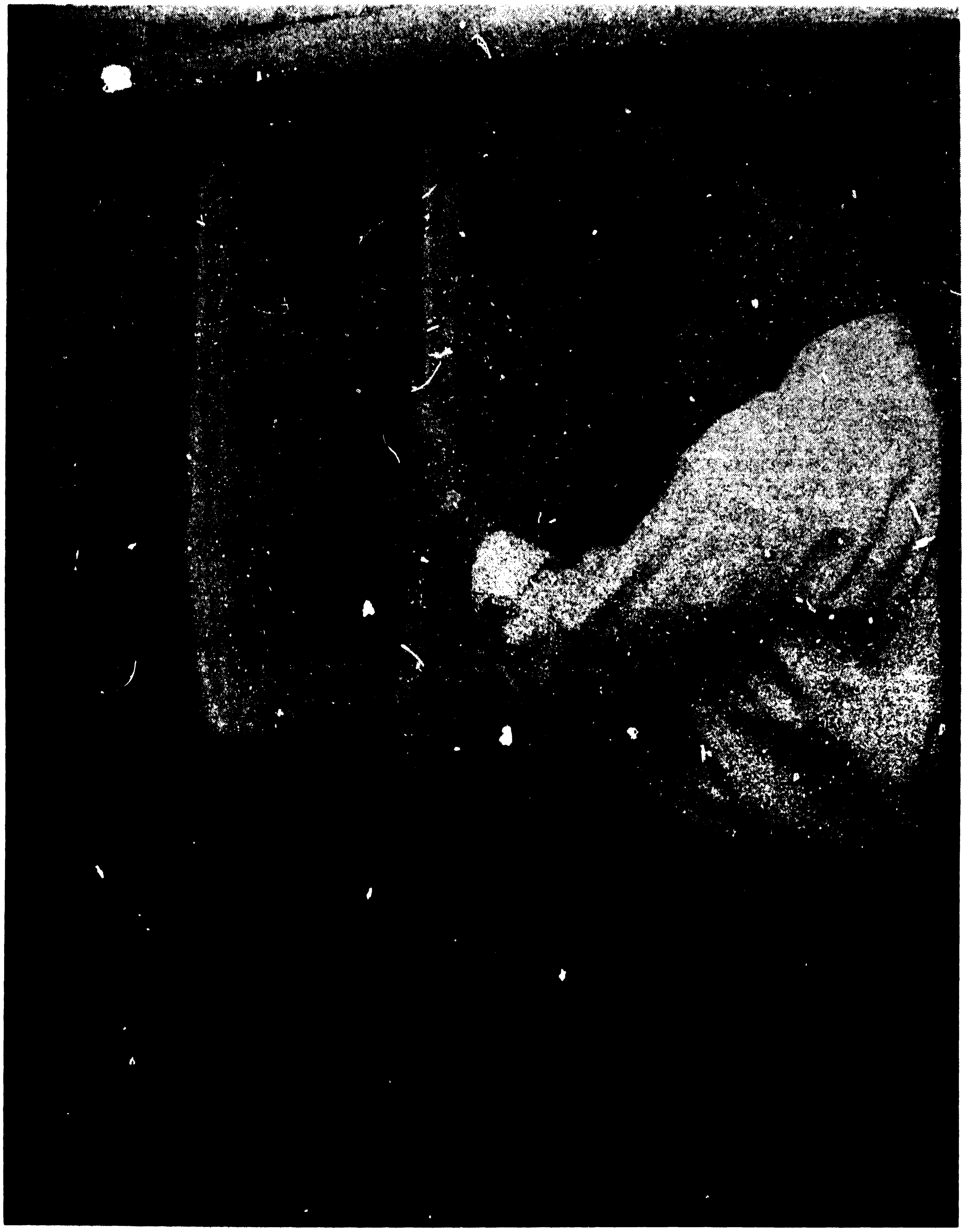

Fig. 20 Globe-Wernicke Company Cello-Clip Map & Plan File Illustrating Wooden Group Holder and Individual Holders

Fig. 21 Globe-Wernicks Company Cello-Clip Map & Plan File — Illustrating Wooden Group Holders

(6) The maps had a tendency to tear at the holes.

(7) Maps have a tendency to get damaged by placing them on the table. (This is true for all systems where a table is required and maps are laid down as a group.) This is caused because the bottom few maps may easily become folded up under the pile, creasing them, without this being recognized.

(8) The Cello-Clip holders were 70 inches from the floor.

7.6.4.4 Globe-Wernicke Company

Cello-Clip Map & Plan File

Using Individual Group Holders for 50 Maps

Figure 20, previously presented, has illustrated the method of suspension in hanging file form. Figure 22 illustrates the individual holder method of group hanging, in detached condition. Figure 23 illustrates map tearing resulting from holder application.

Observations include:

(1) In both refiling and retrieval tests, it took longer using the three individual Cello-Clips than it did using the wooden group holder because extra handling of three individual Cello-Clips was required.

(2) There is some difficulty in restarting the screwing of the wing nuts.

(3) Maps must be held as a group when lifting off screws in order that they will be in order and the holes lined up for replacement.

(4) On both the wooden group holder and the individual group holders, the items closest to the top sheet can be retrieved and refiled more rapidly than those further down.

Fig. 22 Globe-Wernicke Company Cello-Clip Map & Plan File Illustrating Individual Holders

Fig. 23 Globe-Wernicke Company Cello-Clip Map & Plan File Illustrating Map Tearing

7.6.4.5 Hamilton Manufacturing Company
Unit System File with Tracing Lifter
with 100 Maps

Figure 24 illustrates the basic nature of this unit. Figure 25 shows the tracing lifter action as an aid in holding the overburdened maps while selecting an individual map. Figure 26 illustrates a type of map creasing damage which may occur when maps shift into the zone of the tracing lifter.

Observations include:

(1) It was discovered that it was not necessary to fully use the tracing lifter in order to remove maps. Rather than locking it in place, it was only necessary to fold the maps back over the tracing lifter and to lift it up with one hand to take the weight off the maps which were being removed or replaced in the file.

(2) In tests where 100 Geological Survey maps were placed in one pile, no additional difficulty was noted in removing or replacing the higher numbered maps.

(3) The tracing lifter had a tendency to jam when being lifted from one side. It was necessary to use one hand to lift the tracing lifter from one side since the other hand would be holding a map (tables were not used in this test).

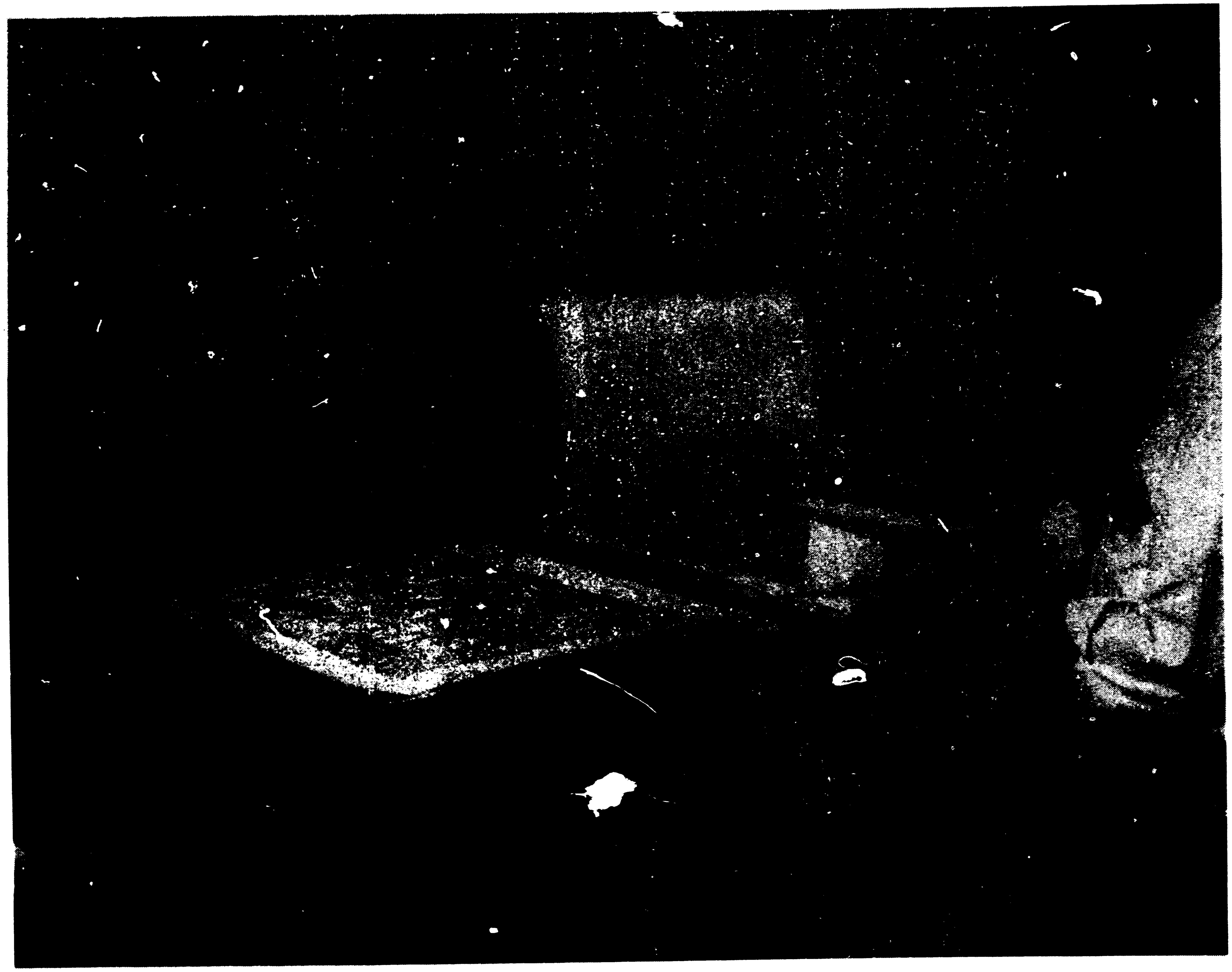

Fig. 24 Hamilton Manufacturing Co. Unit System File With Tracing Lifter With 100 Maps

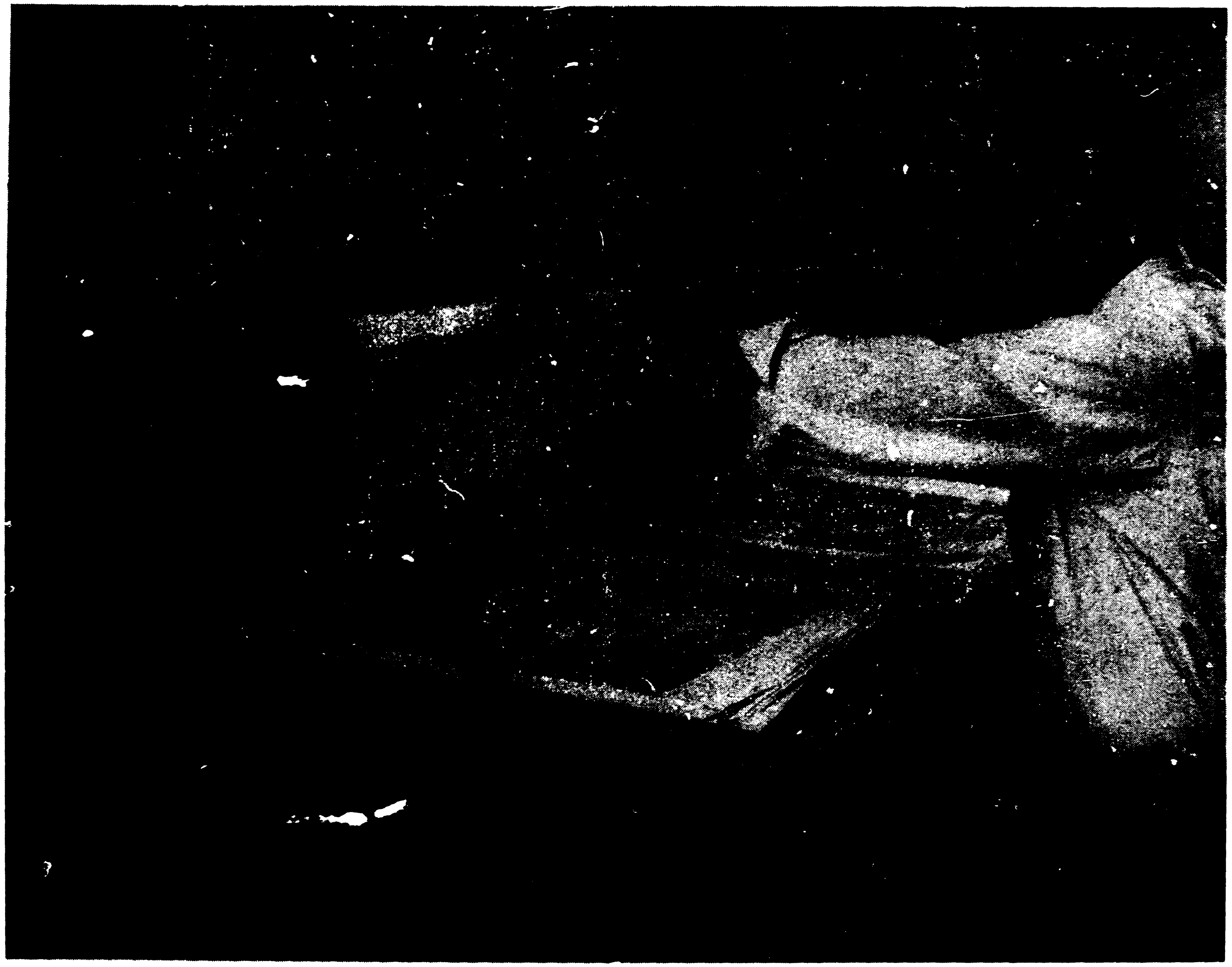

Fig. 25 Hamilton Manufacturing Co. Unit System File With Tracing Lifter With 100 Maps Illustrating Tracing Lifter Action

Fig. 26 Hamilton Manufacturing Co. Unit System File With Tracing Lifter With 100 Maps Illustrating Map Creasing

(4) All items were retrieved from and refiled in a drawer 46 inches from the floor.

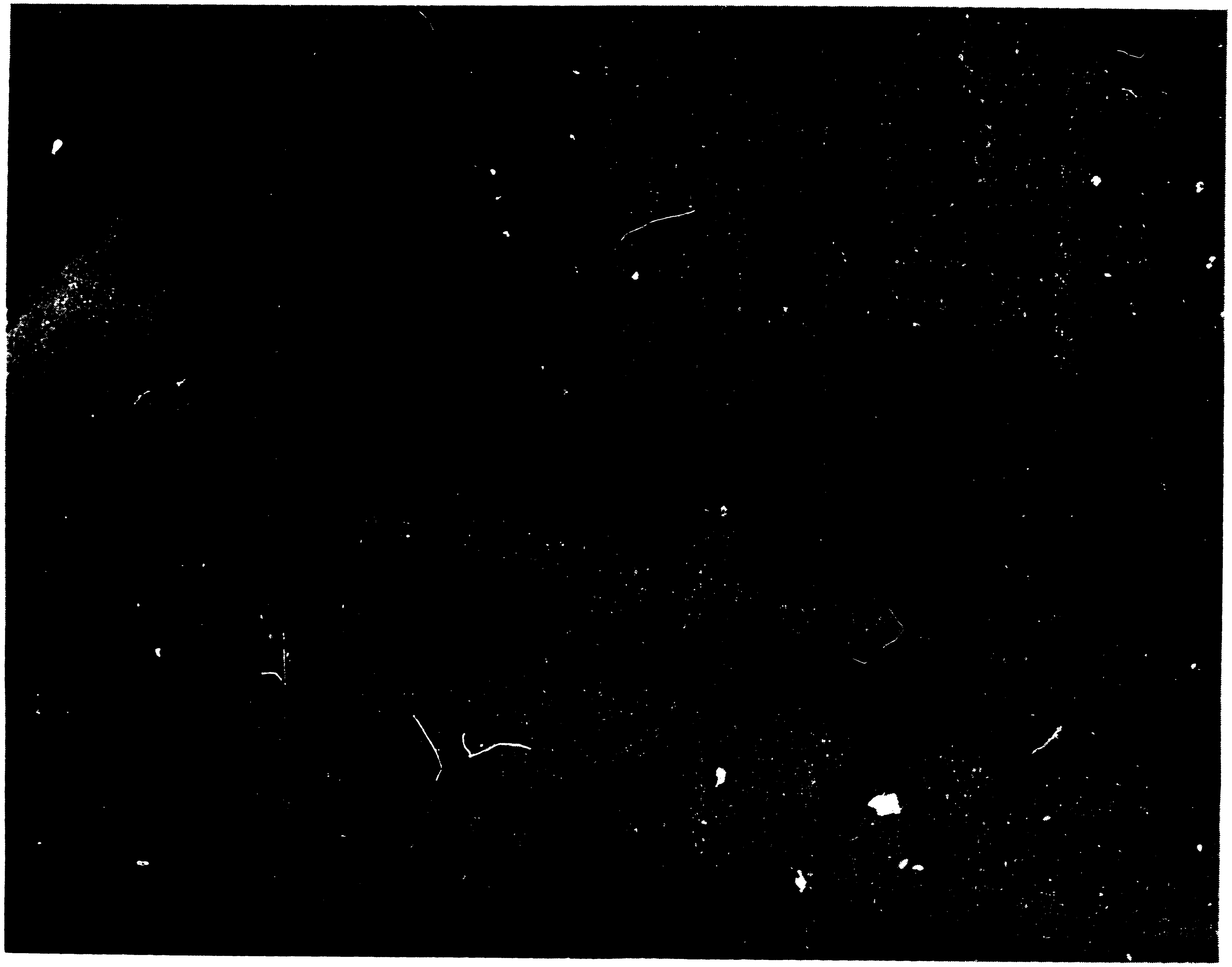

Fig. 27 Hamilton Manufacturing Co. Unit System File Without Tracing Lifter With 100 Maps

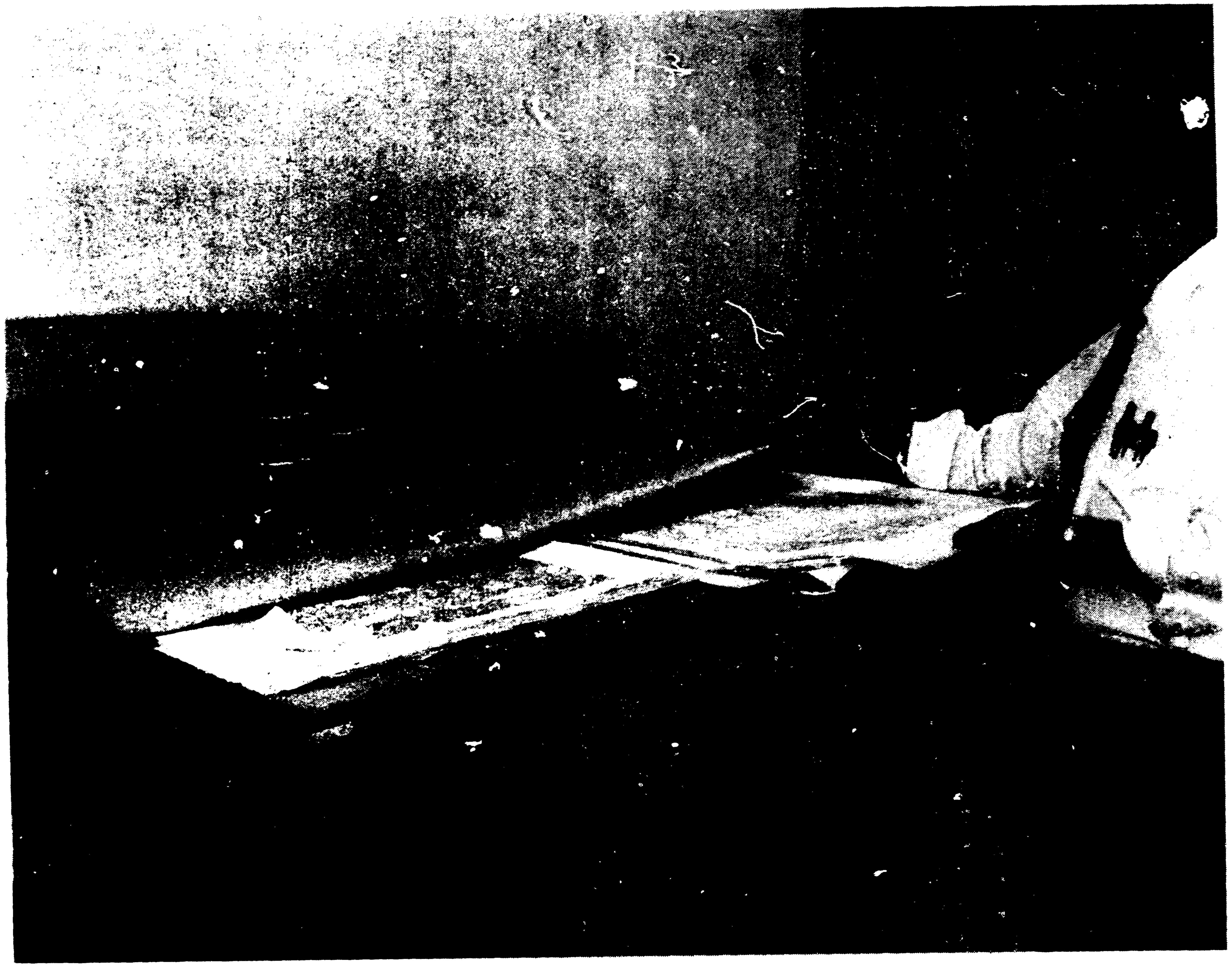

Fig. 28 Hamilton Manufacturing Co. Unit System File With Tracing Lifter With 100 Maps Illustrating Map Sliding

7.6.4.6 Hamilton Manufacturing Company

Unit System File without Tracing Lifter

with 100 Maps

Figure 27 illustrates the basic nature of this unit. It is identical to the preceding unit except the absence of the tracing lifter has been simulated. Figure 28 illustrates forward sliding of maps — a feature common to flat, horizontal drawer filing with or without tracing lifters.

Observations include:

(1) Maps were placed inside a kraft paper 3-edge-open envelope on top of the tracing lifter to simulate normal horizontal drawer filing.

(2) Both subjects used a "tracing lifter" principle in that drawings were rolled back and lifted with one hand while the desired map was withdrawn or refiled with the other hand.

(3) When retrieving maps with higher numbers, it was difficult to lift up the entire pile of maps.

(4) Maps have a tendency to come forward upon return to the horizontal when they have been rolled up in order that a map might be retrieved. It was necessary to take additional time to align and push back maps in order that the drawer would properly close.

(5) Retrieval of maps took substantially less time without the tracing lifter than it did using the tracing lifter (31 to 21 seconds). Refiling of maps took approximately the same time for both principles used.

(6) All items were retrieved from and refiled in a drawer 46 inches from the floor.

7.6.4.7 Hamilton Manufacturing Company

Vertical File

Figure 29 illustrates the basic nature of this unit. Figures 30 and 31 illustrate the difference in packing in an individual rack caused by 100 and 50 maps, respectively. Figures 32, 33, and 34 illustrate problems associated with this unit with either loading factor.

Observations relating to the 100-map case include:

(1) Due to the construction of this particular unit, possibly a manufacturing tolerance problem, the rack hangers did not fit securely inside. Care must be taken not to slam the unit back into the cabinet or all the racks will slip down to the floor (Figure 33).

(2) The index card-holder which identifies each rack interferes with turning the nuts with the wrench.

(3) The wrench has a tendency to slip down below the surface of the nut (Figure 34).

(4) After loosening the nuts and pulling out a single map, the maps surrounding it have a tendency to come forward because the jaws do not open sufficiently far to fully free 100 maps (Figure 30).

(5) 100 maps are very heavy to hold and do not easily slide into position.

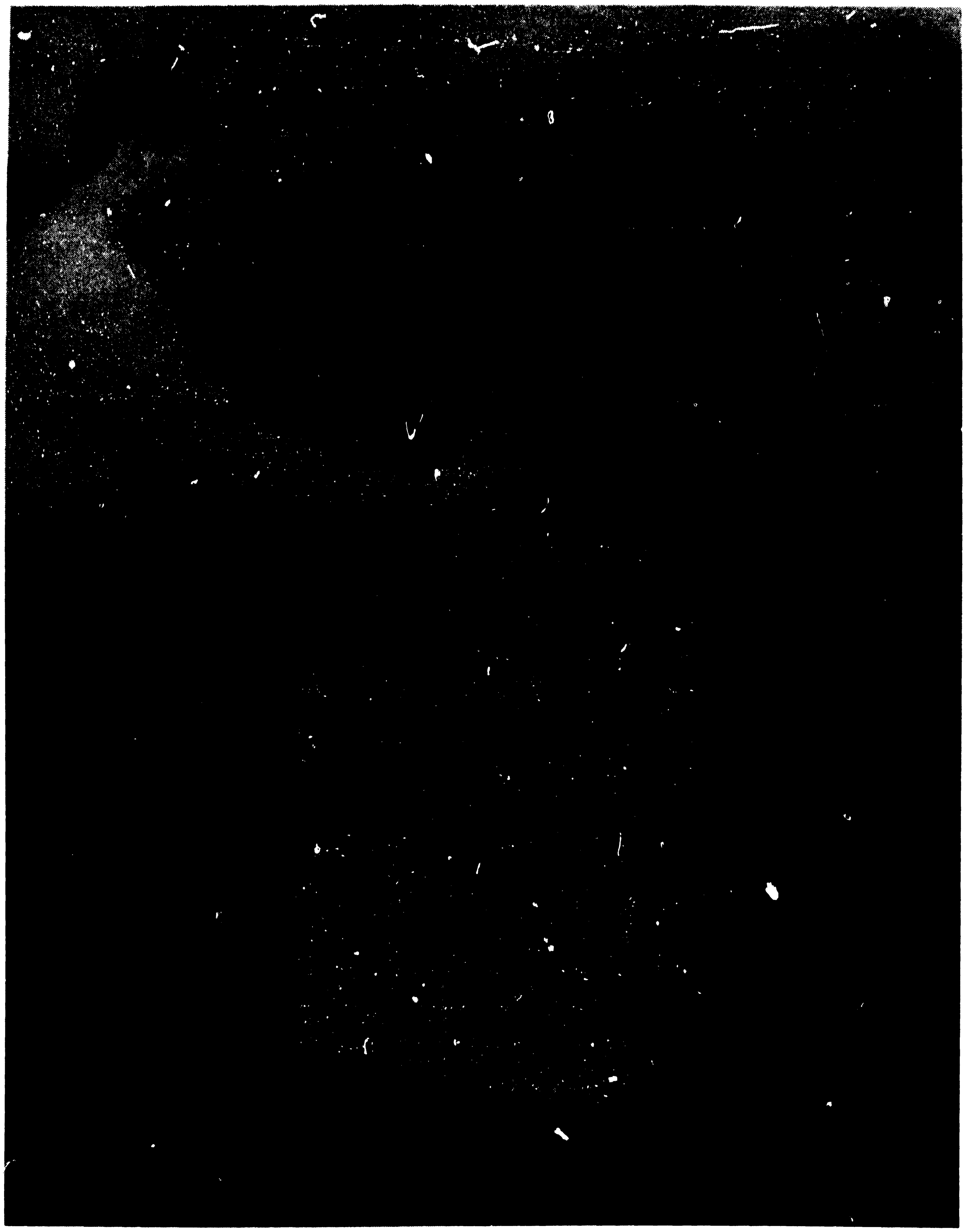

Fig. 29 Hamilton Manufacturing Co. With 100 Maps
Vertical File

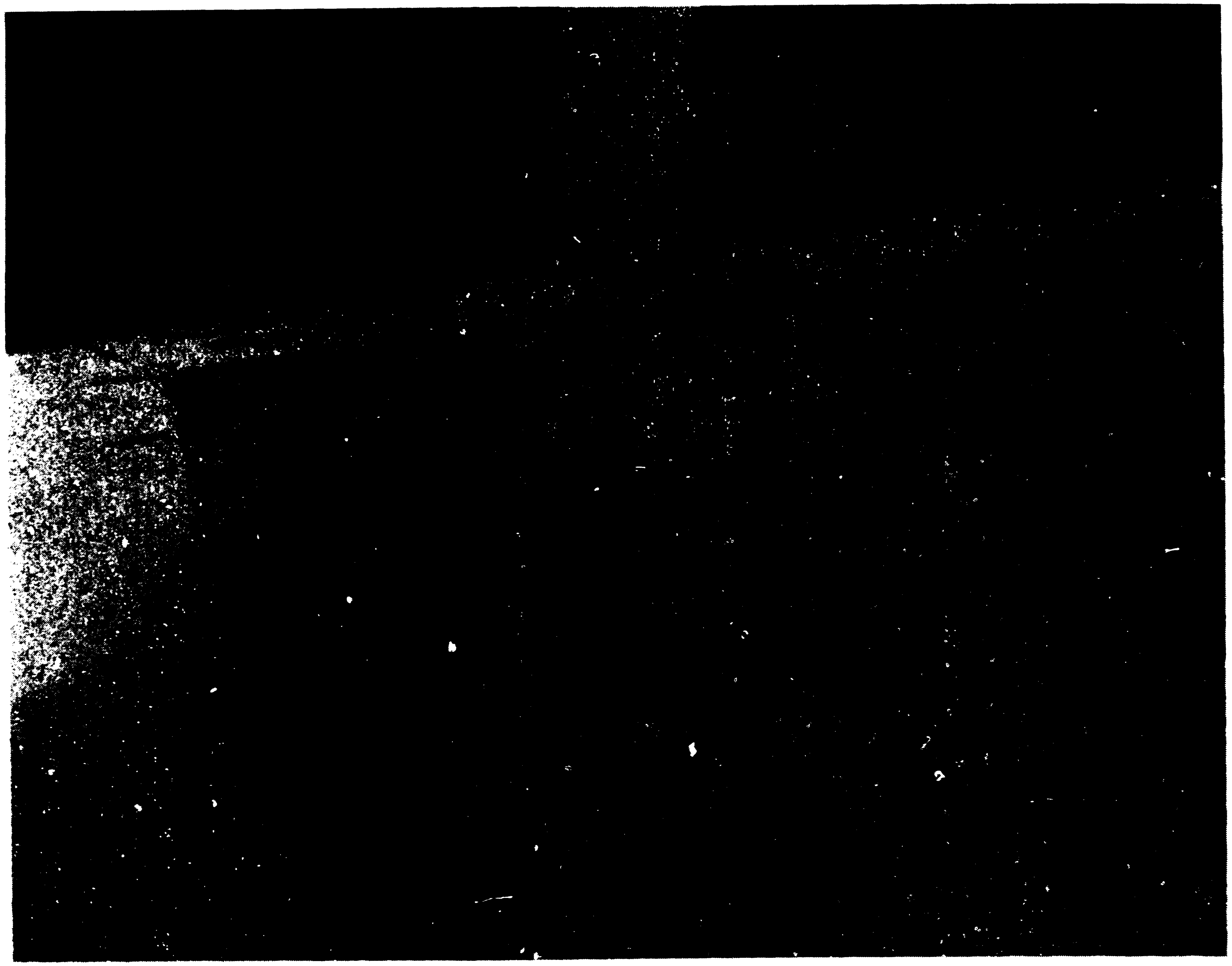

Fig. 30 Hamilton Manufacturing Co. Verticle File Individual Holder With 100 Maps

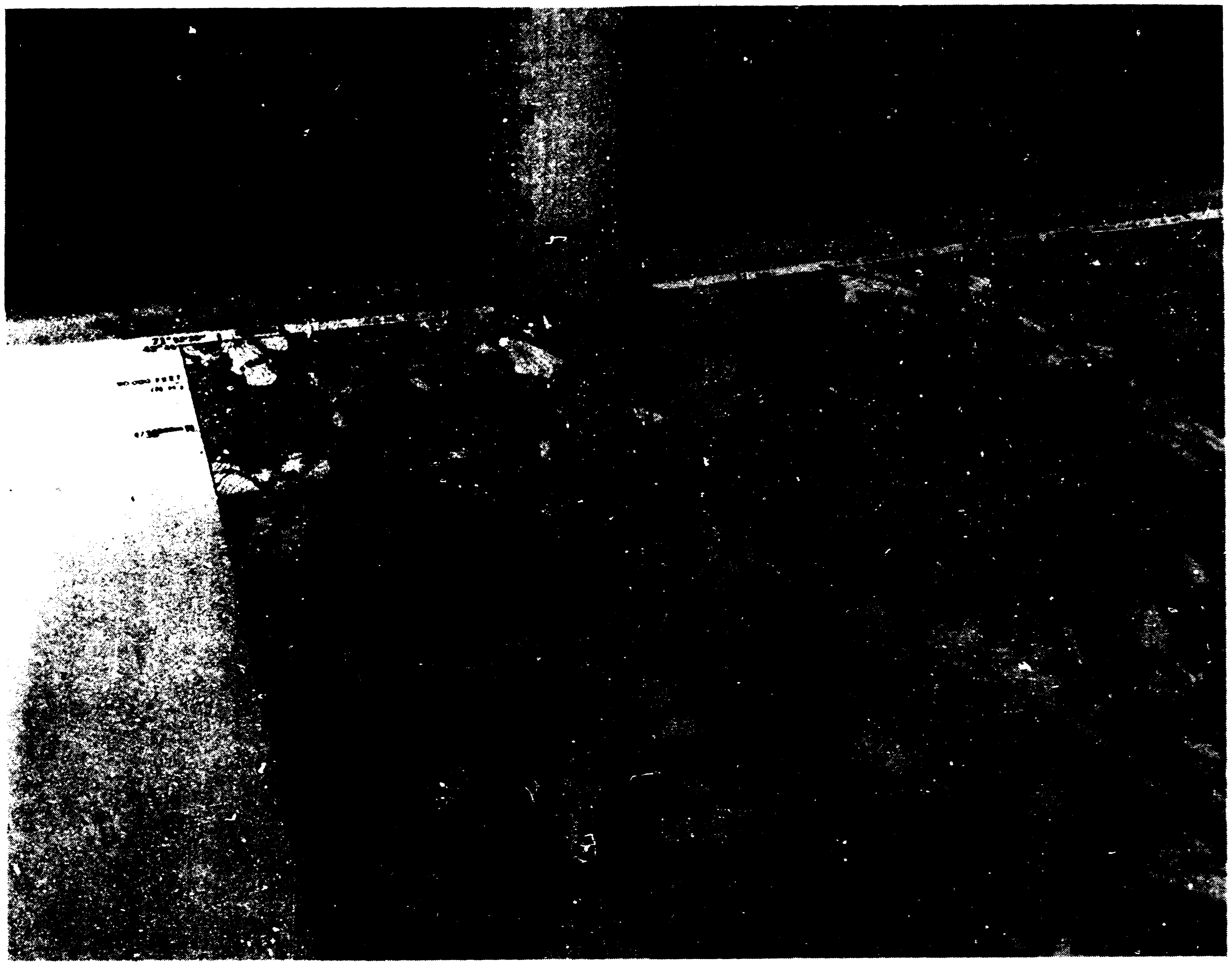

Fig. 31 Hamilton Manufacturing Co. Verticle File Individual Holder With 50 Maps

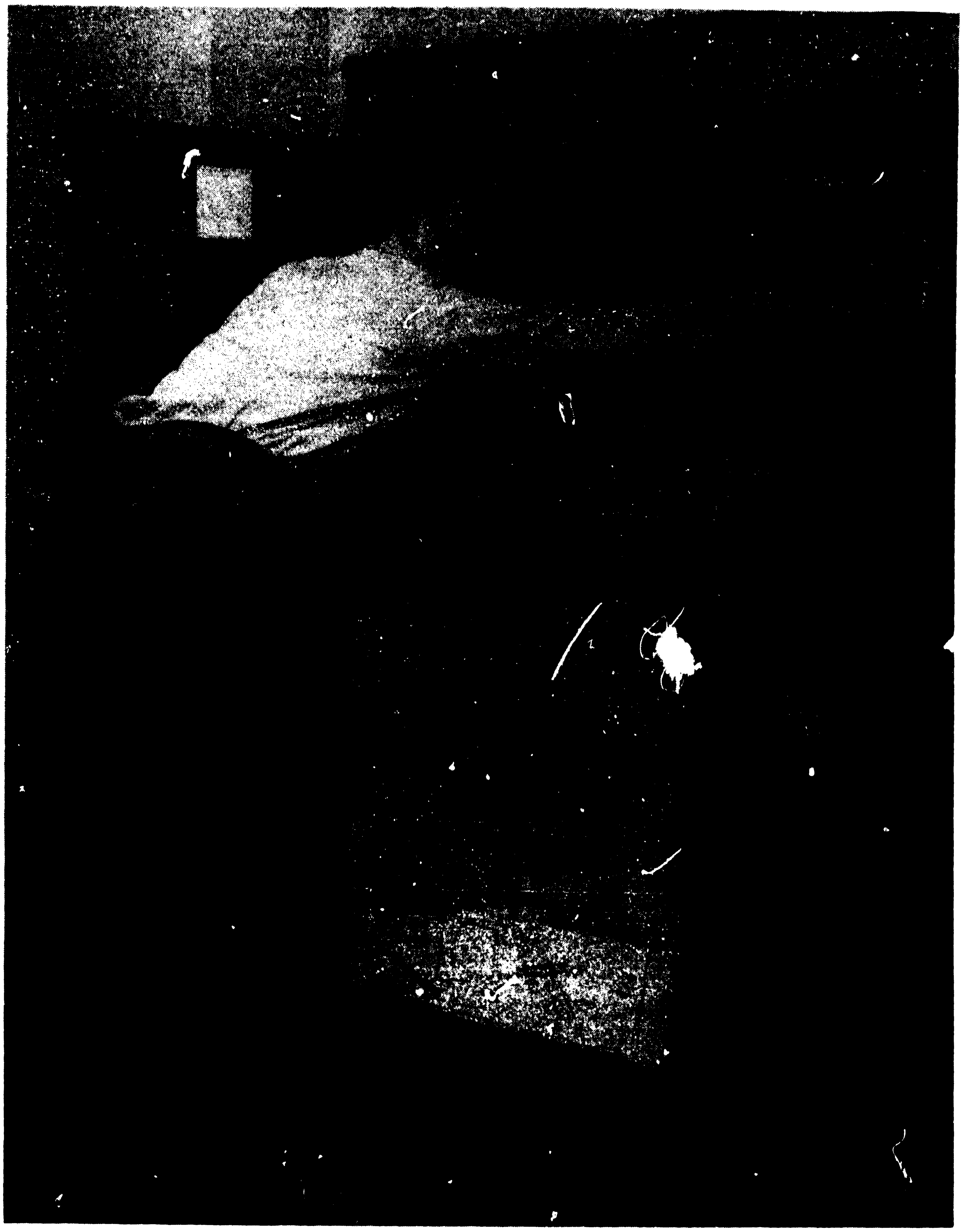

Fig. 32 Hamilton Manufacturing Co. Vertical File — Illustrating Difficult Reach

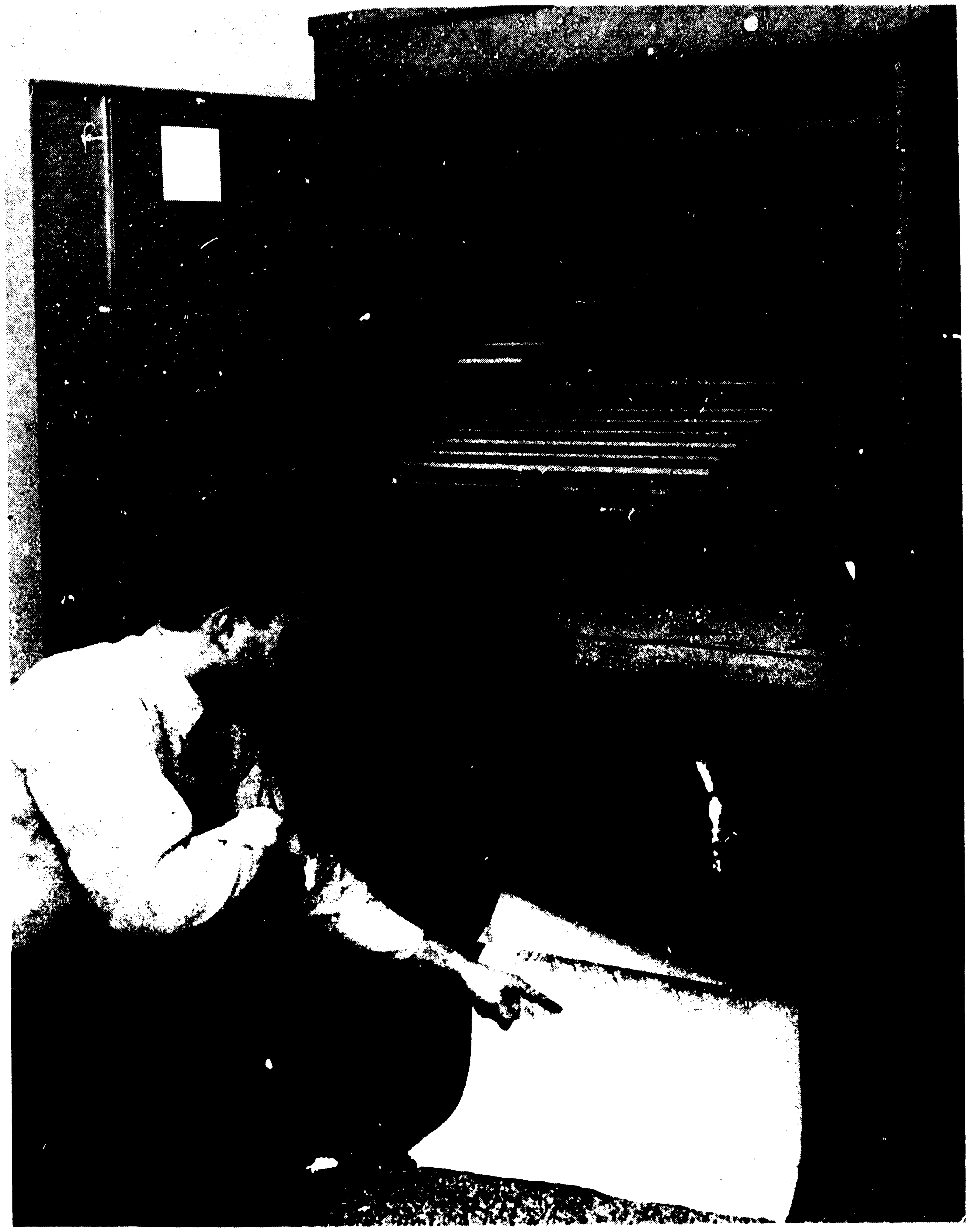

Fig. 33 Hamilton Manufacturing Co Vertical File — Illustrating Fallen Rack

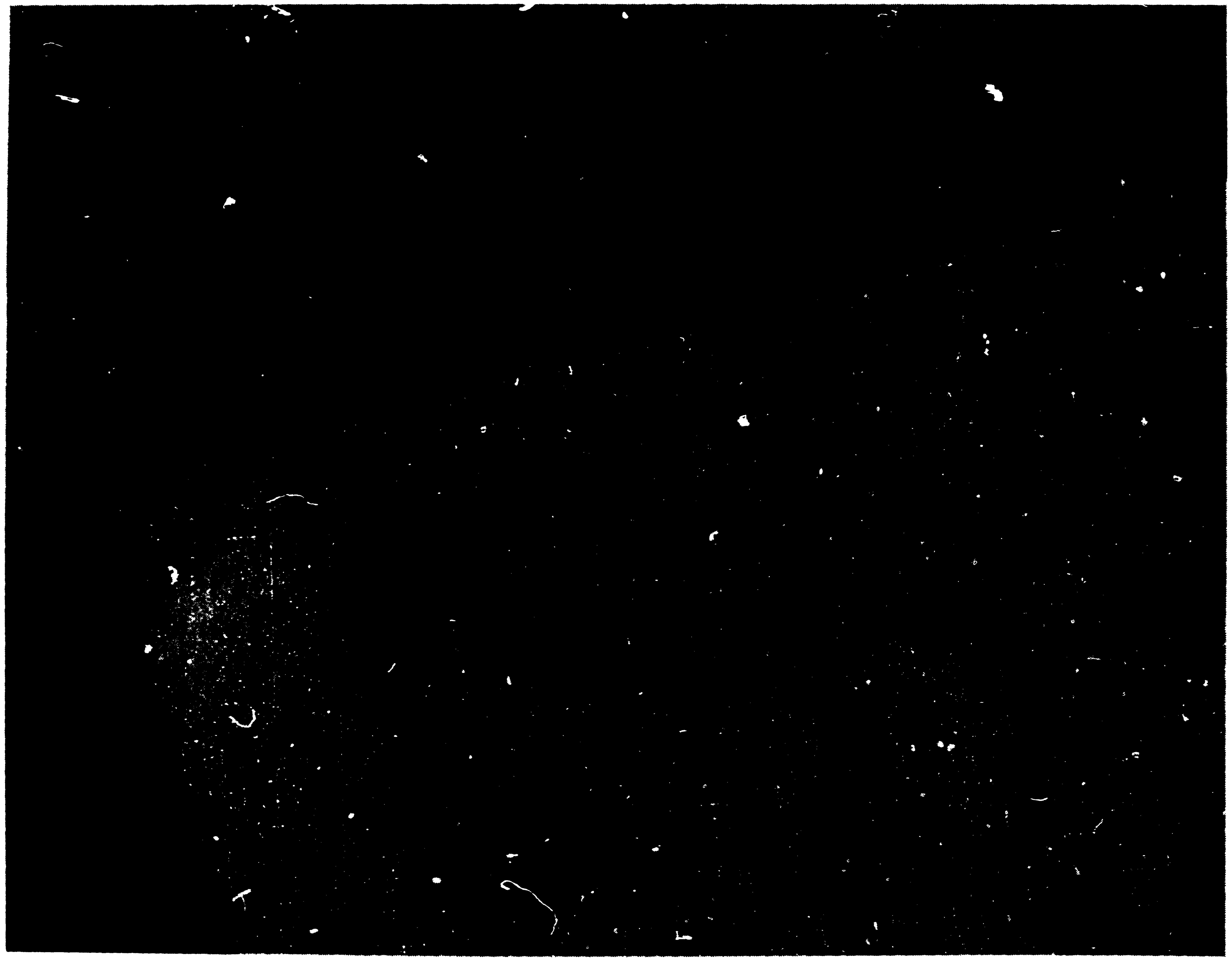

Fig. 34 Hamilton Manufacturing Co. Vertical File Illustrating Wrench & Nut Problem

(6) On occasion maps fell to the floor when the rack was placed into position (Figure 33).

(7) Maps were torn putting them back into the rack when the maps caught on the nuts of the rack immediately preceding it.

(8) If all maps pull out of the holder, additional time must be taken to re-align and place them back into the jaws.

(9) There is no way of knowing whether the maps are positively held. The rack must be jiggled to see whether any maps fall down.

(10) Cabinet doors must be open beyond the width of the racks in order that the rack unit, when pulled out, will not catch on the doors.

(11) The wrench raises burrs on the nuts. Fingers were cut by the burrs sharp edges.

(12) The maps in the rear of the pile were badly damaged.

(13) Maps which were of an odd size and larger than most other maps were torn and damaged on the edges.

(14) Due to the design of the cabinet, positions #16 through 26 are located too far back on the rack to facilitate ease of retrieval (Figure 32). The reach requirement for the last rack is 36 - 1/2 inches which exceeds the recommended reach limit of 26 - 1/2 inches by10 inches.

(15) A test whereby all of the maps were covered with a kraft paper envelope 2 inches longer and 2 inches wider than all the maps did not substantially increase the retrieval or refiling time (see Test Data Sheets). This is probably so because most of the time is taken up with actually unscrewing the nuts and removing the map. Kraft paper would, however, protect some of the maps from becoming scratched or torn.

(16) The racks in the center of the unit were 48 inches from the floor.

Observations relating to the 50-map case include:

(1) It was considerably easier to lift, file, and retrieve the the rack which contained 50 maps than it was with the rack that contained 100 maps.

(2) The jaws opened sufficiently in the refiling and retrieval of 50 maps (Figure 31) so that sliding out a single map is not the problem that it was with 100 maps (Figure 30).

7.6.4.8 <u>Plan Hold Corporation</u>

<u>Wall Rack File</u>

Figure 35 illustrates the basic nature of this unit. Figure 36 illustrates the jaw capacity.

Observations relating to 100-map loading include:

(1) The jaws do not open easily for the insertion of 100 maps.

(2) 100 maps are difficult to lift out of the unit.

(3) When pulling out a map on the bottom of the pile, maps come along with it which had to be replaced in the jaws.

(4) When 100 maps were placed on a table, there was a tendency to dog-ear the bottom maps.

(5) All maps above the map being retrieved frequently had to be removed to get at the map required.

(6) Some difficulty was experienced in removing the rack from the hanging unit.

(7) Extra time must be taken to make sure nuts are aligned parallel to the rack in order for it to properly go back on the hanger.

(8) The top of the Wall Rack File was 62 inches from the floor.

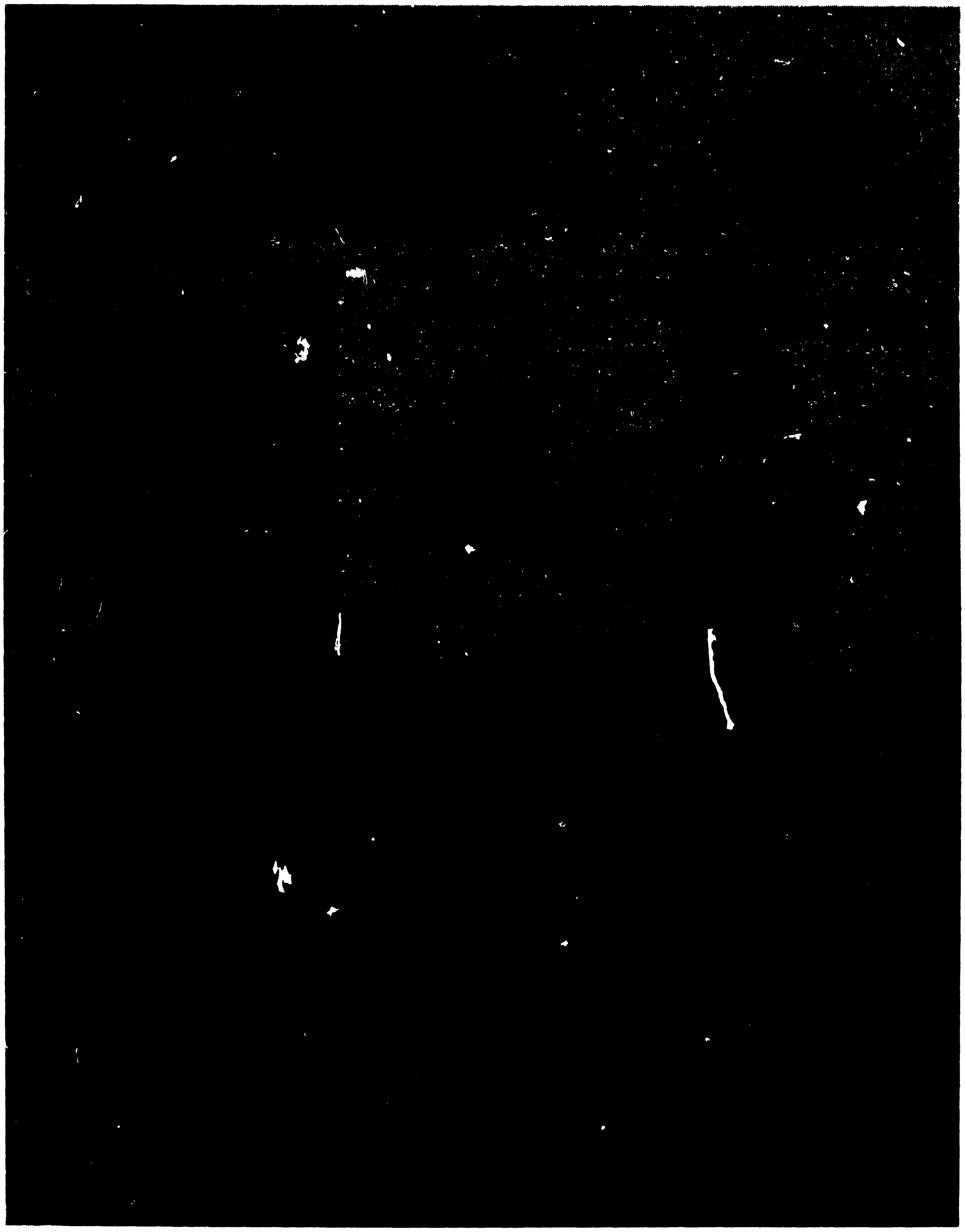

Fig. 35 Plan Hold Corporation Wall Rack File With 100 Maps

Fig. 36 Plan Hold Corporation Wall Rack File
With 50 Maps Illustrating Jaw Capacity

Observations relating to 50-map loading include:

(1) It was considerably easier to lift 50 maps than it was to lift 100 maps.

7.6.5 Overlay Test Observations

The 100 sheets of acetate listed in the Test Materials Inventory, Table 12 presented previously, were used in this set of tests. The equipments used in the testing are listed in Table 17. In the following paragraphs, each equipment is illustrated by photographs and operational observations are given.

A problem common to all methods of storage is that of "backed" or "unbacked" identification numbers on the overlays. Figure 37 illustrates this difference — by comparing India-ink numbers on the acetate sheets with and without a masking tape applied to the side of the overlay opposite the one on which the numbers have been applied. As a general observation, ease and speed were both improved with the backed numbers — quite significantly, as is evidenced by the figures received for retrieval and refiling times (see Section 7.7, Test Results).

Table 17

OVERLAY STORAGE EQUIPMENTS TESTED

1.	Art Metal, Inc.	Planfile
2.	Hamilton Manufacturing Company	Unit System File with Tracing Lifter
3.	Laboratory Test Model	Album

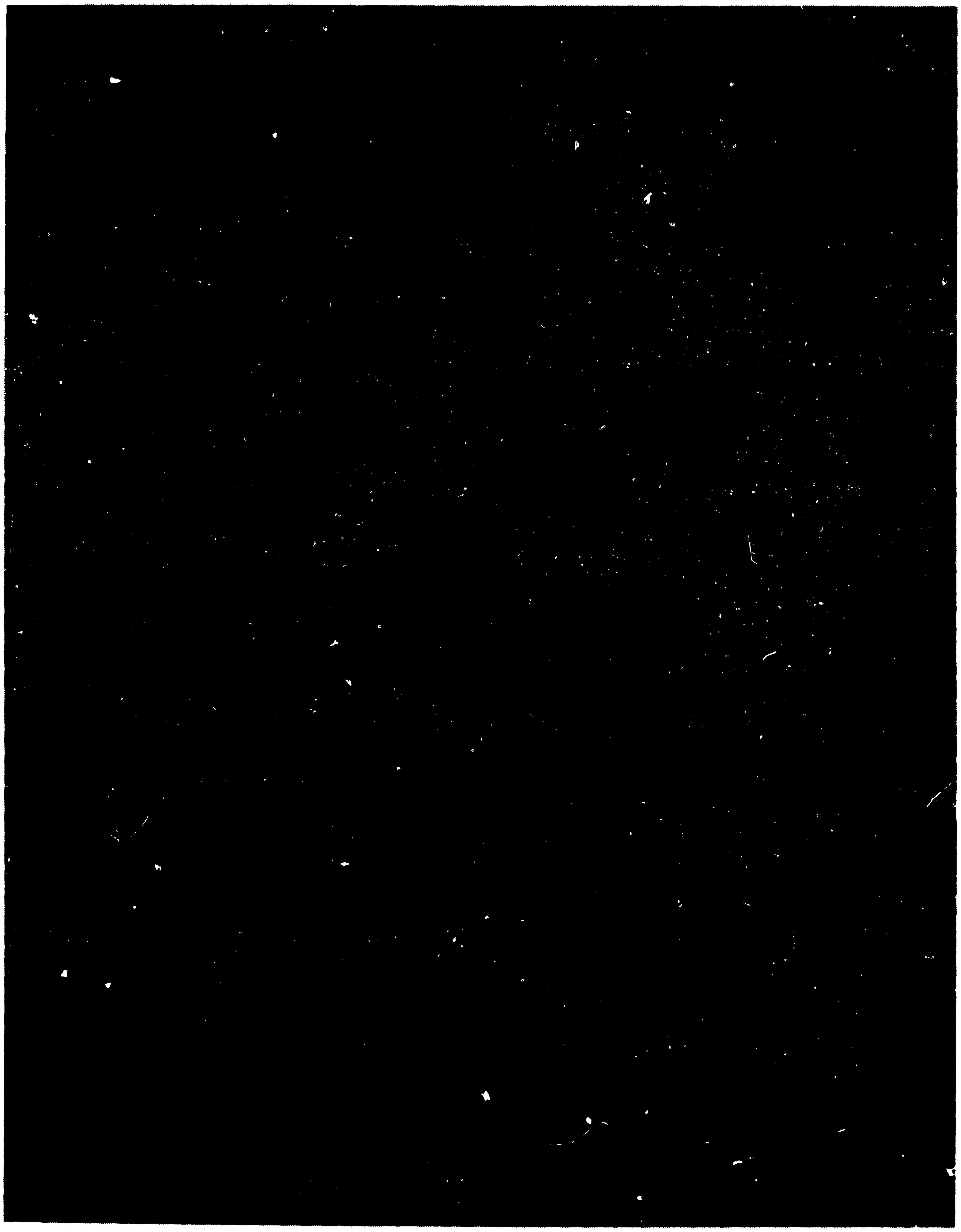

Fig. 37 Overlay Identification Numbers With and Without Backing

7.6.5.1 Art Metal, Inc.

Planfile

Figure 38 illustrates the application of this unit to the storage of overlays.

Observations relating to this unit when the identification numbers were not backed include:

(1) Static electricity makes retrieval difficult.

(2) The accession numbers are difficult to read and it is possible to confuse one number with the next.

(3) Withdrawal of an individual overlay appears to scratch both the overlay being withdrawn and surrounding overlays.

(4) Since the plastic has much less body than the paper in the maps, it is important that the folder not be pulled up too high, or the plastic will have a tendency to bunch up and fall to the bottom of the folder (see Figure 39).

(5) The top of the Planfile was 36 inches from the floor.

Observations relating to this unit when the identification numbers were backed include:

(1) Retrieval is more rapid.

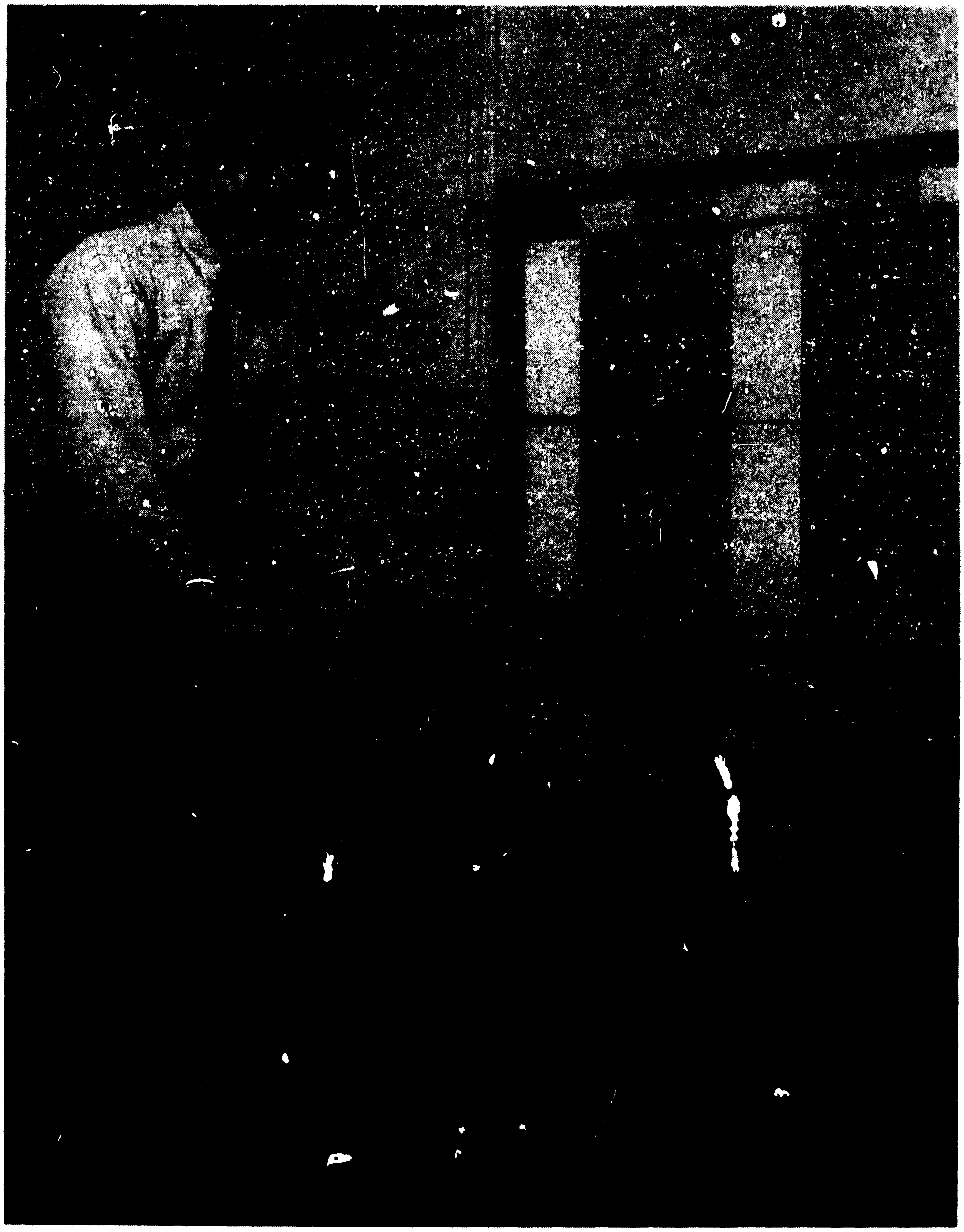

Fig. 38 Art Metal, Inc. Planfile With 50 Overlays

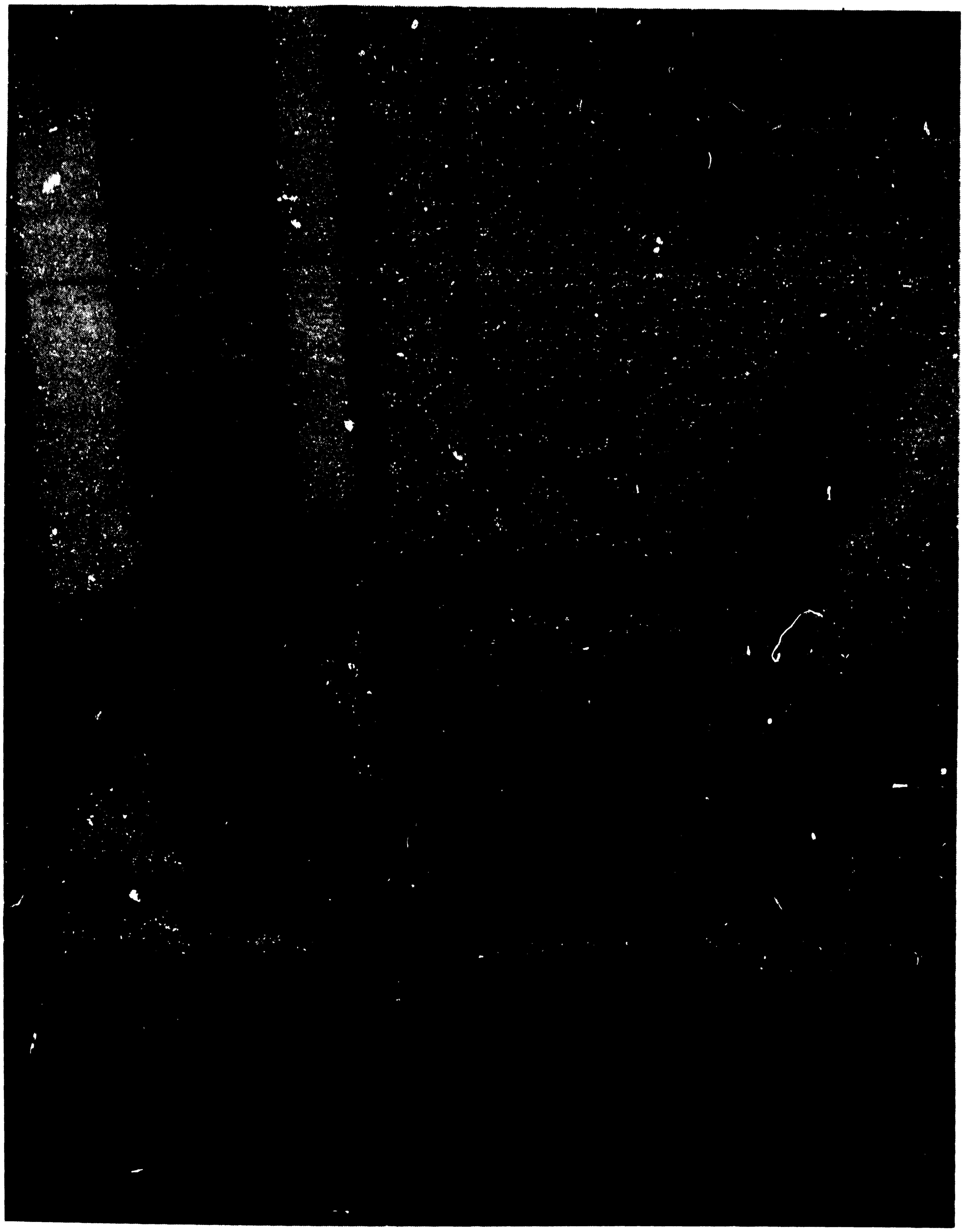

Fig. 39 Art Metal, Inc. Planfile — With 50 Overlays Illustrating Bottom Bunching

7.6.5.2 Hamilton Manufacturing Company

Unit System File with Tracing Lifter

Figure 40 illustrates the application of this unit to the storage of overlays.

Observations relating to the use of this unit with one pile of 100 overlays include:

(1) Static electricity causes overlays to shift forward when lifting out individual overlays (see Figure 41).

(2) Tracing lifter must be used for taking the weight off the overlays to be removed.

(3) Tracing lifter operation is difficult due to the weight of the overlays and the curl of the overlays.

(4) As the drawer is shut, the overlays have a tendency to slide towards the rear of the unit.

(5) Overlays also had a tendency to slide to the side of the pile.

(6) The drawer from which the overlays were retrieved was 46 inches from the floor.

Observations relating to the use of this unit with 2 piles of 50 each include:

(1) Overlays have a tendency to slide over the drawer and the two piles have a tendency to become intermixed (see Figure 42).

Fig. 40 Hamilton Manufacturing Co. Unit System File With Tracing Lifter With 100 Overlays in 2 Piles

Fig. 41 Hamilton Manufacturing Co. Unit System File With Tracing Lifter With 100 Overlays in 2 Piles Illustrating Forward Sliding

Fig. 42 Hamilton Manufacturing Co. Unit System File With Tracing Lifter With 100 Overlays in 2 Piles Illustrating Pile Intermixing

(2) **Overlays worked over toward the left side of the drawer and when tracing lifter was lowered after removing one overlay, additional overlays became damaged in the mechanism.**

(3) **The fact that the overlays became mixed presented problems in refiling.**

7.6.5.3 Laboratory Test Model

Album

To investigate the pcssibility of a method which would avoid overlay scratching due to sliding contact, an album was simulated for tests, as illustrated in Figure 43.

Observations on this approach include:

(1) The advantage of the 3-ring binder is that overlays do not rub against one another and become scratched. Each individual page is turned by itself.

(2) Overlays were filed in an Art Metal, Inc., Planfile in order to keep them under spring compression and prevent them from curling, even in the album.

(3) Static electricity was not noticeable using this system.

(4) 50 overlays contained in an album were light enough for ease of manipulation.

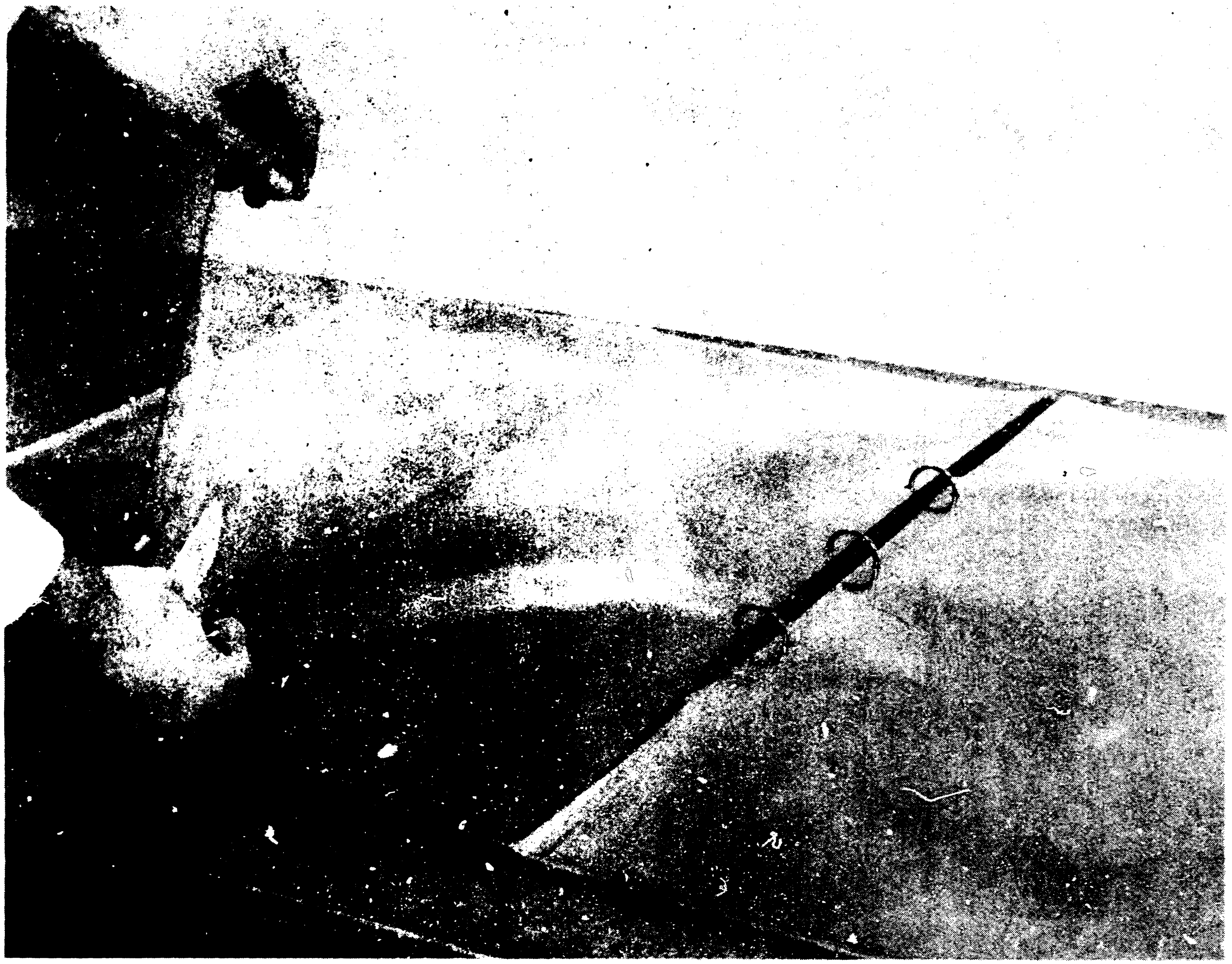

Fig. 43 Laboratory Test Model Album With 50 Overlays

7.6.6 Mosaic Test Observations

Actual tests were not run with mosaics, or simulated mosaics, but Figures 44 through 47 illustrate the manner in which mosaic storage may be accomplished in four different types of units.

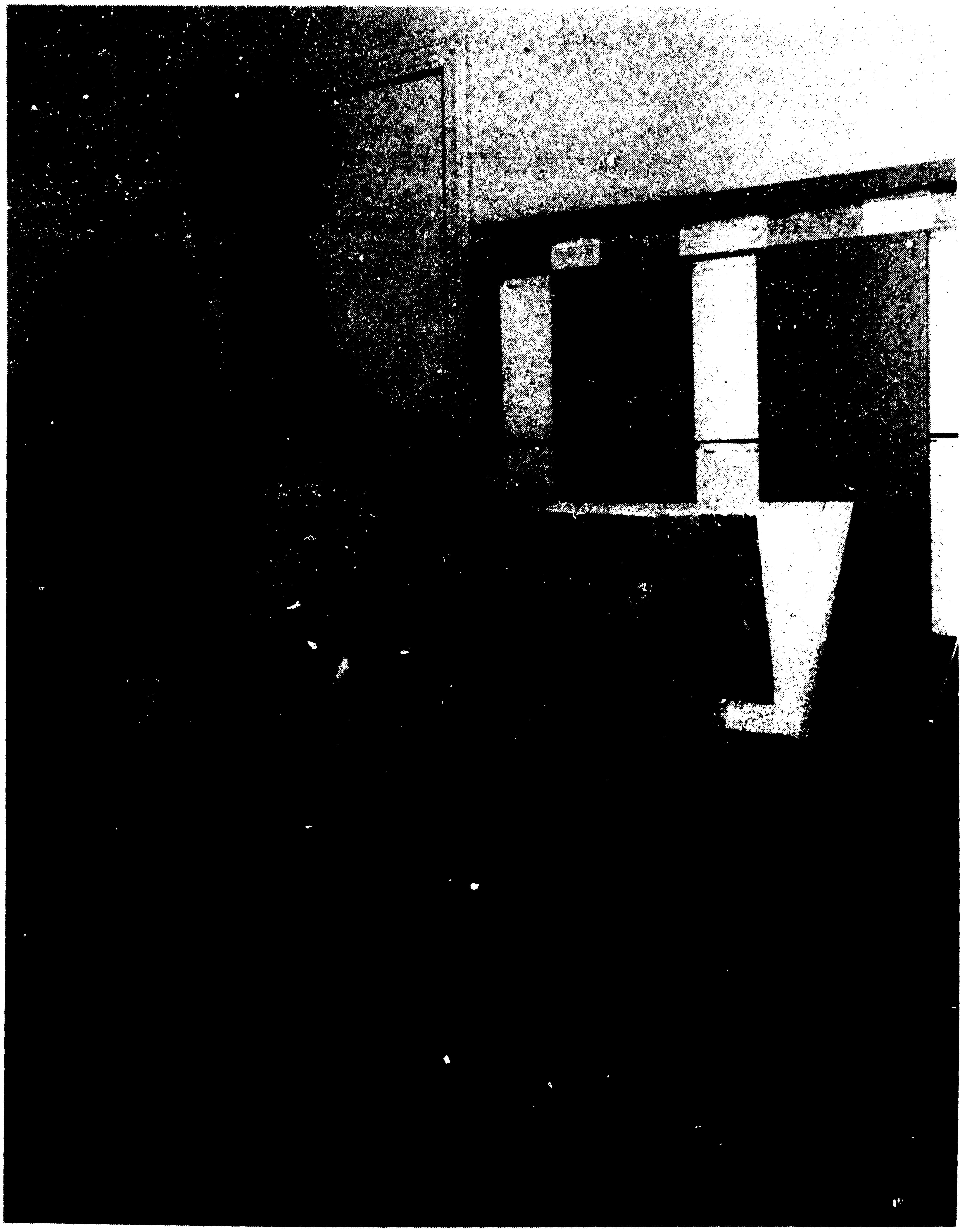

Fig. 44 Art Metal, Inc. Planfile With Photo Index

Fig. 45 Hamilton Manufacturing Co. Board Unit With Photo Index

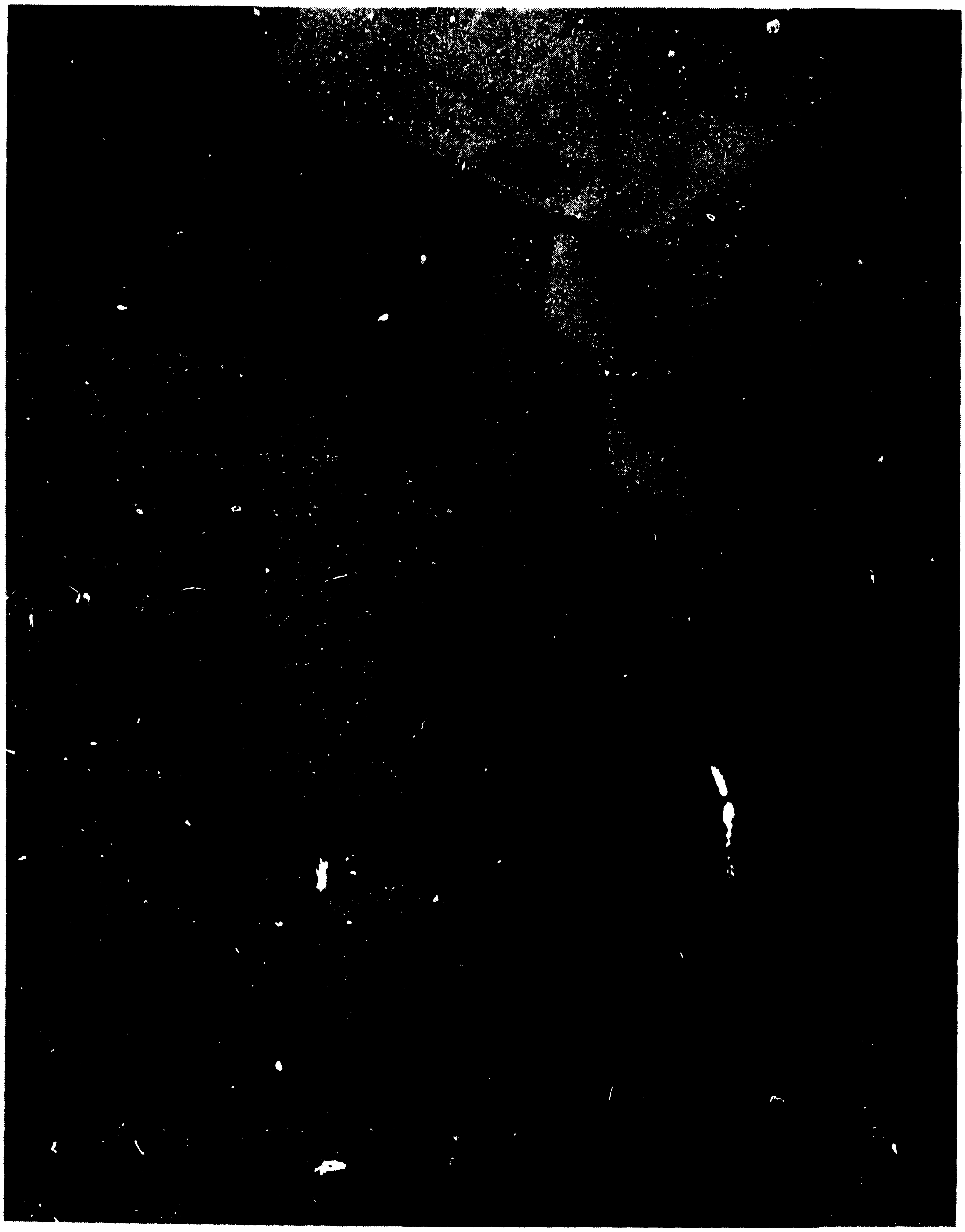

Fig. 46 Hamilton Manufacturing Co. Unit System File With Tracing Lifter With Photo Index

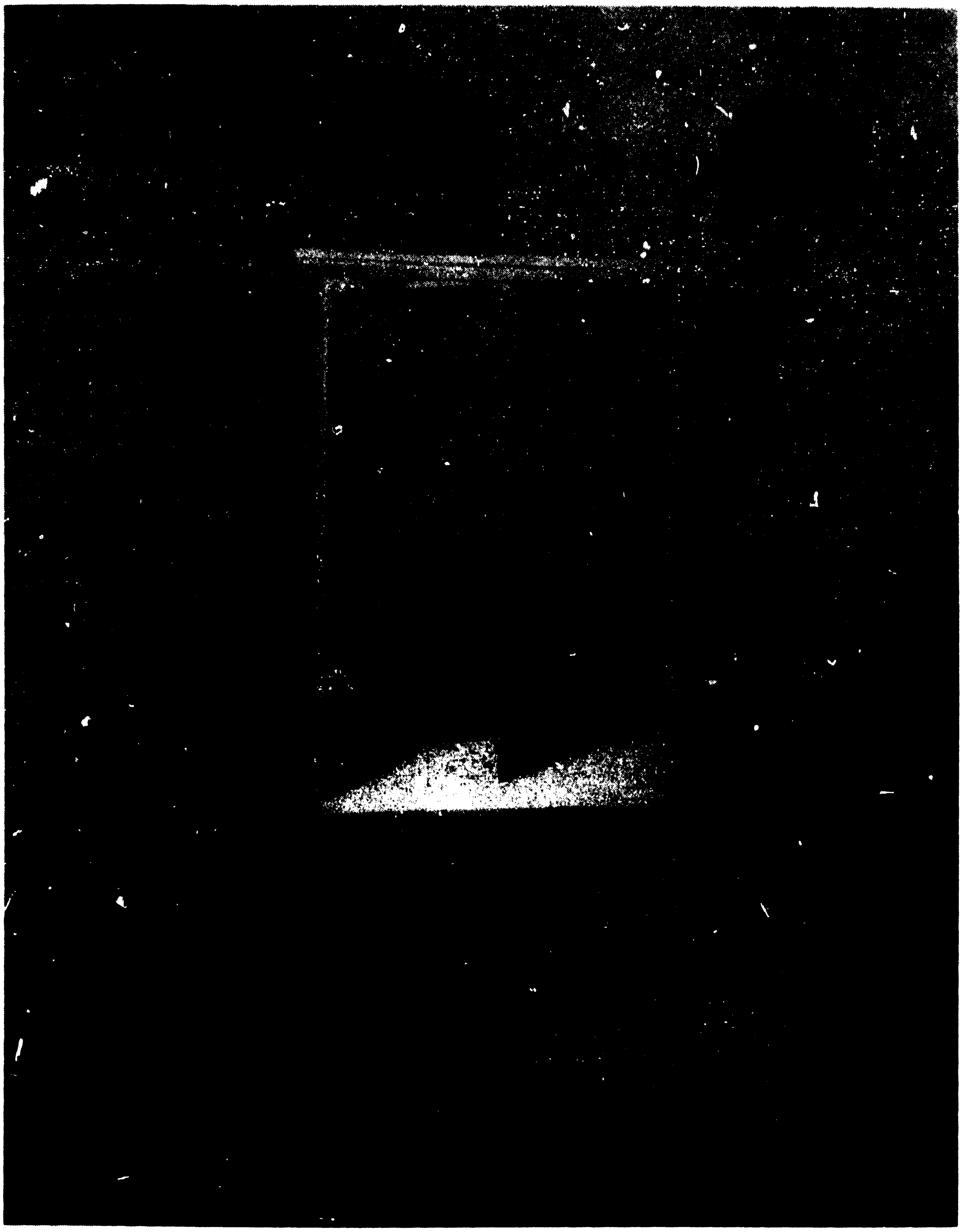

Fig. 47 Plan Hold Corporation Wall Rack File With Photo Index

7.6.7 Photographic Print Test Observations

The actual and simulated photographic prints listed in the Test Materials Inventory, Table 12 presented previously, were used in this set of tests. The equipments used in the testing are listed in Table 18. In the following paragraphs, each equipment is illustrated by photographs and operational observations are given. It will be noted that two basic types of storage equipment were considered: (1) drawer files and (2) open-shelf filing. The discussions are similarly grouped. It should be pointed out in passing that there are other methods of establishing compression during storage — e.g., a drop-front file drawer. The equipments herein were tested as representative of types involving compression.

Table 18

PHOTOGRAPHIC PRINT STORAGE EQUIPMENTS TESTED

A.	DRAWER FILES	
	1. Art Metal, Inc.	Planfile Drawer Unit
	2. Art Steel Company	Steelmaster Filing Cabinet
B.	OPEN-SHELF FILES	
	1. Art Metal, Inc.	Open File Shelving
	2. TAB Products Company	Unit Spacefinder

7.6.7.1 Art Metal, Inc.

Planfile Drawer Unit

Figure 48 illustrates the application of this unit to the storage of photographic prints. Figure 49 illustrates the structure of the unit and the spring loading mechanism by which compression is established.

Observations include:

(1) Spring compression seemed to facilitate retrieval by holding folder up when the photograph was lifted out of the drawer.

(2) The bottom of the drawer from which items were retrieved was 36 inches from the floor.

Fig. 48 Art Metal, Inc. Planfile Drawer Unit With Photographic Prints

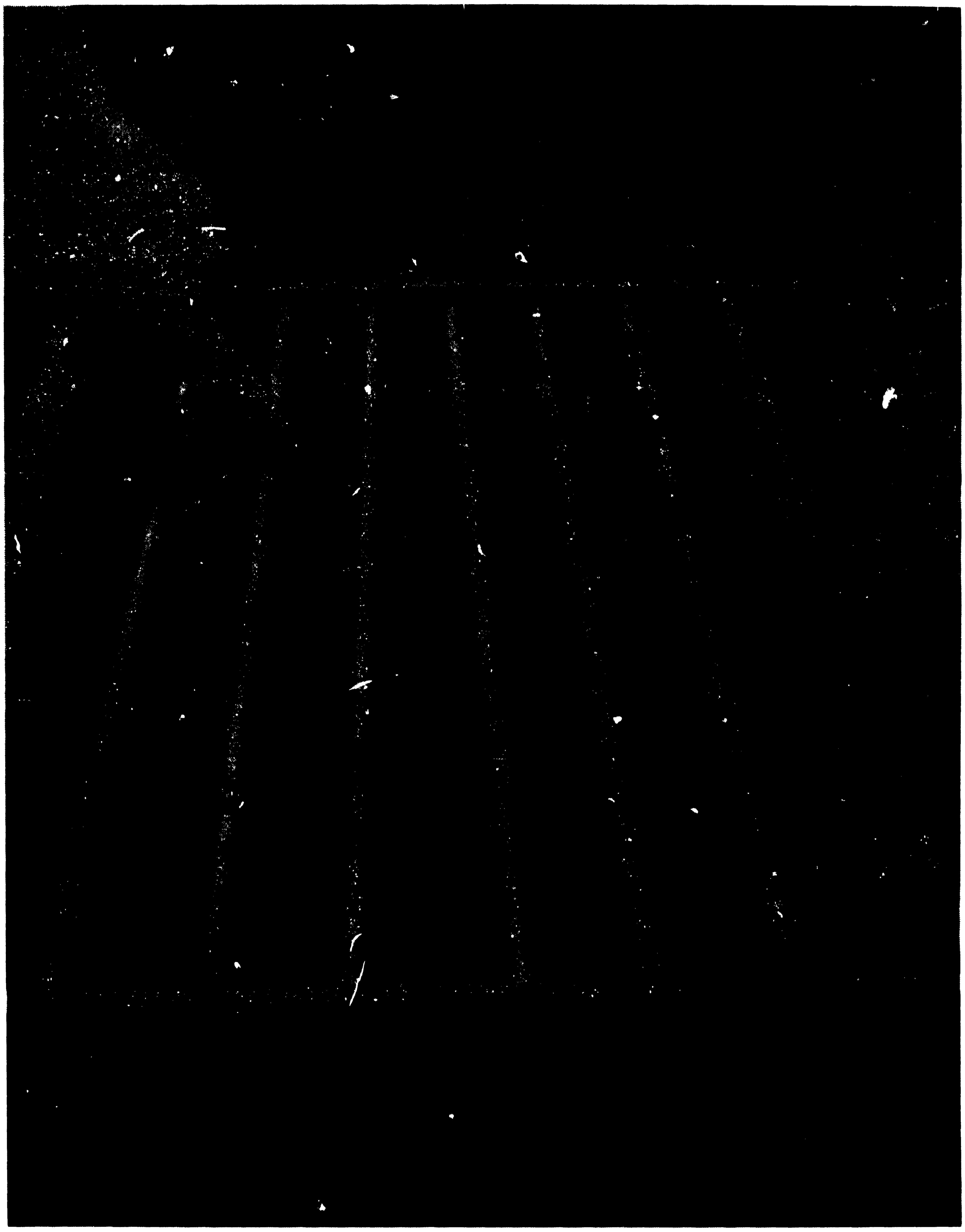

Fig. 49 Art Metal, Inc. Planfile Drawer Unit
Illustrating Structures and Spring Loading

7.6.7.2 **Art Steel Company**

Steelmaster Filing Cabinet

Figure 50 illustrates the application of this unit to the filing of photographic prints. Figure 51 illustrates the method by which compression is established during storage.

Observations concerning this unit include:

(1) Retrieval is more rapid than in the Art Metal, Inc., Planfile Drawer Unit, because fanning of the photographs is possible since compression is not present during search — if the follower block is released.

(2) The bottom of the drawer from which items were retrieved was 40 inches from the floor.

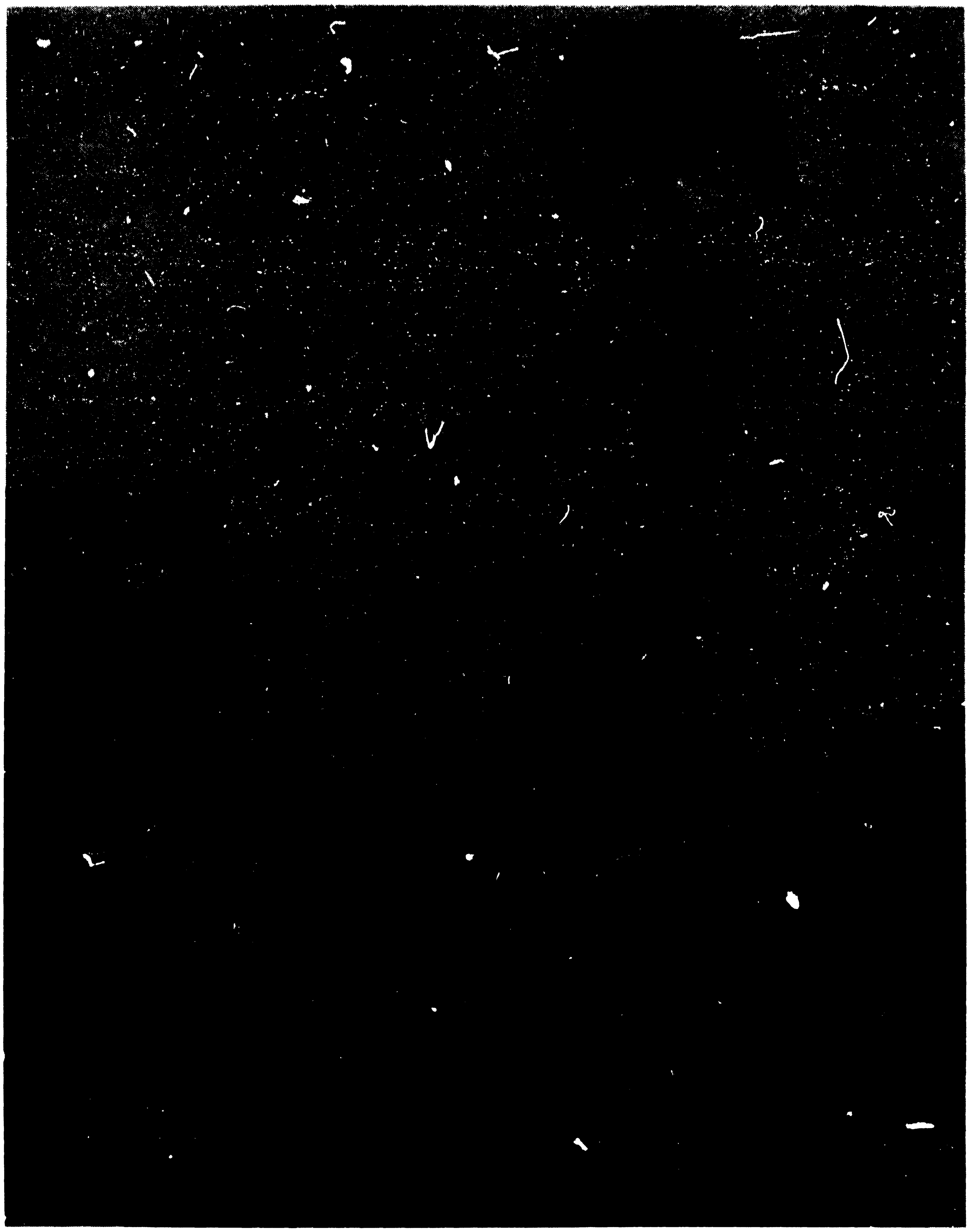

Fig. 50 Art Steel Co. Steelmaster Filing Cabinet
With Photographic Prints

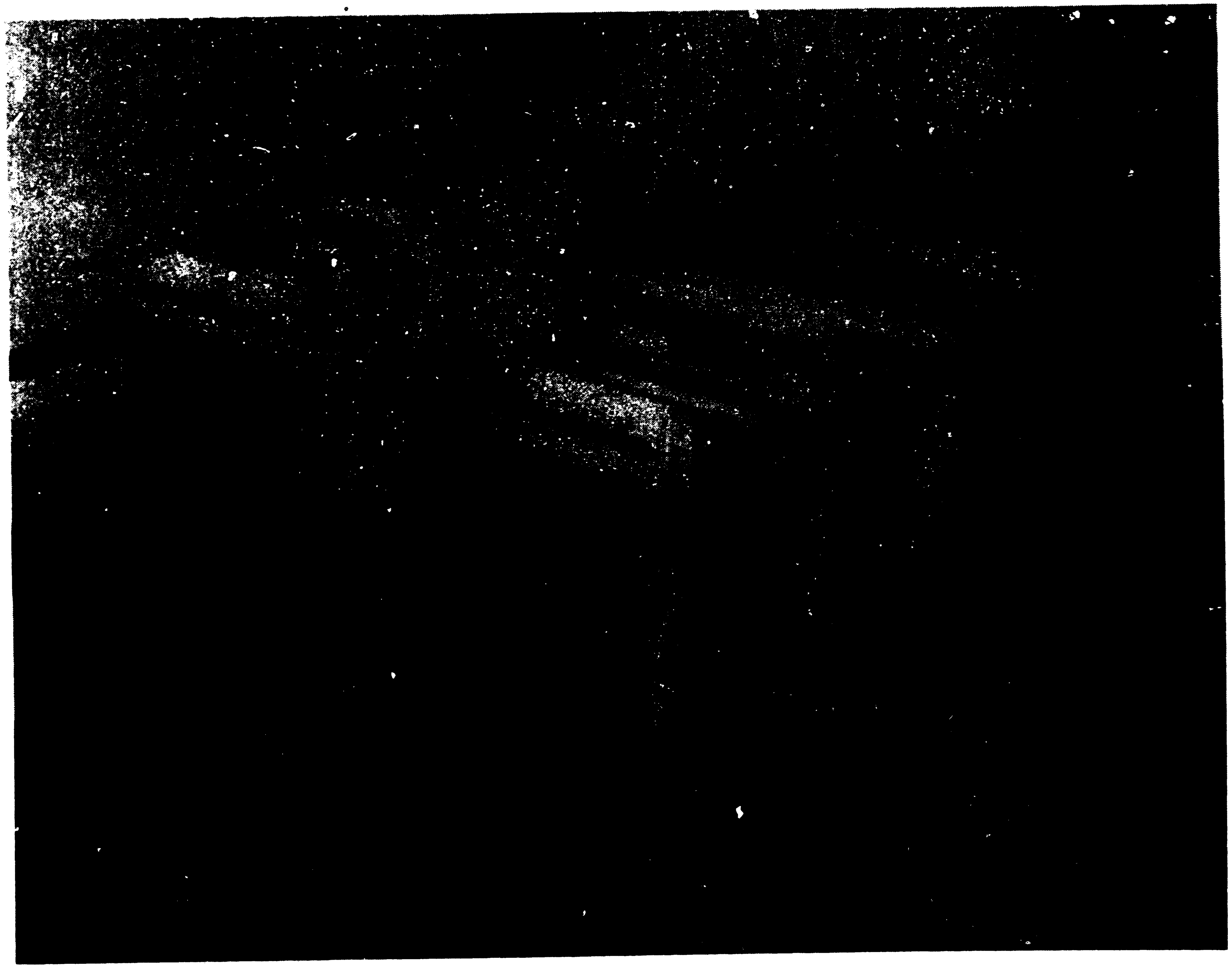

Fig. 51 Art Steel Co. Steelmaster Filing Cabinet With Photographic Prints Illustrating Compression by Follower Block

7.6.7.3 <u>Art Metal, Inc.</u>

<u>Open File Shelving</u>

Figure 52 illustrates the application of this unit to the filing of photographic prints. Figure 13, previously presented in discussion of the storage of aerial roll film cans, has shown the basic manner of adjustment of shelves and separators.

Observations concerning this unit include:

(1) Since spacers can be as close as 1 inch from each other, the rigidity afforded helps keep photographs in place.

(2) The shelf from which all items were retrieved was 44 inches from the floor.

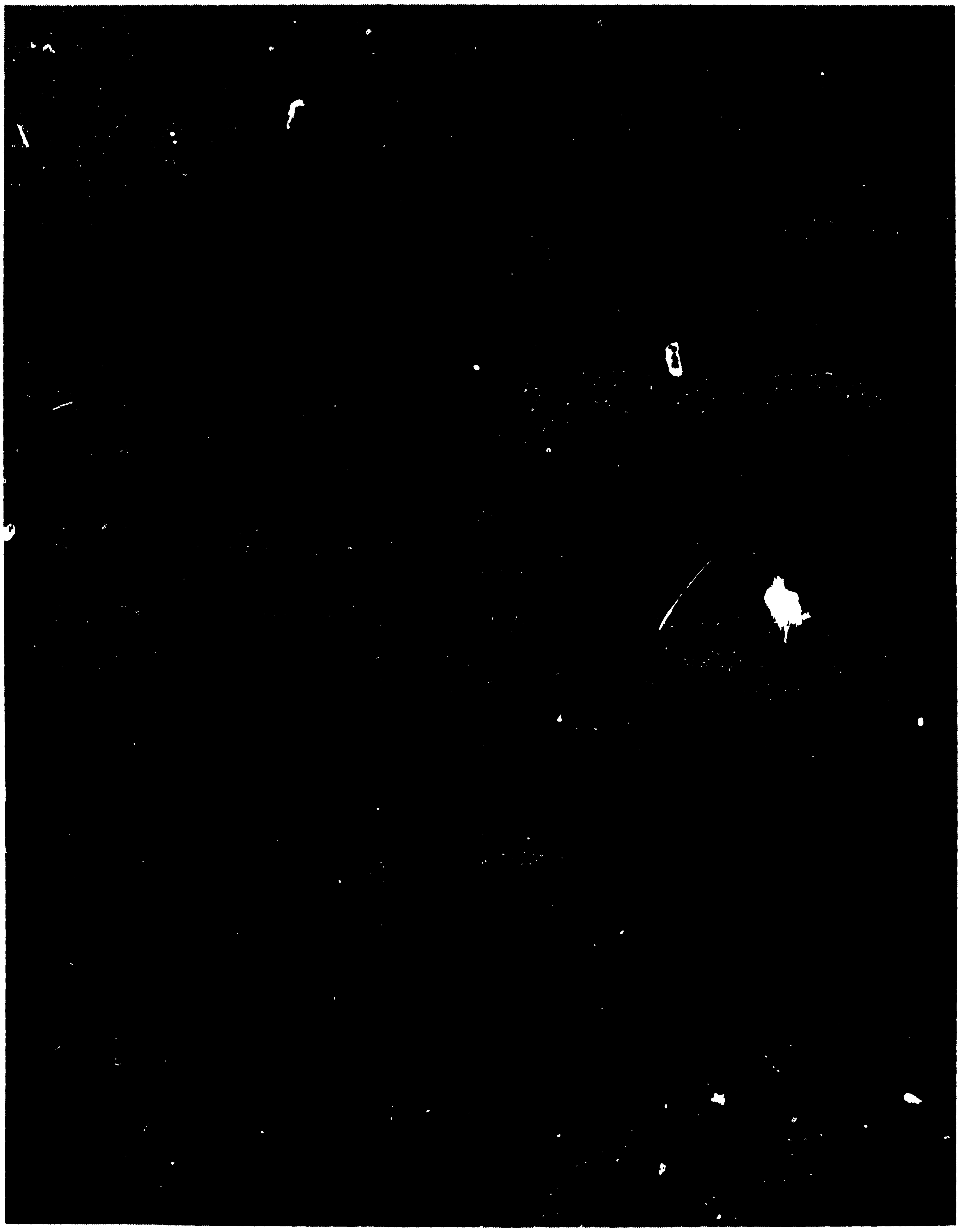

Fig. 52 Art Metal, Inc. Open File Shelving With Photographic Prints

7.6.7.4 TAB Products Company

Unit Spacefinder

Figure 53 illustrates the application of this unit to the filing of photographic prints. Figure 54 illustrates the structure of the unit and the open-mouth module approach to storage.

Observations concerning this unit include:

(1) Friction has a tendency to pull more than one photograph out at a time, when one is being retrieved.

(2) If photos are not pulled straight out, but are pulled up and out, there is the possibility that a box immediately above the photos might be knocked off its railing.

(3) The shelf from which all items were retrieved was 44 inches from the floor.

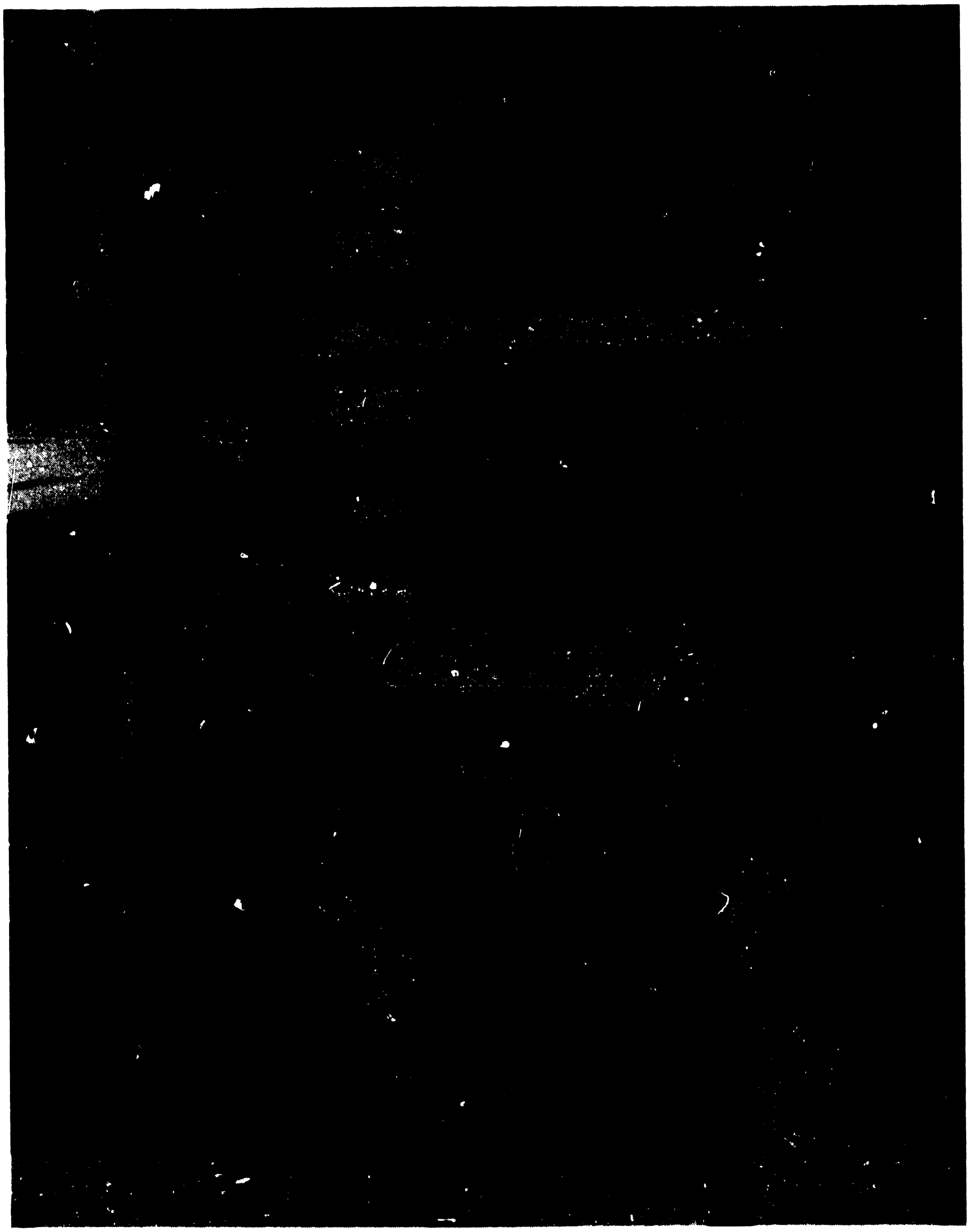

Fig. 53 TAB Products Co. Unit Spacefinder With Photographic Prints

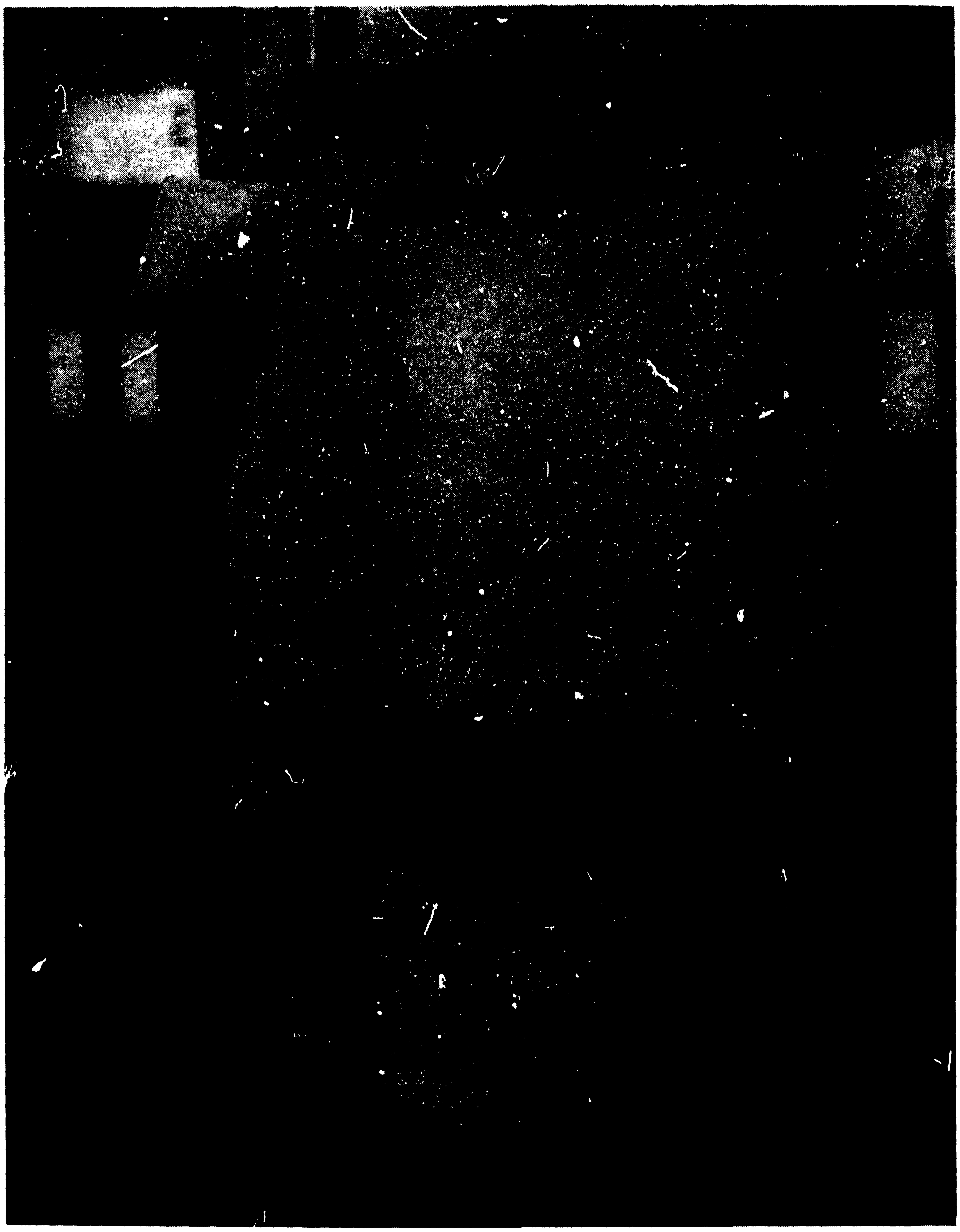

Fig. 54 TAB Products Co. Unit Spacefinder — Illustrating Structure

7.6.8 Target Folder Test Observations

Storage, retrieval, and refiling of Target Folders were not individually tested. Methods of storage which would be appropriate for sizes up to notebook size have been illustrated previously in the form of drawer files and open-shelf files in Figures 48 through 53. Storage for folders of larger units would require open steel shelving of larger size, not shown.

7.6.9 <u>PI Key Test Observations</u>

Storage, retrieval, and refiling of PI keys were not individually tested. Methods of storage which would be appropriate for sizes up to notebook size have been illustrated previously in the form of drawer files and open-shelf files in Figures 48 through 53. Indicative of the general applicability size-wise is the fact that, in the lower right of the TAB Products Company Unit Spacefinder, illustrated in Figure 6, previously presented, and Figure 56, to be presented in the next section, there appear such titles as "Photo-Interpretation Keys of Port and Harbor Facilities, Photo-Interpretation Handbook, Vehicle Identification, Aerial Photo Analysis of Permanently Frozen Ground, Flak Photo Interpretation, Urban Area Analysis, and Industrial Target Analysis."

7.6.10 General Library Material Test Observations

Figures 55 and 56 illustrate the application of variations of open-shelf filing units to the filing of general library materials such as books, periodicals, documents, handbooks, special publications, etc. General library materials were not individually tested, but data was obtained from other sources on the time required for retrieval and refiling.

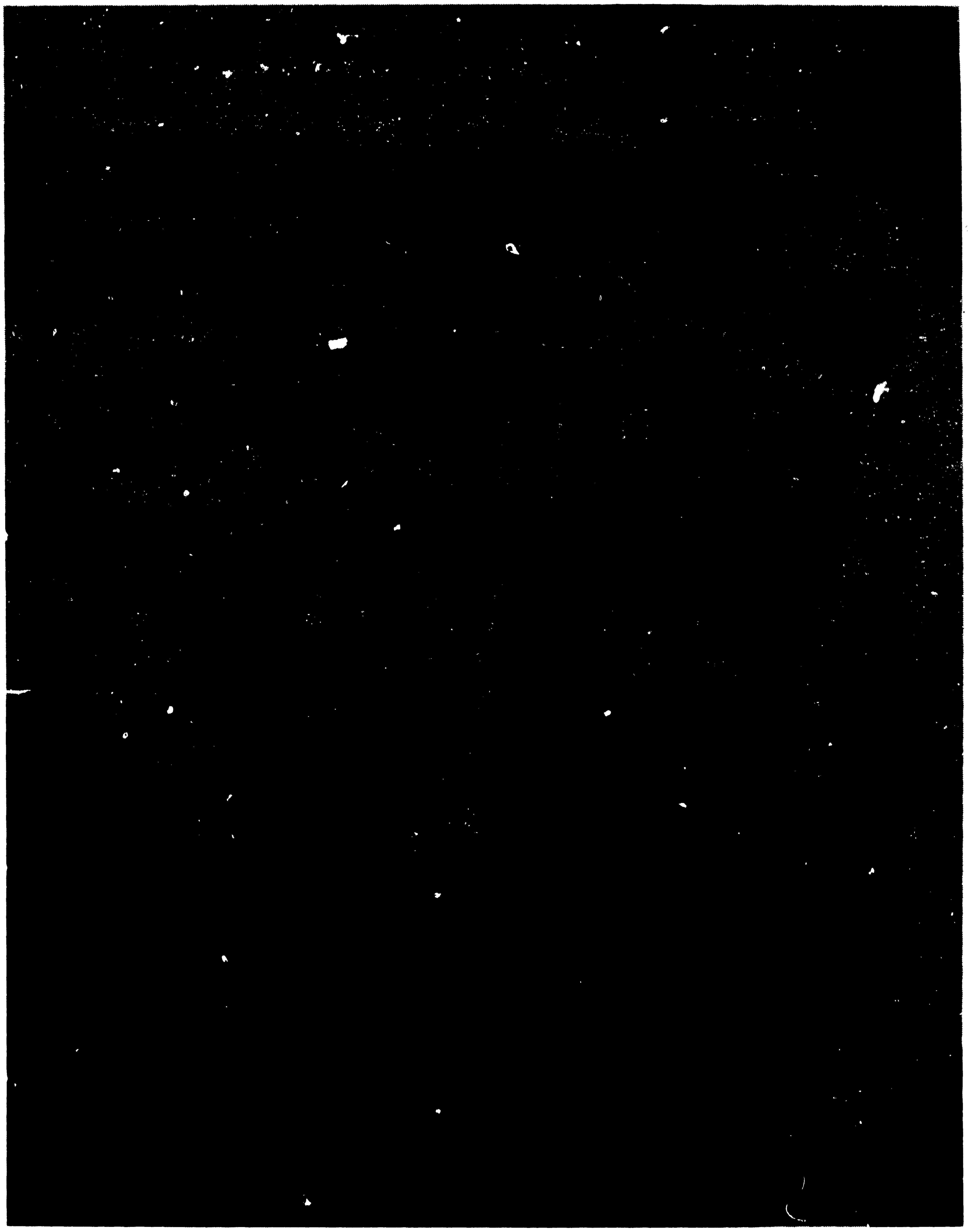

Fig. 55 Art Metal, Inc. Open File Shelving — With General Library Materials

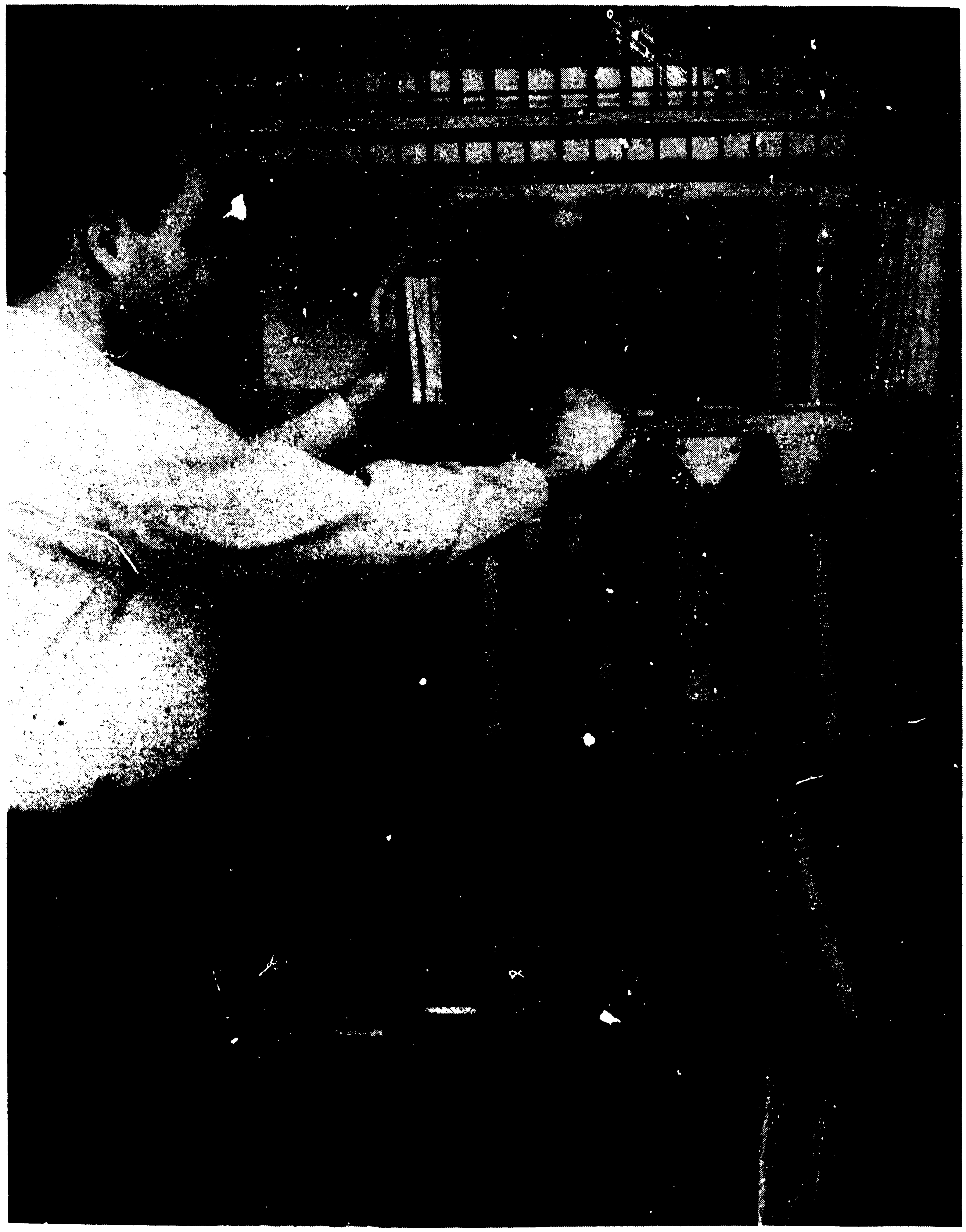

Fig. 56 TAB Products Co. Unit Spacefinder — With General Library Materials

7.7 TEST RESULTS

7.7.1 General

The general nature of the equipments tested, their manner of operation, and qualitative observations resulting from their use have been presented in Section 7.6. The results of the retrieval and refiling tests are presented in this section.

Data concerning individual units under test was taken on forms previously described under Section 7.3, Test Procedures, in Table 10. The data for individual units was assembled into summary form in a table of the form illustrated in Table 19. This form allowed a comparative presentation of the data for the different units tested for a particular type of graphic material and, simultaneously, allowed a check for sufficiency of test trials.

The tests were run on a basis[1] which would allow $\pm$ 10% precision in the value with a 95% confidence level. In general, for a given ratio, $R/\bar{X}$, of range, R, to average value, $\bar{X}$, a certain number of tests are required to establish the precision and confidence specified. Thus, if the trials performed are less than the number required for the ratio $R/\bar{X}$ obtained from the data received, additional trials are indicated.

Within a precision of $\pm$ 10%, it was felt that one equipment should not suffer in comparison with other equipments if the differences in time

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1/ Reference 74, pgs. 368, 369

Table 19

SUMMARY OF RETRIEVAL AND REFILING TIMES

Refile ☐ Retrieve ☐

Sheet ____ of ____

Date ________

By ________

Number	Sheet	Test	Items Tested ____ Size ____ ____		Av. Time	Band	Unit Identification														Trials	$R/\bar{X}$	Required No.	Sufficient
			Quantity Tested	Special Conditions			1	2	3	4	5	6	7	8	9	10	11	12	13	14				
1																								
2																								
3																								
4																								
5																								
6																								
7																								
8																								
9																								
10																								
11																								
12																								
13																								
14																								
15																								
16																								
17																								
18																								
19																								

were less than the allowable error in the measured number. Therefore, the measured times for the different equipments were grouped into bands in the following way: The lowest number received was expanded into a band by a ± 10% broadening and all times lying within this range of value were considered to be in Band 1. The next lowest number, lying outside Band 1, was similarly broadened to create Band 2. The grouping by band in the retrieval case has been given precedence over the grouping in the refiling case, when there is a difference, since it is felt that, statistically, retrieval will pose the more demanding situation.

The summarized data for each type of graphic material tested have been recorded in the manner of Table 19 and are presented in the paragraphs which follow.

In each summary table, the data for the unit having the lowest times has been presented first, followed by units having successively greater times. The detailed data received in individual tests, upon which the summary data is based, are recorded in the manner of Table 10 and presented in Appendix IV. Cross reference to a particular test and a particular detail sheet is made under the "sheet" column in the summary tables.

The figures which are presented in both the detailed sheets of Appendix IV and the summary tables of the present section are based on an approach — act-and-withdraw cycle — with a 10-foot approach and a 10-foot withdrawal — "standing" start. The first sheet in the detailed series establishes an average time of 3.6 seconds (on the basis of 30 tests and 2 subjects) for a subject to walk 10 feet. Therefore, a total of 7.2 seconds should be subtracted from the times indicated if one wishes to consider the time for the retrieval or refiling act alone.

7.7.2 Roll Film Test Results

Table 20 presents a summary listing of the test data obtained. It will be noted that the use of horizontal-axis filing with a pull device is the most satisfactory. Covers were taped to cans to simulate a positive holding action and to allow use of the handle on the can top. Additional observations regarding the retrieval and refiling figures are given below.

7.7.2.1 Retrieval of Roll Film

(1) Film cans placed in horizontal-axis compartments one deep were retrieved most rapidly if the handles on the covers were used for retrieval. The average retrieval time for cans using the handles was 9 seconds, placing them in Band 1.

(2) Film cans filed in the same compartments as mentioned in (1) above, but without having handles used to retrieve these cans, required 12 seconds as an average retrieval time, placing these in Band 2.

(3) When cans were placed with the roll axis vertical on wooden shelves two deep, separate tests were run to determine retrieval time of the cans in the front row and retrieval time of the cans in the rear row. In actual practice, however, the retrieval time for cans placed two deep will probably be the average of the retrieval time for the front cans and the rear cans. The front

Table 20

SUMMARY OF RETRIEVAL AND REFILING TIMES

Refile ☐ Retrieve ☒

Sheet 1 of 3

Date 3/10/64

By JAJ

Items Tested Roll Film (Cans)*

Size 8-1/4 inches diameter

11-1/2 inches height

Number	Sheet	Test	Quantity Tested	Special Conditions	Av. Time	Band	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Trials	$R/\bar{X}$	Required No.	Sufficient
1	5	1	1	Handle Used	9	1													X		10	.22	3	X
2	2	1	1	Front Cans Only	11	2												X			10	.18	2	X
3	4	1	1	No Handle Used	12	2													X		10	.16	2	X
4	3	1	1	Rear Cans Only	26	3												X			10	.22	3	X
5																								
6																								
7																								
8																								
9																								
10																								
11																								
12																								
13																								
14																								
15																								
16																								
17																								
18																								
19																								

*All cans were weighted at 20 lbs. to simulate a fully loaded 9-1/2-inch x 500-foot Aerial Film Can

Table 20

SUMMARY OF RETRIEVAL AND REFILING TIMES

Refile [X] Retrieve [ ]

Sheet 2 of 3

Date 3/10/64

By JAJ

Items Tested: Roll Film (Cans)*

Size: 8-1/4 inches diameter, 11-1/2 inches height

Number	Sheet	Test	Quantity Tested	Special Conditions	Av. Time	Band	Unit Identification 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Trials	$R/\bar{X}$	Required No.	Sufficient
1	5	2	1	Handle Used	10	1													X		10	.20	3	X
2	2	2	1	Front Can Only	10	1												X			10	.10	1	X
3	4	2	1	No Handle Used	12	2													X		10	.42	8	X
4	3	2	1	Rear Can Only	23	3												X			10	.13	2	X
5																								
6																								
7																								
8																								
9																								
10																								
11																								
12																								
13																								
14																								
15																								
16																								
17																								
18																								
19																								

*All cans were weighted at 20 lbs. to simulate a fully loaded 9-1/2-inch x 500-foot Aerial Film Can

Table 20 SUMMARY OF RETRIEVAL AND REFILING TIMES (CONTINUED)

Unit Identification Number	Manufacturer	Unit Title
1	Acco Products, Division of Natser Corporation	Accoway Open Rack
2	Art Metal, Inc.	Open File Shelving
3	Art Metal, Inc.	Planfile
4	Art Metal, Inc.	Planfile Drawer Unit
5	Art Steel Company	Steelmaster Filing Cabinet
6	Globe-Wernicke Company	Cello-Clip Map and Plan File
7	Hamilton Manufacturing Company	Unit System File with Tracing Lifter
8	Hamilton Manufacturing Company	Unit System File without Tracing Lifter
9	Hamilton Manufacturing Company	Vertical File
10	Plan Hold Corporation	Wall Rack File
11	TAB Products Company	Unit Spacefinder
12	Wooden Shelving, open	Roll Axis Vertical
13	Wooden Shelving, compartmented	Roll Axis Horizontal
14	Laboratory Test Model	Allum

cans by themselves took an average of 11 seconds to retrieve, placing them in Band 2. The rear cans by themselves book an average of 26 seconds to retrieve, placing them in Band 3. A more realistic average for total retrieval time from this configuration would be the average of the two retrieval times or 19 seconds, which would still place this as a unit in Band 3.

7.7.2.2 <u>Refiling of Roll Film</u>

(1) Cans refiled in the horizontal-axis compartments one deep where the handles were used for refiling were refiled in the most rapid time, an average of 10 seconds, placing these in Band 1.

(2) Cans refiled in the same configuration as above, but without using handles for refiling purposes, were re-filed at an average of 12 seconds, placing these in Band 2.

(3) It is necessary to take the refiling of cans in the shelves in which they were filed two deep as a composite. Cans refiled in the front row only were refiled in an average time of 10 seconds, which would place this in Band 1. However, this must be averaged with the refiling time for cans placed in the rear row which was an average of 23 seconds, placing these in Band 3. The average

time for refiling cans in both front and rear rows of this configuration would be 17 seconds, placing this in Band 3.

7.7.3 Magnetic Tape Test Results

Since only one type of equipment configuration appears to be available for storage of magnetic tape containers (wire racks which place the cans with their narrow dimension facing forward and places the cans on edge), it was not necessary to run comparative retrieval and refiling tests.

7.7.4 Map Test Results

Table 21 presents a summary listing of the test data received. Observations regarding data received in the retrieval and refiling cases are given below.

7.7.4.1 Retrieval of Maps

(1) Most rapid retrieval was obtained in the Hamilton Manufacturing Company's Unit System File without a Tracing Lifter which simulates a standard horizontal drawer file. The time for this retrieval was 21 seconds and this unit is placed in Band 1,

(2) Also in Band 1 are items retrieved from the rear of the Art Metal, Inc., Planfile. The reason that items retrieved from the rear of the unit were retrieved more rapidly than those from the center was due to the fact that the support shelf did not have to be opened when retrieving drawings. The time for this retrieval was 20 seconds.

(3) The time for retrieving items from the center of the Art Metal, Inc., Planfile unit was 30 seconds. It would appear that the time for retrieving items from the center of the unit and time for retrieving items from the rear of the unit should be averaged to give an average retrieval time of 25 seconds, which would still place this unit in Band 1, and somewhat slower than the Hamilton Manufacturing Company's Unit System File without Tracing Lifter.

Table 21

SUMMARY OF RETRIEVAL AND REFILING TIMES

Refile ☐ Retrieve ☒

Sheet 1 of 3
Date 3/11/64
By JAJ

Items Tested: Maps
Size 22 x 27 x 0.005 inches to 24 x 29 x 0.005 inches

Number	Sheet	Test	Quantity Tested	Special Conditions	Av. Time	Band	Unit Identification 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Trials	R/$\bar{X}$	Required No.	Sufficient
1	8	1	100	2 Folders - Rear of unit	20	1			X												10	.50	10	X
2	15	1	100	Same Pile	21	1								X							10	.38	6	X
3	7	1	100	2 Folders - Center of unit	30	2			X												10	.47	9	X
4	12	1	100	Same Pile	31	2							X								15	.52	11	X
5	21	1	50	One Holder	36	2										X					10	.33	5	X
6	20	-	100	One Holder	58	3										X					10	.50	10	X
7	10	1	50	Wooden Group Holder	89	4						X									10	.35	5	X
8	19	1	50	One Holder	105	5									X						10	.29	4	X
9	11	1	50	3 Individual Group Holders	112	5						X									10	.50	10	X
10	6	1	50	2 Fasteners	128	6	X														10	.44	8	X
11	18	1	100	One Holder	141	6									X						10	.50	10	X
12																								
13			MISFILED MAPS																					
14	13	1	100	± 10 of proper loc.	44								X											
15	9	1	100	± 10 of proper loc.	27				X															
16	14	1	100	In order but 2 higher & 2 lower missing	31				X															
17																								
18																								
19																								

Table 21

Sheet 2 of 3
Date 3/11/64
By JAJ

SUMMARY OF RETRIEVAL AND REFILING TIMES

Refile [X] Retrieve [ ]

Items Tested: Maps
Size: 22 x 27 x 0.005 inches to 24 x 29 x 0.005 inches

Number	Sheet	Test	Quantity Tested	Special Conditions	Av. Time	Band	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Trials	$R/\bar{X}$	Required No.	Sufficient
1	15	2	100	Same Pile	25	1								X							10	.48	10	X
2	12	2	100	Same Pile	26	1							X								10	.48	10	X
3	7	2	100	2 Folders - Center of unit	36	2			X												10	.36	6	X
4	8	2	100	2 Folders - Rear of unit	37	2			X												10	.46	9	X
5	21	2	50	One Holder	53	3										X					10	.38	6	X
6	20	2	100	One Holder	73	4										X					10	.48	10	X
7	10	2	50	Wooden Group Holder	96	5						X									10	.31	4	X
8	11	2	50	3 Individual Group Holders	103	5						X									10	.48	10	X
9	6	2	50	2 Fasteners	115	5	X														10	.39	7	X
10	19	2	50	One Holder	118	5									X						10	.42	8	X
11	18	2	100	One Holder	169	6									X						10	.47	9	X
12																								
13																								
14																								
15																								
16																								
17																								
18																								
19																								

Columns 1–14: Unit Identification

Table 21 SUMMARY OF RETRIEVAL AND REFILING TIMES (CONTINUED)

Unit Identification Number	Manufacturer	Unit Title
1	Acco Products, Division of Natser Corporation	Accoway Open Rack
2	Art Metal, Inc.	Open File Shelving
3	Art Metal, Inc.	Planfile
4	Art Metal, Inc.	Planfile Drawer Unit
5	Art Steel Company	Steelmaster Filing Cabinet
6	Globe-Wernicke Company	Cello-Clip Map and Plan File
7	Hamilton Manufacturing Company	Unit System File with Tracing Lifter
8	Hamilton Manufacturing Company	Unit System File without Tracing Lifter
9	Hamilton Manufacturing Company	Vertical File
10	Plan Hold Corporation	Wall Rack File
11	TAB Products Company	Unit Spacefinder
12	Wooden Shelving, open	Roll Axis Vertical
13	Wooden Shelving, compartmented	Roll Axis Horizontal
14	Laboratory Test Model	Album

(4) Retrieval time for retrieving from the Hamilton Manufacturing Company Drawer with Tracing Lifter was 31 seconds, placing this unit in Band 2.

(5) Retrieval time for retrieving one map out of 50 maps in the Plan Hold Corporation unit was 36 seconds, placing this unit in Band 2.

(6) Retrieval time for retrieving one map out of 100 maps in the Plan Hold Corporation unit was 58 seconds, (as contrasted to 36 seconds for retrieving one out of 50 maps from the same unit). This unit is placed in Band 3.

(7) Retrieval time for obtaining one out of 50 maps in the Globe-Wernicke Company Wooden Group Holder was 89 seconds, placing this unit in Band 4.

(8) Band 5 consisted of two items, both of which were used when retrieving one map out of 50. The Hamilton Manufacturing Company Vertical File required 105 seconds. Three individual group holders in the Globe-Wernicke Company system required 112 seconds.

(9) Band 6 consisted of two items. The Acco Products Accoway Open Rack, in which one map was retrieved from 50 maps at an average of 128 seconds and the Hamilton Manufacturing Company Vertical File, in which one map

was retrieved from 100 maps in 141 seconds (contrast the 141 seconds of the Hamilton Manufacturing Company Vertical File for one out of 100 maps to 105 seconds of the Hamilton Manufacturing Company Vertical File for one out of 50 maps).

7.7.4.2 Refiling of Maps

Although the time for refiling maps in the Reconnaissance Technical Squadron graphic materials warehouse is not as critical as the time for retrieving maps in this warehouse, it is interesting to note that, as a general rule, the times for refiling were fairly consistent with the times for retrieval. Again considering the equipments in bands, one finds map retrieval times grouped in the following manner:

(1) Band 1 consists of the Hamilton Manufacturing Company Unit System File in which refiling time was approximately the same for the drawer used with the Tracing Lifter (26 seconds) and the drawer used without the Tracing Lifter (25 seconds).

(2) The Art Metal, Inc. Planfile belongs in Band 2. This time, both the refiling of maps in the center of the unit and the refiling of maps in the rear of the unit were almost identical (36 seconds for the center of the unit and 37 seconds for the rear of the unit).

(3) Refiling one map in 50 maps in the Plan Hold Corporation Wall Rack File required 53 seconds, placing this in Band 3.

(4) Refiling one map in 100 maps in the Plan Hold Corporation Wall Rack File required 73 seconds, placing this in Band 4.

(5) Refiling one map in 50 maps in the Globe Wernicke Company Cello-Clip Map and Plan File, using a wooden group holder, required 96 seconds; in the Hamilton Manufacturing Company Vertical File, it required 118 seconds; in the Acco Products Accoway Open Rack, it required 115 seconds; and in the Globe-Wernicke Company Cello-Clip Map and Plan File, using three individual group holders, it required 103 seconds, placing all of these items in Band 5.

(6) Refiling one map in 100 maps in the Hamilton Manufacturing Company Vertical File required 169 seconds, placing this in Band 6.

7.7.5 Overlay Test Results

Table 22 presents a summary listing of test data obtained. Observations concerning retrieval and refiling are given below. It will be noted that the use of backing for the identification numbers significantly (of the order of 25%) decreased retrieval time when a comparative series of tests was run in the same storage equipment.

7.7.5.1 Retrieval of Overlays

A significant difference was observed when filing acetate overlays using numbers which were backed by an opaque backing in order that they might stand out as against un-backed numbers.

(1) Acetate overlays filed in the Art Metal, Inc., Planfile unit using backed numbers required 23 seconds for retrieval, placing this item in Band 1.

(2) Acetate overlays filed in the Art Metal, Inc., Planfile unit using no backing required 30 seconds for average retrieval time, placing this item in Band 2.

(3) There was no significant difference in retrieval time when using the Hamilton Manufacturing Company Unit System File with Tracing Lifter between the case of 100 acetate overlays filed in the same pile or the case of 100 acetate overlays filed in two piles (50 in each pile). It required 36 seconds to retrieve one out of the 100 pile and 35 seconds to retrieve one out of the pile in which 50 were contained.

Table 22

SUMMARY OF RETRIEVAL AND REFILING TIMES

Refile ☐   Retrieve ☒

Sheet 1 of 3
Date 3/12/64
By JAJ

Items Tested: Overlays
Size: 22 x 25 x 0.005 inches

Number	Sheet	Test	Quantity Tested	Special Conditions	Av. Time	Band	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Trials	$R/\bar{X}$	Required No.	Sufficient
1	23	1	100	Numbers Backed	23	1			X												10	.35	5	X
2	22	1	100	Numbers Not Backed	30	2			X												10	.43	8	X
3	26	1	100	2 Piles - Numbers Not Backed	35	3							X								10	.51	10	X
4	25	1	100	Same Pile - Numbers Not Backed	36	3							X								10	.50	10	X
5	24	1	50	Numbers Backed	39	3			X											X	10	.32	5	X
6																								
7			MISFILED OVERLAYS																					
8	27	1	100	Within ± 10 of proper order - Nos. not backed	38								X											
9																								
10																								
11																								
12																								
13																								
14																								
15																								
16																								
17																								
18																								
19																								

Table 22

SUMMARY OF RETRIEVAL AND REFILING TIMES

Refile [X] **Retrieve** [ ]

Sheet 2 **of** 3
Date 3/12/64
By JAJ

Items Tested Overlays
Size 22 x 25 x 0.005 inches

Number	Sheet	Test	Quantity Tested	Special Conditions	Av. Time	Band	Unit Identification 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Trials	$R/\bar{X}$	Required No	Sufficient
1	23	2	100	Numbers Backed	28	1			X												10	.39	7	X
2	26	2	100	2 Piles - No Backing	36	2							X								10	.50	10	X
3	22	2	100	No Backing	37	2			X												10	.46	9	X
4	24	2	50	Numbers Backed	38	2			X											X	10	.30	4	X
5	25	2	100	Same Pile - No Backing	39	2							X								10	.32	5	X
6																								
7																								
8																								
9																								
10																								
11																								
12																								
13																								
14																								
15																								
16																								
17																								
18																								
19																								

Table 22 SUMMARY OF RETRIEVAL AND REFILING TIMES (CONTINUED)

Unit Identification Number	Manufacturer	Unit Title
1	Acco Products, Division of Natser Corporation	Accoway Open Rack
2	Art Metal, Inc.	Open File Shelving
3	Art Metal, Inc.	Planfile
4	Art Metal, Inc.	Planfile Drawer Unit
5	Art Steel Company	Steelmaster Filing Cabinet
6	Globe-Wernicke Company	Cello-Clip Map and Plan File
7	Hamilton Manufacturing Company	Unit System File with Tracing Lifter
8	Hamilton Manufacturing Company	Unit System File without Tracing Lifter
9	Hamilton Manufacturing Company	Vertical File
10	Plan Hold Corporation	Wall Rack File
11	TAB Products Company	Unit Spacefinder
12	Wooden Shelving, open	Roll Axis Vertical
13	Wooden Shelving, compartmented	Roll Axis Horizontal
14	Laboratory Test Model	Album

(4) 50 overlays placed in Laboratory Test Model Album placed inside the Art Metal, Inc., Planfile required 39 seconds for retrieval time. These three items are all placed in Band 3.

7.7.5.2 Refiling of Overlays

(1) The overlays with backed numbers were refiled most rapidly in the Art Metal, Inc. Planfile unit. The average time was 28 seconds, placing this unit in Band 1.

(2) All additional refiling time was placed in Band 2. The Art Metal, Inc., Planfile refiling without backing required 37 seconds; the Hamilton Manufacturing Company Unit System File with Tracing Lifter refiling with 100 in the pile required 39 seconds; with 50 in each of two piles required 36 seconds. Refile time in the Laboratory Test Model Album which contained 50 was 37 seconds.

7.7.6 Mosaic Test Results

The equipment configurations available were satisfactory for thin-backed mosaics less than a certain size — as evidenced by Figure 44 through 47, previously presented. It was felt, however, that none of these configurations was satisfactory for masonite-mounted mosacis and, therefore, no comparative tests were run.

7.7.7 Photographic Print Test Results

Table 23 presents a summary listing of the test data obtained. Observations are given below.

7.7.7.1 Retrieval of Photographic Prints

(1) Again, grouping into bands, it is discovered that approximately the same retrieval time is required for three out of the four units tested for photographic print storage. It required 12 seconds to retrieve photographs from the Art Metal, Inc., Open File Shelving; 13 seconds to retrieve photographs from the TAB Products Co. Unit Spacefinder; and 14 seconds to retrieve photographs from the Art Steel Co. Steelmaster Filing Cabinet. All of these items are placed in Band 1.

(2) It required 18 seconds to retrieve photographs from the Art Metal, Inc., Planfile Drawer Unit, placing this item in Band 2.

7.7.7.2 Refiling of Photographic Prints

(1) It required 12 seconds to refile photographs in the Art Metal, Inc., Open File Shelving; 12 seconds to refile photographs in the TAB Products Co. Unit Spacefinder; and 14 seconds to refile photographs in the Art Steel Co. Steelmaster Filing Cabinet, placing all of these items in Band 1.

(2) It required 16 seconds to refile items in the Art Metal, Inc., Planfile Drawer Unit, placing this item in Band 2.

Table 23

SUMMARY OF RETRIEVAL AND REFILING TIMES

Refile ☐ Retrieve ☒

Sheet 1 of 3

Date 3/13/64

By JAJ

Items Tested Photographic Prints

Size 9-1/2 x 10 x 0.010 inches

Number	Sheet	Test	Quantity Tested	Special Conditions	Av. Time	Band	Unit Identification 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Trials	$R/\bar{X}$	Required No.	Sufficient
1	30	1	100		12	1		X													10	.25	3	X
2	31	1	100		13	1											X				10	.31	4	X
3	29	1	100		14	1					X										10	.43	8	X
4	28	1	100		18	2				X											10	.28	4	X
5																								
6																								
7																								
8																								
9																								
10																								
11																								
12																								
13																								
14																								
15																								
16																								
17																								
18																								
19																								

Table 23

SUMMARY OF RETRIEVAL AND REFILING TIMES

Refile [✓ X] Retrieve ☐

Sheet 2 of 3
Date 3/13/64
By JAJ

Items Tested Photographic Prints
Size 9-1/2 x 10 x 0.010 inches

Number	Sheet	Test	Quantity Tested	Special Conditions	Av. Time	Band	Unit Identification 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Trials	$R/\bar{X}$	Required No.	Sufficient
1	30	2	100		12	1		X													10	.25	3	X
2	31	2	100		12	1											X				10	.48	10	X
3	29	2	100		14	1					X										10	.50	10	X
4	28	2	100		16	2				X											10	.44	8	X
5																								
6																								
7																								
8																								
9																								
10																								
11																								
12																								
13																								
14																								
15																								
16																								
17																								
18																								
19																								

Table 23 SUMMARY OF RETRIEVAL AND REFILING TIMES (CONTINUED)

Unit Identification Number	Manufacturer	Unit Title
1	Acco Products, Division of Natser Corporation	Accoway Open Rack
2	Art Metal, Inc.	Open File Shelving
3	Art Metal, Inc.	Planfile
4	Art Metal, Inc.	Planfile Drawer Unit
5	Art Steel Company	Steelmaster Filing Cabinet
6	Globe-Wernicke Company	Cello-Clip Map and Plan File
7	Hamilton Manufacturing Company	Unit System File with Tracing Lifter
8	Hamilton Manufacturing Company	Unit System File without Tracing Lifter
9	Hamilton Manufacturing Company	Vertical File
10	Plan Hold Corporation	Wall Rack File
11	TAB Products Company	Unit Spacefinder
12	Wooden Shelving, open	Roll Axis Vertical
13	Wooden Shelving, compartmented	Roll Axis Horizontal
14	Laboratory Test Model	Album

7.7.8 <u>Target Folder Test Results</u>

Although Target Folders were not specifically tested, the remarks under General Library Materials are germane and should be reviewed.

7.7.9 <u>PI Key Test Results</u>

Although PI Keys were not specifically tested, the remarks under General Library Materials are germane and should be reviewed.

7.7.10 General Library Material Test Results

Specific tests of retrieval and refiling of general library materials — e.g., books, periodicals, documents, handbooks, special publications — were not conducted, on the basis that data in this field would be available and that no suggested method of storage offered advantages over open shelf filing. The data obtained is given below.

7.7.10.1 Retrieval of General Library Materials

General Library Materials include a variety of book and report-type materials and are shelved on open shelves. Retrieval times for these materials are to some extent independent of the array of the stored materials and of the indexing system. It is assumed that materials belonging to a given editorial series will be shelved together (e.g., all NIS volumes will be found at one shelf location) as a convenience both for security accountability and for operation of the closed-stack service. The postulated indexing system servicing this store [1] is expected to provide both the item address necessary for retrieval and indication of any "off-shelf" status of any item. Under these conditions, retrieval of general library items from the store is reduced to a simple paging operation.

Determination of paging time required for this type of material was approached in two ways. Recourse was had to the literature of library science relating to this problem. In addition, contact was made with a commercial firm, a large national insurance agency, which has had long experience

1/ Cf. infra Section 9.5 for discussion of indexing store relationships.

with a large file arranged in open-shelf equipment. Library literature is more particularly concerned with the problems of shelving books, but at least two studies treat with the subject of retrieval (paging) from shelves [1,2]. Depending on the shelf arrangement, the maximum time indicated as necessary to retrieve from a large library stock is estimated at three minutes. Within the restricted collection expected to be used in the Reconnaissance Technical Squadron activity, limited to a single tier and a single range of shelves, this can probably be reduced to one minute for a single item.

Evidence from the commercial use of open shelf filing investigated accords well with the library experience. In this company, time and motion studies were made to determine the optimum conditions for retrieval from the shelf-filed store. The present configuration, based on these studies, provides a single operator, located at a corridor position, to cover 16 ranks (8 to her left and 8 to her right) of shelving bays, 8 bays deep. The units are filled nine shelves high. The linear distance from the operator's desk to the furthest bay is 25 to 30 feet. Filing array is straight numerical. Under these conditions, the maximum time allowed for retrieval is three (3) minutes.

1/ Jesse, William H., Shelf Work, Chicago, American Library Association, 1952.

2/ Brown, Charles H. and H. G. Bousfield, Circulation Work in College and University Libraries. Chicago, American Library Association, 1933.

7.7.10.2 Refiling of General Library Materials

Refiling of General Library Materials is expected to require a slightly longer time than retrieval, since a two-step process is involved. The materials returned to the service area will have to be first set into an array according to the array of the collection and, second, moved to and interfiled in the collection. Provision is made in the General Library Materials area for this preliminary ordering step. Time for refiling is estimated at two minutes for a single item.

7.8 EQUIPMENT STORAGE EVALUATION

Using the equipment configuration evaluation criteria detailed in Section 7.2, storage equipment for five of the nine basic types of graphic materials were specifically evaluated using the equipment rating sheets. The remainder were evaluated qualitatively. Using their basic report order numbers, the five specifically rated were: (1) roll film, (3) maps, (4) overlays, (5) mosaics, and (6) photographic prints. The four qualitatively rated were: (2) magnetic tapes, (7) target folders, (8) PI keys, and (9) general library materials. Each is discussed individually in the paragraphs which follow.

In some of the equipment configurations for map storage and overlay storage, various tests were conducted to determine whether items which had been misfiled within $\pm$ 10 positions of their proper locations would require longer to retrieve than items found in their proper order. In all instances, it was determined that regardless of equipment being tested, it took between 20% and 40% longer to find an item if it had been misfiled than it took for normal item retrieval. This misfiling test was a highly controlled experiment in that no items were misfiled further away than 10 positions from its proper location. Thus, misfiling will seriously slow down retrieval time from any units, and the system established must guard against misfiling and provide features for its correction. Data on misfiling effects upon retrieval and refiling are given in the detailed storage evaluation tables under their respective sections (i.e., later presented in Tables 27, 29, and 33).

7.8.1 Roll Film Storage Evaluation

Two types of units were tested for the storage of film cans. They were both essentially open shelf filing: in one type of unit, cans were placed on end, with the roll axis vertical, and two deep; in the other type of unit, the cans were placed on their sides, with the roll axis horizontal, one deep. These are evaluated in summary in Table 24 and individual criteria scores for each unit are given in Table 25. On the equipment rating sheets, these are identified by direction of the roll axis. Although more cans per floor area might be stored if cans were to be placed two deep, the disadvantages of doing this far outweigh the advantages. Retrieval and refiling times when cans were placed one deep with roll axis horizontal were substantially faster than when cans were placed two deep with the roll axis vertical. Another distinct advantage of placing cans one deep was the operator consideration: much less stooping would be necessary — i.e., to place the front can on the floor when retrieving a rear can and then replacing the front can back on the shelves. It is significant to note that, when cans were fitted with a handle and this handle was used to pull cans from horizontal axis compartments, a much surer grip was afforded than when the same storage configuration was used but cans had to be pulled from the compartments by their sides. This lessened the tendency to have a can slide out of the subject's hands as was experienced when retrieving and refiling without using the handle. Since the can may weigh up to 20 lbs

Table 24

ROLL FILM STORAGE EVALUATION - SUMMARY

	Unit/Method	Point Score
1.	Roll Axis Horizontal One-can Deep	88
2.	Roll Axis Vertical Two-cans Deep	70

Table 25

EQUIPMENT COMPARISONS

Sneet 1 of 2
Date 3/16/64
By JAJ

Number	Equipment Rating Criteria For Roll Film (Cans)	Weighting Factor	Unit Identification															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Special Storage Considerations	6												12	12			
2	Retrieval and Refiling Speed	5												5	10			
3	"Wear and Tear" on Materials	4												8	8			
4	"Off the Shelf" Availability	4												8	8			
5	Operational Considerations	3												3	6			
6	Size and Form Versatility	3												6	6			
7	Material Conversion Requirements	3												6	6			
8	Independent Accessibility	3												6	6			
9	Unit Capacity	2												4	4			
10	Unit Record Access	2												2	4			
11	Retrieval & Refiling Ease	2												2	4			
12	Adequate Labeling Surfaces	2												2	4			
13	Simultaneous Access	2												2	4			
14	Item Identification Without Removal From File	1												1	2			
15	File Rearrangement Ease	1												1	2			
16	Weight and Mobility	1												2	2			
	Totals for Rated Equipment													70	88			

Table 25 EQUIPMENT COMPARISON (CONTINUED)

Unit Identification Number	Manufacturer	Unit Title
1	Acco Products, Division of Natser Corporation	Accoway Open Rack
2	Art Metal, Inc.	Open File Shelving
3	Art Metal, Inc.	Planfile
4	Art Metal, Inc.	Planfile Drawer Unit
5	Art Steel Company	Steelmaster Filing Cabinet
6	Globe-Wernicke Company	Cello-Clip Map and Plan File
7	Hamilton Manufacturing Company	Unit System File with Tracing Lifter
8	Hamilton Manufacturing Company	Unit System File without Tracing Lifter
9	Hamilton Manufacturing Company	Vertical File
10	Plan Hold Corporation	Wall Rack File
11	TAB Products Company	Unit Spacefinder
12	Wooden Shelving, open	Roll Axis Vertical
13	Wooden Shelving, compartmented	Roll Axis Horizontal
14	Laboratory Test Model	Album
15	Proposed Model	Mosaic Storage Unit
16	Hamilton Manufacturing Company	Board Unit

each, any equipment design which will permit a sure grip of a can and require less handling of a can appears to be reflected in the amount of time required for retrieval and refiling as well as in safety.

7.8.2 Magnetic Tape Storage Evaluation

The storage of magnetic tape reels was not evaluated since it appears that all equipment configurations for storage of magnetic tape containers are essentially the same: with minor differences, these are wire racks which store magnetic tapes on their narrow side with as little space as possible between them.

7.8.3 Map Storage Evaluation

The evaluations established for the seven types of equipment tested are given in summary in Table 26 and by individual criterion in Table 27.

The equipment tested can be divided into three major groups: those pieces of equipment which permit maps to be stored loose, such as Hamilton Manufacturing Company Unit System File with Tracing Lifter or the Art Metal, Inc., Planfiles; those equipments which permit the hanging of maps as a group but do not require that maps be perforated or hung on individual rods (such as the Hamilton Manufacturing Company Vertical File or the Plan Hold Corporation Wall Rack File) and those equipments which require the perforation of maps in some manner in order that they may be strung on bolts, fasteners, etc. (such as the Acco Products Accoway Open Rack or the Globe-Wernicke Company Cello-Clip Map and Plan File).

With the exception of the Hamilton Manufacturing Company Vertical File, the speed of retrieval appears to be directly related to the way in which maps are contained within the unit. The speed of retrieval is in the same order as that listed above. The units which permit loose individual filing of maps show the most rapid retrieval of the maps.

One problem encountered in all hanging units, which hang maps as a group is that it requires that the entire pile (which can be quite heavy if 100 maps are being filed) must be lifted out and laid down on a separate surface in order to retrieve any one map. This is not so with either of the units which permit loose individual filing. In these units, weight of maps is not a problem. In the Art Metal, Inc., Planfile, it is possible to leaf through the

Table 26

MAP STORAGE EVALUATION - SUMMARY

	Unit		Point Score
1.	Art Metal, Inc.	Planfile	297
2.	Hamilton Mfg. Co.	Unit System File Without Tracing Lifter	259
3.	Hamilton Mfg. Co.	Unit System File With Tracing Lifter	257
4.	Plan Hold Corporation	Wall Rack File	250
5.	Globe-Wernicke Co.	Cello-Clip Map and Plan File	230
6.	Hamilton Mfg. Co.	Vertical File	224
7.	Acco Products Co.	Accoway Open Rack	221

Table 27

EQUIPMENT COMPARISONS

Sheet 1 of 2
Date 3/17/64
By JAJ

Number	Equipment Rating Criteria For Maps	Weighting Factor	Unit Identification															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Special Storage Considerations	6	30		42			30	36	24	30	30						
2	Retrieval and Refiling Speed	5	15		35			25	30	35	20	30						
3	"Wear and Tear" on Materials	4	16		28			16	24	28	12	20						
4	"Off the Shelf" Availability	4	28		28			28	28	28	28	28						
5	Operational Considerations	3	6		21			9	15	18	6	12						
6	Size and Form Versatility	3	18		14			18	12	12	18	21						
7	Material Conversion Requirements	3	18		21			18	21	21	21	21						
8	Independent Accessibility	3	18		21			18	21	21	18	18						
9	Unit Capacity	2	12		14			8	6	6	10	6						
10	Unit Record Access	2	12		14			12	14	14	12	12						
11	Retrieval & Refiling Ease	2	10		14			10	12	14	8	12						
12	Adequate Labeling Surfaces	2	6		14			6	10	10	12	8						
13	Simultaneous Access	2	14		10			14	10	10	12	14						
14	Item Identification Without Removal From File	1	7		7			7	7	7	6	7						
15	File Rearrangement Ease	1	5		7			5	6	6	5	5						
16	Weight and Mobility	1	6		7			6	5	5	6	6						
	Totals for Rated Equipment		221		297			230	257	259	224	250						

Table 27 EQUIPMENT COMPARISON (CONTINUED)

Unit Identification Number	Manufacturer	Unit Title
1	Acco Products, Division of Natser Corporation	Accoway Open Rack
2	Art Metal, Inc.	Open File Shelving
3	Art Metal, Inc.	Planfile
4	Art Metal, Inc.	Planfile Drawer Unit
5	Art Steel Company	Steelmaster Filing Cabinet
6	Globe-Wernicke Company	Cello-Clip Map and Plan File
7	Hamilton Manufacturing Company	Unit System File with Tracing Lifter
8	Hamilton Manufacturing Company	Unit System File without Tracing Lifter
9	Hamilton Manufacturing Company	Vertical File
10	Plan Hold Corporation	Wall Rack File
11	TAB Products Company	Unit Spacefinder
12	Wooden Shelving, open	Roll Axis Vertical
13	Wooden Shelving, compartmented	Roll Axis Horizontal
14	Laboratory Test Model	Album
15	Proposed Model	Mosaic Storage Unit
16	Hamilton Manufacturing Company	Board Unit

maps without picking them up in order to find the one required. In the Hamilton Manufacturing Company Unit System File with Tracing Lifter, the tracing lifter takes the weight off from the maps before retrieving the required ones.

In both the Hamilton Manufacturing Company Unit System File with Tracing Lifter and the Art Metal, Inc., Planfile, the speed of retrieval for individual maps does not appear to be directly related to the position of the map in the drawer or folder. It does not seem to take significantly longer to retrieve, say, Map #90 than it does to retrieve Map #20.

In all systems where maps are hung as a group it does appear to take significantly longer to retrieve maps the further they are away from the first map. This is especially true when all the maps must be carefully lifted off a post or fastener, keeping holes aligned in order to retrieve an individual map and then all maps must be placed back on the posts as a group.

The Art Metal, Inc., Planfile, taking into consideration all factors, is the highest recommended unit by a factor of almost 20% over the next rated units. The Hamilton Manufacturing Company Unit System File with Tracing Lifter, Hamilton Manufacturing Company Unit System File without Tracing Lifter, and the Plan Hold Corporation Wall Rack File are all within a few percentage points of one another and would be in the second recommended category. The least desirable units are those units which require placing holes or attachments through the maps to be filed, along with the unit which caused a great deal of operator inconvenience, the Hamilton Manufacturing Company Vertical File.

7.8.4 <u>Overlay Storage Evaluation</u>

It was established in Sections 7.6.5 and 7.7.5 that when an overlay had a backed number and was retrieved from a given unit the retrieval time was substantially faster than the case in which an overlay had an unbacked number. The recommendation would be made, therefore, that, irrespective of the equipment configuration chosen for plastic overlays, backing should be used for numbers in order to assist operator retrieval times. In the equipment rating sheets, presented in summary in Table 28 and in detail in Table 29, the backing factor was assumed and equipments were rated accordingly.

In both the Hamilton Manufacturing Company Unit System File with Tracing Lifter and Art Metal, Inc., Planfile units, overlays were placed loose. In addition to loose filing of overlays, a test was made with a Laboratory Test Model Album configuration which was placed within the Art Metal, Inc., Planfile. The overlays, if placed in an album in actual practice, would have to be placed in a large unit which would either support the overlays vertically as in the Art Metal, Inc., Planfile or horizontally as in the Hamilton Manufacturing Company Unit System File. Because of their size, albums could not be filed on ordinary open library shelving; nor could they be stored vertically since the overlays have very little body and would have a tendency not to stand up. Therefore, even though the overlays are rated as if they were in an album by themselves, it should be understood that they would be placed within a filing unit.

Table 28

OVERLAY STORAGE EVALUATION - SUMMARY

	Unit		Point Score
1.	Art Metal, Inc.	Planfile	122
2.	Hamilton Mfg. Co.	Unit System File With Tracing Lifter	103
3.	Laboratory Test Model	Album	97

Table 29

EQUIPMENT COMPARISONS

Sheet 1 of 2
Date 3/18/64
By JAJ

Number	Equipment Rating Criteria For Overlays	Weighting Factor	Unit Identification															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Special Storage Considerations	6			12				12							18		
2	Retrieval and Refiling Speed	5			15				10							5		
3	"Wear and Tear" on Materials	4			8				8							12		
4	"Off the Shelf" Availability	4			12				12							12		
5	Operational Considerations	3			9				6							6		
6	Size and Form Versatility	3			9				6							6		
7	Material Conversion Requirements	3			9				9							6		
8	Independent Accessibility	3			9				9							9		
9	Unit Capacity	2			6				4							2		
10	Unit Record Access	2			6				6							4		
11	Retrieval & Refiling Ease	2			6				4							2		
12	Adequate Labeling Surfaces	2			6				4							4		
13	Simultaneous Access	2			6				6							6		
14	Item Identification Without Removal From File	1			3				3							2		
15	File Rearrangement Ease	1			3				2							1		
16	Weight and Mobility	1			3				2							2		
	Totals for Rated Equipment				122				103							97		

Table 29 EQUIPMENT COMPARISON (CONTINUED)

Unit Identification Number	Manufacturer	Unit Title
1	Acco Products, Division of Natser Corporation	Accoway Open Rack
2	Art Metal, Inc.	Open File Shelving
3	Art Metal, Inc.	Planfile
4	Art Metal, Inc.	Planfile Drawer Unit
5	Art Steel Company	Steelmaster Filing Cabinet
6	Globe-Wernicke Company	Cello-Clip Map and Plan File
7	Hamilton Manufacturing Company	Unit System File with Tracing Lifter
8	Hamilton Manufacturing Company	Unit System File without Tracing Lifter
9	Hamilton Manufacturing Company	Vertical File
10	Plan Hold Corporation	Wall Rack File
11	TAB Products Company	Unit Spacefinder
12	Wooden Shelving, open	Roll Axis Vertical
13	Wooden Shelving, compartmented	Roll Axis Horizontal
14	Laboratory Test Model	Album
15	Proposed Model	Mosaic Storage Unit
16	Hamilton Manufacturing Company	Board Unit

The distinct advantage of placing an overlay within an album so as to eliminate scratching and the fact that the overlay within the album would cause "less wear and tear" on the material was not enough to override the disadvantages which would arise when storing overlays within the album, mainly due to the fact that retrieval time was increased. The Art Metal, Inc., Planfile appeared to be a more satisfactory unit for the storage of overlays than did the Hamilton Manufacturing Company Unit System File. Apart from their ability to become scratched easily and the fact that they have less body than paper, the filing of overlays is very similar to the filing of maps, and it is interesting to note that the criteria which rated the Art Metal, Inc., Planfile superior in map filing to the Hamilton Manufacturing Company Unit System File also created the same result in the evaluation of overlay storage. The Art Metal, Inc., Planfile was approximately 20% ahead of its nearest competitor.

The issue of time versus scratching is one which must be solved for a particular application and will depend upon the half-life of the overlay and its responsibility.

7.8.5 Mosaic Storage Evaluation

Mosaic storage equipment was not specifically tested for speed of retrieval and refiling. However, four representative types of equipment were evaluated according to all criteria of the equipment evaluation sheet except Speed of Retrieval and Refiling and Weight and Mobility. The evaluations are presented in summary in Table 30 and in detail in Table 31. It will be noted that if the three lowest ranking units were placed in roughly the same category, or band, it would appear that the proposed model mosaic storage unit would be approximately 30% more desirable than these other units.

Although equipment test configurations for filing and retrieval of mosaics were unavailable, some conclusions as to filing and retrieval times can be drawn from the tests which were run on both maps and overlays. Mosaics are similar to both, except for the fact that they might be larger than the overlays or the maps, thicker than the overlays or the maps, and weigh more than the overlays or the maps. It would appear that a spring-compression unit similar to the Art Metal, Inc., Planfile — with sideloading instead of top-loading — would probably lend itself to the fastest storage and retrieval times. This would probably be slightly faster than flat horizontal drawer storage because of the additional time which would be required when lifting up a pile of mosaics in a drawer in order to retrieve one close to the bottom. Both of these would probably be slightly faster than storing the mosaics in a unit

Table 30

MOSAIC STORAGE EVALUATION - SUMMARY

Unit			Point Score
1.	Proposed Model	Mosaic Storage Unit	148
2.	Hamilton Mfg. Co.	Unit System File Without Tracing Lifter	116
3.	Hamilton Mfg. Co.	Board Unit	116
4.	Plan Hold Corp.	Wall Rack File	107

Table 31

EQUIPMENT COMPARISONS

Sheet 1 of 2
Date 3/19/64
By JAJ

Number	Equipment Rating Criteria For Mosaics	Weighting Factor	Unit Identification															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Special Storage Considerations	6								18		12					24	6
2	Retrieval and Refiling Speed	5								-		-					-	-
3	"Wear and Tear" on Materials	4								8		12					16	8
4	"Off the Shelf" Availability	4								16		16					12	12
5	Operational Considerations	3								6		6					12	9
6	Size and Form Versatility	3								9		12					12	12
7	Material Conversion Requirements	3								12		12					12	12
8	Independent Accessibility	3								12		12					12	12
9	Unit Capacity	2								8		8					8	8
10	Unit Record Access	2								6		4					8	8
11	Retrieval & Refiling Ease	2								6		4					8	8
12	Adequate Labeling Surfaces	2								4		2					8	6
13	Simultaneous Access	2								6		4					8	8
14	Item Identification Without Removal From File	1								3		2					4	4
15	File Rearrangement Ease	1								2		1					4	3
16	Weight and Mobility	1								-		-					-	-
	Totals for Rated Equipment									116		107					148	116

Table 31 EQUIPMENT COMPARISON (CONTINUED)

Unit Identification Number	Manufacturer	Unit Title
1	Acco Products, Division of Natser Corporation	Accoway Open Rack
2	Art Metal, Inc.	Open File Shelving
3	Art Metal, Inc.	Planfile
4	Art Metal, Inc.	Planfile Drawer Unit
5	Art Steel Company	Steelmaster Filing Cabinet
6	Globe-Wernicke Company	Cello-Clip Map and Plan File
7	Hamilton Manufacturing Company	Unit System File with Tracing Lifter
8	Hamilton Manufacturing Company	Unit System File without Tracing Lifter
9	Hamilton Manufacturing Company	Vertical File
10	Plan Hold Corporation	Wall Rack File
11	TAB Products Company	Unit Spacefinder
12	Wooden Shelving, open	Roll Axis Vertical
13	Wooden Shelving, compartmented	Roll Axis Horizontal
14	Laboratory Test Model	Album
15	Proposed Model	Mosaic Storage Unit
16	Hamilton Manufacturing Company	Board Unit

similar to the Plan Hold Corporation Wall Rack File which would grip either one or a group of mosaics in some sort of clamp configuration. This is so because the mosaic (or a group of mosaics) would have to be removed from the Wall Rack File, placed on a table surface, the holder released, the required mosaic removed, the remainder (if any) reclamped in the holder and replaced in the Wall Rack File.

It would appear, then, that a configuration which permitted the filing of individual mosaics without attachments or clamping together as a group would have a tendency to have faster storage and retrieval time than those required when clamping or grouping together.

As has been previously discussed in the case of group storage of maps in a similar equipment configuration, unless extreme care is exercised mosaics can be damaged when placing on the table for removal of individual mosaics from the group holding fixture.

Each type is discussed individually in the following paragraphs.

The Hamilton Manufacturing Company Unit System File without Tracing Lifter permits placing mosaics flat within a horizontal drawer, piled one on top of the other. There are some advantages in this system, although one of the larger disadvantages is the problem encountered when attempting to retrieve the mosaic at the bottom of a heavy pile of mosaics. Not only is this awkward, but mosaics might become damaged in the process. Another type of configuration considered was that using the Plan Hold Corporation Wall Rack File. This would permit clamping one mosaic (or a group of mosaics) and hanging it (them) up in the Plan Hold Corporation Wall Rack File. One of the large disadvantages with this system, however, is the fact that mosaics could not be retrieved individually. The whole configuration would have to be removed from its hanging rack, placed on a table, the holder would have to be unclamped, the individual mosaic removed, and the holder returned to file. The third type of equipment considered was the Hamilton Manufacturing Company Board Unit which is divided into sections a few inches apart. In this configuration one mosaic (or a group of mosaics) would be placed in each section. However, since the mosaics would be standing on end, they would have a tendency to warp unless the sections were tightly packed. If the sections were tightly packed, another problem will arise in that it would become difficult to remove individual mosaics. The fourth type of configuration considered was one similar to the Art Metal, Inc., Planfile. This would hold mosaics under spring compression and at the same time permit relatively rapid retrieval and refiling from the side.

Underscoring the problem of mosaic storage is their potentially large size. If mosaics were only 36 x 48 inches, many of the pieces of equipment tested could be used for their storage. The Hamilton Manufacturing Company Unit System File without Tracing Lifter and the Art Metal, Inc., Planfile both come in standard sizes for the storage of material up to 36 x 48 inches. This size would not present special difficulty for filing by means of the Plan Hold Corporation Wall Rack File. However, when mosaics approach the maximum size specified — i.e., 60 x 60 inches — special filing problems arise. No standard off-the-shelf equipments which are capable of filing this size of mosaic appear to be available. Drawings, however, are later presented which show a unit similar in nature to the Art Metal, Inc., Planfile turned on its side. This unit, with its spring compression seems to be an ideal way of handling mosaics. Filing a 60 x 60 inche mosaic in horizontal drawers, assuming drawers could be built to handle this size, would be extremely awkward and there would be additional problems in having to lift a heavy mosaic out of a drawer in contrast to sliding it out of the spring loaded unit in an already vertical position. The other type of unit used for filing large mosaics, that of a large sectioned storage area, has some advantages over the drawer filing in that mosaics would not have to be individually lifted, but rather could be slid out towards the user, again in a vertical position. This unit does, however, have the disadvantage of curling and bending — due to the weight of the mosaic itself.

7.8.6 Photographic Print Storage Evaluation

The evaluation of the four equipments tested are presented in summary in Table 32 and in detail in Table 33.

It should be noted that the Art Metal, Inc., Planfile Drawer Unit appears to be the only unit having the required size storage capability which is an "off-the-shelf" item.

In photographic storage, the overriding design consideration should be the provision of an ability to hold photographs flat under compression.

The open shelf units, while having many other advantages, do not hold the photographic prints under compression.

The time required to retrieve photographs from both open shelf units (Art Metal, Inc. and TAB Products Company) was a little faster than the time required to retrieve photographs from a standard file drawer. The reason for this is that in open shelf filing the photographs are obtainable by walking directly up to the unit, whereas in a file drawer it is necessary to open the drawer before removing the photographs.

It should be noted that, in the Steelmaster File Cabinet, the follower block was not pushed up tight in order to hold photographs in their Pendaflex folders under compression. If it were necessary to release a follower block each time a photographs was to be retrieved, retrieval time would be increased significantly.

It will be noted that the Art Metal, Inc., Planfile Drawer Unit is rated almost 10% higher than the other three units, whose ratings are all within 1% of each other.

Table 32

PHOTOGRAPHIC PRINT STORAGE EVALUATION - SUMMARY

	Unit		Point Score
1.	Art Metal, Inc.	Planfile Drawer Unit	163
2.	Art Steel Co.	Steelmaster Filing Cabinet	151
3.	Art Metal, Inc.	Open File Shelving	151
4.	TAB Products Co.	Unit Spacefinder	150

Table 33

EQUIPMENT COMPARISONS

Sheet 1 of 2
Date 3/20/64
By JAJ

Number	Equipment Rating Criteria For Photographic Prints	Weighting Factor	Unit Identification															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	Special Storage Considerations	6		12		24	18						12					
2	Retrieval and Refiling Speed	5		20		15	20						20					
3	"Wear and Tear" on Materials	4		12		16	12						12					
4	"Off the Shelf" Availability	4		12		16	12						12					
5	Operational Considerations	3		9		12	12						9					
6	Size and Form Versatility	3		12		12	12						12					
7	Material Conversion Requirements	3		12		12	12						12					
8	Independent Accessibility	3		12		12	12						12					
9	Unit Capacity	2		8		4	4						6					
10	Unit Record Access	2		8		8	8						8					
11	Retrieval & Refiling Ease	2		8		8	8						8					
12	Adequate Labeling Surfaces	2		8		6	6						8					
13	Simultaneous Access	2		8		6	6						8					
14	Item Identification Without Removal From File	1		4		4	4						4					
15	File Rearrangement Ease	1		2		4	1						3					
16	Weight and Mobility	1		4		4	4						4					
	Totals for Rated Equipment			151		163	151						150					

Table 33 EQUIPMENT COMPARISON (CONTINUED)

Unit Identification Number	Manufacturer	Unit Title
1	Acco Products, Division of Natser Corporation	Accoway Open Rack
2	Art Metal, Inc.	Open File Shelving
3	Art Metal, Inc.	Planfile
4	Art Metal, Inc.	Planfile Drawer Unit
5	Art Steel Company	Steelmaster Filing Cabinet
6	Globe-Wernicke Company	Cello-Clip Map and Plan File
7	Hamilton Manufacturing Company	Unit System File with Tracing Lifter
8	Hamilton Manufacturing Company	Unit System File without Tracing Lifter
9	Hamilton Manufacturing Company	Vertical File
10	Plan Hold Corporation	Wall Rack File
11	TAB Products Company	Unit Spacefinder
12	Wooden Shelving, open	Roll Axis Vertical
13	Wooden Shelving, compartmented	Roll Axis Horizontal
14	Laboratory Test Model	Album
15	Proposed Model	Mosaic Storage Unit
16	Hamilton Manufacturing Company	Board Unit

Although the Art Metal, Inc., Planfile Drawer Unit required longer retrieval time, it appeared that the protection afforded photographs by the constant spring compression would more than compensate for its slower retrieval time.

Although the Art Metal, Inc., Planfile Drawer Unit required longer retrieval time, it appeared that the protection afforded photographs by the constant spring compression would more than compensate for its slower retrieval time.

7.8.7 <u>Target Folder Storage Evaluation</u>

Storage equipment specifically intended for Target Folders was not tested and was not evaluated. The nature of the material is sufficiently similar that the conclusions drawn under General Library Materials, later presented, are germane.

7.8.8 <u>PI Key Storage Evaluation</u>

Storage equipment specifically intended for PI Keys was not tested and was not evaluated. The nature of the material is sufficiently similar that the conclusions drawn under General Library Materials, later presented, are germane.

7.8.9 <u>General Library Materials Storage Evaluation</u>

No rating sheet appears for General Library Materials storage because it is felt only one type of equipment will lend itself to the storage of varied materials, such as books, periodicals, documents, reports, atlases, folios, and special documents — e.g., ASSOTW, NIS, etc.

The materials listed will be supported on open shelf filing which has sufficient depth to hold the largest items to be filed. In addition, it will have both adjustable horizontal shelves and adjustable dividers within each horizontal shelf. This will permit obtaining essentially one type of equipment for the storing of General Library Materials which will, at the same time, be versatile enough to store the many sizes and types of these materials.

On the basis of an observed commercial experience of considerable scope and a long-standing tradition in the library profession, the method of open-shelf filing for both books and other miscellaneous material is seen to be the most effective. Equipment adequate for open-shelf filing of these materials is available from many sources. It should provide a means for the positive support of limp items at any given shelf location. File retrieval times for shelf-filed miscellaneous material, as determined from the quoted sources, indicates that this operation should require 1 to 3 minutes per item. This is well within reasonable limits. The array of materials on the shelves has not been considered as a determinant in these considerations. Relationships between the physical array of materials and file location symbols and indexing is treated later in Section Nine.

7.8.10 Equipment Evaluation Summary

In review of the techniques explored, by test, through the literature, or by conceptual consideration, the following methods seem to be most advantageous under the basic premises of:

(1) simplicity of design,

(2) manual operation, and

(3) off-the-shelf availability.

There does not seem to be any question that filing roll film cans with their axes horizontal, one deep is far superior to any sort of system which would require filing of film cans two deep. In addition, it appears that some sort of handle or gripping surface on the roll film can itself, or in which the roll film can rests, would afford a positive manner of assuring that the persons retrieving film cans would have less of a tendency to drop them.

Although some kinds of open file shelving will lend themselves to the storage of aerial roll film cans, it is felt that the volume of storage and the frequency of use will warrant the use of modular steel shelves with separators, all cut to appropriate size.

The standard wire rack with magnetic tape containers vertical is the only type of storage readily available; it seems satisfactory; and no other manner has presented itself which would be more convenient or more efficient.

The Art Metal, Inc., Planfile technique has been evaluated, on the basis of the equipment rating sheets, as being superior for the filing of four types of materials:

1. Maps
2. Overlays
3. Mosaic Boards
4. Photographic Prints

The reason that this unit has been judged superior in these areas is basically because of its spring-compression principle. This principle, which holds individual or groups of sheets of paper, hardboard, or film under spring compression, is far superior to any other types of equipment configuration which requires that material obtain its support from the fact that, as in the case of maps, it is lying in a flat horizontal drawer or, as in the case of photographic prints, that a follower block must be pushed up against the rear most folder to give it compression.

The Hamilton Manufacturing Company Unit System File with Tracing Lifters is an approach intended to ease the retrieval and refiling of objects from these drawers. The tracing lifters, themselves, do in fact make it simpler to remove or refile a given object from the Hamilton Manufacturing Company Unit System File than would normally be the case for removing this object without the tracing lifter. However, the weighting assigned to this one factor was not sufficient to overcome some of the other problems which arose when using this unit.

Mosaic storage presents a special problem. Here, again, the spring compression principle provides distinct advantages. Large mosaics cannot be bent and will, therefore, not fit into a 36 x 48-inch Art Metal, Inc., Planfile unit in the way that a 48 x 60-inch map can be folded in half to be filed in this unit. Another problem with standard Art Metal, Inc., Planfile Units is that they only can be opened from the top. It becomes very awkward to handle a mosaic which is 5 feet long and 5 feet wide if one pulls it out from the top. Therefore, a special unit has been recommended as combining the advantages of the Art Metal, Inc., Planfile unit compression without the major disadvantages of top loading.

Target folders, PI keys, and general library materials all lend themselves most appropriately to open shelf filing with suitable restraining devices to support limp items and with suitably large area shelf space for folios, atlases, and other large or special documents.

SECTION EIGHT. FACTORS INFLUENCING SELECTION OF PHYSICAL HANDLING TECHNIQUES SUITABLE FOR THE RECONNAISSANCE TECHNICAL SQUADRON ENVIRONMENT

The environment of a Reconnaissance Technical Squadron poses no unusual requirement for the selection of physical handling techniques. There are: (1) the normal concerns of the basic nature of what is to be stored and the implications of its use profile on material conversion in or for storage, (2) the handling system requirements, (3) the storage configuration, and (4) the basic building environment. Each is discussed below.

8.1 FORMS AND DIMENSIONS OF DATA BASE TYPES

The data base proposed for the Reconnaissance Technical Squadron is composed of a wide variety of forms, sizes, and materials (see Tables 2 and 3, presented previously). While it is desirable to store similar types of items in the same storage configuration, this is not always possible when a wide variety of sizes is encountered in a given data base type. This may require the adoption of material conversion requirements on items exceeding a certain set level of size (e.g., all items over 48 x 36 inches may be folded to satisfy anthropometric considerations — if, of course, their basic nature allows folding — and also to facilitate use of an optimum storage equipment configuration size). It is realized that many of the data base forms are thin-based material and as such are better stored in groups, as opposed to single sheets, in order to protect them from rough handling. However, when this technique is employed, certain restrictions on the quantity of materials to be grouped must be adopted, based on such factors as anthropometric considerations, retrieval speed desired, and storage and refiling problems encountered.

8.2 HANDLING SYSTEM OPERATIONAL REQUIREMENTS

In designing the physical handling system, the Reconnaissance Technical Squadron operational requirements must be taken into consideration. These requirements include:

(1) expected workload,

(2) speed of response,

(3) user workplaces to be serviced,

(4) input material flow,

(5) material obsolescence cycle

(6) servicing of satellite facilities such as an Image Interpretation Cell or a Mobile Wing Reconnaissance Technical Squadron,

(7) use of content-based indexing,

(8) terminology, and

(9) general use of the computer to augment photo-interpretation operations and activities.

Since many of these factors have not been defined, many assumptions have had to be made,for the purposes of this study, to determine their effects on the proposed system design.

8.3 USER WORKPLACE REQUIREMENTS

During the review of the equipment data obtained from the many manufacturers of graphic materials handling equipment, it soon became apparent that some of the equipment configurations required that certain limitations or restrictions be placed upon, or alternations be made to, the data base material in order to facilitate its storage in a particular configuration. Two examples of this are found in the area of map storage equipment. One required hole punching; the other required the application of an adhesive tape with a pre-punched hole structure.

However, since the Reconnaissance Technical Squadron must also generate data base, by copy procedures, for its own internal use and for satellite operations, such material conversion requirements imposed by the storage configuration may not be satisfactory in data base production workplaces (e.g., TTR production or other copy-camera situations where addition of holding materials might affect the operation of the vacuum frame).

8.4 STORAGE AREA CONFIGURATION

The storage area configuration influences the choice of equipments and techniques in that those which are selected must be responsive to (1) the size of the storage area as a whole (set by the anticipated total volume of data base); (2) the compartmentation of the storage area for the different types of material; (3) the interrelationship of the individual compartments as it affects speed of retrieval and refiling, as well as logical work flow and operational convenience; (4) structural considerations such as ceiling heights and flow loading restrictions; (5) separation of work function — e.g., input processing, output processing, user response processing, and administration, all in addition to basic storage; and (6) the normal environmental conditions discussed in paragraph 8.5.

8.5 GENERAL FACILITY ENVIRONMENT

The general facility environment proposed for the Reconnaissance Technical Squadron complex approaches that of the standard business office environment utilizing electronic data processing equipment in that the temperature, humidity, and dust content of the air will all be closely controlled (see also Section Two, Definition of the Problem).

It has been assumed that adequate lighting, low noise level, and proper ventilation will all be provided as a part of the basic environmental shell.

In addition, the general requirements for security will be satisfied by the general building configuration implemented by normal military security organization. In this regard, therefore, the choice of equipment configuration need not provide for protection against adverse environmental conditions, nor of iteself contain provisions for preventing access to the material therein stored.

SECTION NINE. FACTORS INFLUENCING ORGANIZATION OF THE PHYSICAL STORE

The factors which have a direct influence on the physical organization of the graphic materials store may be considered in five general groups as follows:

(1) Functional role of the graphic materials in the photo-interpretation process

(2) Physical characteristics of the graphic materials

(3) Editorial class or source sequences

(4) Use patterns of the store

(5) Intellectual content of the graphic materials

Functional role distinguishes between that which is interpreted and that which is a tool for interpretation. This distinction has an influence on the structure of the store. The factors relating to the actual physical characteristics of the graphic materials being handled are perhaps the most significant in the design of a system for the physical storage and handling of these materials. The factors relating to the editorial class or source sequences of the graphic materials are, however, important in the particular storage problem under consideration. Of importance, also,are those considerations relating to the use of the store; use patterns in a store of Reconnaissance Technical Squadron graphic materials have been seen to be such as to have a strong influence on the structure of the store. Finally, the intellectual content of the graphic materials, though having less immediate effect upon the physical storage of those materials, must be taken into account in developing and structuring the store. These five groups of factors relating to the structuring of the physical storage system will now be discussed in some detail.

9.1 FUNCTIONAL ROLE

It seems axiomatic that the distinction between graphic materials which are to analyzed and interpreted and those which serve as tools for the interpretive process should be reflected in the storage structure. There is a categorical difference in form similarly differentiating between the materials to be interpreted and the reference material (see Table 34). There is a flow and activity rate in the objects which are the raw material in the photo-interpretation process (the photography) which demands certain housekeeping practices and which is not present in materials which are used as references. The distinction between photography and all other materials used to interpret photography seems, therefore, essential in laying out the physical storage of these various file elements; a distinction based on a real functional role.

Such a distinction must not, however, overlook the fact that there is a certain introversion of function in the case of intelligence photography. New photography is most often interpreted by means of previous photography, and not only by means of maps, keys, etc. Some means must be provided, therefore, to reassemble previous photography and its interpretation (overlays, annotations, reports, etc.) for this purpose, if the distinction of functional role is established as the primary division of the physical store. This is not an impossible task and certainly is the current practice in many installations. Mechanical and electronic assistance in this task of

Table 34

FILE ORGANIZATION BY FUNCTIONAL NATURE

Input Materials	
1. Roll Film	Cylindrical Solids
2. Magnetic Tape	Cylindrical Solids
Reference Materials	
3. Maps	Flat Sheets
4. Overlays	Flat Sheets
5. Mosaics	Flat Sheets
6. Photographic Units	Flat Sheets
7. Target Folders	Rectangular Solids
8. PI Keys	Rectangular Solids
9. General Literary Materials	Rectangular Solids

assembling or reassembling photography and its interpretation are already being considered and are a premise of this study. The introversion of function peculiar to the photography in the photo-interpretation process should not, therefore, stand in the way of establishing functional role as the first element in the structuring of the physical store.

There is another significant factor which should be recognized vis-a-vis functional role and the physical store. This store is, in the same fashion as in a computer, a data memory — with the qualification that it is a case of destructive readout; that is, when out on loan the data does not exist in the store. Pursuing the analogy, there is always selective readout to the input-output buffer — in this case the user workplace. In the same fashion that data may be flexibly stored in a computer memory and recalled by address alone, so may the graphic materials of this collection. It is important to recognize this attribute of the graphic materials store and further to recognize that it is quite unlike a general library collection in that there is no functional requirement that physical browsing be permitted within the storage area.

9.2 PHYSICAL CHARACTERISTICS OF GRAPHIC MATERIALS

There are at least three physical characteristics of graphic materials each of which has a direct effect on the organization of the materials into a physical store. These characteristics are the physical form of the material, the dimensions of an individual unit of the material, and the quantity of each material. Each of these characteristics has an immediate effect on the organization of storage for the related material.

9.2.1 Form of Graphic Materials

Graphic materials constituting the data base for operational use in the Reconnaissance Technical Squadron come in a variety of media in various shapes and sizes ranging from the small cylindrical shapes of the various film cans and magnetic tapes to the large, flat, hardboard sheets which constitute the base for mosaics. Within these two extremes, there are many varying data-base forms as illustrated in Table 35

The size variations complicate the choice of equipment configurations since achievement of an optimum equipment configuration may be impaired due to limitations caused by any wide variations in material sizes or types. In order to determine the equipments best suited for testing for applicability in the Reconnaissance Technical Squadron application, the data base forms were analyzed according to type and size range, and equipment configurations were chosen, as has been previously described in paragraph 7.5.

TABLE 35

DATA BASE MATERIAL FORMS

Material Form	Data Base Type
A. Cylindrical Solid	
1. Cylindrical	Film Cans, Magnetic Tapes
B. Rectangular Solid	
1. Books	
Albums	Keys, ASSOTW's, NIS
Notebook	Keys, Miscellaneous
Standard	Keys, Miscellaneous
2. Folders	Target Folders, Miscellaneous
3. Periodicals	Keys, Miscellaneous
C. Sheet	
1. Acetate Sheets	Overlays, Film Negatives
2. Flat Sheets, Single - Paper	
Large	Maps, Photos
Medium	Maps, Photos
Small	Photos, Miscellaneous
3. Flat Sheets, Multiple	Reports, Miscelleneous
4. Flat Sheets, Single - Hardboard	
Large	Mosaics
Medium	Mosaics
Small	Mosaics

9.2.2 Dimensions of Graphic Materials

As has been previously discussed, the data base collection exhibits a wide range of forms and sizes from the extreme of 60 x 60 inches associated with mosaics to the 7 3/4-inch diameter by 2-15/16-inch deep can used for 70-mm film. Such a wide range of sizes further complicates the selection of an optimum storage equipment configuration. It is possible that a data base type may, because of the extreme size variation within the type, be stored in different equipment configurations. This problem can be minimized by the adoption of size ranges in bands and, where practicable, the data base may be altered to fit within an optimum band size. As an example of material adaptability, maps in excess of 48 x 36 inches may be folded in half without seriously affecting their usage either as a photo-interpretation tool or when placed on a vacuum platform printing frame for Tactical Target Record generation. Masonite-backed mosaics, on the other hand, are intractable in this regard. Some of the size ranges of the data base collection anticipated for the RTS are shown in Table 36.

9.2.3 Quantity of Graphic Materials

The quantities of graphic materials discussed in the report have been estimated as being representative figures for the active storage facility at the Reconnaissance Technical Squadron. However, these figures should not be taken as limiting, but rather have been established

Table 36

ESTIMATED DIMENSIONS OF GRAPHIC MATERIAL DATA BASE TYPES

	Data Base Type	Size Range (inches)	
		Maximum	Minimum
1.	Roll Film (Cans)	8-1/4 (d) x 11- 3/4 (h)	7-3/4 (d) x 2-15/16 (h)
2.	Magnetic Tapes	11-1/2 (d) x 1-15/16 (h)	8 (d) x 3/4 (h)
3.	Maps	57-1/4 x 41-1/2 x 0.005	29 x 22 x 0.005
4.	Overlays	60 x 60 x 0.005	25 x 22 x 0.005
5.	Mosaics	60 x 60 x 0.250	12 x 12 x 0.125
6.	Photographic Prints	9 x 18 x 0.015	9 x 9 x 0.010
7.	Target Folders	9-1/2 x 11-3/4 x 1	9-1/2 x 11-3/4x 0.250
8.	PI Keys	11 x 17 x 1	8-1/2 x 11 x 0.250
9.	General Library Materials		
	9.1 Albums	29 x 22 x 0.500	20 x 20 x 0.250
	9.2 Books	12 x 14 x 2.500	6 x 9 x 0.250
	9.3 Periodicals	8-1/2 x 11 x 0.500	5-1/2 x 7-1/2x 0.250
	9.4 Reports	10 x 12 x 1.500	8-1/2 x 11 x 0.250

as a basis upon which to make recommendations for system operational requirements, storage area capacity calculations, personnel requirements calculations, equipment design and capacity calculations, and handling techniques — i.e., design center values. Table 37 summarizes the estimated quantities of data base types representing the graphic materials data base collection predicted for the Reconnaissance Technical Squadron.

Table 37

ESTIMATED QUANTITIES OF DATA BASE TYPES

	Data Base Type	Estimated Quantities
1.	Roll Film (Cans)	54,000
2.	Magnetic Tapes	10,000
3.	Maps	9,000
4.	Overlays	1,000
5.	Mosaics	1,000
6.	Photographic Prints	2,600
7.	Target Folders	1,500
8.	PI Keys	150
9.	General Library Materials Books Periodicals Reports	90,000
	Total	169,250

9.3 EDITORIAL SERIES OR SOURCE SEQUENCES OF GRAPHIC MATERIALS

A characteristic which appears to be common to all graphic materials used in photo-interpretation is their issuance by the originating source in some sort of series or sequence. Membership in an editorial class can therefore be used as one means of organization of the graphic store. Since there is a high correlation between the physical form and dimensions of graphic materials and the editorial class to which they belong, the use of editorial class in developing the arrangement of the store is a natural second step. The editorial classes occurring in the two major divisions of graphic materials used in photo-interpretation are discussed briefly here.

9.3.1 Editorial Classes of Roll Film and Magnetic Tape

There is essentially one type of editorial class for the basic roll film and magnetic tapes. This is the "taking organization" — i.e., the squadron, wing, or other group within the Air Force which is responsible for producing the photography and tapes. Breakdown of originating agencies would be by the organization within the Air Force responsible for flying a specific mission.

9.3.2 Editorial Classes of Reference Materials

The editorial classes for reference materials are of three basic types: (1) series within a given editorial class, (2) editorial classes constituting general publishing agencies within and without the government, and (3) editorial classes constituting special publishing agencies — some within, some without the government. The following are representative examples.

9.3.2.1 Maps

There are many agencies responsible for the issuance of maps, including such domestic agencies as:

(1) Aeronautical Chart and Information Center

(2) Army Corps of Engineers

(3) Army Map Service

(4) Coast and Geodetic Survey

(5) Naval Hydrographic Office

and foreign originating agencies such as countries of interest, cities within the countries of interest, etc.

9.3.2.2 Overlays

Overlays will most likely be produced by the organizations within the Air Force n are involved in photo-interpretation efforts. Therefore, the photo-interpreters who are interpreting maps and photographs within the Reconnaissance Technical Squadron facility might be one issuing agency. Other organization within the Air Force would constitute other issuing agencies.

9.3.2.3 Mosaics

Mosaics will most probably be prepared by the Reconnaissance Technical Squadron facility itself and related agencies within the photo-intelligence community.

9.3.2.4 Target Folders

See General Library Materials.

9.3.2.5 PI Keys

See General Library Materials.

9.3.2.6 General Library Materials

Materials which will flow into the General Library Materials collection will be published by a wide variety of sources, both governmental and non-governmental.

9.4 USE PATTERNS OF GRAPHIC MATERIALS IN THE STORE

A set of characteristics which has a direct influence on the physical arrangement of graphic materials in the store relates to the patterns of use to which the store is subjected. Arrangement of the physical store of graphic materials should proceed on the basis of principles relating to their physical characteristics and their editorial class, as described above, but when these factors have been taken into consideration, it is necessary to modify the resulting array according to the use pattern which it is expected that the store will experience. There are four aspects of the use of a store of information materials which are generally applicable in the analysis of a given situation. These relate to (1) the input flow of materials to the store, (2) the reference activity to which the store is subjected (where materials are withdrawn from the store and returned), (3) the consumption activity to which the store is subjected, and (4) the obsolesence rates which result in the purging of materials from the store. Each of these use activities is uniquely patterned for every particular store. In the development of techniques for the handling of graphic materials for the photo-interpretation process, it is necessary to estimate each of these use factors as they may be expected to occur in the operational situation.

9.4.1 Input of Graphic Materials in the Photo-Interpretation Process

The operational characteristics of the Reconnaissance Technical Squadron suggest that a high input level is to be expected in the data base roll film collection and a figure of approximately 300 cans per day has been selected as representative. In cases where such a high input of data base types is expected, then the storage configuration must be modified to take this into consideration to assure that the normal input procedure will not seriously affect the reference activity requirement of the data base collection. In cases of high input activity, it is also recognized that a unique type of filing system should be employed to control the rapidly changing inventory in the highly active file.

9.4.2 Reference Activity in the Photo-Interpretation Process

It is recognized that the majority of photo-interpretation effort performed within the Reconnaissance Technical Squadron will fall into the category of flash reporting. This will place little or no demand upon the reference material collection. However, since there will be operational situations requiring more detailed exhaustive studies, such as the immediate and detailed reporting effort, the material handling system must be capable of reacting quickly to the immediate needs of the photo-interpreter, which in some instances may result in traffic of 50-100 items per user-workplace, per case.

9.4.3 Consumption of Graphic Materials in the Photo-Interpretation Process

Within the Reconnaissance Technical Squadron, it is doubtful that normal operations will result in appreciable consumption of the materials in the data base collection, since the Reconnaissance Technical Squadron itself has producer capabilities in many areas (e.g., tactical target records, photographic prints, etc.). Although the implicit responsibility of a Reconnaissance Technical Squadron to supply an Image Interpretation Cell or a Mobile Wing Reconnaissance Technical Squadron exists, it is felt that this responsibility will not affect the physical handling techniques selected or the organization chosen for the store. Whether these satellites are supplied directly out of the store, or indirectly through the reproduction user workplace the actions are identical to those in the normal internal cycle — i.e., a damage-and-replace cycle, an obsolescence cycle (i.e., no replacement), or an ordinary loan to a user workplace (i.e., reproduction).

9.4.4 Obsolescence of Graphic Materials in the Photo-Interpretation Process

As is the case in any warehouse operation, ultimately the data base volume will reach the point where it completely fills the storage area — unless, of course, a high out-on-loan reference activity and/or a high consumed-in-process rate is experienced. When this point is reached, the average rate of obsolescence must equal that of input. The buffers in the process which must accommodate expected transients (or surges) in the average rates are three:

(1) nominal capacity as compared to the actual,

(2) input processing temporary storage capacity, and

(3) output processing temporary storage capacity.

When one considers a process which involves obsolescence, or purging, in any form other than completely monotonic against the accession number series, there is the problem of file reorganization. When the rates of input, use, and output are high, file reorganization must be a natural, orderly, continuous process as contrasted to a semi-annual shelf inventory and file reorganization.

Another factor which must be accommodated is that of co-existence. That is, the functional activities which constitute input processing must not conflict with those which constitute output processing, and vice versa, and neither must conflict with the basic process — servicing the users.

9.4.5 Bibliographic Control

Implicit in all of these patterns of use is the need for control of the data inventory itself and, equally as important, for control of the identifiers by which this data store is managed operationally for the users. The control must be complete, precise, and must include self-monitoring and self-checking wherever possible; otherwise chaos will reign in a store of some 170,000 separate items. The manner in which inventory control — in both the bibliographic and the physical sense — is maintained is described in paragraphs 10.1.5 and 10.3.2, later presented.

9.5 INTELLECTUAL CONTENT OF GRAPHIC MATERIALS AND INDEXING CONSIDERATIONS

A basic guiding concept in the spatial organization of the graphic materials store for the photo-interpretation process has been to avoid criteria of intellectual content, the framework of most library systems. It has been suggested instead that the aspects of graphic materials relating to their functional role, their physical characteristics, their editorial class, their quantity, and the patterns of their use should be considered as the criteria for structuring their physical array. Questions of intellectual content are handled on the basis of what is, in essence, an external classification system. Matters concerning intellectual content of the graphic materials store are handled, thus, by what is essentially an independent array and the factor of consequence is the set of relationships between the physical array and the patterns of intellectual content. In reviewing these considerations, certain basic principles of indexing and file organization will be touched upon along with the particular functions which indexing structures have or could have in the photo-interpretation process.

9.5.1 Basic Considerations

One of the first things that must be done in approaching the problem of intellectual content of graphic materials is to clarify certain relationships involved in the information handling process as applied to these materials. Such clarification is needed with regard to the relationship between the physical array of graphic materials and their indexing. The point that needs to be emphasized here is the fundamental independence of physical array and indexing. It is often assumed that, because a certain indexing structure is operationally necessary to a given body of material, it is therefore necessary to impose on the material itself a certain physical order based on that indexing structure. No such necessity in fact exists. A body of information materials may exist in a physical array which is independent of the array of the indexing structure, provided that the relationship between intellectual index and physical store is adequately maintained through some coding procedure. It is important to remember, therefore, that the physical array of graphic materials used in the photo-interpretation process does not necessarily have to reflect its intellectual content and that it will not if it is more effective to organize the materials in some other manner.

A similar point which must be emphasized concerns the relationship between the notation selected and both arrays — the physical store and intellectual content. By notation is meant that coding procedure by which an item in a physical array is identified. It is possible so to construct such a code or notation that it reflects something of the intellectual content of the item to which it is attached. An example of this kind of relationship between notation and intellectual content is the content-based code now being considered for the Reconnaissance Technical Squadron, illustrated in Figure 57. Here part of the code number identifies the geographical area of the item to which it is attached. It is possible also to construct such a code or notation in a way in which the notation reflects the physical storage location of the item to which it is attached. In such a system, for example, the code number or notation would be a direct key to the filing cabinet, shelf or bin where the item sought is located. What is at issue here in the fact that there is no intrinsic reason why a given notation or code number should reflect either storehouse equipment or intellectual content. In the last analysis, these things are intrinsically independent. They may be combined in any particular data handling situation, but there is no logical imperative which demands such a relationship. A code or notation may therefore embody some indication of the storehouse location, the intellectual content of the things stored, or neither of these. All three opportunities are open to the designer of the information system.

It may also be well at this point to consider one or two basic principles of indexing theory which may be particularly applicable to the problems involved in storage of graphic materials. In the development of the means for controlling the intellectual content of informational materials. there are two goals which are sought. The first of these is the control of the language, or sets of linguistic symbols, which form the <u>indicia</u> of the

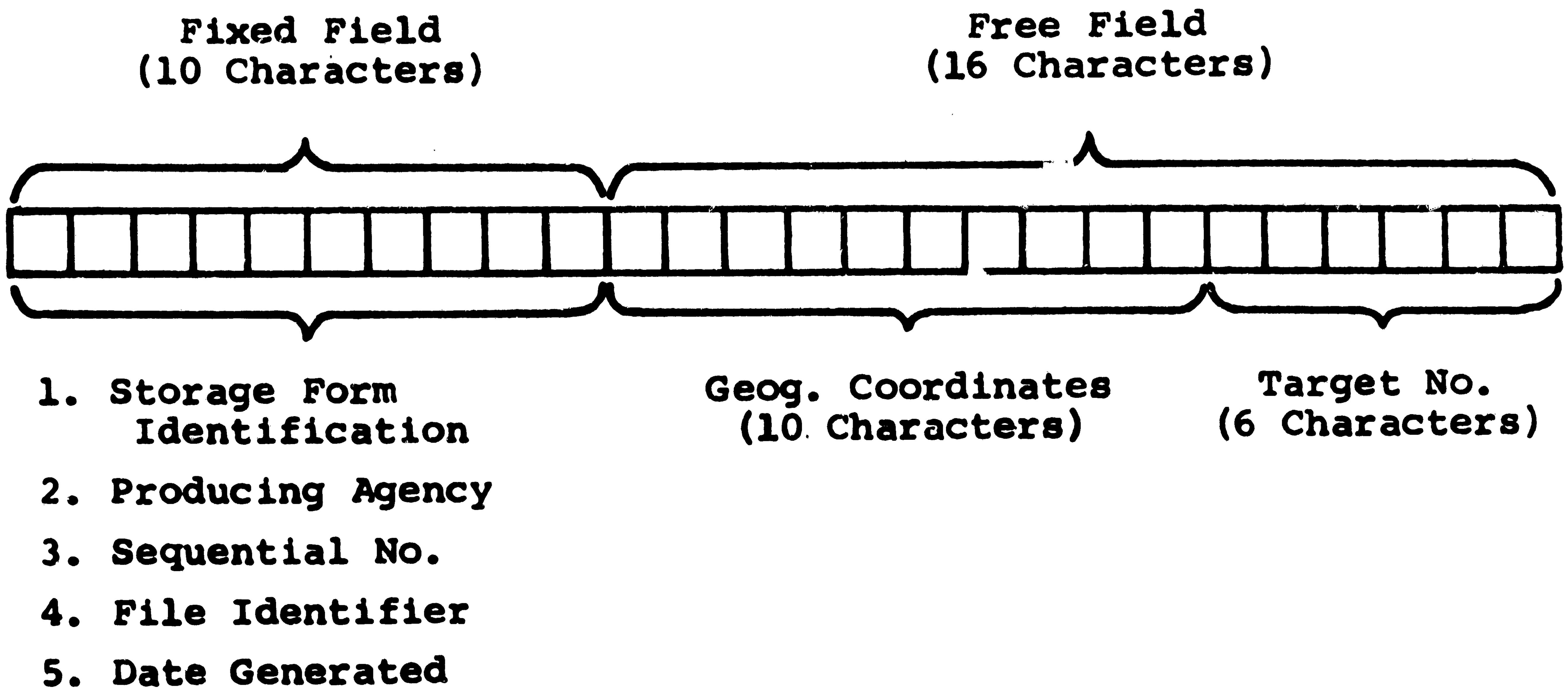


Figure 57

TENTATIVE NOTATION STRUCTURE/CONTENT-BASED

indexing activity. The second is the development of means to represent conceptual patterns to which these indicia may be related and through which the relationships between terms may be expressed. This twofold approach to control of subject content is seen in the traditional tools of library management: the subject heading list and the classification schedule. They are also seen in some of the most recent work on language data storage and retrieval.[1]

It is almost universally recognized that indexing of subject content of informational materials requires some sort of vocabulary control. The development of devices for vocabulary control usually involves the consideration of two aspects of the problem. One of these concerns the choice of terms or the development of a controlled vocabulary which forms the basic set of india used for the indexing operation. The other involves the development of the means by which the controlled set of terms is matched with, and related to, terms occurring in the informational material to be indexed. The content, structure, arrangement, and manipulation of a dictionary of terms for the purpose of indexing graphic materials related to the photo-interpretation process is seen to represent a substantial part of the related indexing activity.

Vocabulary control, however, represents only a part of the solution to the indexing problem. Complementing this linguistic approach

1/ Salton, Gerald "A Flexible Automatic System for the Organization, Storage, and Retrieval of Language Data (SMART)." Information Storage and Retrieval. Harvard Computation Laboratory, Scientific Report ISR-5, 1964.

must be the development of patterns of concepts, or classifications, through which the individual terms may be related in meaningful constellations. The generic-specific relationship is only one of the many patterns which must be developed. Modern information storage and retrieval theory sees the handling of this kind of relational apparatus within the dictionary as operationally too restrictive and it has even been suggested that a single indexing vocabulary or controlled set of indicia may be combined with more than one concept network in the development of complex and overlapping indexing structures. The inherent difficulty of geographical materials as objects of indexing activity certainly indicates the high probability that complex indexing approaches such as these will have to be applied to the problem. That is, the extremely high informational content of an intelligence photograph provides a wide spectrum of indexing problems — high both in terms of overlapping concept structures and in terms of the quantity of objects of indexing activity.

9.5.2 Functions of the Indexing Structures in Photo-Interpretation

The content of the Reconnaissance Technical Squadron storage system should really be viewed as two distinct parts:

(1) Aerial or ground photography of all types from whatever source; and

(2) All maps and charts, all textual material, such as NIS volumes, Reconnaissance Technical Squadron reports, photo-interpretation keys, engineering source material handbooks, order of battle material, and the like.

The aerial photograph is a means of representing earth-space reality. In a sense, it includes all the intellectual contents of the area covered, within the recognized limits of resolution, angle of aspect, atmospheric haze, and similar image degrading or obscuring elements. A single vertical photograph could easily contain images of:

(1) An enemy military installation,

(2) Enemy forces in deployment,

(3) The existing transportation system in all its complexity,

(4) Urban areas and settlements,

(5) Important industrial areas, perhaps of strategic importance,

(6) Physical facilities associated with local resource development,

(7) Important terrain and training features,

(8) Details on vegetation cover, and in all likelihood other more unusual elements like port facilities, specialized agricultural features, etc.

The elements of earth-space reality which these images represent can, however, only be inferred from the aerial photography by a process of examination and interpretation. This interpretation is largely a personal act of the photo-interpreter, drawing upon his memory and skill, but is also in great part assisted by a wide variety of interpretive devices.

Maps and charts are the most obvious of these interpretive tools. They are more limited in their information content than aerial photographs since they contain only symbols and abbreviated text which represent a portion of the earth-space reality. On the other hand, maps and charts can identify certain cultural features by type and name (a factory building on the photograph becomes a specific type of known ownership). They can also reveal objects concealed on the photograph (a mine opening on a steep, densely vegetated hillside), can give accurate measurements of relief as well as water depth, and can provide other types of special information. In some instances, special maps will have been prepared for one or more aspects of military importance, although these are perhaps most commonly now located in the NIS series.

The textual information (interpretive tools other than maps) contained in the Reconnaissance Technical Squadron facility is truly encyclopedic in nature, unless radically stringent limitations are to be imposed on acquisition of intelligence material and background data. Professional photo-interpreters, regardless of the specific nature of their immediate jobs, quite naturally feel that all information relating to the physical and cultural landscape of a particular region is of value and interest to their work . The vast array of photo-interpretation keys, prepared during and since World War II, alone covers nearly every conceivable topic and region. In topical specialities, one can refer during the analysis of the physical landscape to a key on geomorphological features of glaciated regions or in the cultural landscape to a key on the cranes to be found throughout the world in ports, shipyards, and naval facilities. Regional keys have been especially prepared in the last fifteen years on a number of the more active, strategic regions of the world. Such regional keys are themselves most exhaustive in content, trying to encompass all reality that the photo-interpreter might encounter in analyzing photographs in a particular region. Lastly, nothing could be more detailed than the NIS series, which by its very nature, is a compendium of all known military and non-military information pertaining to a given country.

If the store of graphic materials in the Reconnaissance Technical Squadron facility is thus viewed as consisting of two groups, photography and the tools for its interpretation, the relationships between these two groups and the indexing structures required to correlate them can be visualized as in Figure 58. In this illustration the attempt has been made to symbolize only the existence of a store of photography, the existence of a store of interpretive tools, and the existence of an indexing structure or structures of varying complexity. The role which these indexing structures

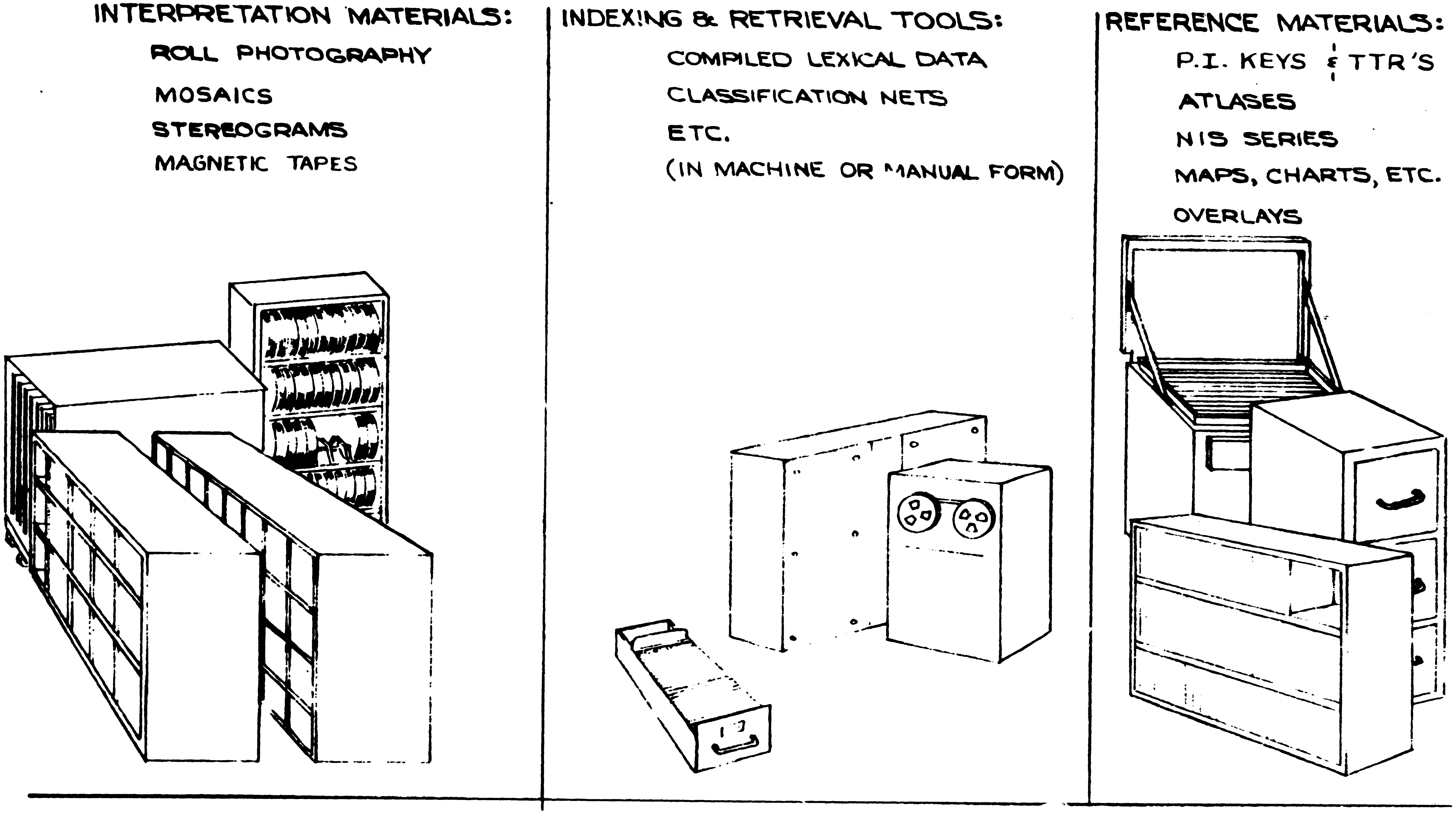


FIGURE 58

STORAGE - INDEXING RELATIONSHIPS

(the embodiment of the intellectual content of the stores) play in the arrangement of the physical store of graphic materials depends on the way in which the indexing function is conceived with respect to the graphic materials themselves. On the one hand, the store of photography and the store of interpretive tools can be visualized being arranged in an array directly related to the intellectual content. In this case an array by a particular aspect of content must be chosen since the materials can only be placed in a single array at a given time. This is a particularly significant point when one considers the factor of viewpoint. A flash interpretation may search only for ground weapon movement. A detailed interpretation may search only for shipyard repair activity. A strategic interpretation may search for evidence of growth or creation of industrial complexes. Thus one may desire to impose simultaneously several concept patterns upon one physical store of graphic materials — each reflecting a viewpoint of interest, concern, and priority. Other possible relationships dependent upon intellectual content of the materials will therefore have to be represented, off-line (i.e., "out-of-store"), in the indexing structure. An example of such a file organization would be the arrangement of photography and interpretive tools in an array by geographical area and the provision of indexes for the relation of all other intellectual content (weapon types, industrial complexes, vegetation, geological structure, etc.) by means of the indexing devices.

On the other hand, it is entirely possible to organize the graphic materials (both photography and interpretive tools) in an array, or arrays, independent of the intellectual content of the material itself. In this instance, all access to intellectual content of the materials is provided through the indexing structure and file organization of the graphic materials is provided on bases other than intellectual content. An example of such a file organization would be the array of graphic materials according to physical form, author, source, series, or some other convenient housekeeping device, and the provision of indexing for all intellectual content.

From this discussion, it can be seen that the effect of the intellectual content upon the physical arrangement of the store of graphic materials is dependent on the decision to arrange, or not to arrange, the materials in a physical array according to some aspect of intellectual content. As far as indexing structure is concerned, it makes little difference whether the material is physically arranged according to a single aspect of intellectual content or not. All other aspects of intellectual content will have to be handled by the index in any event. Organization of the physical file according to some aspect of intellectual content (for example, geographical area) has some advantages and some disadvantages. On the one hand, housekeeping problems, especially with respect to such high flow rate items as photography, are made far more difficult by the necessity of setting the incoming material into a physical array based upon an intellectual pattern. The problems of category straddling and lack of fit will always arise. On the other hand, reference activity to the files of graphic materials is probably greatly facilitated by their arrangement in some well-known array relating to their intellectual contents, BUT one should recall that a premise of the present consideration is that browsing is not a functional requirement. Arrangements of the graphic materials stores in an array according to some arbitrary housekeeping rubric such as physical form and editorial class is probably the most convenient. It allows the easy housekeeping of the stores independently from their intellectual content. It permits also rapid inventory of those things which are of a security classified nature. It permits better use of storage equipment. It presents no great additional burden to the indexing structure. And finally, it offers users the economy of time.

SECTION TEN. SYNTHESIS OF GRAPHIC MATERIALS STORAGE, RETRIEVAL, AND HANDLING SYSTEM

This section presents a representative system synthesized to meet the graphic materials storage, retrieval, and handling requirements of a Reconnaissance Technical Squadron. The system presented is intended to accommodate a graphic materials collection of some 170,000 items — in the type and number distribution previously given in Table 37, repeated here for convenience.

The system has been synthesized on the basis that:

(1) it is strictly a data store, highly analagous to a computer memory, in which browsing through the intellectual content, unguided by an index, is not a functional requirement;

(2) the physical array and the indexing array are independent, but easily related;

(3) the indexing array and physical item address control are provided external to the hard-copy graphic materials system;

(4) the physical array is ordered by (i) functional role, (ii) physical form, (iii) editorial (or source) series, and (iv) use patterns;

Table 37

ESTIMATED QUANTITIES OF DATA BASE TYPES

Data Base Type	Estimated Quantities
1. Roll Film (Cans)	54,000
2. Magnetic Tapes	10,000
3. Maps	9,000
4. Overlays	1,000
5. Mosaics	1,000
6. Photographic Prints	2,600
7. Target Folders	1,500
8. PI Keys	150
9. General Library Materials Bocks Periodicals Reports	90,000
Total	169,250

(5) the physical array has been so arranged as to maximize simplicity of design and manual handling and to minimize the times of retrieval and refiling;

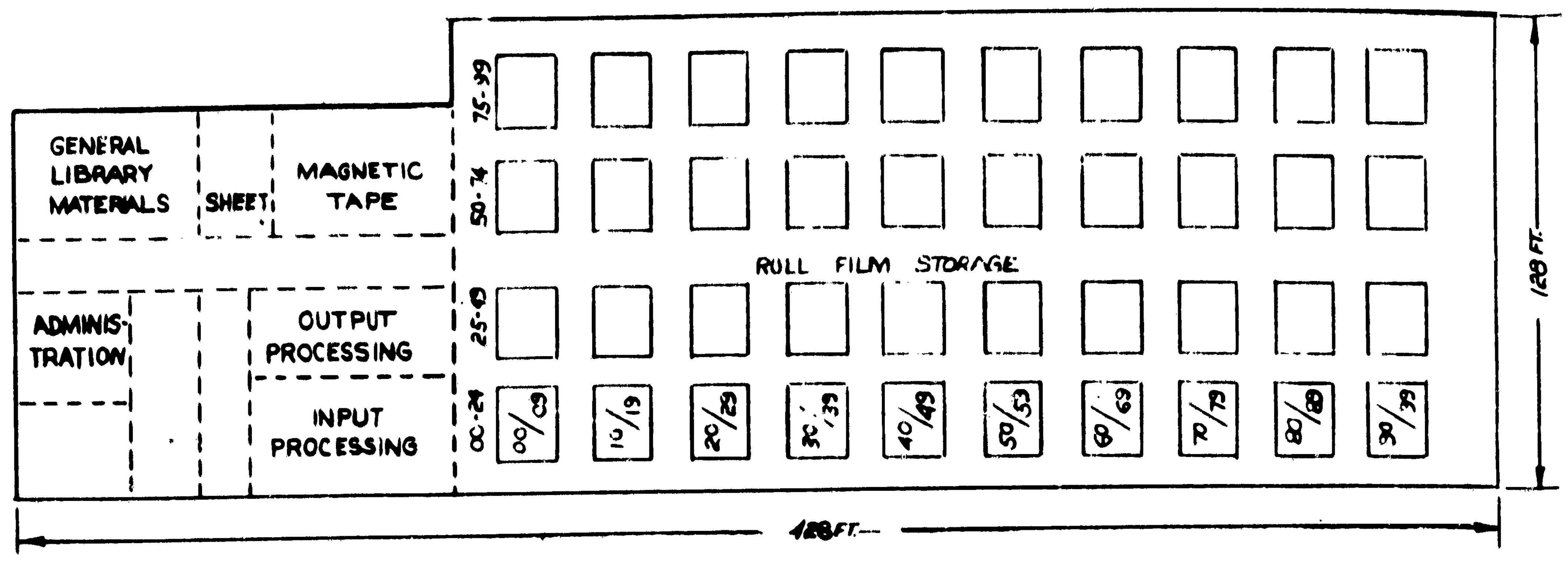
(6) the physical array includes a materials shuttle cart which acts simultaneously as a physical carrier, a means of organizing its cargo, and a means of providing floating address control;

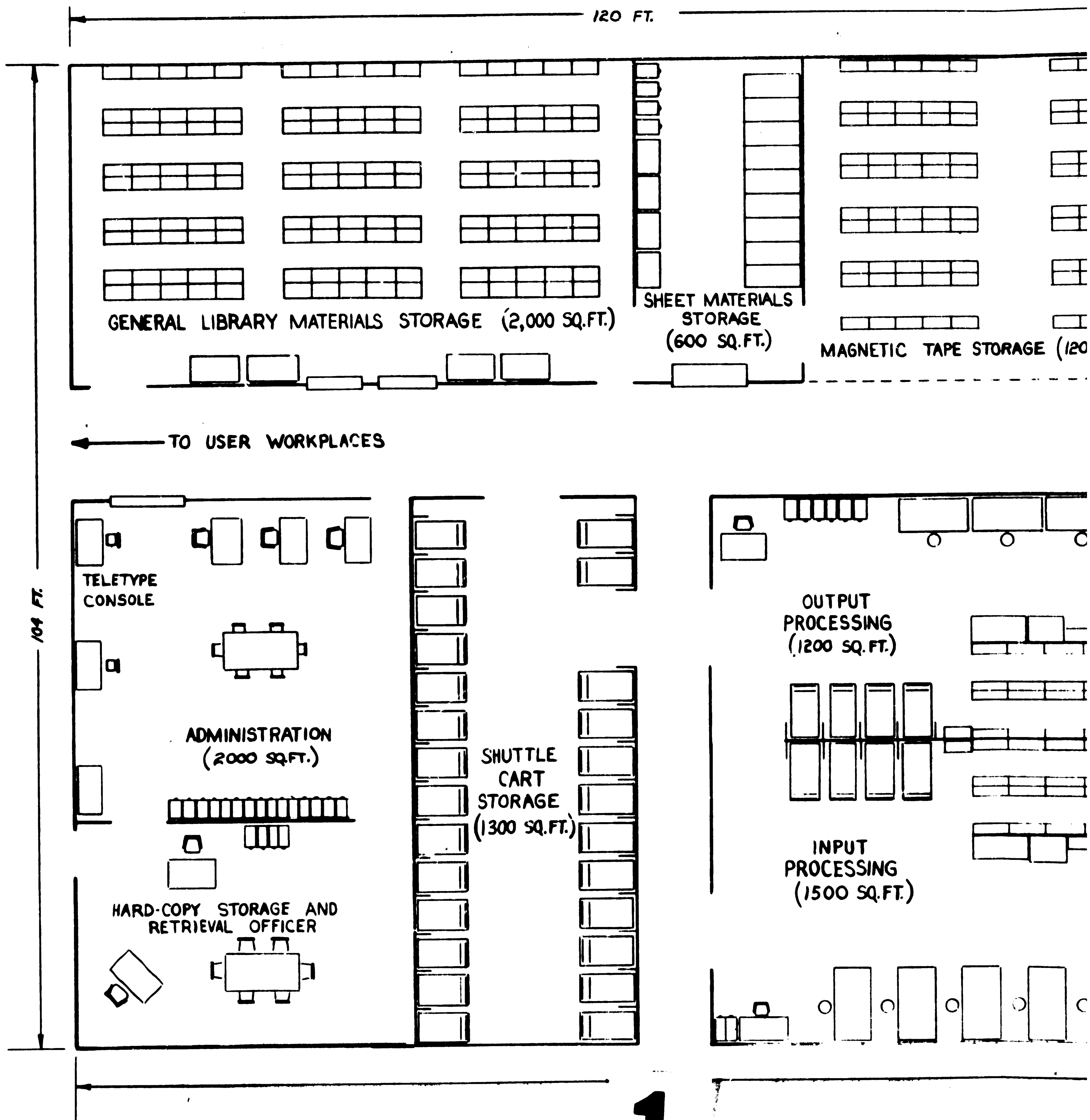
(7) the physical array recognizes human factors considerations; and

(8) the processing requirements for input, output, and operational control are met.

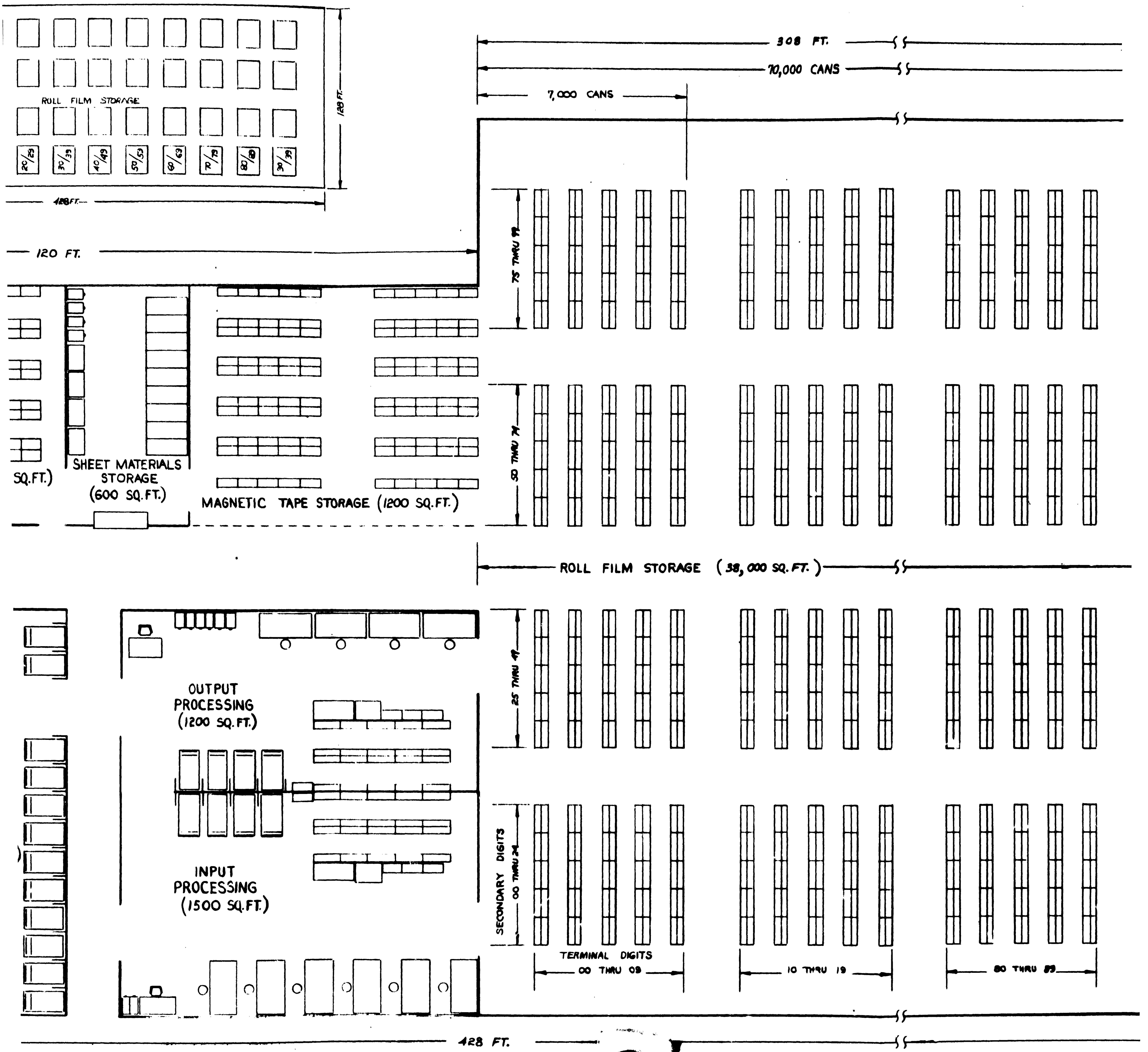
The resultant system is arranged in the manner indicated in Figure 59. The allocation of floor space is given in Table 38. The equipment types and quantities associated with these choices are given in Table 39.

The storage configuration illustrated accommodates 3 basic types of processing: (1) input, (2) output, and (3) operational control and administration and 4 basic types of storage area: (1) roll film, (2) magnetic tape, (3) sheet materials, and (4) general library materials. The sections which follow describe these processes and storage areas of the system in more detail in terms of (1) the functional organization, (2) indexing relationships, (3) the actual layout of the storage area, (4) the equipment types within the storage configuration, and (5) the associated personnel requirements, respectively.


GENERAL LIBRARY MATERIALS
SHEET
MAGNETIC TAPE
ADMINIS-TRATION
OUTPUT PROCESSING
INPUT PROCESSING
75-99
50-74
25-49
00-24
ROLL FILM STORAGE
128 FT.


120 FT.
GENERAL LIBRARY MATERIALS STORAGE (2,000 SQ.FT.)
SHEET MATERIALS STORAGE (600 SQ.FT.)
MAGNETIC TAPE STORAGE (12
TO USER WORKPLACES
TELETYPE CONSOLE
ADMINISTRATION (2000 SQ.FT.)
HARD-COPY STORAGE AND RETRIEVAL OFFICER
SHUTTLE CART STORAGE (1300 SQ.FT.)
OUTPUT PROCESSING (1200 SQ.FT.)
INPUT PROCESSING (1500 SQ.FT.)
104 FT.

1

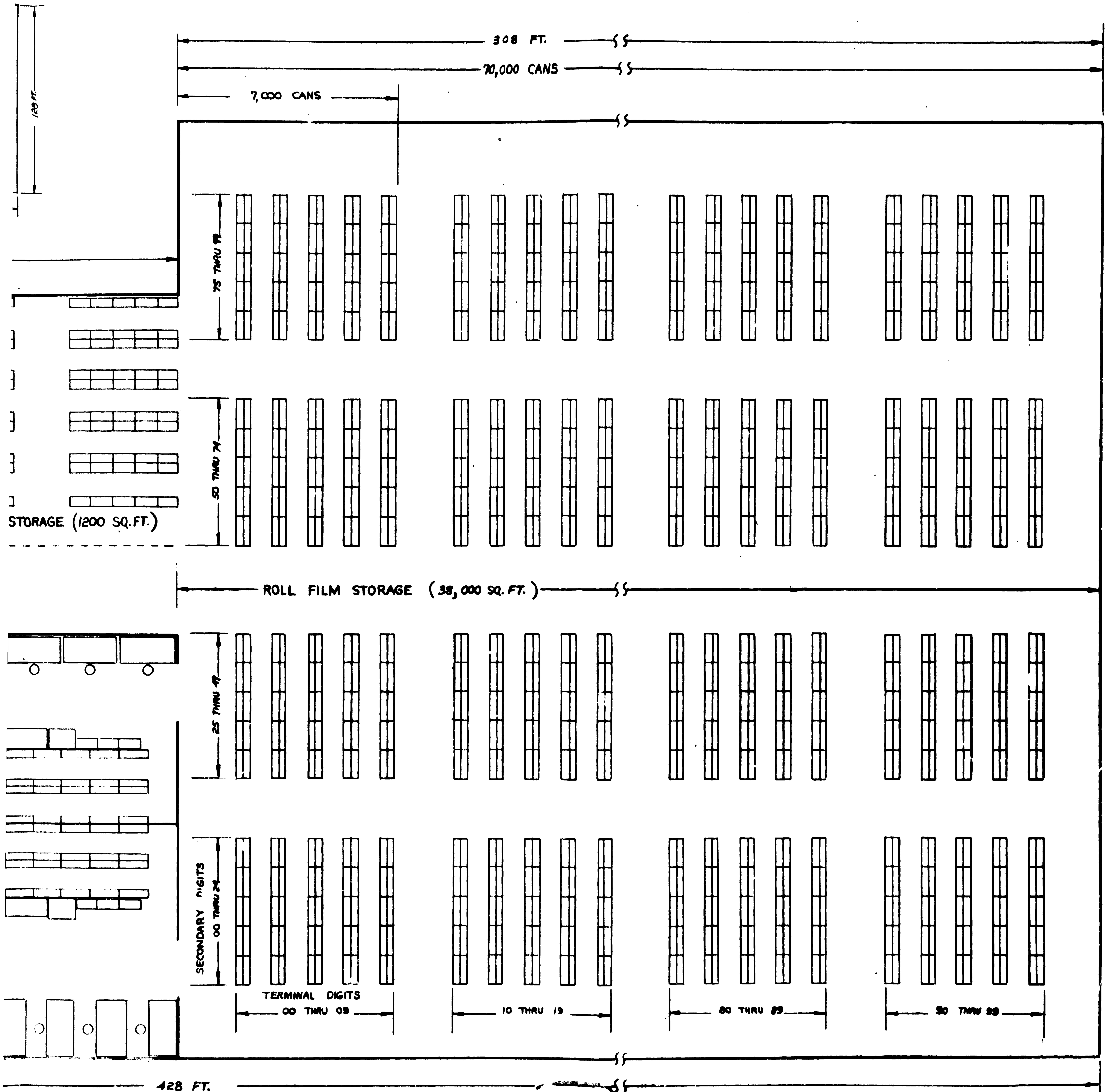


FIGURE

RECONNAISSANCE TECH

GRAPHIC MATERIALS S

GENERAL L



3

FIGURE 59
RECONNAISSANCE TECHNICAL SQUADRON
GRAPHIC MATERIALS STORAGE AREA
GENERAL LAYOUT

Table 38

ALLOCATION OF FLOOR SPACE

Area Name	Square Feet
A. STORAGE AREAS	
1. Roll Film	38,000
2. Magnetic Tape	1,200
3. Sheet Materials	600
4. General Library Materials	2,000
B. PROCESSING AREAS	
1. Input	1,500
2. Output	1,200
3. Material Shuttle Carts	1,800
4. Operational Control and Administration	3,000
C. GENERAL AREAS	
1. Aisles and Miscellaneous Space	1,500
Total	50,800

Table 39

AREA DISTRIBUTION OF EQUIPMENT TYPES AND QUANTITIES

Hard-Copy Storage Area Subdivision	Equipment Types and Quantities							
	Roll Film Racks	Magnetic Tape Racks	Open File Shelving Units	Planfile Units	Planfile Drawer Units	Proposed Mosaic Storage Units	Material Shuttle Carts - General	Material Shuttle Carts - Film Can
A. Storage Areas								
1. Roll Film	2,000							
2. Magnetic Tape		100						
3. Sheet Materials				3	2	9		
4. General Library Materials			135					
B. Processing Areas								
1. Input	20	1	2	1		1	2	2
2. Output	20	1	2	1		1	2	2
3. Carriers							26	
TOTALS	2040	102	139	5	2	11	30	4

10.1 FUNCTIONAL ORGANIZATION

The general functional organization of the Graphic Materials Storage, Retrieval, and Handling System is depicted in Figure 60. The processing functions implicit within this organization are discussed individually in the paragraphs which follow.

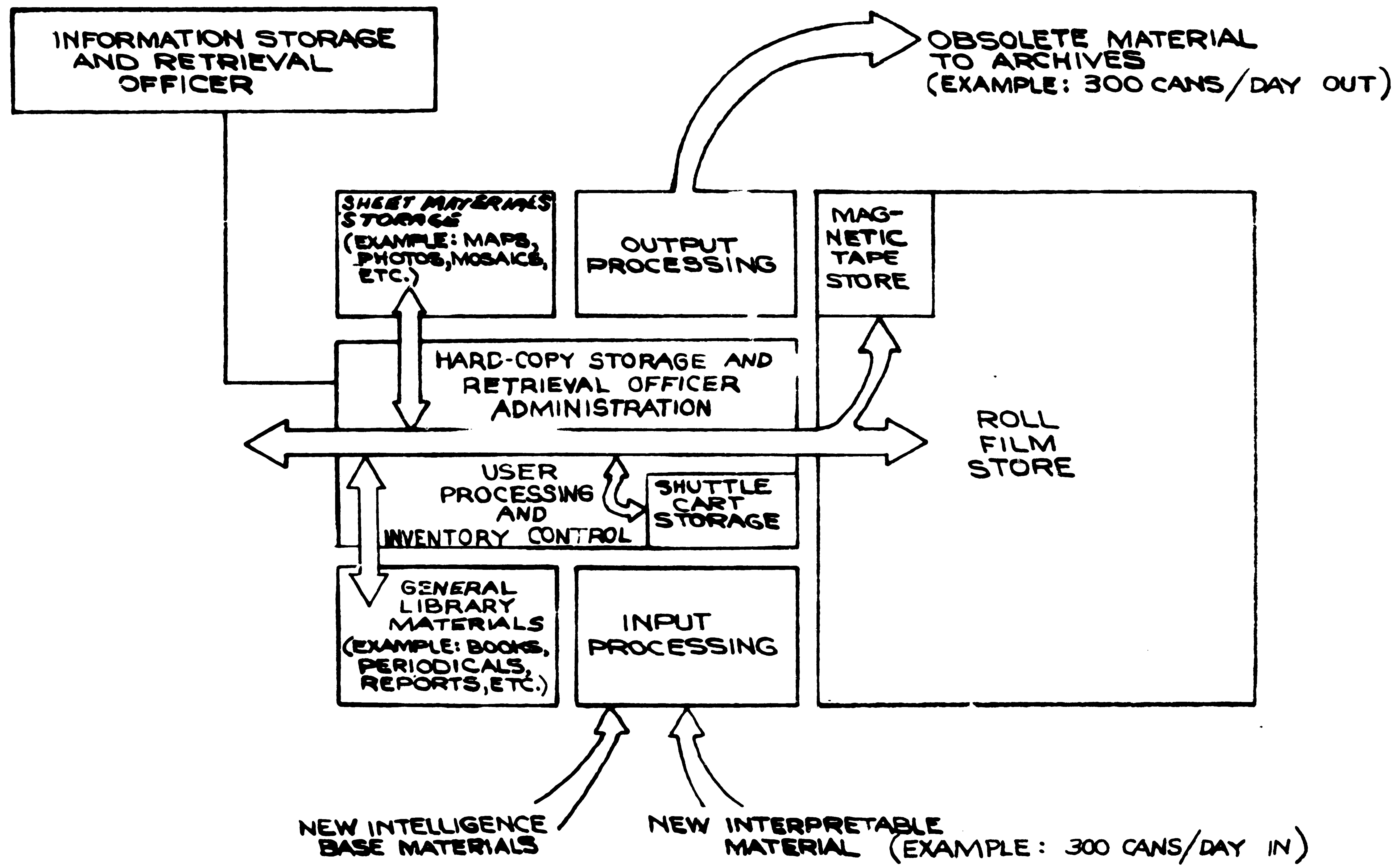


FIGURE 60
GRAPHIC MATERIALS STORAGE, RETRIEVAL AND HANDLING SYSTEM
FU… ..IONAL ORGANIZATION

10.1.1 Input Processing

The input processing function involves the receipt of new intelligence base materials and new interpretable material from activities within and organizations outside the Reconnaissance Technical Squadron. Associated with this function are the usual receiving room operations associated with any graphic materials storage activity, including the temporary storage of the material pending cataloging and integration into the materials store control system as well as delivery of the new materials to their respective locations for final storage in the data base collection.

10.1.2 User Processing

User workplace servicing is perhaps the most important function within the graphic materials handling system, and is concerned with accurate and fast reaction to the individual user's need. This function is, in some respects, analogous to the operation of a supermarket dispensing foodstuffs in that the user presents to the Information Storage and Retrieval Officer a request — either specific or general. This request specifies information of given intellectual content and, most probably, specifies the form in which certain of the information is desired — e.g., aerial photography of a given area at a given scale as of a given date. The Information Storage and Retrieval Officer processes this request against the indexing array stored in his computer and obtains a list of most probably qualifying references. This list is given to the requestor, who specifies which items he wants. The Information Storage and Retrieval Officer then processes this requirements list through the computer to determine location of the physical items (in or out of store, and, if out, where) to determine relative priorities among competing users, and to establish an ordered requirements list which is ordered by the physical form and general location of the desired graphic material and is sequenced by item material storage address number for optimum retrieval time of the entire group of material desired. A manual process may be used for these material control and operational priority determination processes, but the significant points are: (1) it is done on a squadron-wide basis under, effectively, Operations Officer control and (2) it prevents the time delay which would result if in-file or out-of-file determination were left for visual examination by the graphic materials handler. The Information Storage and Retrieval Officer then forwards this perfected "shopping list" to the Hard-Copy Storage and Retrieval Officer in the Graphic Materials Storage Area.

The shopping list is used by the handling personnel in the Graphics Material Storage Area to assemble the desired modular package of information from the several different data base form storage areas. Upon completion of the assembly of this module of information into one of the material shuttle carts, the inventory control function checks cart contents and instructs the computer as to the temporary storage address (i.e., specific shuttle cart number and destination workplace identification) of the graphic material items that have been removed from the main data base store. Also included within the user processing function is the ultimate delivery of the module of information to the user workplace and, upon completion of the specific work tasks, the return of the information module to the Graphic Materials Storage Area where the individual items are integrated back into the data base store and the computer instructed that said items have been returned to store.

It has been assumed that all communications mentioned above will be handled by a teletype system integral with the Reconnaissance Technical Squadron.

10.1.3 Output Processing

The Reconnaissance Technical Squadron facility will have a certain nominal materials storage area available. Therefore, an output processing, or material obsolescence, function must be established to limit data base storage volume requirements to this nominal. It is anticipated that, upon completion of the nominal accumulation (i.e., an adequate quantity of graphic materials to comprise a data base to satisfy the needs of the Reconnaissance Technical Squadron), the output processing function will approach that of the input processing function in size and importance since the material "in" and material "out" rates must, on the average, be equal. The nature of the processing function is similar to, but reverse in nature, to that of input processing.

10.1.4 Physical Maintenance of the Data Base Store

The maintenance-of-the-data-base-storage function begins with the receipt of new intelligence base materials after the input processing function has been undertaken. This function is responsible for the physical placement of the new data base materials, or of those materials that have been returned from user workplaces, in the proper locations within the given data base form storage equipments, based on the material storage address assignment provided as a part of the storage instruction.

10.1.5 Inventory Control

As material is received for integration into the data base store, supplementary information will be obtained either as a result of the input processing cataloging or from material provided by the data base originators which will permit supply of appropriate intellectual content data and physical form data to the computer. The computer will generate a material storage address which becomes a "store" command for the handlers in the Graphic Materials Storage Area. Actual storage placement is verified to the computer and the computer memory has an inventory record in terms of both intellectual content of the item and its physical location.

Output processing is handled in a similar, but reverse direction, manner. The computer still stores (for a pre-selected, planned time) the intellectual content identifiers and the material storage address, but, in this case, that address is a secondary address identifying a location other than the Graphic Materials Storage Area.

Inventory Control will also accommodate shuttle-cart checks on material going to and being received from user workplaces, periodic inventory checks, special situation checks, and storage space volume planning.

10.1.6 Administration

Administrative responsibilities associated with the operation of the physical storage area and associated functions will be under the direction of the Hard-Copy Storage and Retrieval Officer. It is assumed that all requests to the Hard-Copy Storage and Retrieval Officer from within and without the Reconnaissance Technical Squadron facility will be channeled through the Information Storage and Retrieval Officer. This senior, who is responsible for control of all information at the Reconnaissance Technical Squadron Facility — whether in hard-copy form, binary-bit form in the computer, or reduced form in Tactical Target Records.

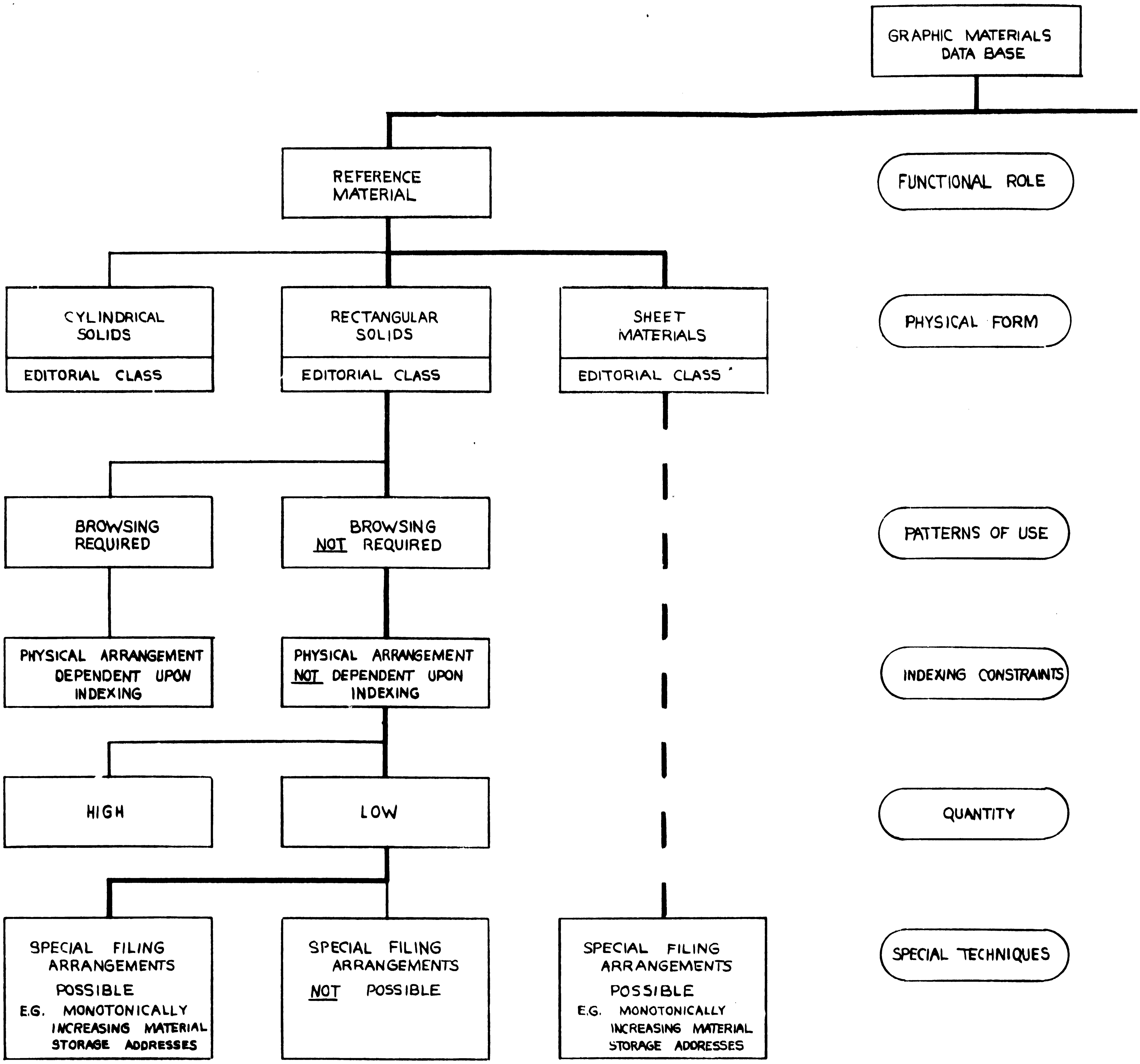
The Hard-Copy Storage and Retrieval Officer is responsible for all operational and housekeeping operations within the Graphic Materials Storage Area and for the graphic materials dissemination network which, throughout the Reconnaissance Technical Squadron area, links User Workplaces with the basic Graphic Materials Storage Area.

10.2 STORAGE ARRAY AND INDEXING RELATIONSHIPS

Certain assumptions have been made with respect to the array of graphic materials in the store in the analysis of the graphic handling problem. These assumptions are based upon the basic considerations of file organization discussed in paragraph 9.5 and are illustrated in summary form in Figure 61.

10.2.1 Basic Pattern of File Organization

It is assumed, in the first instance, that the store of graphic materials is divided into two parts: the data base photography and magnetic tapes, and all other graphic materials. The principle, or differentium, for this division is the functional role as mentioned in paragraph 9.1 above. Materials in each of these two sections of the store are assumed to be arranged in separate groups according to the physical characteristics of the specific materials themselves. For example, data base materials which are in the form of a scroll and are stored in film cans form a natural subgroup of the group of materials in the section "photography". The physical characteristics of the several types of materials are therefore the basis for this second - cut division. It should be noted here, however, that these physical characteristics have to be considered as establishing certain broad categories. For example, sheet materials should probably be grouped according to certain broad dimensional limits. The schema of file organization illustrating this kind of groupment has been presented previously as Table 34, here repeated for convenience.



7. TARGET FOLDERS
8. P.I. KEYS
9. GENERAL LIBRARY MATERIALS

3. MAPS
4. OVLRLAYS
5. MOSAICS
6. PHOTOGRAPHIC PRINTS

1

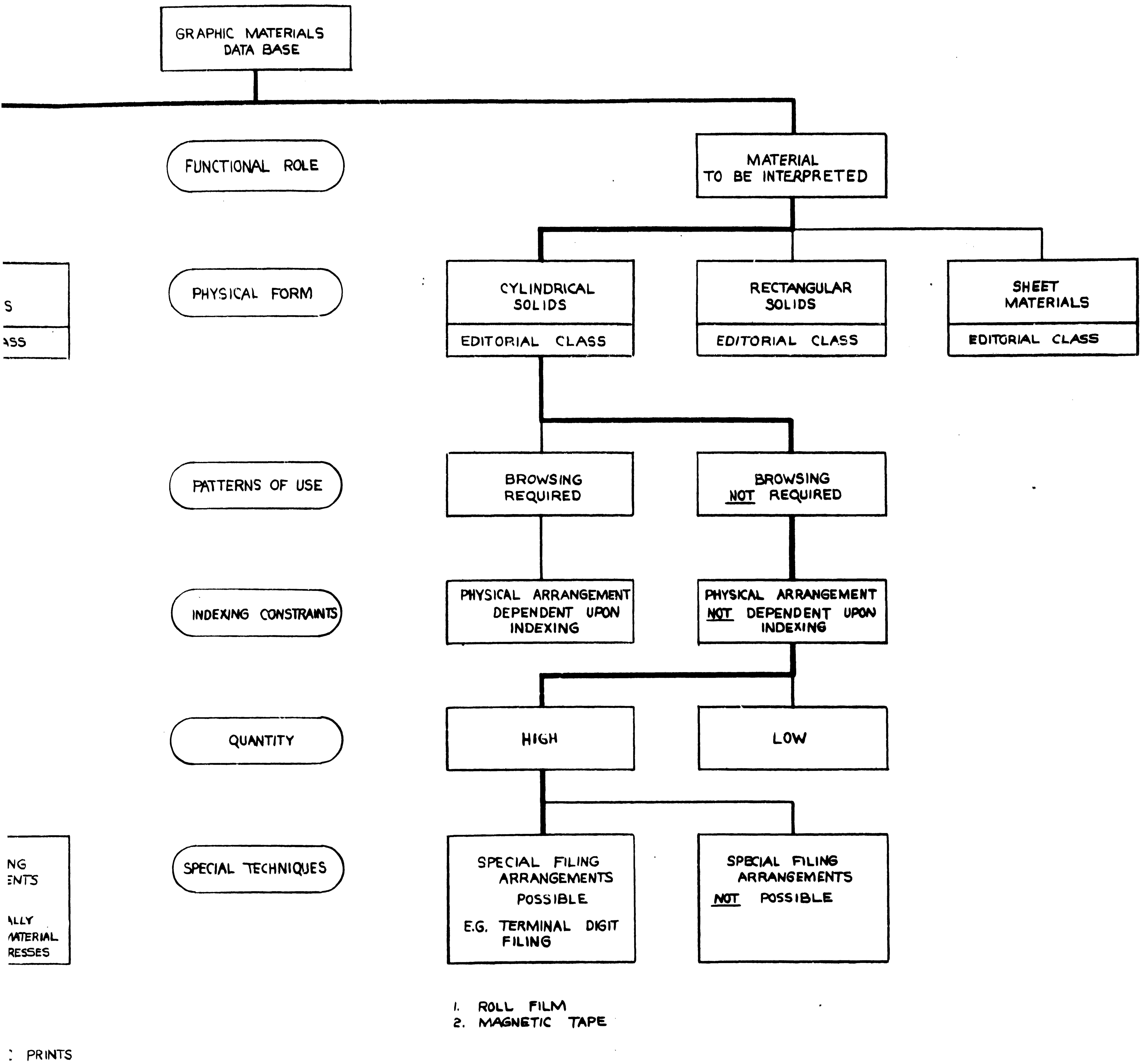


FIGURE 61

METHOD SELECTION TREE

Table 34

FILE ORGANIZATION BY FUNCTIONAL NATURE

Input Materials	
1. Roll Film	Cylindrical Solids
2. Magnetic Tape	Cylindrical Solids
Reference Materials	
3. Maps	Flat Sheets
4. Overlays	Flat Sheets
5. Mosaics	Flat Sheets
6. Photographic Units	Flat Sheets
7. Target Folders	Rectangular Solids
8. PI Keys	Rectangular Solids
9. General Literary Materials	Rectangular Solids

The foregoing array suggested for the graphic materials store is based upon three differentia: functional role, physical shape, and broad dimensional category. Within this basic array for the graphic materials store, it is suggested that the materials should be arranged according to "editorial class". What is meant by editorial class is the source or series of the organization creating the materials. In this way all ONC maps falling within the broad size limit of 48 x 36 inches will form a subdivision of that physical category. Generally speaking, it is expected that a given editorial class will be most frequently restricted to one dimensional subgroup. The postulated array of the graphic materials store which is used in the present study can therefore be summarized by listing the four basic differentia upon which it is based as follows:

(1) functional role

(2) physical shape

(3) physical dimension (within broad limits)

(4) editorial class

Within this postulated array, all the specific types of graphic materials (even the bibliographical materials) are seen to have a place. Thus, the reference materials which are flat and have a general dimension of 9 x 12 inches must include all books, reports, file folders, etc.

10.2.2 Special Consideration Based on Use Patterns

Within the framework of the postulated array, it is recognized that certain use patterns of materials may seriously affect the logic of their organization. The particular type of material for which the consideration of use patterns is obviously necessary is the incoming reels of photography and magnetic tape. Here, the high flow rates of input and retrieval and obsolescence makes it necessary to consider modification of the basic postulated array according to some technique which will facilitate file use activity.

It is assumed that this file use activity is concentrated on the most recent photography. It is assumed that the frequency of reference to older film is far less than that which has been most recently acquired. It happens that there is a method of file sub-arrangement which is particularly applicable to this problem of high use of recently acquired materials. This method is known as "terminal digit filing". It is suggested, therefore, that the postulated array of graphic materials be modified in the case of data base photography of cylindrical type in such a way that the physical storage of these materials follows the pattern of terminal digit filing in combination with color coding. The effect of this arrangement will be to reduce the labor and cost of input and retrieval from this physical store, to increase the speed of these operations, and to reduce interference among input, output, and user processing activities. A more detailed discussion of the principles of terminal digit filing is to be found in Appendix I.

10.2.3 Store-Indexing Relationships

According to the above statement of the postulated array of graphic materials in the store, it can be seen that the intention in the present setting is to arrange these materials in a structure which is, in large part, independent of the intellectual content of the material itself. It is recognized that the arrangement of the graphic materials within the various editorial classes may reflect in some way the intellectual content of these materials. The AMS map series is structured to an arrangement by geographical area. As far as such sub-structures exist within the editorial classes employed in the postulated array, there will be, therefore, some reflection of intellectual content in the files. It should be noted, however, that intellectual content does not form the main principle of the postulated array.

The organization of the files of graphic materials in the postulated array according to the stated principles or differentia, does not mean, however, that control according to intellectual content is abandoned. A structure of indexing is assumed which will allow the rapid correlation of the various physical kinds of graphic materials according to the particular intellectual needs of the photo-interpreter and according to the specific search prescription. This indexing structure must provide the means for representing the various aspects of earth-space reality in the form of linguistic symbols. It must also (and less obviously) provide the means for relating those linguistic symbols to patterns of concept which are operationally necessary to the interpretive task. The complexity of the linguistic task itself (not to mention the greater complexity of concept structuring) suggests, on reflection, that these tasks cannot be performed within the physical array of the graphic materials themselves. The representation of even one aspect of intellectual content in the physical array of the material does not, in the long run, reduce the complexity of the indexing problem, and it certainly introduces difficulties in the area of file maintenance. For these reasons, it has not been allowed in the present study to have a large effect on the postulated array.

Attention must be called to the problem of notation. It was pointed out above that there is a fundamental independence between the notation and the intellectual content. It is necessary, however, that the notation or coding pattern reflect the differentia which form the basis of the postulated array. Code symbols representing the categories and sub-categories as listed above are, therefore, required. It is estimated, however, that these notational elements will not require more than four (4) digits. Beyond this and in the sub-arrangement of the editorial classes, there is room for the representation in the notation of the editorial classes. The notation or code which it is expected would be used with the postulated array therefore consists of a set of elements of ten (10) digits in length which specifies the functional role, the physical shape class, dimensional class, editorial class, and material address location as symbolized in Figure 62.

Special attention must be given to the notation required for the modifications of the postulated array suggested for terminal digit filing. In this instance, the notational elements relating to the order of the incoming roll of film must be structured in such a way as to permit the manipulation of the material according to the terminal digit filing technique. The detailed explanation of that technique and mention of its relation to notational elements is given in Appendix I.

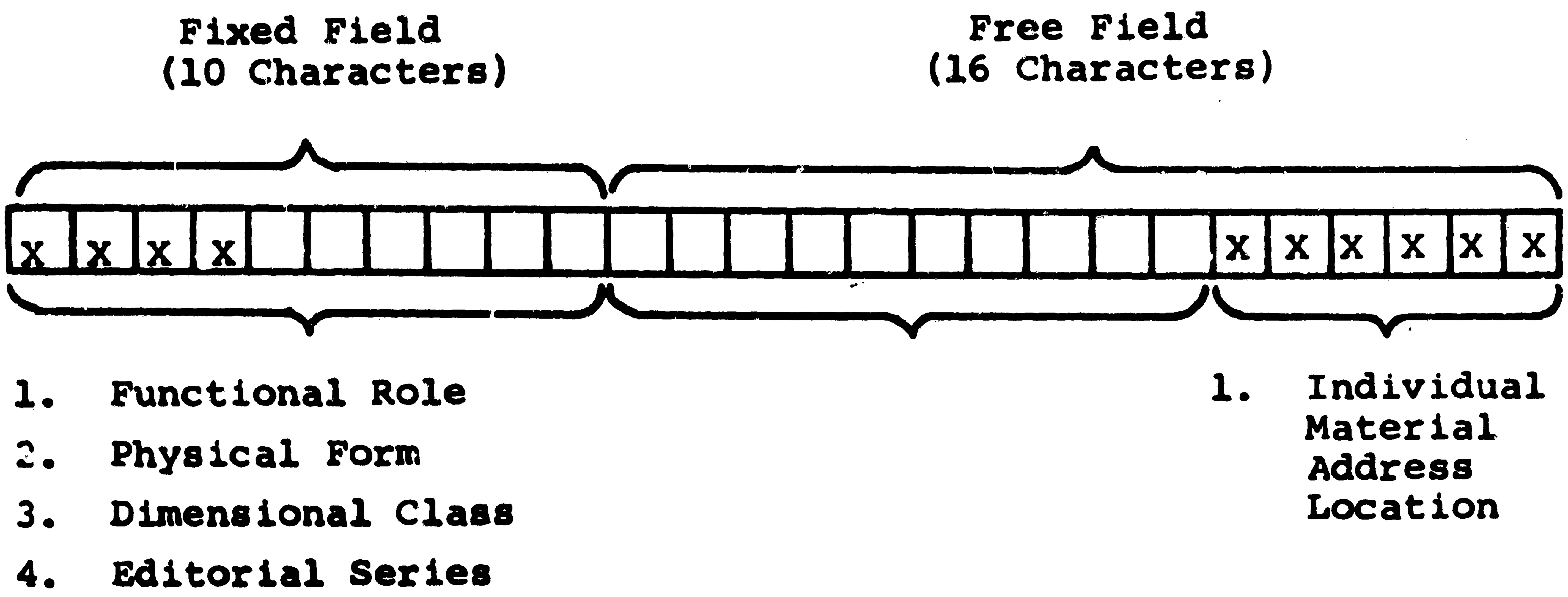


Figure 62

TENTATIVE NOTATION STRUCTURE/FORM-AND-LOCATION-BASED

10.3 DESCRIPTION OF SYSTEM OPERATIONAL CHARACTERISTICS

To facilitate the reader's understanding of the interlocking relationship of the functions previously described in paragraph 10.1, a systems operational flow chart, Figure 63, has been generated to illustrate the operational activites of the system in performing the functional tasks described. To facilitate the reader's understanding, this operational flow chart has been subdivided into four major areas as follows:

(1) Input Processing

(2) User Processing and Inventory Control

(3) Maintenance of Data Base Store and Inventory Control

(4) Output Processing

Detailed descriptions of each of these areas follow.

10.3.1 Input Processing

Due to the continuing need for the maintenance of an up-to-date intelligence data base, it is anticipated that there will be a continual flow of material into and out of the data base collection. For the purposes of this report, six possible originators or suppliers of data base for the RTS collection have been identified as follows:

(1) Photo Reconnaissance Squadrons

(2) RTS Satellite Operations (Information Interpretation Cell - IIC --- Mobile Wing Reconnaissance Technical Squadron - MWRTS)

(3) External Intelligence Screening Workplace

(4) Mission Review Workplace

(5) Chart Updating and Target Materials Workplace

(6) Flight Planning Workplace

It is also assumed that graphic materials from other than these six sources may be included in the data base collection. However, the material will be channeled through one of the listed work stations for content evaluation prior to receipt at the input processing area, as is indicated on Sheet 1 of Figure 63.

The input from the Reconnaissance Squadrons will constitute processed silver film contained in either 9-1/2-inch, 5-inch, or 70-mm metal film cans. This film will be delivered to the photo-interpretation area where it will be examined in a very fast manner at one of the Flash Interpretation Workplaces to determine whether it is satisfactory for inclusion in the data base collection and to catalog it for the computer as far as the intelligence content is concerned. After the film has been examined, it is then brought to the Incoming Materials Temporary Storage Area (where provision for the storage of up to 600 film cans has been provided) where it will remain until reports have been obtained from the Flash Interpretation Workplace as to the identification number to be assigned to the can. With the receipt of the identification number, the inventory control operation will then affix a material storage address number to the can which will serve as its locator within the data base collection. The materials storage address number is then fed into the computer along with the identification number to permit correlation of the content information and the physical storage area identification to facilitate later location of the particular film can in the user workplace servicing function. The can is then loaded on a material shuttle cart specially designed for roll film only where it is then trundled into the Data Base Storage Area and placed in the proper cubicle for which it has been designated. It is expected that there will also be a roll film input from the satellite operations and this will be handled in a similar manner, except that since the flash interpretation has already taken place at the mobile field interpretation unit, the material will only remain in temporary storage until the proper cataloging information has been received, at which time it will fit into the previously described flow pattern.

Other types of graphic materials will be handled in a similar manner as has been explained before, first funneling through either the satellite operations or the four workplaces within the Reconnaissance Technical Squadron. In a similar manner they will be held in temporary storage pending receipt of information to permit the proper correlation of the identification number with the materials storage address for use in the computer, at which time they will then be placed in their respective data base form storage location.

It has been assumed that there will be a teletypewriter located in the administration area to facilitate rapid absorption of the incoming data base into the main data base collection with a minimum of lost motion and time.

10.3.2 User Processing and Inventory Control

The reference-material-acquisition-from-storage collection cycle is illustrated in Figure 63, sheet 2.. The process starts with the generation of a fragmentary operational order specifying specific photo reconnaissance sortie assignments. Since the proposed Reconnaissance Technical Squadron will be the depository for the products of many sorties flown by many different photo reconnaissance squadrons there must, of necessity, be a mission priority assignment made within the Reconnaissance Technical Squadron in cases where the quantity of missions exceeds the designed input characteristics of the Photo-Interpretation Workplace and/or similarities in mission-flown will require parallel use of graphic reference materials. The mission priority assignment will be established by Operations Control and the information will be given to the various user workplace control offices as well as the Pre-Receipt Workplace control officer.

With the receipt of the mission-priority assignment and fragmentary operational order, the Pre-Receipt Workplace will be put into use to assemble via the teletypewriter network those reference materials constituting the data base of interest for the specific missions to be interpreted. The computer memory will be queried via the teletypewriter network for data base references and the information will be generated on the teletypewriter in hard-copy form in multiple copies. The hard-copy printout will then be sent to the affected user workplaces to permit the selection of desired reference material. As a part of this pre-receipt mode of operation at the specific user workplaces, personnel assignments will be made and the teletypewriter hard-copy print-out will be reviewed to establish which of the complete list of reference materials contained in the hard-copy file are to be used during the particular interpretation assignment. As has previously been described, the teletypewriter printout will contain two types of material storage information as follows:

(1) The Material Storage Address of the item contained in the main data base storage area

(2) The Temporary Address of the item when it is currently being utilized at a user workplace - i.e., a floating address.

In cases where mission assignments overlap and multiple use of the same reference materials is encountered, the mission priority assignment will be consulted in order to establish which user workplace will receive the material that is out of file. The user workplace control officer will then reassign the affected data base and this information will be sent to the storage area at the time of the request for additional information. With the completion of the selection of preferred references the identification numbers and material storage addresses are communicated via teletype from the user workplace to the storage and retrieval office as well as the change in temporary material storage address made at the user workplaces.

Receipt of requests at the storage area for only those items identified as being in the storage area will reduce the lost motion associated with identification of temporary storage addresses, of out-of-file items, etc. In parallel with this, the change in temporary address will be so noted for those items which are out of file and at the time of reference material verification and checkout the computer will be so queried to change the temporary address, thus keeping the records up to date.

Prior to receipt of the user request within the storage area, priority assignments have been made by Operations and the requests are then distributed to the data base control clerks. In cases where there is a large quantity of material required, material shuttle carts will be used to collect the reference materials from file and transport to the user. From the storage area, a particular shuttle cart will be selected and assigned to a specific user. If the request for material encompasses the complete range of data base forms such as roll film, magnetic tapes, sheets and books, then the material shuttle cart will first be pushed into the film store where the material clerks will load on the film cans required. The next stop would be the magnetic tape file where similarly the required magnetic tapes would be placed in the racks provided. The cart would then be pushed to the receiving window at the sheet storage and general library materials storage areas where, in parallel with the operation within the film can storage area, modules of information have been prepared. These modules can be dropped into place in the material shuttle cart with a minimum of time and motion. The final step before the material module will leave the storage area is a checkout by inventory control and verification that the information module is complete and accurate. The material is then transported to the user workplace where the material shuttle cart becomes the local workplace temporary storage area as well as reference area - in an organized physical array. In parallel with the transport of the material to the user workplace, a workplace material storage assignment step is carried out wherein the checkout list is fed into the computer to establish that the materials are no longer in the main data collection but have been assigned to a specific user workplace on a specific shuttle cart. In the event that in any given day a single user workplace may be called upon to perform unrelated tasks, it is only necessary that the information module contained in one shuttle cart be kept intact and another shuttle cart alternated with it at the user workplace. Thus, the modular data base collection for a specific task is always intact and is self-organizing.

As has been described in the above paragraphs, the computer has been pressed into service in this proposed system to facilitate inventory control in the identification of locations, both permanent and temporary, of the entire data base collection.

10.3.3 Maintenance of Data Base Store and Inventory Control

The maintenance of the data base store, illustrated on Sheet 3 of Figure 63, is complicated by the fact that there are two parallel operations that must go on at the same time: that of user workplace servicing and that of the continuing input to the data base file. In the input case, the material will be received by the store control clerks, usually on a special cart. During the input processing cycle, a material storage address using color coding to control misfiling within a data base form, has been affixed to each item to be stored. In the cases of film cans, this consists of a color coded label which has been affixed both to the can cover and the leading and trailing edges of the film itself. In the cases of the sheet and general library materials, a color-coded stamp or label will be applied; where practical, the label will be placed on the back of the n in the lower righthand corner so that when the item is placed in the file, the label will appear at the righthand side and is easily readable as the material collection is scanned.

The operation concerned with the return to file of those items that have been assigned to specific user workplaces begins with the assembly of the reference materials into the information module on the materials shuttle cart. As soon as the materials have all been returned to the shuttle cart and have been checked off at the user workplace by reference to the teletype print-out, the material is transported to the storage area.

The first step, upon receipt of a shuttle cart in the storage area, will be the immediate querying of the computer for a complete material inventory for that particular shuttle cart, since it is entirely possible that, since the time of the initial user request, additional items may have been requested from the storage area which were supplied by runners, etc. Therefore, it is necessary that a complete listing of a specific shuttle cart material inventory be obtained. This is generated by querying the computer memory storage through the teletype system and obtaining on the teletypewriter a hard-copy printout. The reference materials then are verified and checked by using the hard-copy printout. After completion of this verification and check-in, the reference materials are then trundled by means of the cart to the respective storage areas and returned to file. The material shuttle cart is returned to the storage area for garaging. In parallel with the operation of actually returning the material to the files, the computer is again queried through the teletype system to give information as to the material storage address assignments, in other words, to change the actual material storage address from the temporary workplace and shuttle cart assignment previously given to the material storage address within the data base store area.

10.3.4 Output Processing

Due to physical limitations in data base store size, it has been previously mentioned that one of the functions of the material handling system will be the output processing or material obsolescence cycle. This cycle, illustrated on Sheet 4 of Figure 63, will be originated by the Hard-Copy Storage and Retrieval Officer based on inputs of data base quantity evaluations from his inventory control clerk personnel, based on input quantity estimate, actual data base store size, and estimated store space remaining.

The Hard-Copy Storage and Retrieval Officer will then generate in some form a material obsolescence request which will be distributed to the decision makers within the Reconnaissance Technical Squadron. It is assumed that in order to purge the data base material, agreement must be reached from among five different user workplace areas as follows:

(1) External Intelligence Screening Workplace

(2) Mission Review Workplace

(3) Chart Updating and Target Materials Workplace

(4) Flight Planning Workplace

(5) Operations Control Workplace

Reference to Sheet 1 of Figure 63, previously presented, will also indicate that these same workplaces are responsible for the major portion of input to the data base collection. Therefore, it follows that the decision to remove material from the data base collection must be one of evaluating the impact upon the operations of the workplace and should, therefore, rest with the originators of the original data base and with Operations.

Upon receipt of a material obsolescence acknowledgement indication from the decision makers within the Reconnaissance Technical Squadron, the Hard-Copy Storage and Retrieval Officer can notify his control clerk personnel of the material release notification and actually assign personnel to the purging task. The material will be removed from the main data base store and placed in a temporary storage area in the output processing work area. As the material is physically being removed from the data base store, material re-assignments are made and the computer queried as to the proposed storage address for the material removed from file. This will keep the inventory control system up to date at all times and will serve to indicate to personnel within the Reconnaissance Technical Squadron what material was included in the collection and its final disposition. One copy of the material re-assignment address sheet will be sent to the Reconnaissance Technical Squadron shipping area where it will be brought together with the actual material brought from the output processing temporary store. The material will then be shipped out of the Reconnaissance Technical Squadron using the normal military shipping procedures and facilities.

It is felt that the above system will be the most advantageous to operations at the Reconnaissance Technical Squadron, since it permits the continual recording of the material that is in the data base store, material which is in the user processing cycle, and also material which once constituted a part of the data base store and has been since sent to external storage areas. Instantaneous recall is therefore afforded even from those areas external to the Reconnaissance Technical Squadron facility.

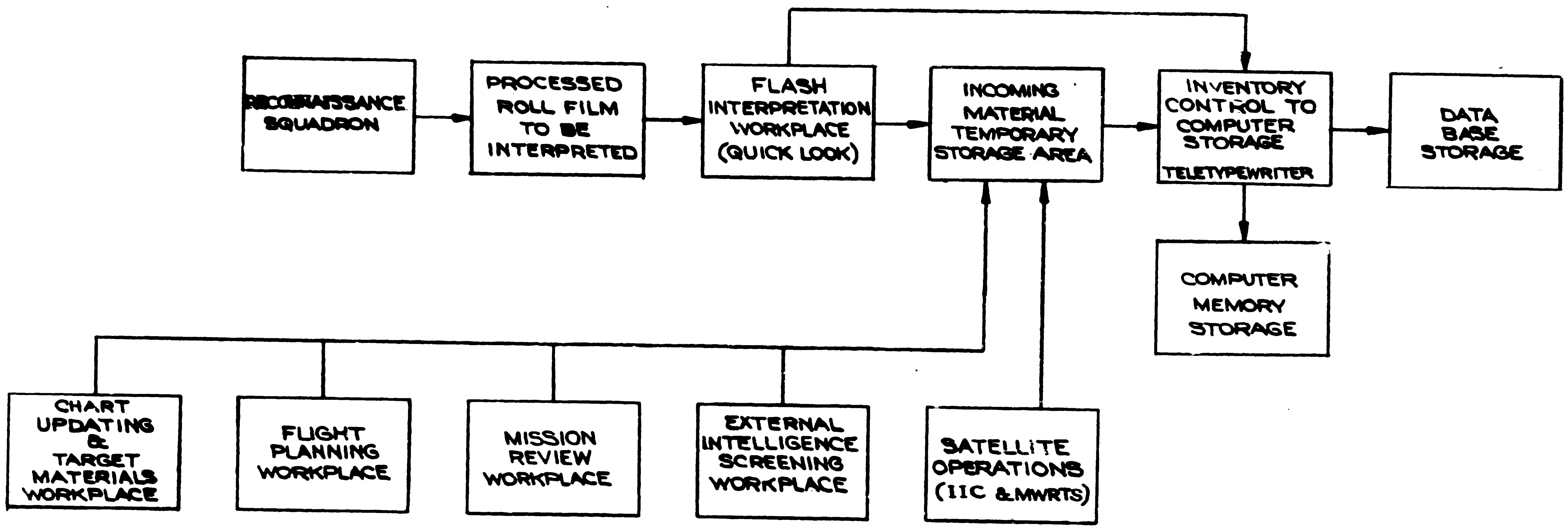
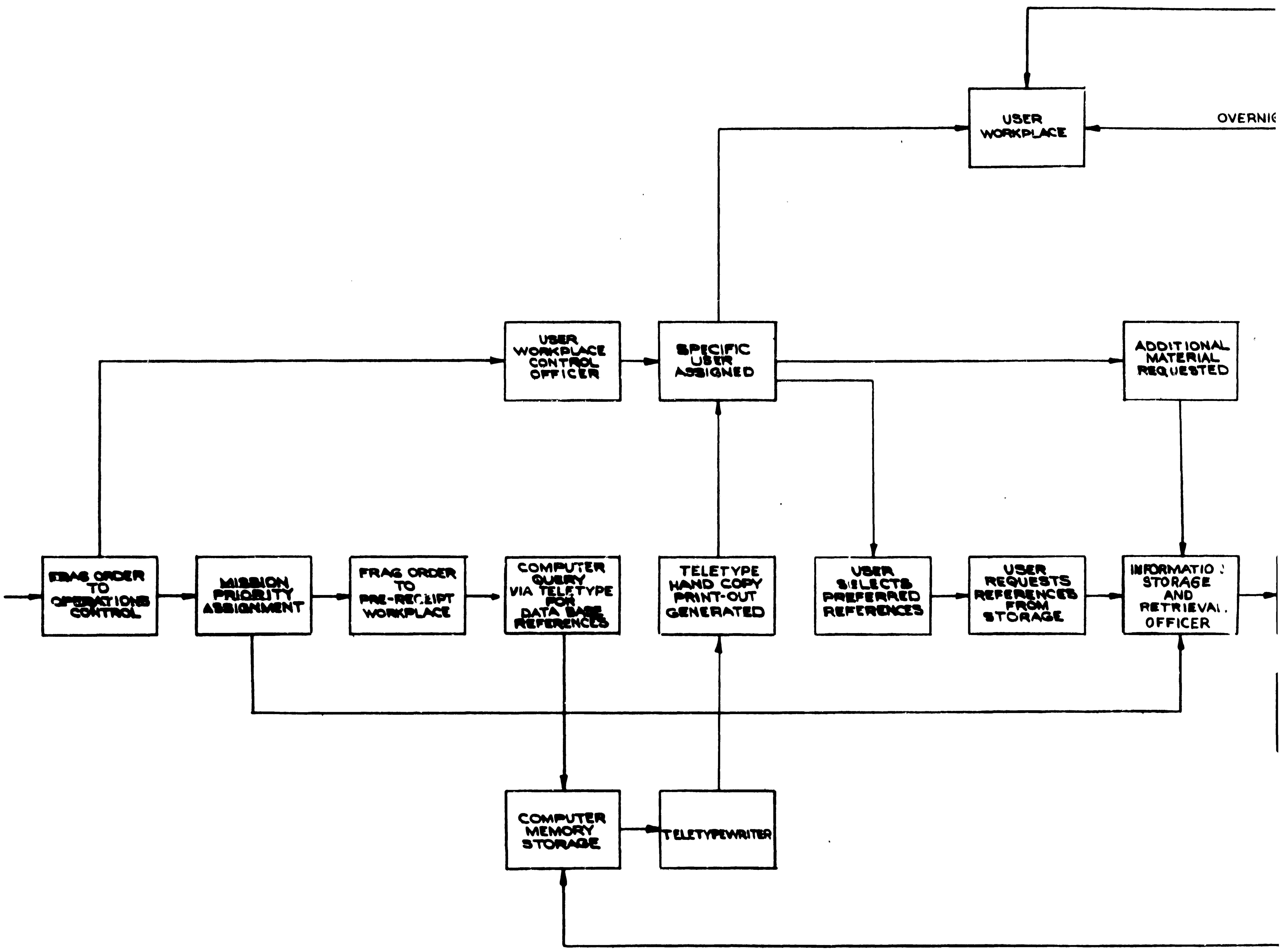


FIGURE 63

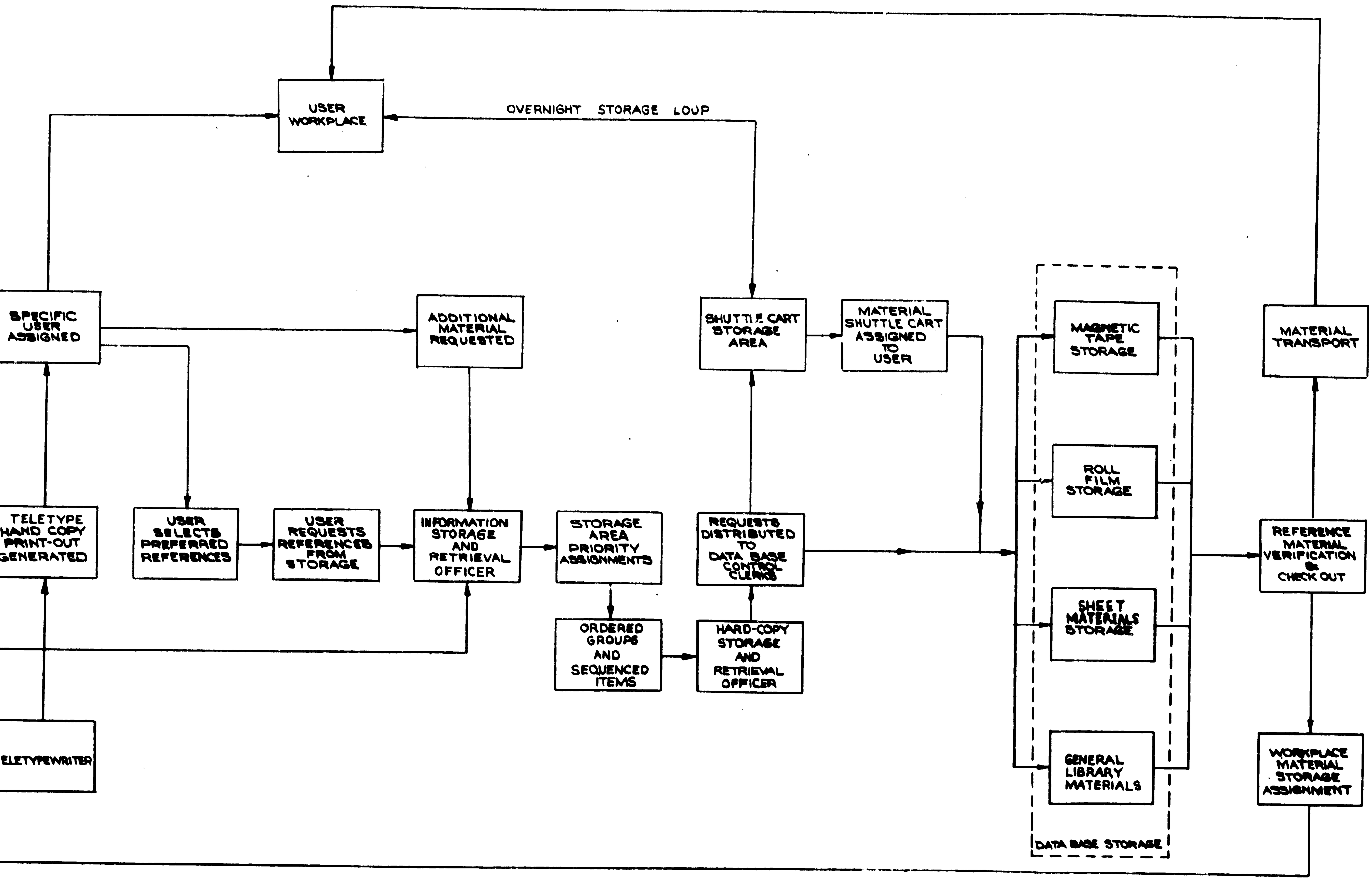
OPERATIONAL FLOW CHART

INPUT PROCESSING

SHEET * 1 OF 4
(CONTINUED ON PAGE)


USER WORKPLACE
OVERNIG
USER WORKPLACE CONTROL OFFICER
SPECIFIC USER ASSIGNED
ADDITIONAL MATERIAL REQUESTED
FRAG ORDER TO OPERATIONS CONTROL
MISSION PRIORITY ASSIGNMENT
FRAG ORDER TO PRE-RECEIPT WORKPLACE
COMPUTER QUERY VIA TELETYPE FOR DATA BASE REFERENCES
TELETYPE HAND COPY PRINT-OUT GENERATED
USER SELECTS PREFERRED REFERENCES
USER REQUESTS REFERENCES FROM STORAGE
INFORMATIO STORAGE AND RETRIEVAL OFFICER
COMPUTER MEMORY STORAGE
TELETYPEWRITER

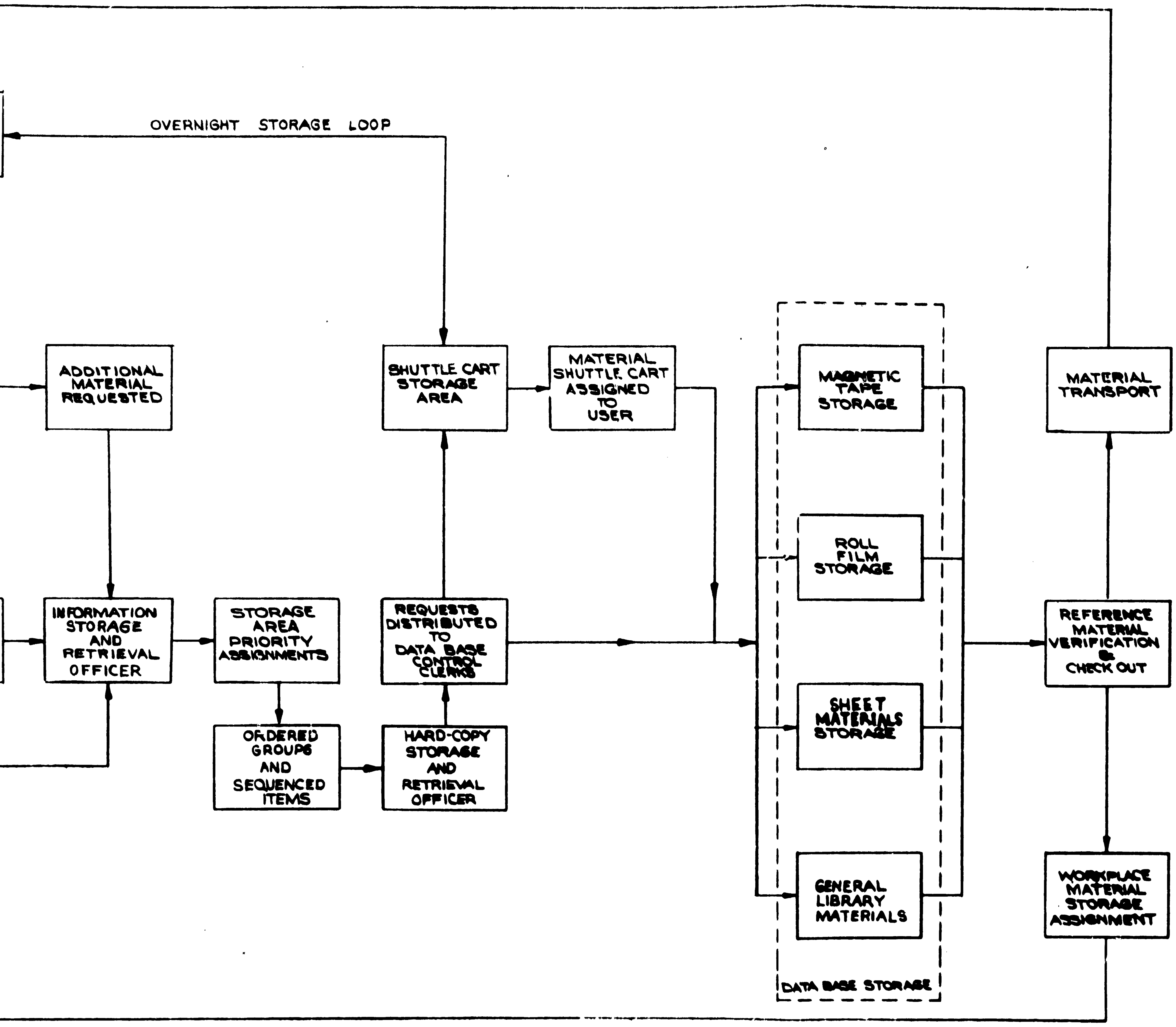
1



FIGU

OPERATIONA
USER PROCESSING

2

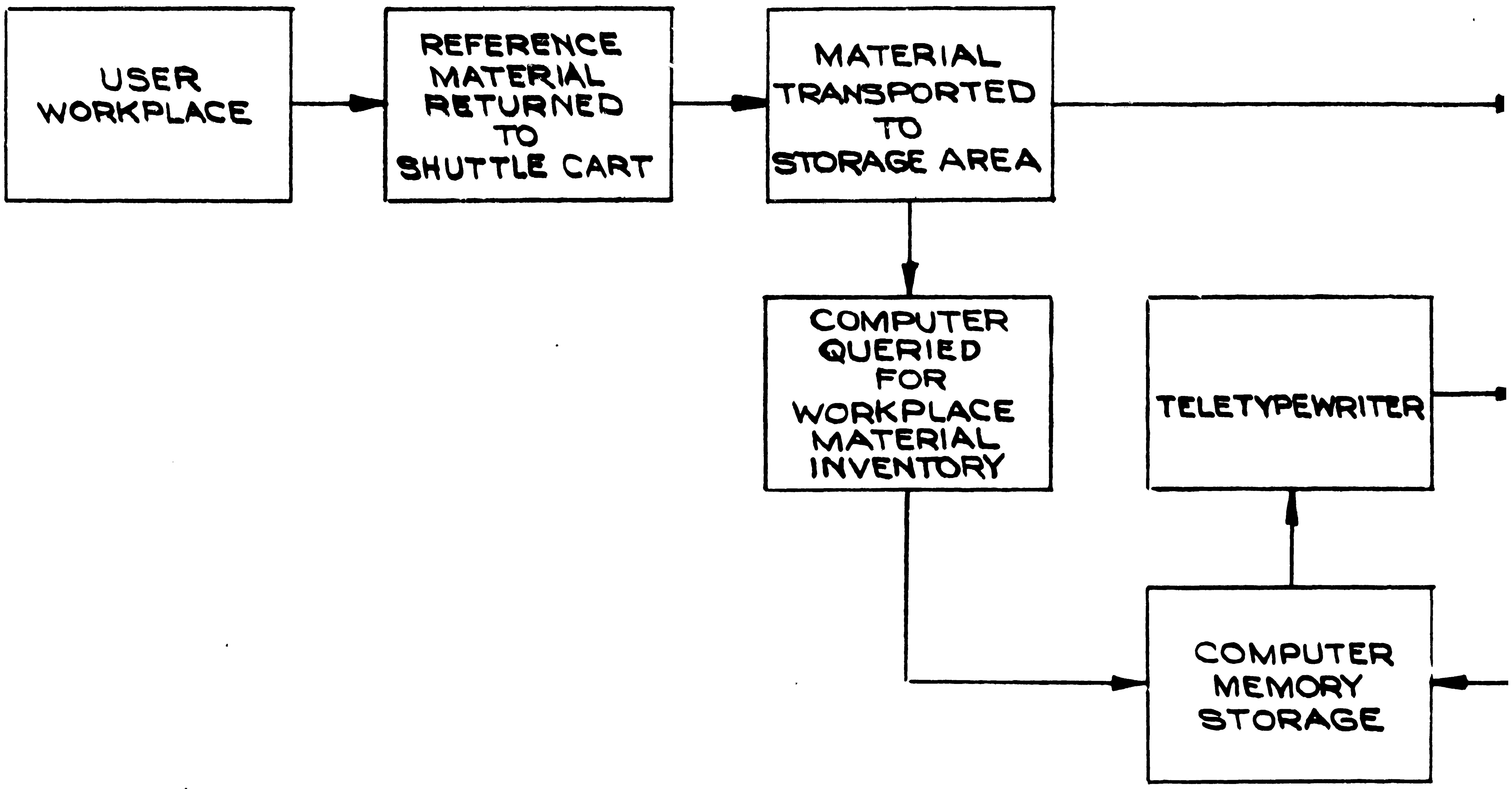


3

FIGURE 63

OPERATIONAL FLOW CHART
USER PROCESSING AND INVENTORY CONTROL

SHEET #2 OF 4


USER WORKPLACE
REFERENCE MATERIAL RETURNED TO SHUTTLE CART
MATERIAL TRANSPORTED TO STORAGE AREA
COMPUTER QUERIED FOR WORKPLACE MATERIAL INVENTORY
TELETYPEWRITER
COMPUTER MEMORY STORAGE

1

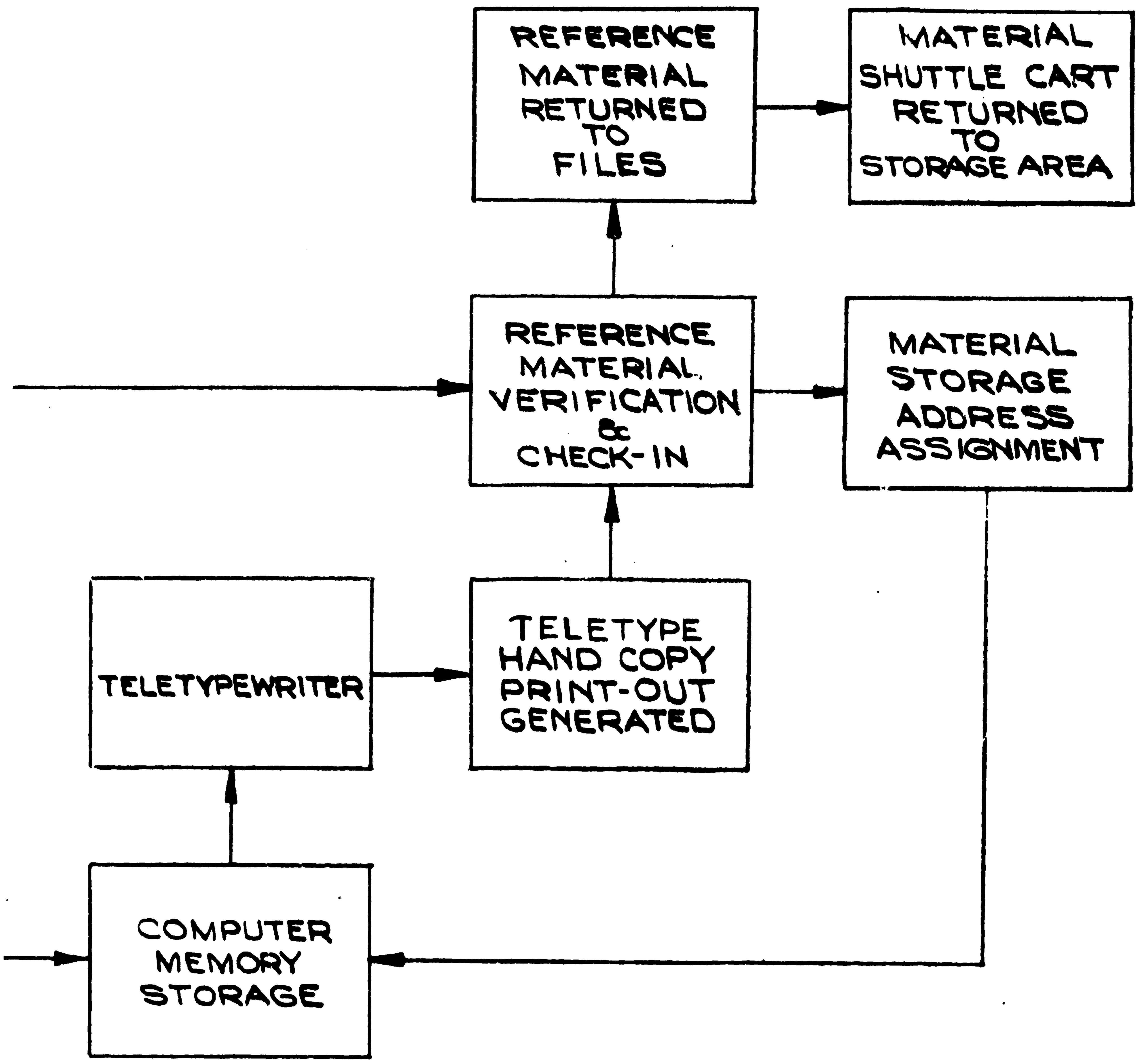


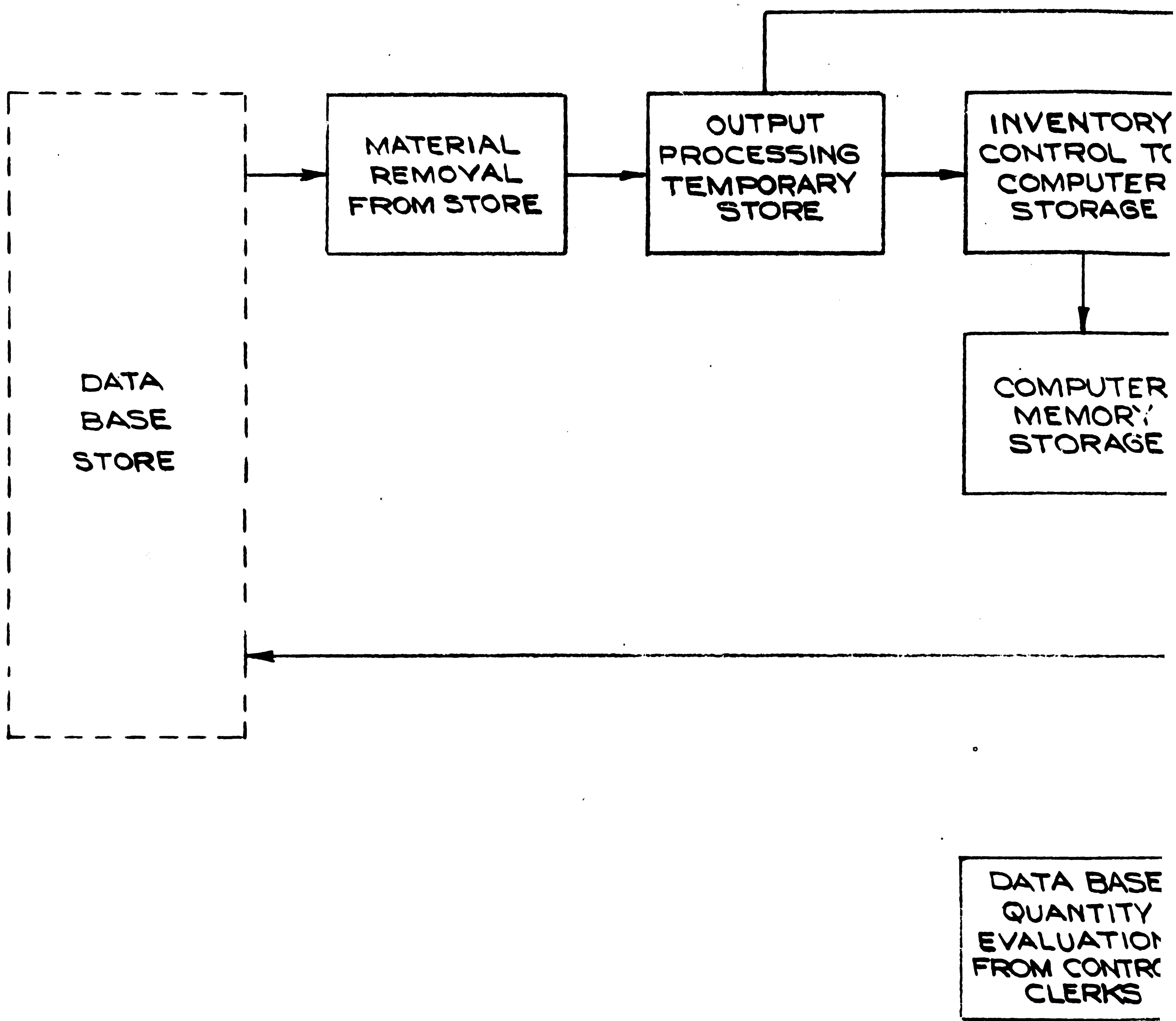
FIGURE 63

OPERATIONAL FLOW CHART

MAINTENANCE OF DATA BASE
STORE AND INVENTORY CONTROL

SHEET # 3 OF 4
(CONTINUED ON PAGE)

2


DATA
BASE
STORE
MATERIAL
REMOVAL
FROM STORE
OUTPUT
PROCESSING
TEMPORARY
STORE
INVENTORY
CONTROL T
COMPUTER
STORAGE
COMPUTER
MEMORY
STORAGE
DATA BASE
QUANTITY
EVALUATIO
FROM CONTR
CLERKS

1

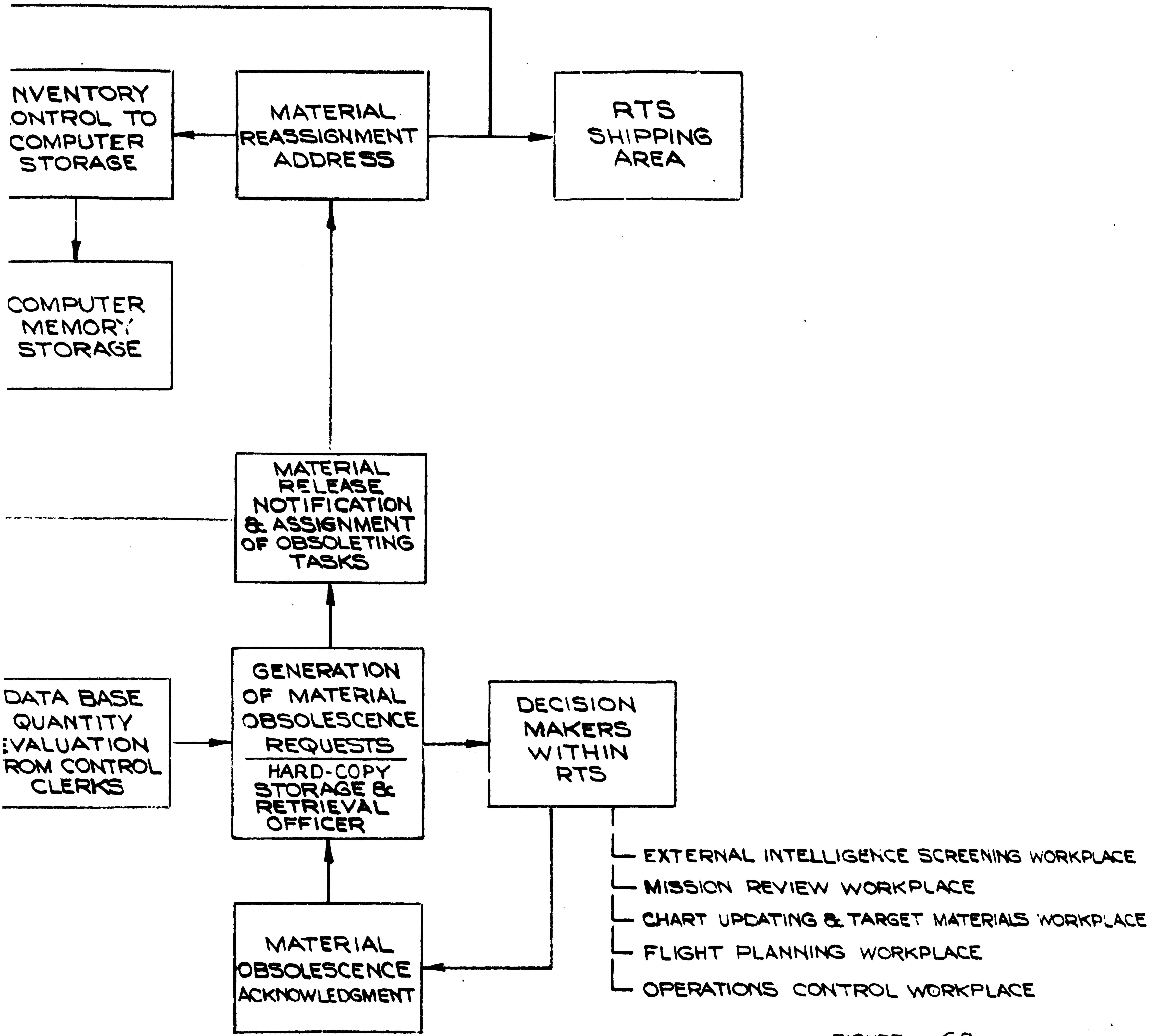


FIGURE 63

OPERATIONAL FLOW CHART

OUTPUT PROCESSING

2

SHEET* 4 OF 4

10.4 GRAPHIC MATERIALS STORAGE AREA CONFIGURATION AND EQUIPMENT CONSIDERATIONS

10.4.1 Over-all Area Layout

The assumed quantities of the different data base forms, given previously in Table 37, have been used in the establishment of specific and over-all area requirements for the Graphic Materials Storage Area. The general layout previously shown in Figure 59 has an over-all storage area requirement of approximately 51,000 sq. ft. of single-level floor space, ba. ! on the specific storage area configurations given previously in Table 38. Each of these subordinate areas is discussed individually in the following paragraphs. The group of storage areas are discussed first; the processing areas follow.

The number of equipment units selected, and the area allocations made, have been based on the estimated total quantity of graphic materials, given previously in Table 37, and the unit capacities established on the basis of manufacturers' specifications as modified by the implications of the tests performed, given in Table 40.

10.4.2 Film Can Storage Area

The film can storage area has been designed to store approximately 70,000 units of roll film in 2000 roll film can storage racks arranged in accordance with the requirements of the terminal digit filing system. The suggested roll film can storage rack configuration is illustrated in Figure 64; Figure 65 illustrates the roll film carrier tray which is suggested to insure safety in handling (since some cans will weigh up to 20 pounds) and to optimize the speed of retrieval and refiling. The carrier tray is not numbered, to afford interchangeability in use among the three processes. The basic roll film can and

Table 40

REPRESENTATIVE EQUIPMENT UNIT CAPACITY DATA

Representative Equipment	Est. Unit Space (sq.ft.) Required Including Aisle	Estimated Quantities Per Unit						
		Maps	Photos	Overlays	Mosaics	Film Cans	Mag. Tapes	General Library Materials*
Art Metal, Inc. Planfile	26	3000	X	3000	120	X	X	X
Hamilton Manufacturing Company Unit System File with Tracing Lifter	38	1000	X	1000	40	X	X	X
Globe-Wernicke Company Cello-Clip Map and Plan File	20	1200	X	1200	X	X	X	X
Acco Products Co. Accoway Open Rack	16	2200	X	2200	X	X	X	X
Plan Hold Corporation Wall Rack File	22	1000	X	1000	X	X	X	X
Hamilton Manufacturing Company Vertical File	30	1300	X	1300	X	X	X	X
Art Metal, Inc. Planfile Drawer Unit	16-1/2	X	2600	X	X	X	X	X
TAB Products Company Unit Spacefinder	16	X	8200	X	X	X	100	720*
Art Metal, Inc. Open File Shelving	13	X	8000	X	X	24	X	650*
Proposed Design Roll Film (Can) Storage	16	X	X	X	X	35	X	X
Proposed Design Mosaic Storage Rack	30	X	X	X	120	X	X	X

* Based on Average item thickness of 0.25 inches
Stacking Factor = 75%

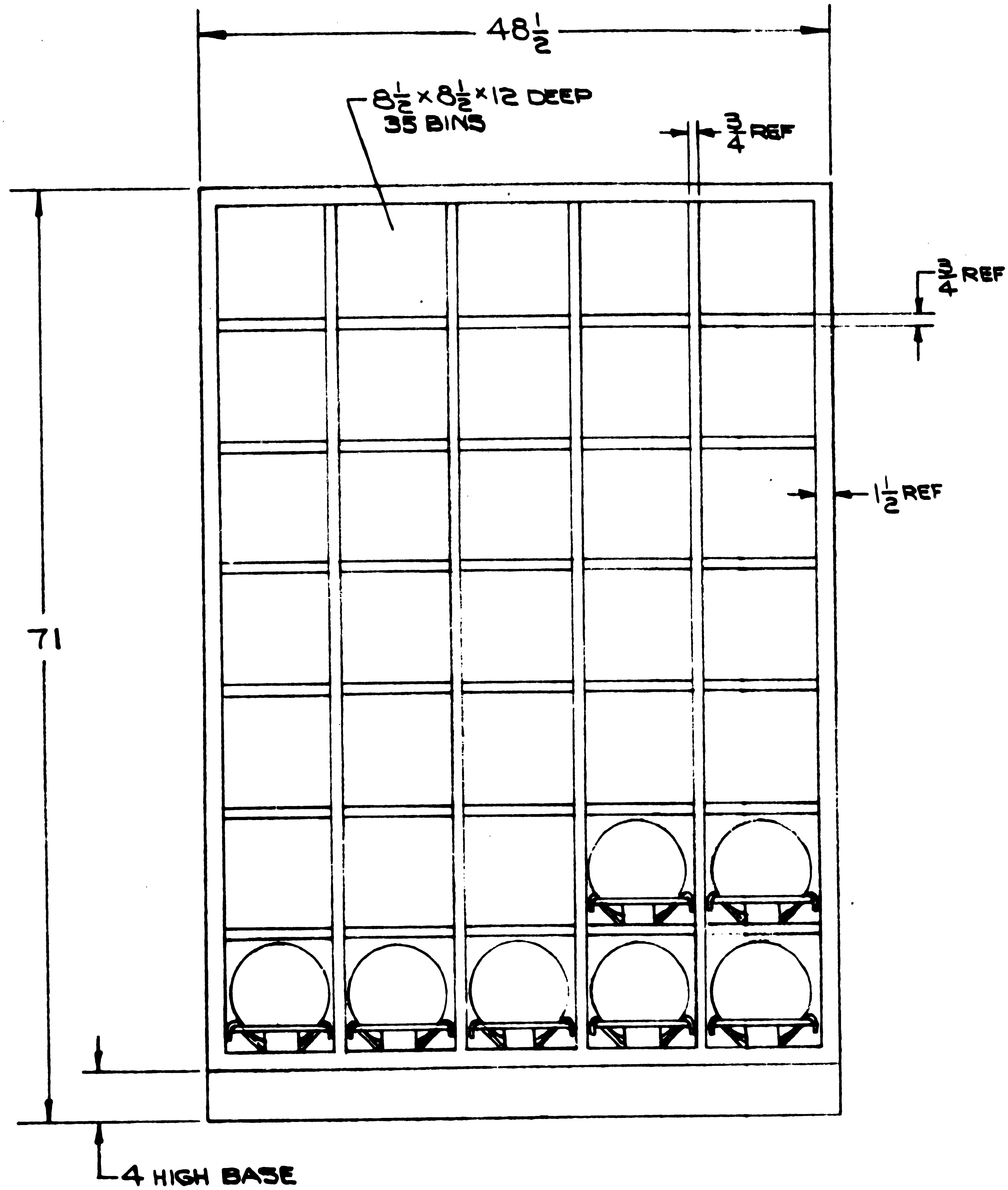


FIGURE 64

ROLL FILM STORAGE RACK

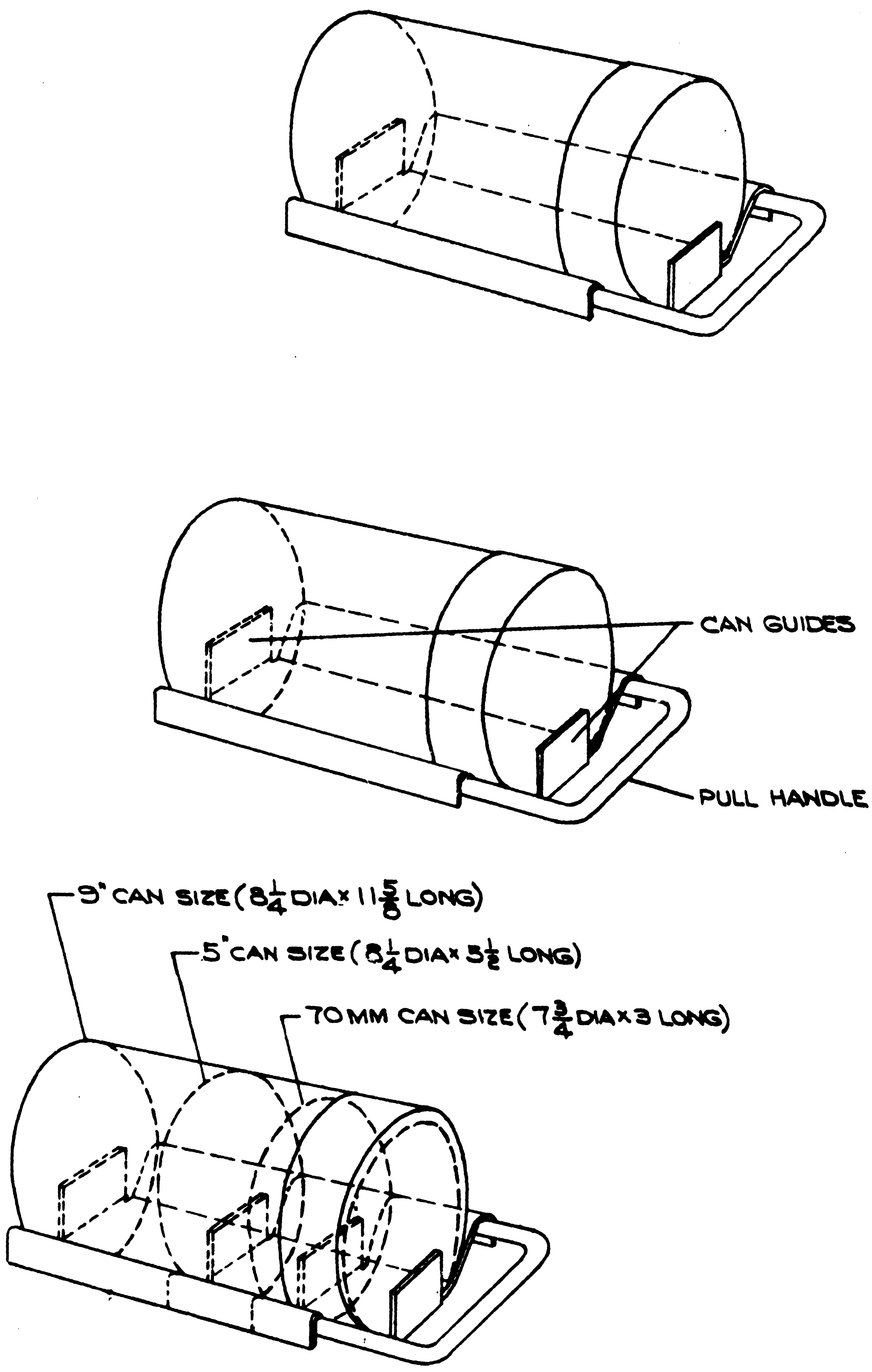


FIGURE 65

ROLL FILM CAN TRAY

the basic storage cubicle are, however, marked with the material storage address to establish what amounts to a floating address system which allows constant, reliable inventory control. The use of the roll film can tray thus enables swift, packaged, constantly identifiable transfer from storage location to material shuttle cart to user workplace and return.

Anthropometric factors for open shelf filing, illustrated in Figures 66 and 67, have been considered to insure that the storage area personnel will be able to handle the large fully loaded film cans, which may weigh in excess of 20 lbs, easily and without personal danger.

The main aisles of the film can storage area have been designed to permit parallel passage of two carts in order to prevent traffic jams and confusion during multiple, simultaneous user workplace request processing activities. The individual aisle spaces between storage racks have been designed in accordance with anthropometric considerations in order to permit the bending required for the insertion of film cans in the lower cubicles without interference from adjacent film racks. In the design of the storage area it has been assumed that the material shuttle carts will not be brought into the individual rack aisles but will remain in the main aisles during the retrieval and refiling operation.

The testing of representative equipment configurations made obvious the fact that the weight of the film can (20 lbs.) plus the cylindrical shape made handling of the film cans awkward (apart from can top pop-off and pull-off) and indicated that provision should be made to assist the operator

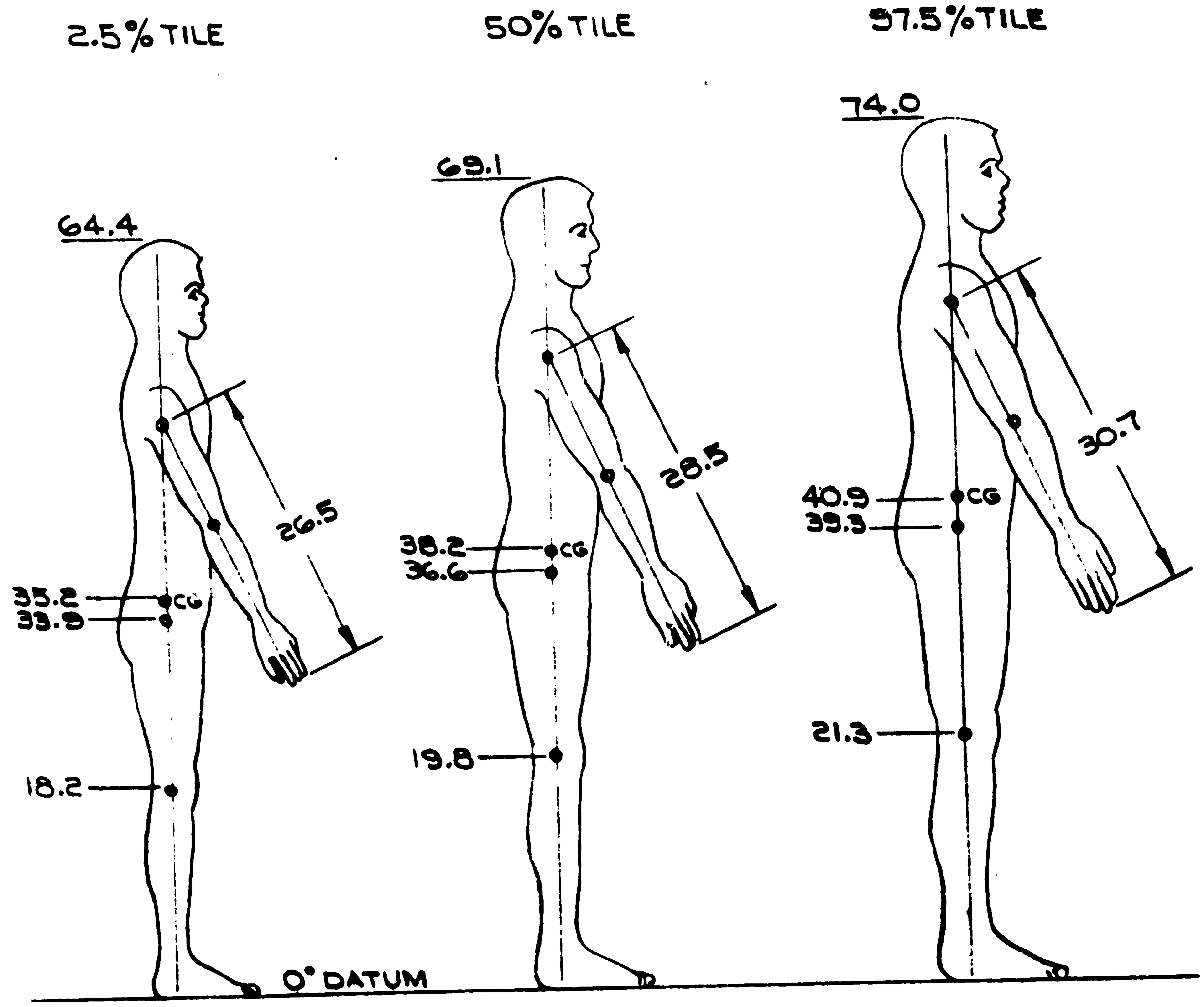
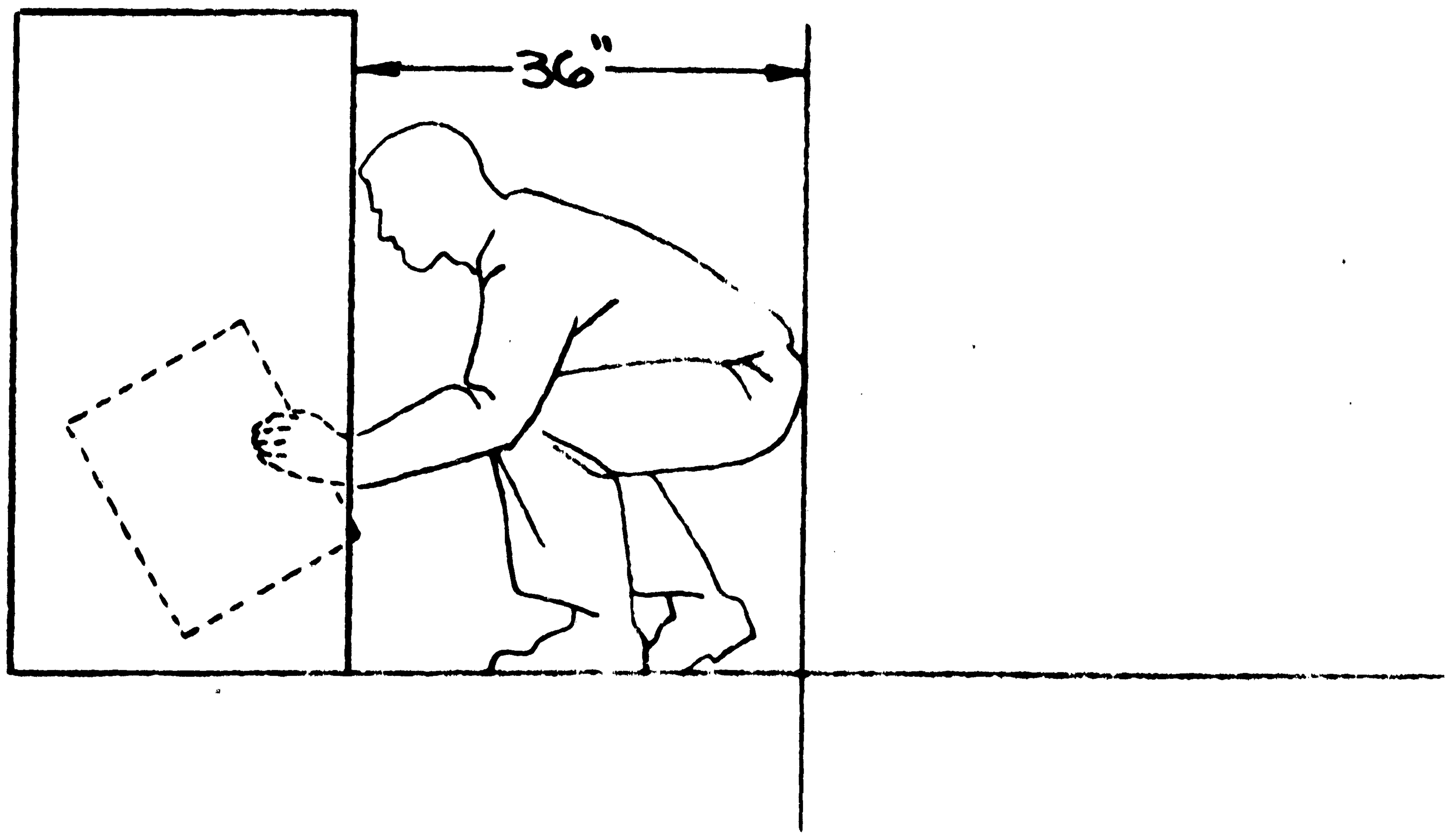


FIGURE 66

ANTHROPOMETRIC DATA - STANDING ADULT MALE

ACCOMMODATING 95% OF U.S. ADULT MALE POPULATION



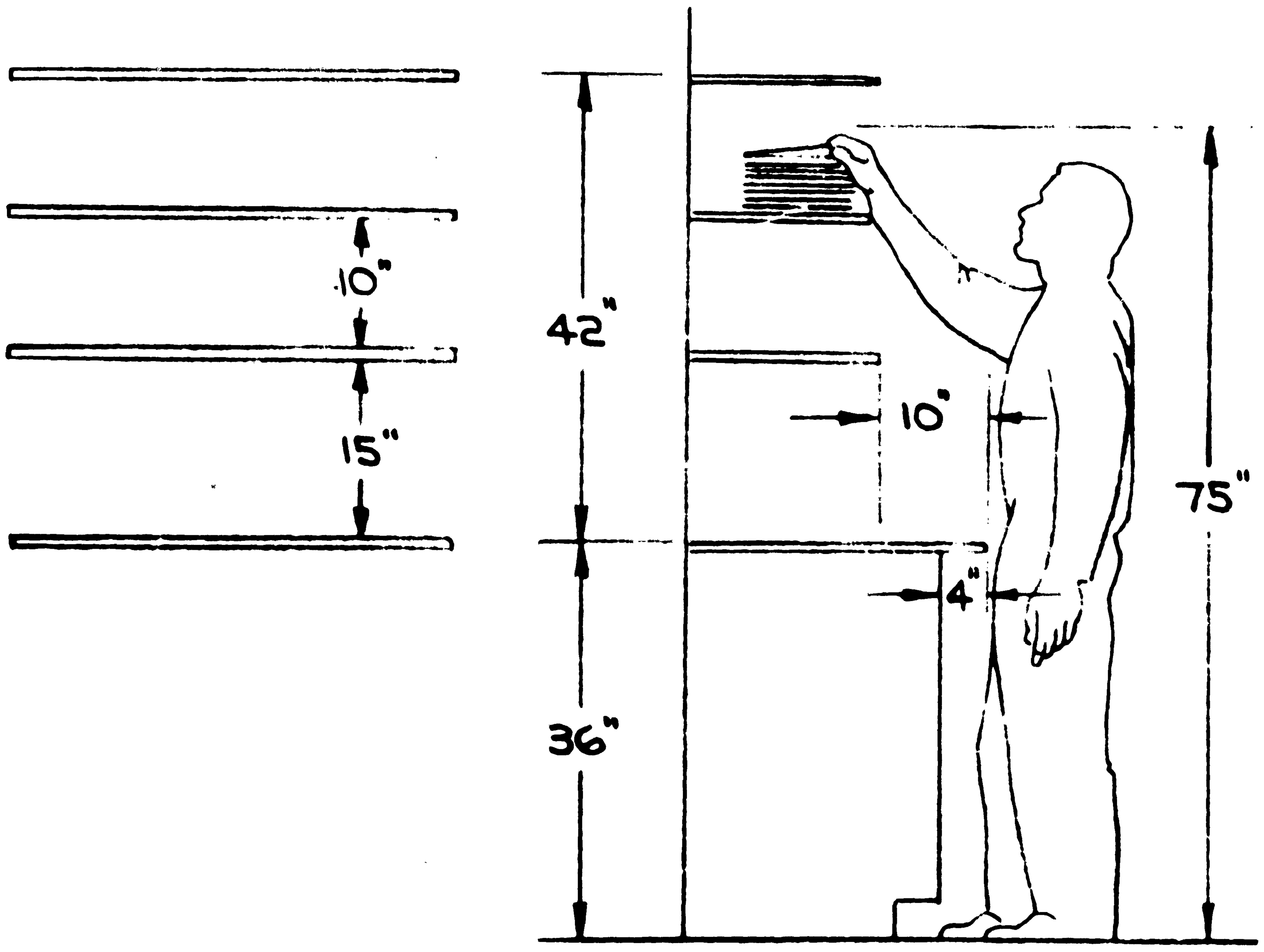


FIGURE 67

ANTHROPOMETRIC LIMITS
STORAGE AREA ARRANGEMENT

in handling the cans in order to prevent accidental dropping of the film can on the floor and possible physical injury. The roll film can tray previously shown in Figure 65 has been designed to facilitate handling of the rollfilm cans, and to permit easy withdrawal and insertion into the storage area a id material shuttle cart cubicles, and thus to meet the need positively established by test.

Each film can storage rack has been designed to hold 35 film cans of the 9 1/2-inch x 500-foot size. Roll film of smaller size is filed in the same size cubicle — as indicated by the fact that the roll film can tray, illustrated previously in Figure 65, will accommodate each of the three basic roll film sizes.

This decision was made on the basis of the following facts: 1) the mix of the three sizes is not reliably predictable, 2) the rate of accession (input) is high — some 300 cans per day, 3) the rate of purging (output) must, on the average, be the same amount, 300 cans per day, once the basic 6-month accumulation has been made, and 4) the rate of transfer to and from the user workplace is high. All of these factors mitigate against the use of special size cubicles for each film type which, though it would save a small amount of floor space, might create operational chaos in the accommodations which would have to be made if any one size exceeded its design storage amount.

The basic area arrangement is made, as previously illustrated in Figure 59, on a terminal digit basis with 700 cans per terminal digit — i.e., 20 modular racks in a straight line. Each terminal digit section is clearly labelled with large, easily read signs and each basic cubicle within the modular rack is clearly labelled with the full material storage address number.

10.4.3 Magnetic Tape Storage Area

As shown in the storage area general layout, space has been provided for the storage of 10,000 magnetic tapes in standard data processing magnetic tape storage open shelf filing racks. Each rack is capable of holding 100 magnetic tape reels stored in metal cans. The racks have been arranged in a terminal digit filing system, due to expected high traffic rate for input, output, and user processing.

The main aisle of the magnetic tape storage area has been designed to permit passage of two material shuttle carts simultaneously and the individual rack aisles have been designed to meet anthropometric considerations associated with the use of open shelf filing, previously presented in Figures 66 and 67.

10.4.4 Sheet Materials Storage Area

Equipments suitable for storage of single sheet items, such as maps, overlays, photographic prints, mosaics, etc., have been located within the sheet storage area. These equipments include:

(1)	Art Metal, Inc. Planfiles	3
(2)	Art Metal, Inc. Planfile Drawer Units	2
(3)	Proposed Model Mosaic Storage Units	9

Table space has been provided for the making up of information modules based on the user requests. A service window is provided for servicing the material shuttle cart as it passes by this storage area. It is anticipated that the sheet materials handling personnel will be permanently located within the sheet storage area.

Since it is not intended that the materials shuttle carts actually be brought into this area during the retrieval of the sheet graphic materials, aisle space has been reduced to that required for the personnel within the area.

10.4.5 General Library Materials Storage Area

In estimating the total number of open shelves required for the storage of the 90,000 items which it is anticipated will be stored in this area, it was necessary to assume a basic document thickness. Using a document thickness of 1/4 inch with a stacking factor of 75%, the 90,000 items would require approximately 135 open shelf filing racks, each having six adjustable shelves.

Shelf depths should be in the order of 12 to 15 inches in order to facilitate storage of the large number of documents exceeding normal text-book size. In the cases of large albums, it is envisioned that these will be stored flat in order to prevent damage to the binding, as is the current practice throughout the various reference libraries within the military intelligence community.

Since a browsing function is not required within the storage areas, there has been no reference table space supplied for that purpose. However, it appears as if operations within the storage area will be concerned with the making up of information modules for the various user workplaces and adequate work table space has been supplied for the temporary storage of these information modules prior to putting the items onto the material shuttle cart for transportation to the user workplaces. Since it is not intended that the materials shuttle cart be physically brought into this area, aisle sizes have been reduced accordingly to satisfy only the anthropometric requirements of the personnel.

A service window with counter space has been designed into the work area so that the material shuttle cart does not have to be driven into the storage area; rather a simple pick-up can be made on the way to the user workplaces by simply stopping at the general library materials service window. It is anticipated that personnel will be permanently located in the general library materials storage area.

10.4.6 Input Processing Area

An area will be set aside within the input processing space for the temporary storage of a two-day supply of incoming material pending cataloging and integration into the materials store control system, as well as delivery to the respective locations for final storage. The temporary storage configuration is made up of the following equipment:

(1)	Roll Film Can Storage Racks	20
(2)	Magnetic Tape Storage Racks	1
(3)	Art Metal, Inc. Planfile Units	1
(4)	Proposed Model, Mosaic Storage Units	1
(5)	Open Shelf Files	2

(6)	Material Shuttle Carts/Regular	2
(7)	Material Shuttle Carts/Roll Film	2

In addition to the temporary storage area for graphic materials, a supply cabinet will be provided for the storage of the usual office supplies.

Work table space will be provided for the physical labeling of the graphic materials prior to inclusion in the store, as well as providing area for the generation of the necessary paper work associated with the input processing function. Space has also been provided within the input processing area for four material shuttle carts, two of which will have the special roll-film configuration.

10.4.7 Output Processing Area

Since temporary storage volume requirements of the output processing cycle will ultimately equal those of the input processing cycle, similar spatial requirements exist. Storage equipment placed in the output processing area to facilitate the temporary storage of graphic materials pending their output processing include:

(1)	Roll Film Can Storage Racks	20
(2)	Magnetic Tape Storage Racks	1
(3)	Art Metal, Inc., Planfile Units	1
(4)	Proposed Model, Mosaic Storage Units	1
(5)	Open Shelf Files	2
(6)	Material Shuttle Carts/Regular	2
(7)	Material Shuttle Carts/Roll Film	2

In order to handle the necessary office supplies associated with the output processing function, a standard office supply cabinet has also been provided.

Since the work associated with output processing requires the generation of forms and documents to control the destination of the material being removed from the data base, space has been provided for this clerical work. In addition, space has been provided for the storage of four material shuttle carts, two of the normal user workplace servicing type and two of the special roll-film configuration to facilitate withdrawal of the graphic materials from the data base store during the material obsolescence effort.

10.4.8 Material Shuttle Cart Area

The material shuttle cart has been designed to fulfill five basic needs within the Reconnaissance Technical Squadron:

(1) A physical carrier which will facilitate the basic collection process which involves such physically disparate items as a 60 x 60-inch mosaic and a multiplicity of 20-pound roll film cans,

(2) A physical carrier suitable for physical transport of the graphic materials from the storage area to the user workplace.

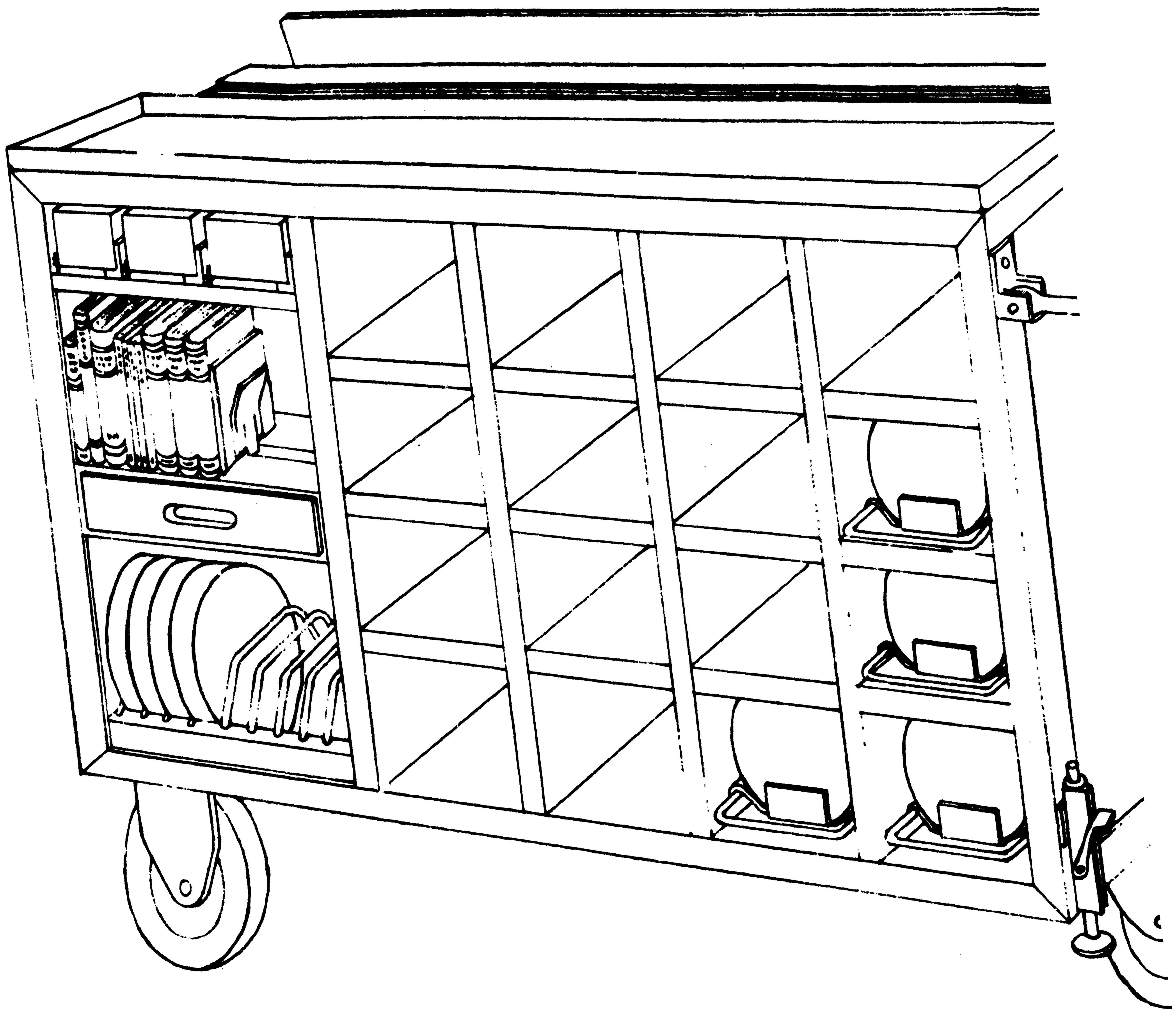
(3) A physical carrier which provides organized local storage at the user workplace,

(4) A physical carrier which will provide a floating address control — i.e., an addressable storage register with identifiable and constantly inventoried contents, and

(5) A physical carrier which, when necessary or desirable, will provide additional working surface.

To meet these objectives space has been planned for the garaging of some 26 of the 60 total material shuttle carts which are used in the basic collection of graphic materials and in transporting these materials from the graphic materials storage area to the user workplaces. The basic shuttle cart configuration, shown in Figure 68, provides for the transport of 16 roll film cans, 3 Tactical Target Record cassettes, 10 magnetic tapes, as well as providing for 76 inches of shelf space for general library materials such as books, magazines, and periodicals (18 inches in the cubicle and 58 inches on top). Space for the storage of mosaics is provided at the side of the material shuttle cart, as shown in the front view general configuration Figure 69. Large folios, atlases, and other large-size general library materials and/or small mosaics can be stored in the space between the inclined plane support for the large mosaics and the basic cart. A special cubicle using the spring compressors similar to those used in the Art Metal, Inc., Planfile configuration has been provided for the transport of maps, overlays, and photographic prints. Detailed identifications are given in Figures 70, 71, and 72. The version specially adapted for transport of 48 cans of roll film is shown in Figure 73.

As can be seen by referring to the side view of the general configuration, Figures 70 and 71, a foot-operated brake has been provided to lock the material shuttle cart firmly in place when it is in use at the user workplace.



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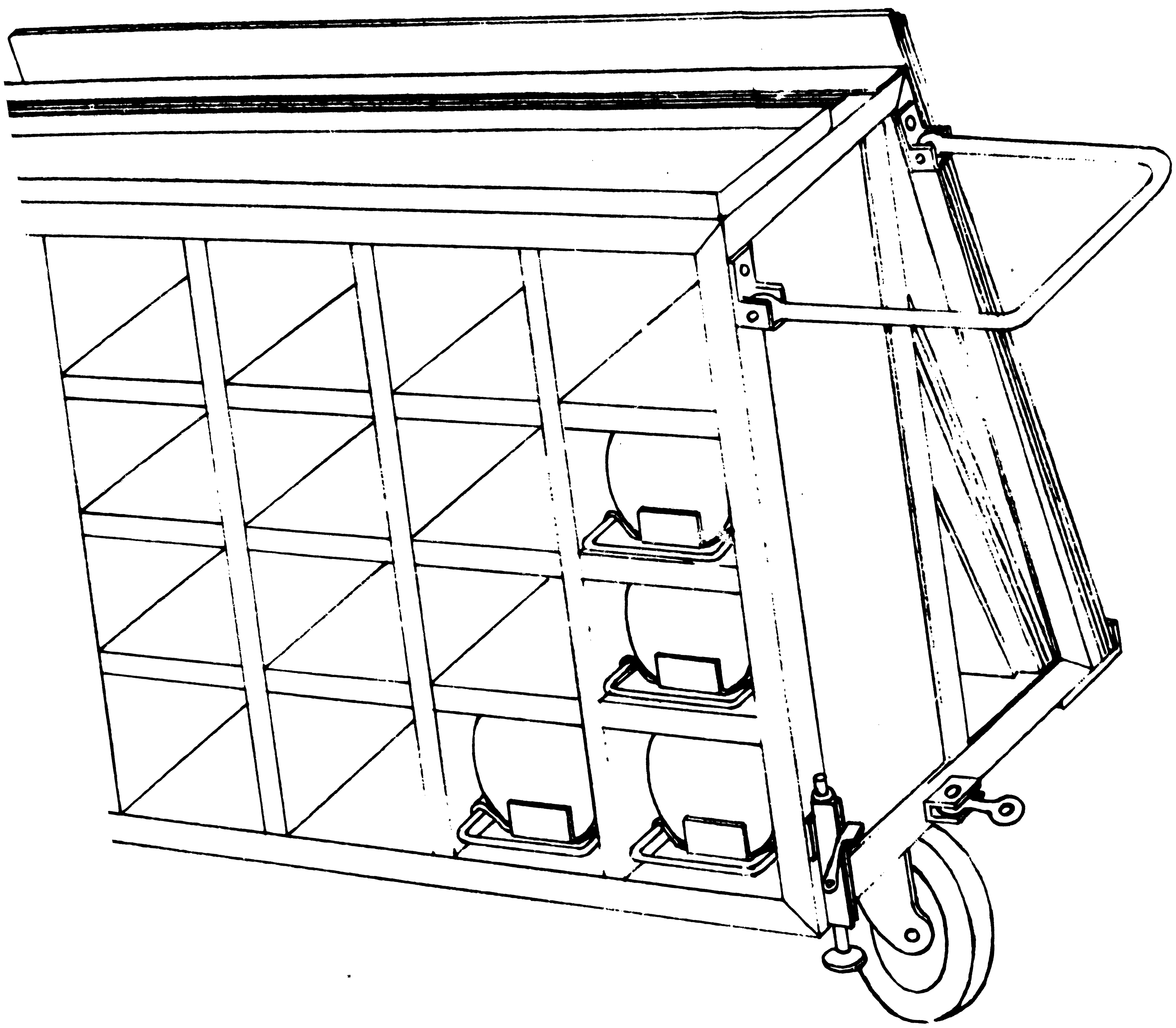


FIGURE 68

MATERIAL SHUTTLE CART
BASIC

337/338

2

In conjunction with its use at the user workplace, two reference table configurations have been provided. One configuration provides for an integrally mounted folding table to be attached to the material shuttle cart as shown in Figure 74. Another approach is to use a separate folding table which can be stored in the space provided on the side as shown in the front view of the general configuration of the material shuttle cart.

A folding handle has been provided on the material shuttle cart to facilitate moving the unit around by hand. However, if the demand at a given workplace exceeds the ability of a single cart, or if it is desirable for security or other reasons, to return all carts to the Graphic Materials Storage Area overnight, then the carts can be coupled together as shown in Figure 75 and pulled by an electrically operated tractor from the material storage area to the user workplace. The tractor shown in the illustration is capable of pulling up to 10, 000 lbs. on trailers and could theoretically pull up to 15 to 20 loaded material shuttle carts.

Main aisle spaces have been set at 8 feet in width to permit parallel passage of the material shuttle carts. Within the materials shuttle cart garaging area, it is recommended that small stalls be provided to facilitate the orderly parking of the unloaded material shuttle carts to maximize the storage space and to minimize the loss of time associated with the retrieval of carts parked in a random fashion within the storage area. This orderly arrangement will also reduce the damage to the carts that would result from a random approach to cart garaging.

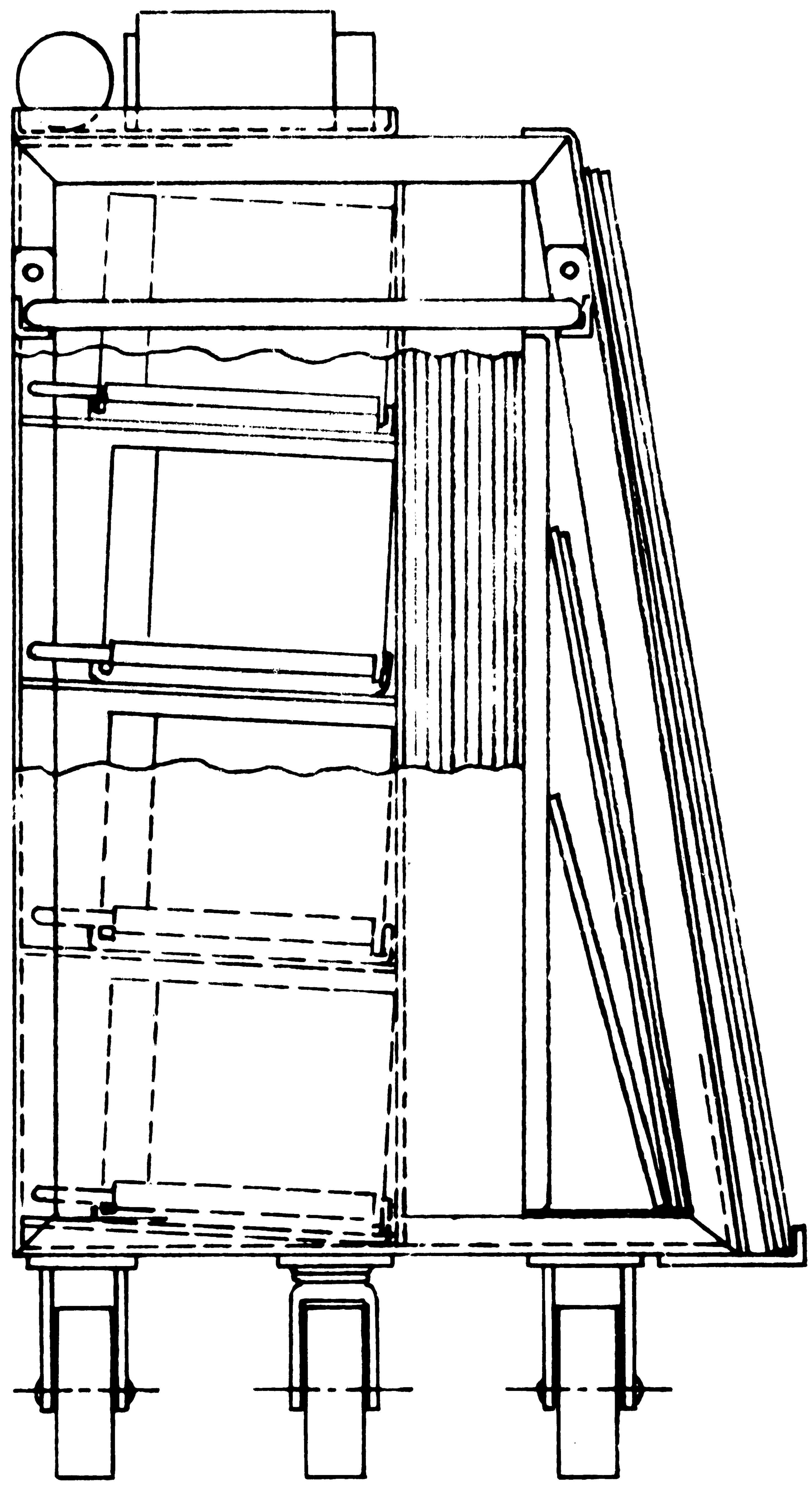
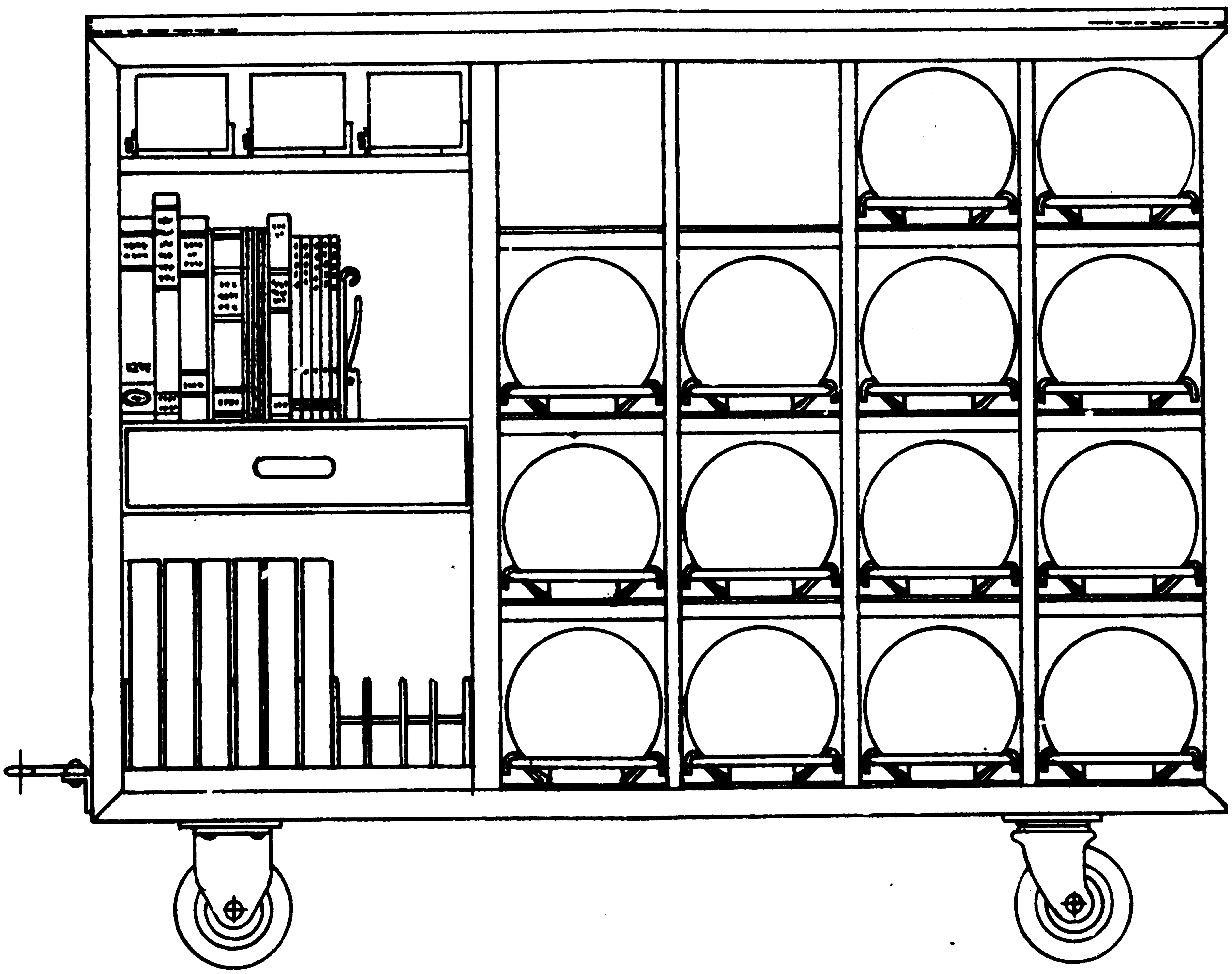


FIGURE 69

MATERIAL SHUTTLE CART

FRONT VIEW GENERAL CONFIGURATION



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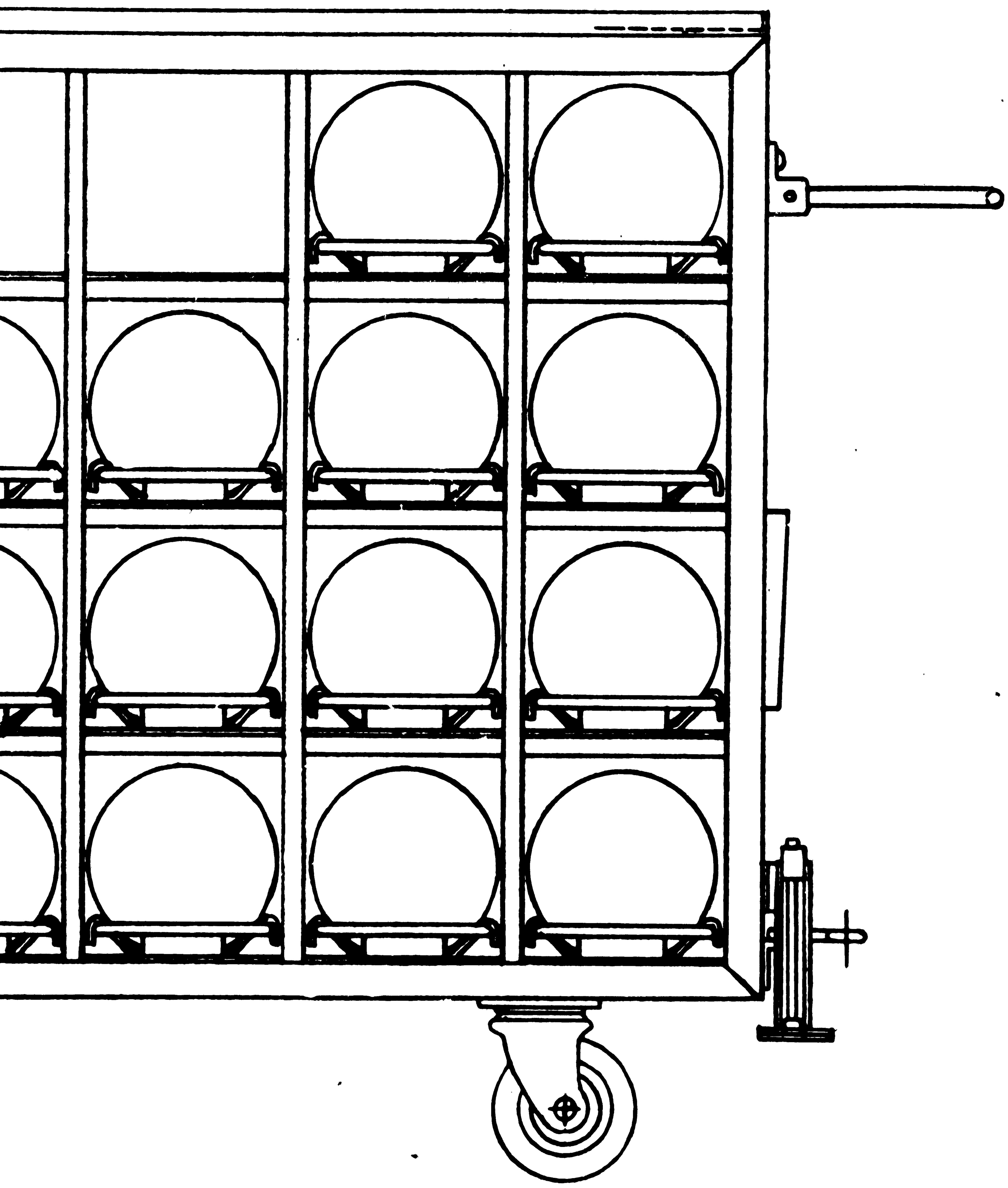
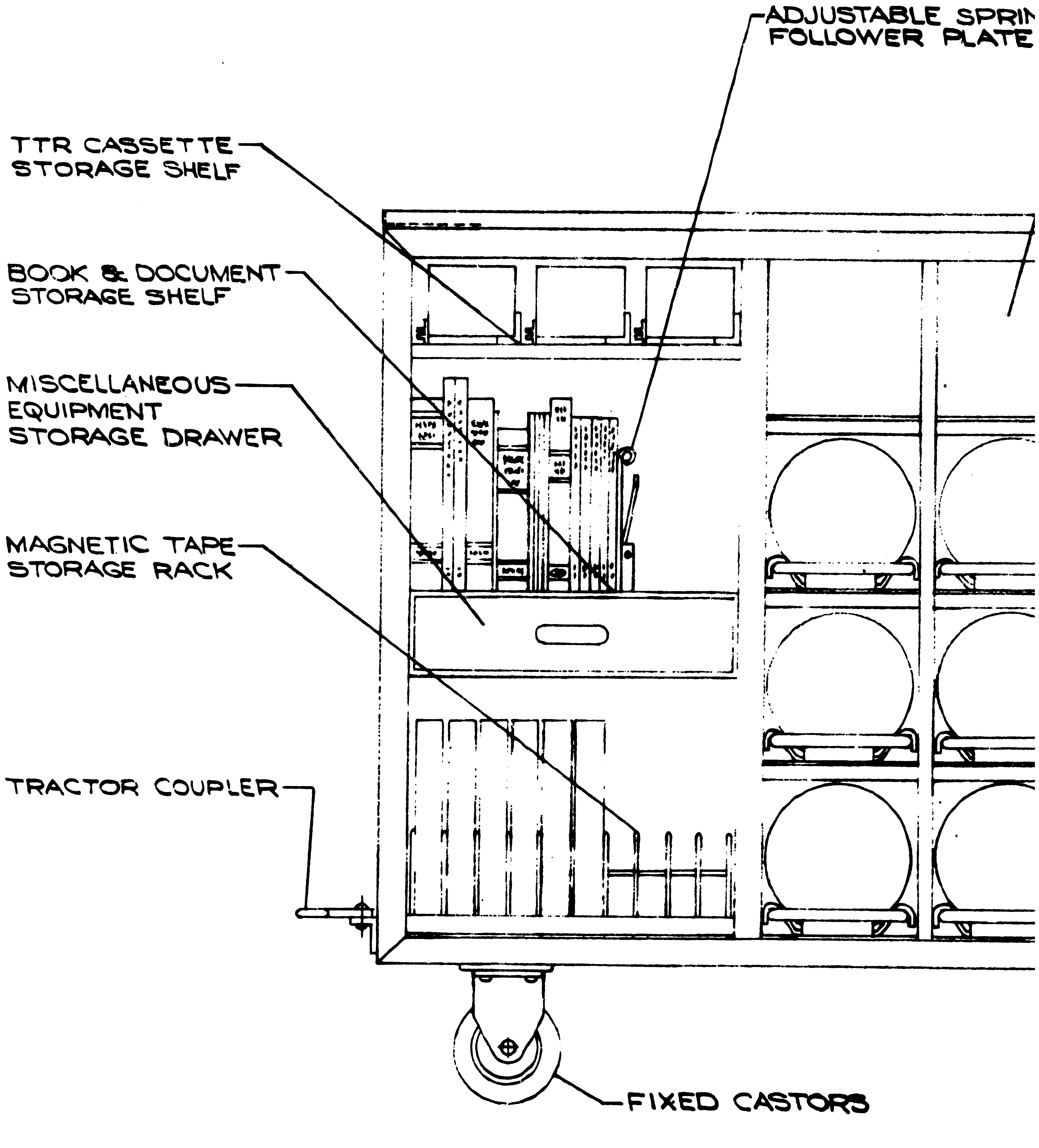


FIGURE 70

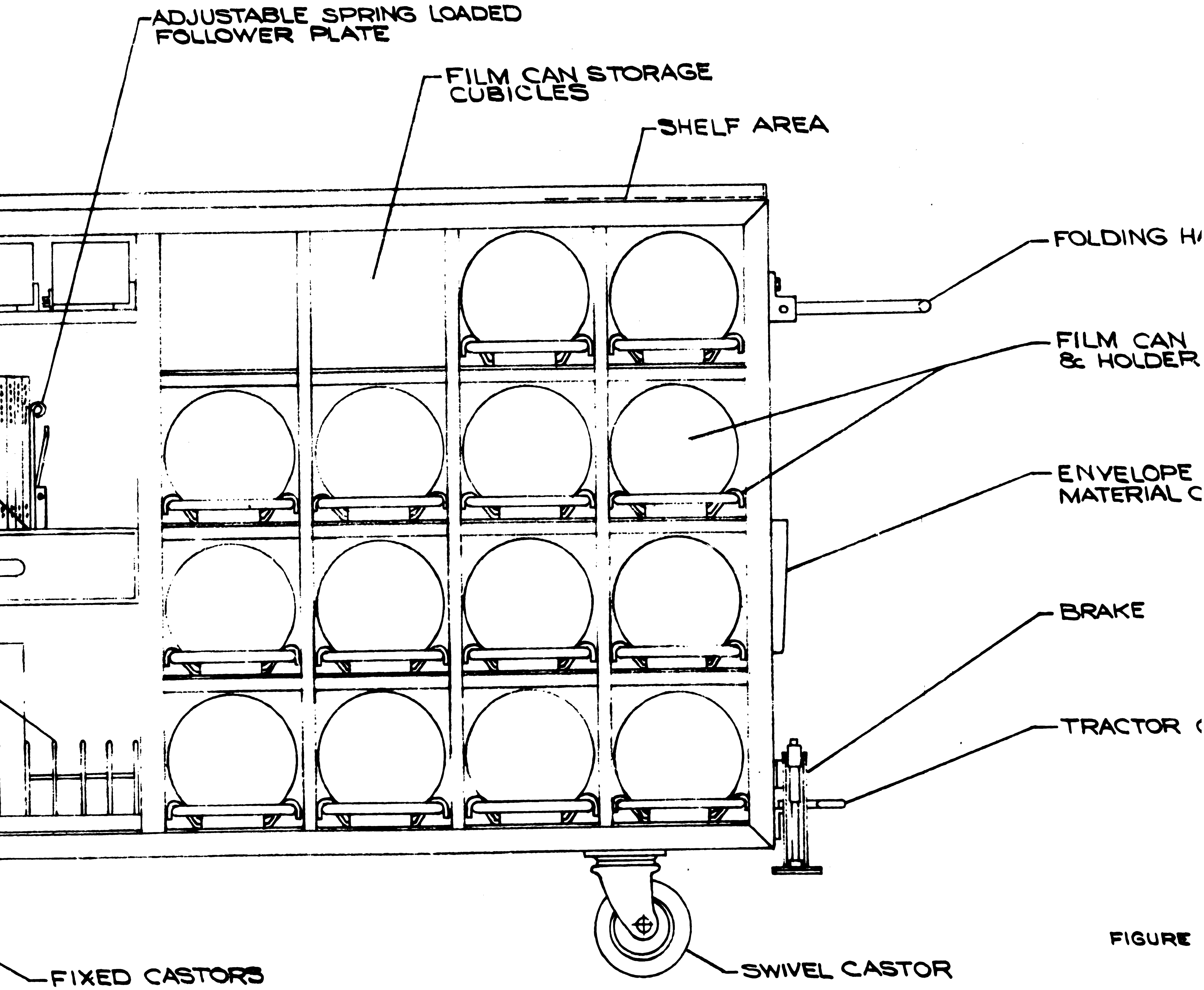
2

MATERIAL SHUTTLE CART

SIDEVIEW
GENERAL CONFIGURATION


ADJUSTABLE SPRIN
FOLLOWER PLATE
TTR CASSETTE STORAGE SHELF
BOOK & DOCUMENT STORAGE SHELF
MISCELLANEOUS EQUIPMENT STORAGE DRAWER
MAGNETIC TAPE STORAGE RACK
TRACTOR COUPLER
FIXED CASTORS

1



FIGURE

MATERIAL SHU

SIDEVI

GENERAL CON

3

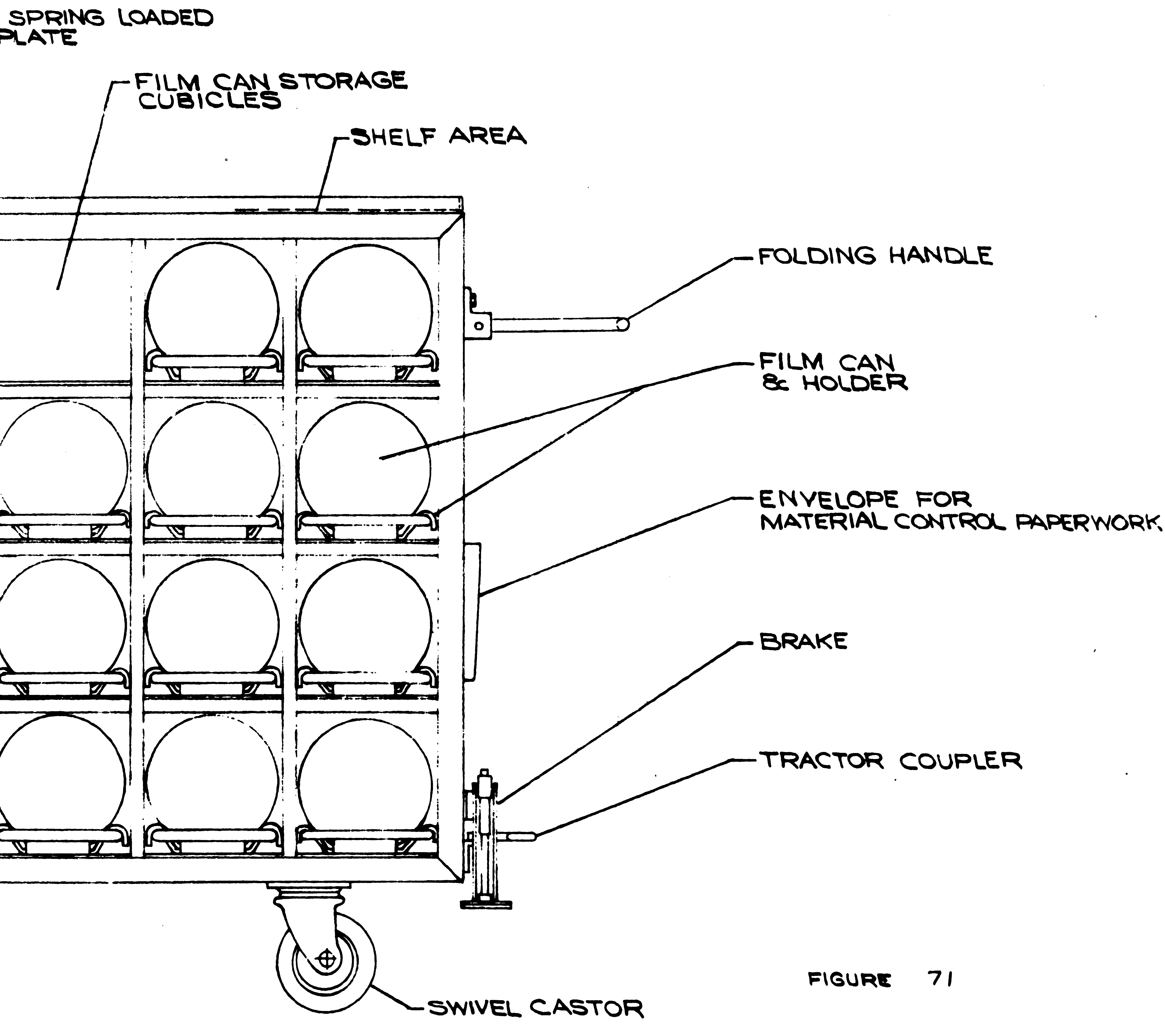


FIGURE 71

MATERIAL SHUTTLE CART

SIDEVIEW
GENERAL CONFIGURATION

3

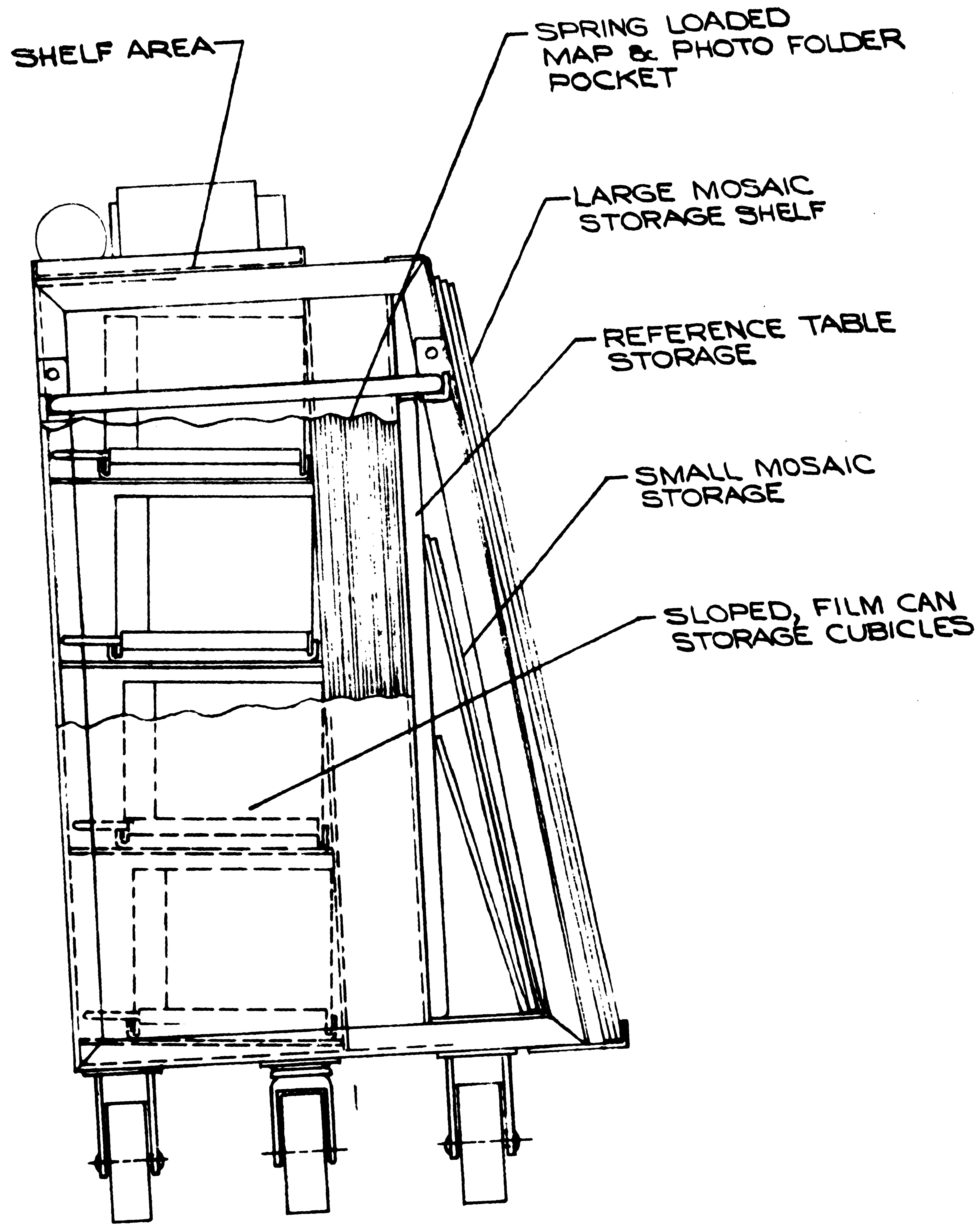


FIGURE 72

MATERIAL SHUTTLE CART

FRONT VIEW GENERAL CONFIGURATION

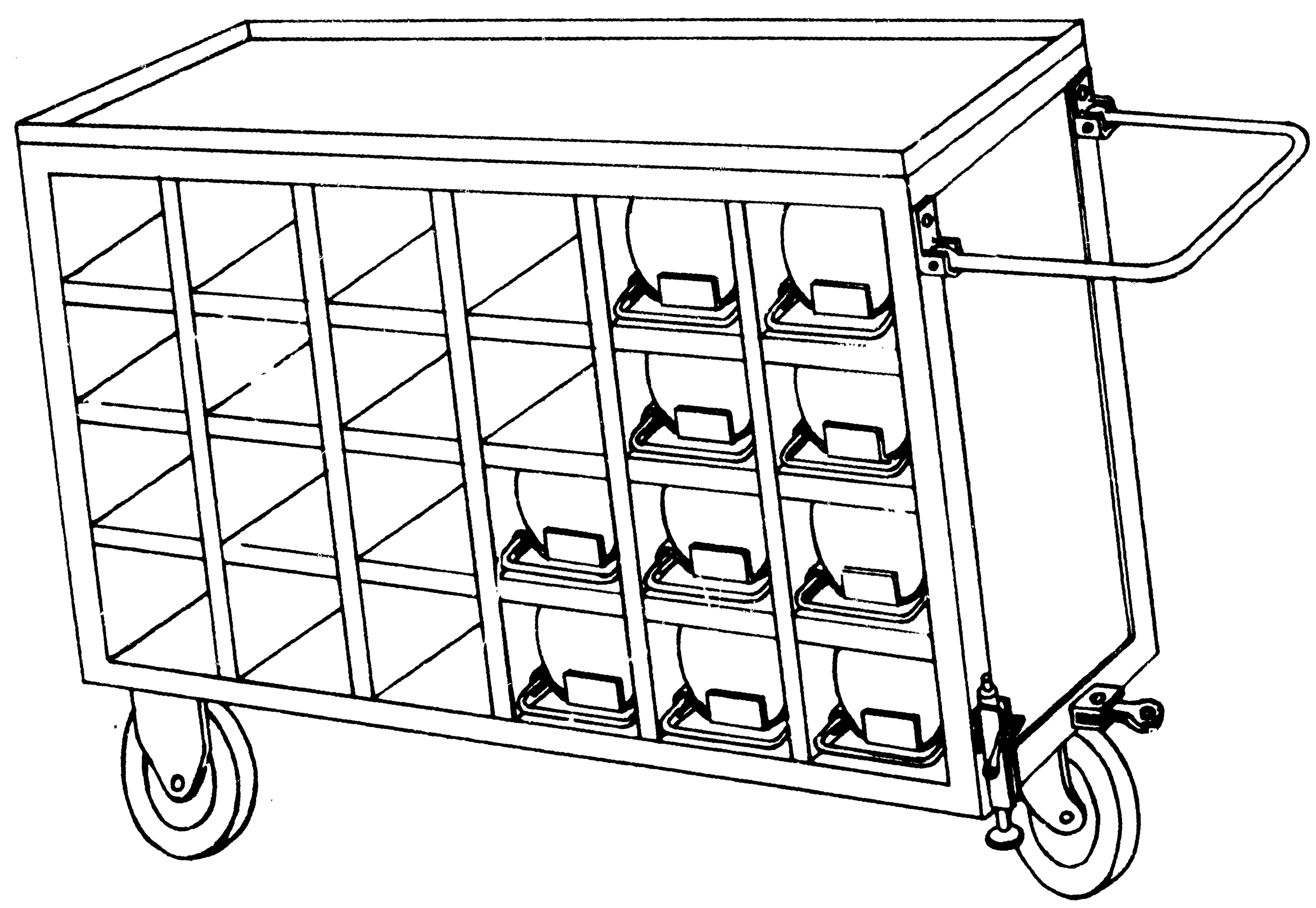
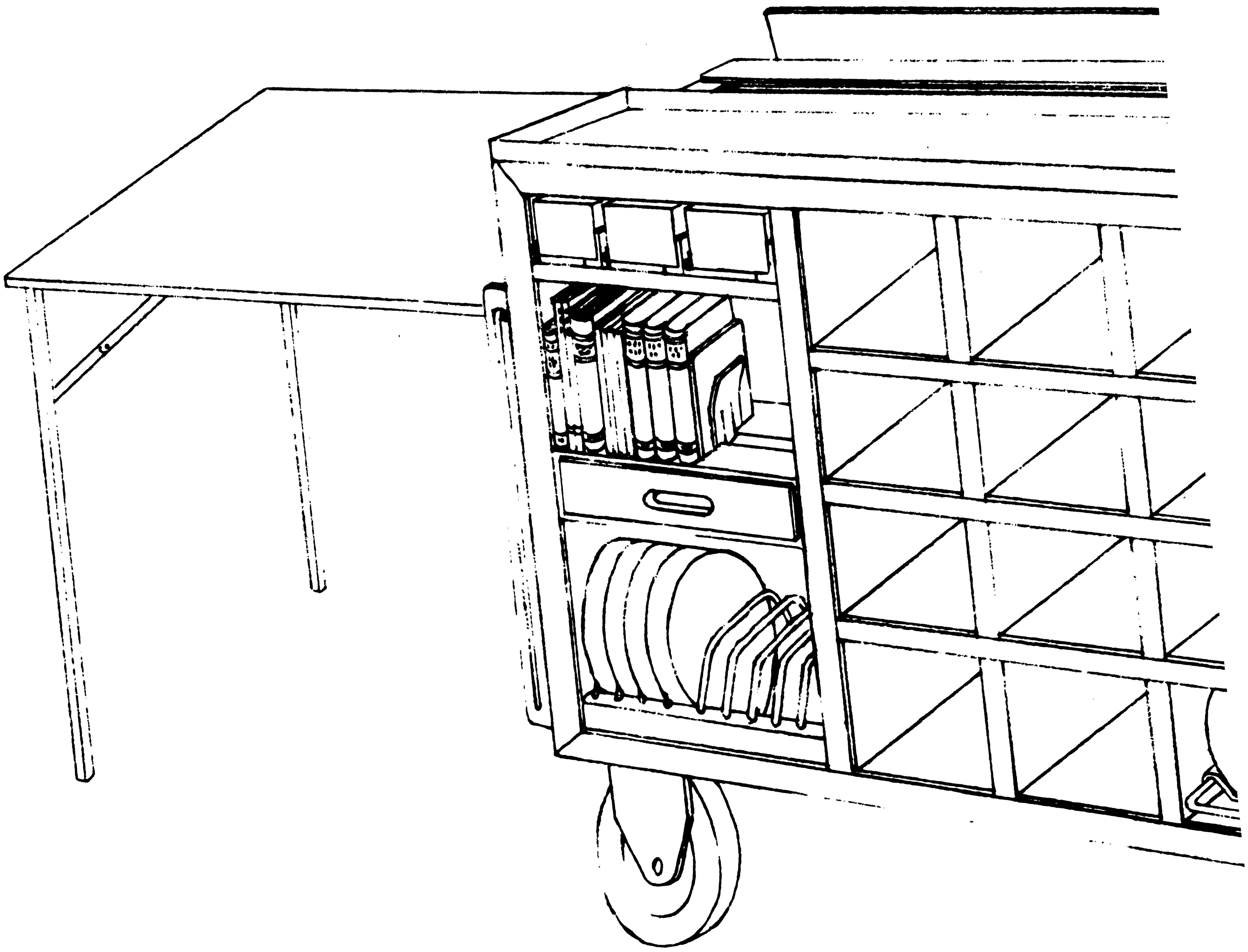


Fig. 73 Material Shuttle Cart Film Can Storage



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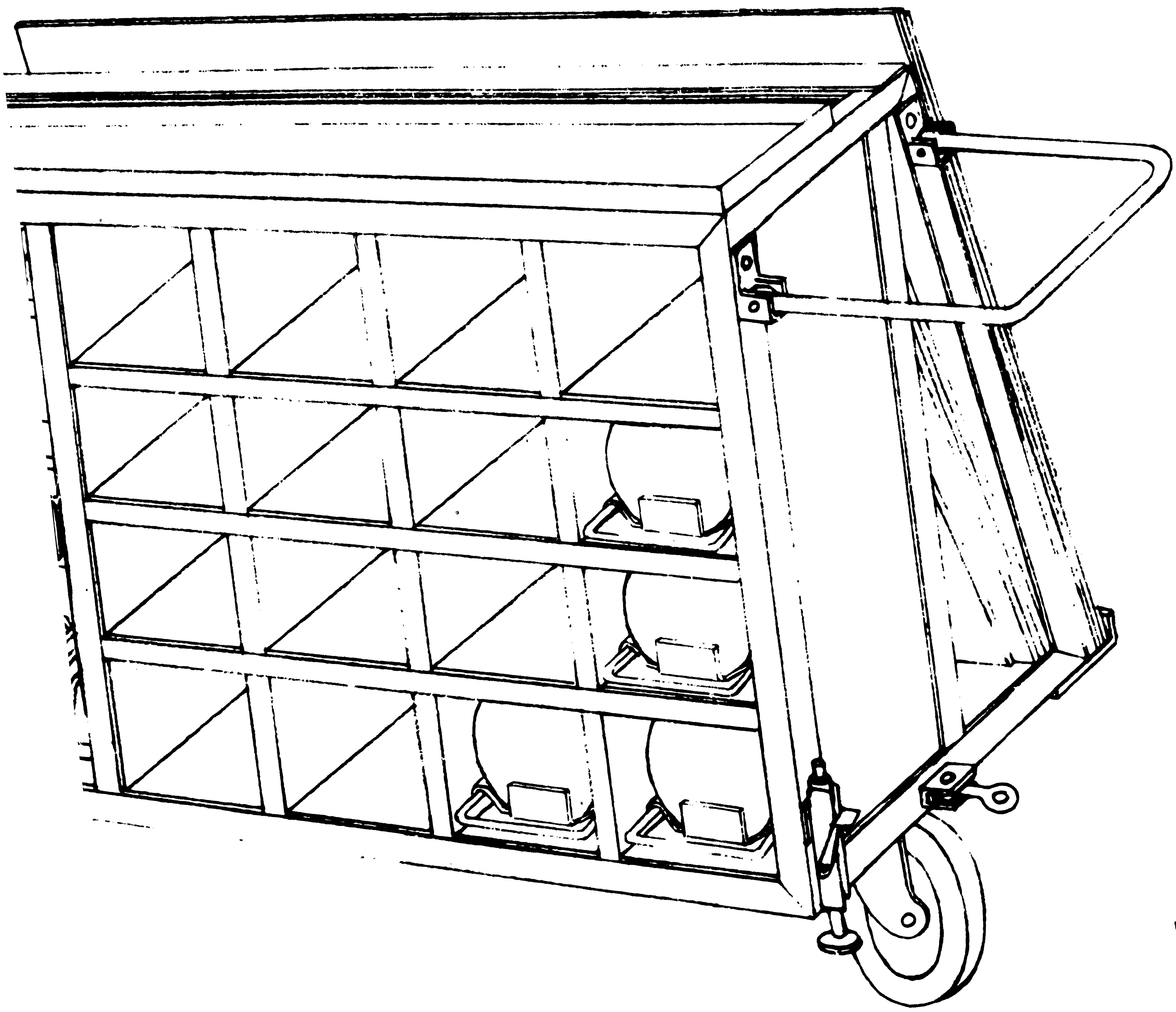
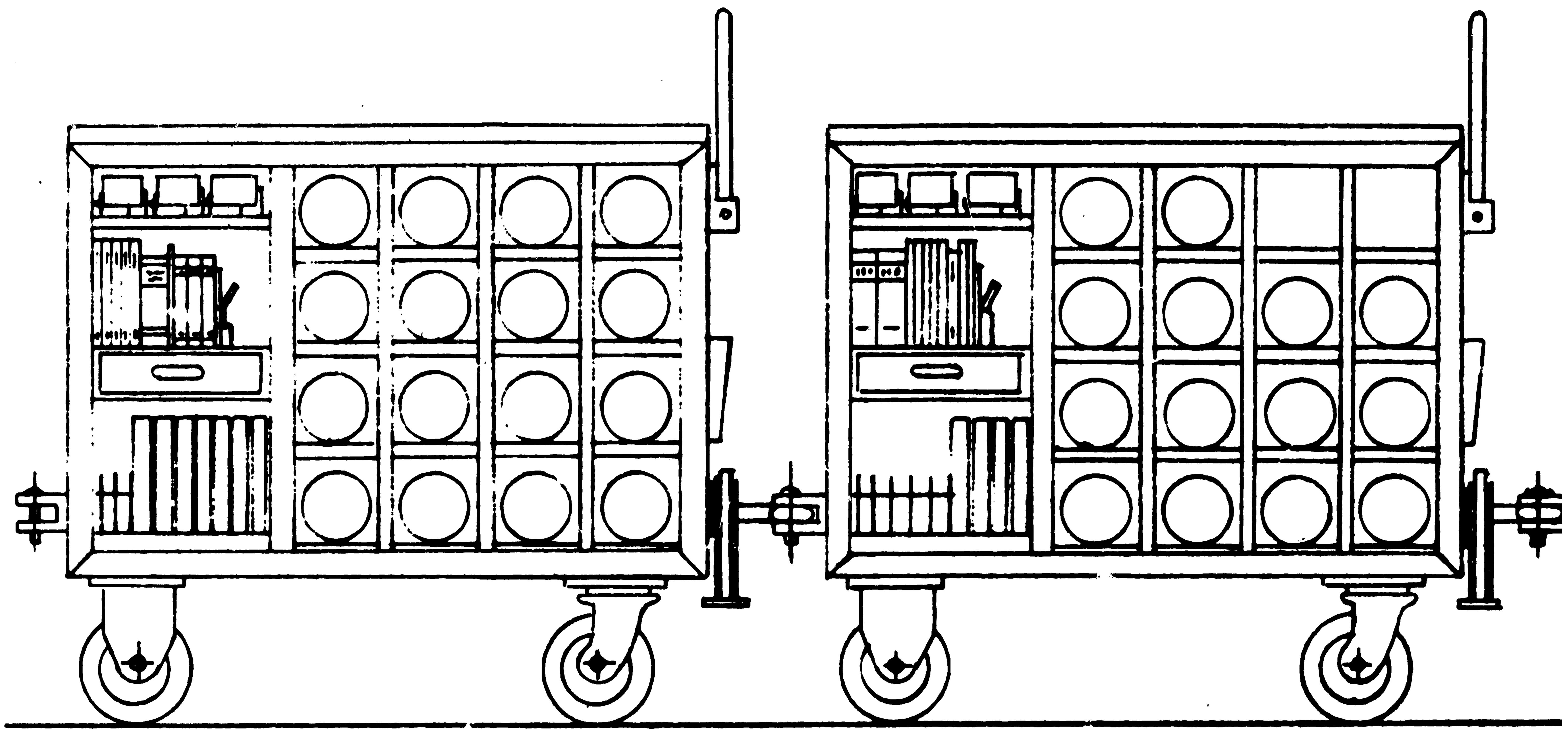


FIGURE 74

MATERIAL SHUTTLE CART
WITH ADDED INTEGRALLY MOUNTED REFERENCE TABLE

2



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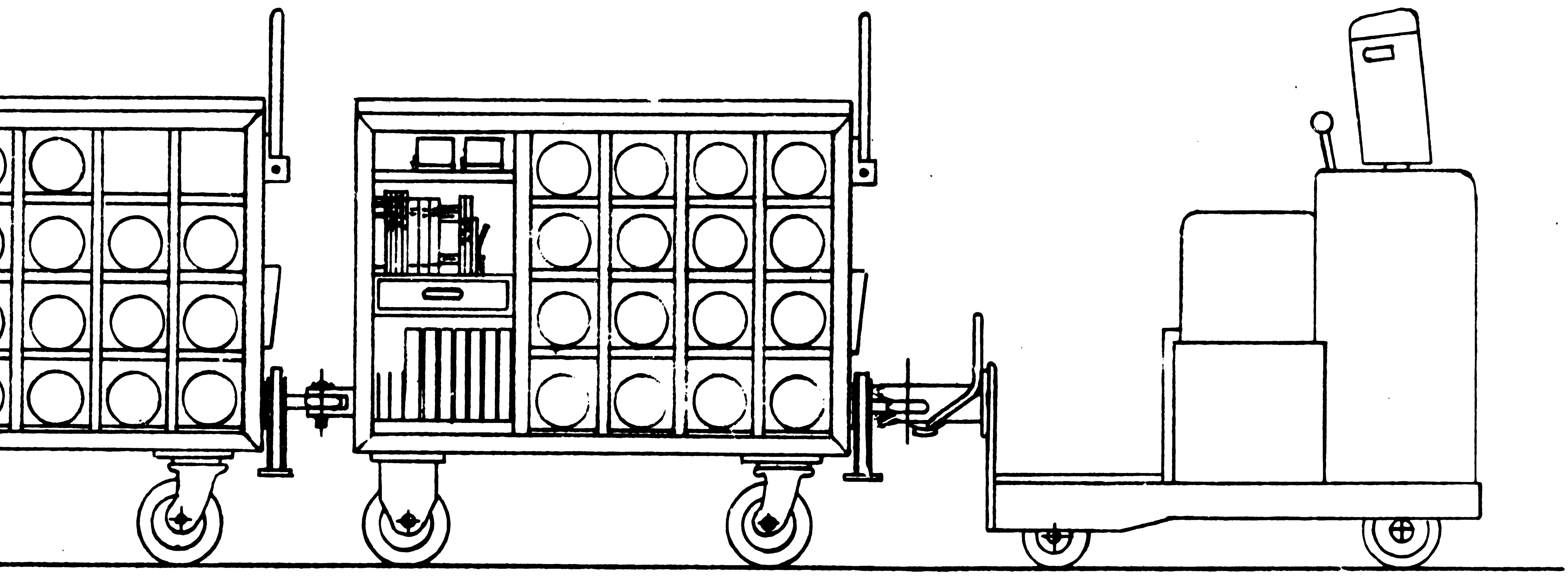

FIGURE 75

2

MATERIAL SHUTTLE CART
(IN TRAIN CONFIGURATION)

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10.4.9 <u>Operations and Administration Area</u>

Coordination of all efforts within the Graphic Materials Storage Area will originate within the administration area. Personnel and equipment associated with the user processing function and inventory control will be located in this area. As has been previously explained, user requests will be received on a teletypewriter, permanently manned, which is used for communication between Information Storage and Retrieval Officer and the Hard-Copy Information Storage and Retrieval Officer. The hard copy print-out from the teletypewriter will be used as the shopping list within the storage area and will be used as the check-off list associated with verification of the information module.

Inventory control will be accomplished by using the teletype to update the computer memory continuously regarding the physical location of the items within the graphic materials store in transit, at the individual user workplaces, or in output processing. Desk space must be supplied for these operations as well as for personnel associated with the verification and check-off of the material going to and from the user workplaces. These workspaces should be adjacent to the main corridor to permit quick access to the material shuttle carts which will be using this corridor.

Space has been provided for standard file cabinets which are necessary for the storage of the paperwork associated with the warehousing function.

The operations within the hardcopy storage area will be the responsibility of the Hard-Copy Storage and Retrieval Officer, a subordinate of the

Information Storage and Retrieval Officer. He will be physically located within the Graphic Materials Storage Area in order that he may direct its activities and personnel. Therefore, space has been planned for an office. Ready room space should also be supplied within the administration area for handling personnel, to facilitate dispatching operations whether for users request or for internal inventory control and/or checking tasks.

10.5 EQUIPMENT CONFIGURATIONS

Equipment types have been presented under Section 10.4, Graphic Materials Storage Area Configuration and Equipment Considerations, in association with area layout and floor space allocations. These general descriptions are supplemented in this section with descriptions of specific equipments which are deemed representative of the types recorded.

10.5.1 Roll Film (Can) Storage Equipment

For the storage of film cans it is recommended that a rack be constructed which, in inches, is 71 high x 48 wide x 12 deep. This rack will contain 35 cubicles each one 8-1/2 x 8-1/2 x 12 inches and will handle the storage of up to 35 individual cans of 9-1/2-inch aerial film. The suggested rack has been illustrated previously in Figure 64.

10.5.2 Magnetic Tape Storage Equipment

Storage of magnetic tape may be accomplished in the TAB Products Co. Model 4830, 5-shelf reel cabinet, or equivalent. This unit has dimensions, in inches, of 83 outside height x 36 width x 16-3/4 depth. It is capable of handling 100 reels of magnetic tape, 20 on each of five shelves.

10.5.3 Sheet Materials Storage Equipment

For sheets up to 20 x 24 inches, the Art Metal, Inc., Planfile Drawer Unit, Style No. 1180, or equivalent type is recommended. This unit has two drawers. The filing space per drawer, in inches, is 25-7/8 width x 22-13/16 height x 23-1/8 depth. The outside dimensions of this unit, in inches, are 29-1/4 width x 51-13/16 height x 24-7/16 depth.

For sheets from 20 x 24 inches through 36 x 48 inches the Art Metal, Inc., Planfile Unit 4836-BDL, or equivalent type, is recommended. This unit has outside dimensions, in inches, of 55 width x 45 height x 31 depth.

It is recommended that paper sheets larger than 36 x 48 inches be folded to 36 x 48 inches.

It is recommended that overlay sheets larger than 36 x 48 inches be compressed between two sheets of hardboard and stored in the unit recommended for mosaic storage.

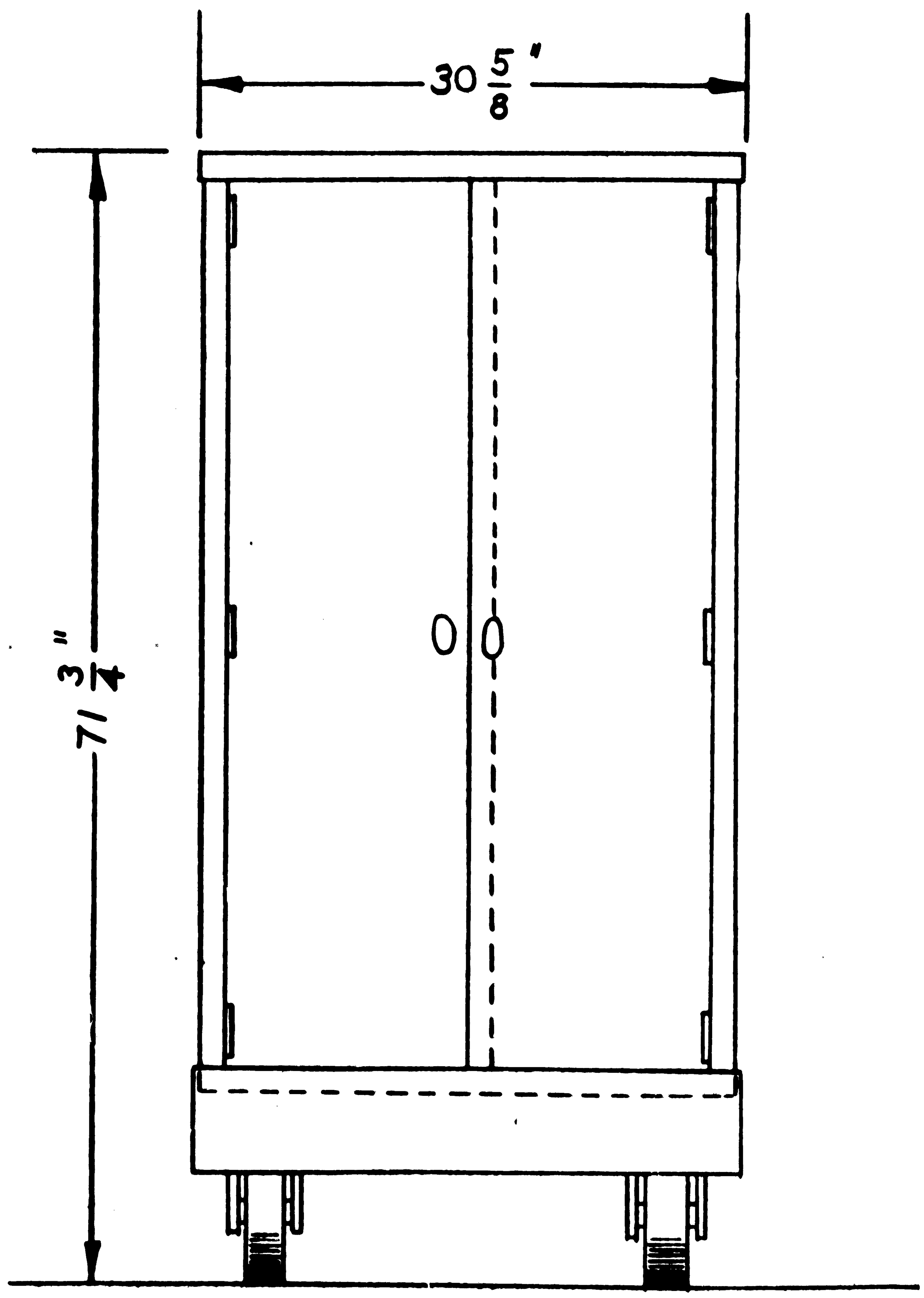
10.5.4 Mosaic Storage Equipment

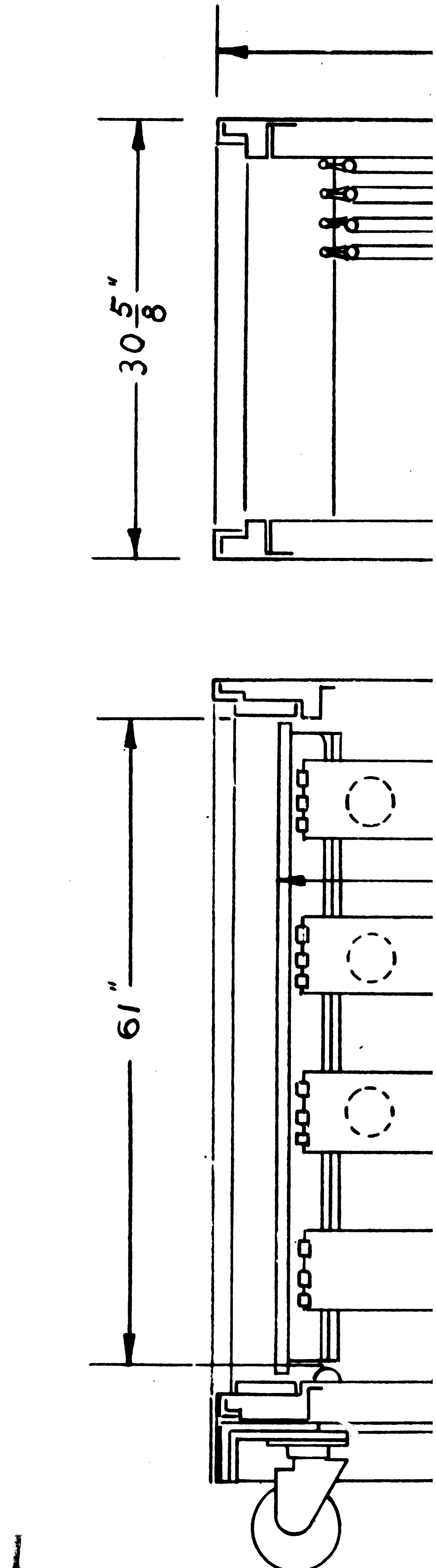
It is recommended that a unit be built to the specifications of that shown in Figure 76, or equivalent. The dimensions of this unit, in inches, are 71-3/4 height x 30-5/8 width x 66 depth. It is capable of storing 120 60 x 60-inch mosaics under spring compression.

It is also recommended that large overlays be stored in this same type of unit, compressed between two hardboards.

10.5.5 General Library Materials Storage Equipment

For storage of miscellaneous library material, the Art Metal, Inc., Open File Shelving Style #2322, or equivalent, is recommended. This unit is 36 inches wide and is double-faced: materials can be stored on both sides of the unit. It is 90 inches in height and horizontal shelves may be placed at any level at 1-inch intervals. Vertical dividers may be placed at 1-inch intervals on any horizontal shelf. The upper shelves themselves are 12 inches in depth; the base shelf is 15 inches in depth.





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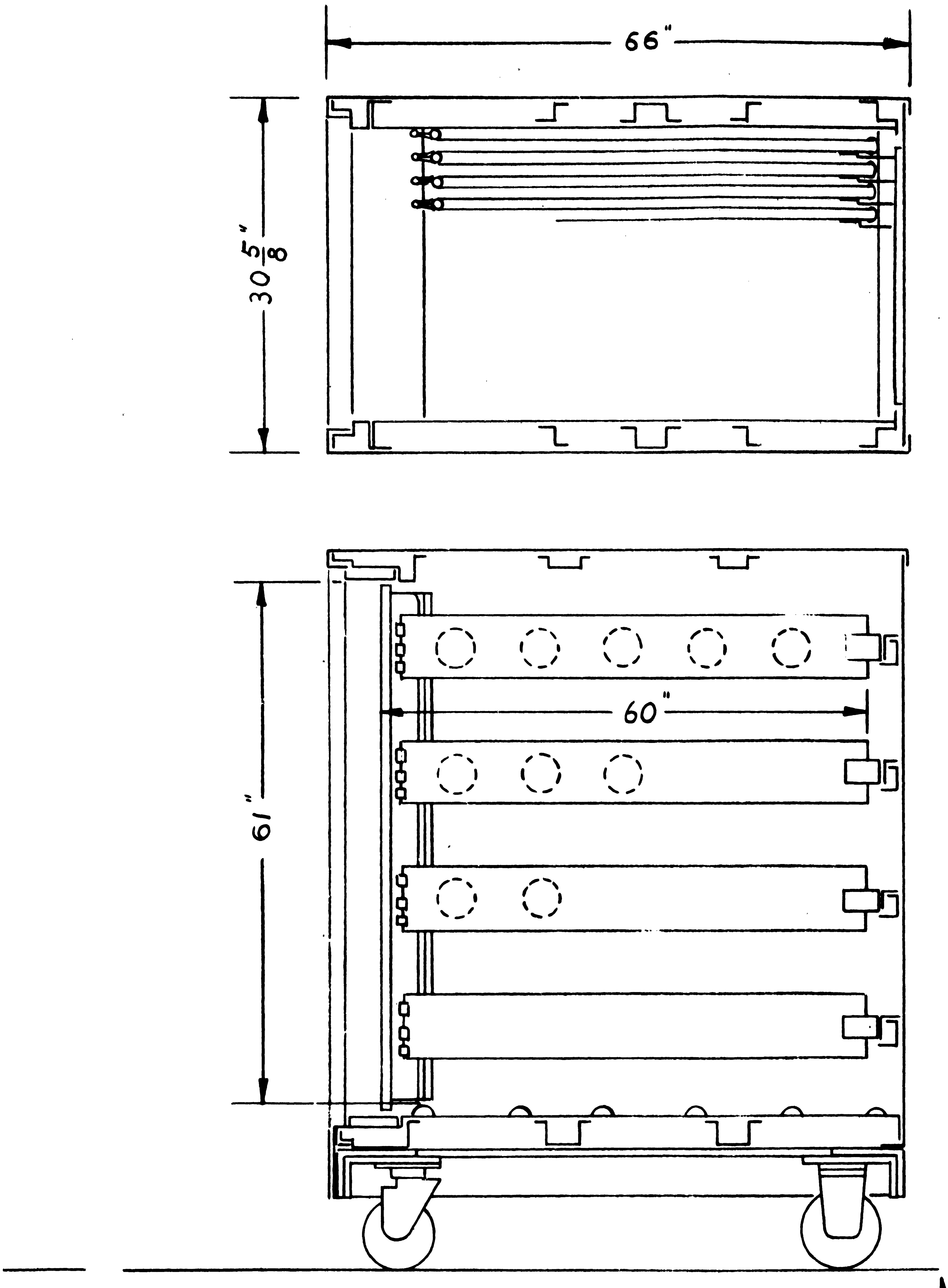

2

FIGURE 76

MOSAIC STORAGE UNIT
PROPOSED CONFIGURATION
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10.5.6 <u>Material Shuttle Carts</u>

Material shuttle carts of the general nature described in paragraph 10.4.8 are recommended.

10.6 PERSONNEL REQUIREMENTS

The estimated total number of personnel required to man the Graphic Materials Storage Area is 28, distributed among the storage type subdivisions in the manner shown in Table 41.

In order to determine the personnel requirements for the graphic materials handling system, it was necessary first to relate the effect of the expected material flow rates upon the functional characteristics of the system as they apply to operations within the four basic graphic materials storage area subdivisions. Flow rate figures were established for input processing, user processing, and output processing, since these three operations occur simultaneously. It has been assumed in the establishment of the personnel requirements for the Graphic Materials Storage Area that the responsibilities of these personnel do not extend beyond the physical confines of the storage area. For example, it has been assumed that the storage area personnel will not be assigned the responsibility of physically transporting the user material from the storage area to the user workplace, but rather that this task will be the responsibility of an additional group of transporters. Similarly it has been assumed that the storage area personnel are not responsible for physically transporting material to and from the input and output processing areas to the RTS shipping area; that this responsibility will be that of the same transporters. It has also been assumed that the incoming material has passed through shipping room procedures and that the boxes have been physically broken open and packing removed to facilitate the quick integration of the

Table 41

PERSONNEL REQUIREMENT DISTRIBUTION

Storage Area Subdivision	Quantity
A. STORAGE AREAS	
1. Roll Film 2. Magnetic Tape	4
3. Sheet Materials	6
4. General Library Materials	4
B. PROCESSING AREAS	
1. Input	5
2. User	Storage Area Personnel
3. Output	4
4. Inventory Control	2
5. Operations	3
Total	28

newly received information into the main data base store.

10.6.1 Input Processing

This function is responsible for the preparation of the material for inclusion in the main data base store and the operation commences with receipt of the material which has previously passed through a basic shipping room incoming materials procedure and is in an unpacked state. It has been estimated that the expected daily graphic materials input processing traffic will be distributed among the physical storage area subdivisions in the quantities given in Table 42. This totals an input processing traffic of approximately 650 items to be handled each day on what has been assumed will be a single shift basis. It is estimated, therefore, that one man could perform the necessary sorting and unpacking of the incoming materials and place them in temporary storage racks with the input processing area.

The input processing supervisor must correlate the physical items received with the material identification paperwork which has been received from the originators and enter this information into a log sheet. A copy of this log sheet will be used for the preparation of material storage address labels.

Upon completion of the material checking function the material storage address labels must be prepared; it is assumed that this function can be accomplished by one man. Since the man who has been assigned the responsibility for the sorting and unpacking of the incoming items will not spend more than half of his time doing this, it is assumed that this man can also be responsible for the physical labeling of the items.

Table 42

ESTIMATED INPUT PROCESSING QUANTITIES

	Category	Units	Quantity
1.	Roll Film	Cans	300
2.	Magnetic Tapes	Cans	30
3.	Sheet Materials	Maps Overlays Mosaics	50
4.	General Library Materials	Books Periodicals Reports	270
	Total		650

Included in the input processing function is the physical removal of the items from the input processing area and the placing of the items into the main data base store. Based on retrieval and refiling rates established during the operational testing of the representative storage configurations, it is estimated that 2 men will be required for the physical integration of the received items into the main data base store. The total input processing man-power requirements, then, is 5 men.

10.6.2 User Processsing

10.6.2.1 User Request Daily Traffic

It has been established that the Reconnaissance Technical Squadron facility must be capable of handling an input of 300 photo-reconnaissance film cans of various assorted size on a daily basis and for the purposes of this section it is estimated that approximately 80% of these 300 cans will require flash analysis prior to placing in the graphic materials store in order to identify the content. Allowing approximately 10 minutes per roll for the flash investigation, this indicates that there must be at least six flash analysis workplaces and in all probability there will be more than twice that amount in order to handle the other interpretation requirements. It is therefore assumed that there will be at least 15 photo-interpretation workplaces plus ten other user areas requiring servicing, probably on a 2-demand per day basis. Therefore, it is assumed that a user processing rate of 50 customers per day must be met.

10.6.2.2 Typical User Request Requirement

It has been assumed that the typical user will require approximately 100 items from the graphic materials store in each request, distributed among storage area subdivisions in the manner of Table 43.

10.6.2.3 Retrieval Manpower Required

If the retrieval rates that have been established in the testing of the equipment configurations are used to satisfy the typical user request outlined above, then a single user workplace requirement of this estimated size can be serviced in approximately 9 minutes. Therefore to service 50 customer's requests per day on a single shift basis will require 7 men in the user processing area on a 7-effective-hours-per-day basis.

10.6.2.4 Refiling Personnel Required

Since the amount of manpower necessary to retrieve items from the data base collection must also be matched by a similar amount of manpower to replace the items in the data base collection, it therefore follows that 7 men are required to return the materials to file after they have been returned from the user workplace.

10.6.2.5 Summary

It therefore follows that based on the assumptions outlined above, it is necessary that 14 men are required to carry out the user processing effort.

10.6.3 File Inventory

Based on the assumptions used in the user processing discussion above, two men will be required to maintain a log of the data base allocated to the user workplaces and to feed this information into the computer to keep

Table 43

ESTIMATED INDIVIDUAL REQUEST COMPOSITION

Storage Area Subdivision and Material Type		Quantity	
A.	CYLINDRICAL MATERIALS		
	1. Roll Film	16	
	2. Magnetic Tape	10	26
B.	SHEET MATERIALS		
	3. Maps	16	
	4. Overlays	16	
	5. Mosaics	2	
	6. Photographic Prints	25	59
C.	GENERAL LIBRARY MATERIALS		
	7. Target Folders 8. PI Keys 9. Other Library Materials	15	15
	Total		100

the material inventory up to date at all times.

10.6.4 Output Processing

Many of the operations in the input processing functions also must be carried out in the output processing function in that the material must be physically removed from the main data base store and placed into boxes for delivery to the shipping room. A control log must be maintained in order to allow the preparation of shipping paper work and to establish the ultimate destination of the items for inclusion into the computer memory to keep the material inventory up to date. It has been assumed that these functions can be handled by four men working on a normal 7-effective-hours-per-day.

10.6.5 Operations and Administration

The Hard-Copy Storage and Retrieval Officer will supervise the entire Graphic Materials Storage Area. It is estimated that he will need two men for general administrative work.

10.6.6 Summary

Tabulation of the manpower requirements of the various functions outlined above indicates that it will require 28 men on a single shift basis to service 50 user requests approximating the average of 100 items per user request spread over the various data base form configurations as described above.

SECTION ELEVEN. RECOMMENDATIONS

There are two principal recommendations which result from this study -- over and above the techniques, methods, equipments, and general layout synthesized for the system in Section Ten.

The first, and most important, recommendation is to undertake a study of the basic methods by which the intellectual content of this estimated collection of graphic materials may best be managed to yield a maximum return in photographic interpretation effectiveness. The present study, by design and stated intent has confined consideration of concept structure, of vocabulary, of indexing array to the very minimum consistent with its impact upon the physical methods of storage, retrieval, and handling of the graphic materials. The whole area of concepts, vocabulary, and indexing is most important if one is to make the use of this graphic materials collection meaningful. The study should consider two important areas: the first is the basic intellectual treatment, the second is the relationship of this intellectual treatment — expressed in a selected set of concepts, vocabulary, and indexing array, or arrays — in the form of external classification systems to be superimposed upon, and in detail, related to the physical array established in the present study.

The second recommendation relates to consideration of techniques of automation — as contradistinct from manual operation — in those areas of the system which have high volumes of materials having the least variety in physical form. Roll film, in the standing amount of 54,000 cans and a daily processing rate of 1, 400, constitutes the principal area where it is felt that automation would increase effectiveness and, in high demand situations, economy.

The form variation within the roll film collection is three different types/sizes, but one may observe in the systems synthesis that all three types/sizes may be accommodated by one carrier tray. Magnetic tape represents a collection similarly qualifying for this type of consideration. Among the balance of the graphic materials collection (e.g. maps, overlays, photographic prints, mosaics, and general library materials) the variety of types and sizes and the basic form of the materials themselves make consideration of automation less attractive. Thus roll film and magnetic tape are the two types of material for which consideration of automation techniques is recommended.

APPENDIX I

TERMINAL DIGIT FILING

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I-2	Terminal Digit Filing Showing Location of Two Consecutive Cans	375
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I-4	Properly Filed Roll Film	382
I-5	Improperly Filed Roll Film	383

A. GENERAL NATURE

The purpose of this appendix is to describe the application of a Terminal Digit Filing System to the storage areas for roll film and magnetic tape.

Film and tape cans present a special problem in the Graphic Materials Storage Area. The problem is twofold. On the one hand, it is anticipated there will be a high demand for individual cans of film within the warehouse for specific user applications. In addition, there is an input processing requirement of 300 cans per day coming into the storage system and an output processing requirement of 300 cans per day which must be eliminated from the storage system.

There is the further problem that these two functions must be performed simultaneously with the basic processing function which the Graphic Materials Storage Area is intended to perform: processing of user requests. Table 43, previously given, and related material in paragraph 10.6 establish an estimated daily use rate of 16 cans of roll film per request and 50 requests per day, or a total of 800 cans per day. Thus there will be movement of some 1,400 cans per day within the roll film storage area. Further, it is assumed that those roll film cans desired for reference will most probably be among the cans most recently acquired. Thus, if the store were organized in a straight numerical sequence manner, there would be a high probability of congestion caused by the simultaneous needs of input processing and user request processing; output processing alone would be reasonably unaffected, if the principal criterion for purging was obsolescence due to age.

The solution proposed to meet the potential congestion problem is known as terminal digit filing. In terminal digit filing, cans of film or magnetic tape are still assigned consecutive numbers as they arrive. However consecutive numbers are filed in completely different sections using a very strict structure. The purpose is to distribute cans which arrive at the same time evenly over a large file area so that if 100 cans out of the most recently arrived 300 were required, they would not all be found in the same file area but rather would be in 100 distinctly different locations.

Terminal digit filing works as follows: Each can has its own six-digit number. In normal filing, can number 65, 154 would be filed in the 65, 100 series of shelves, the second horizontal row and the eighth vertical column. Can 65, 155 would be filed in the 65, 100 series of shelves in the first horizontal row in the same vertical column. Thus, if two messengers were retrieving these two cans simultaneously, there would be potential congestion because the cans are located right next to each other on the shelves. (See Figure I-1).

Terminal digit filing, on the other hand, requires that a number be broken down into three sets of two digits each. 65,154 becomes 06-51-54. The two digits 54 are known as the terminal digits or primary digits. The two digits 51 are known as the secondary digits and the two digits 06 are known as the final digits. In terminal digit filing, items are filed by the last two digits rather than by the first two digits as in standard filing. Thus, as illustrated in Figure I-2, 06-51-54 would be located in the 06 horizontal row (actually the seventh physically, since the first is labeled 00) of the 51st vertical column

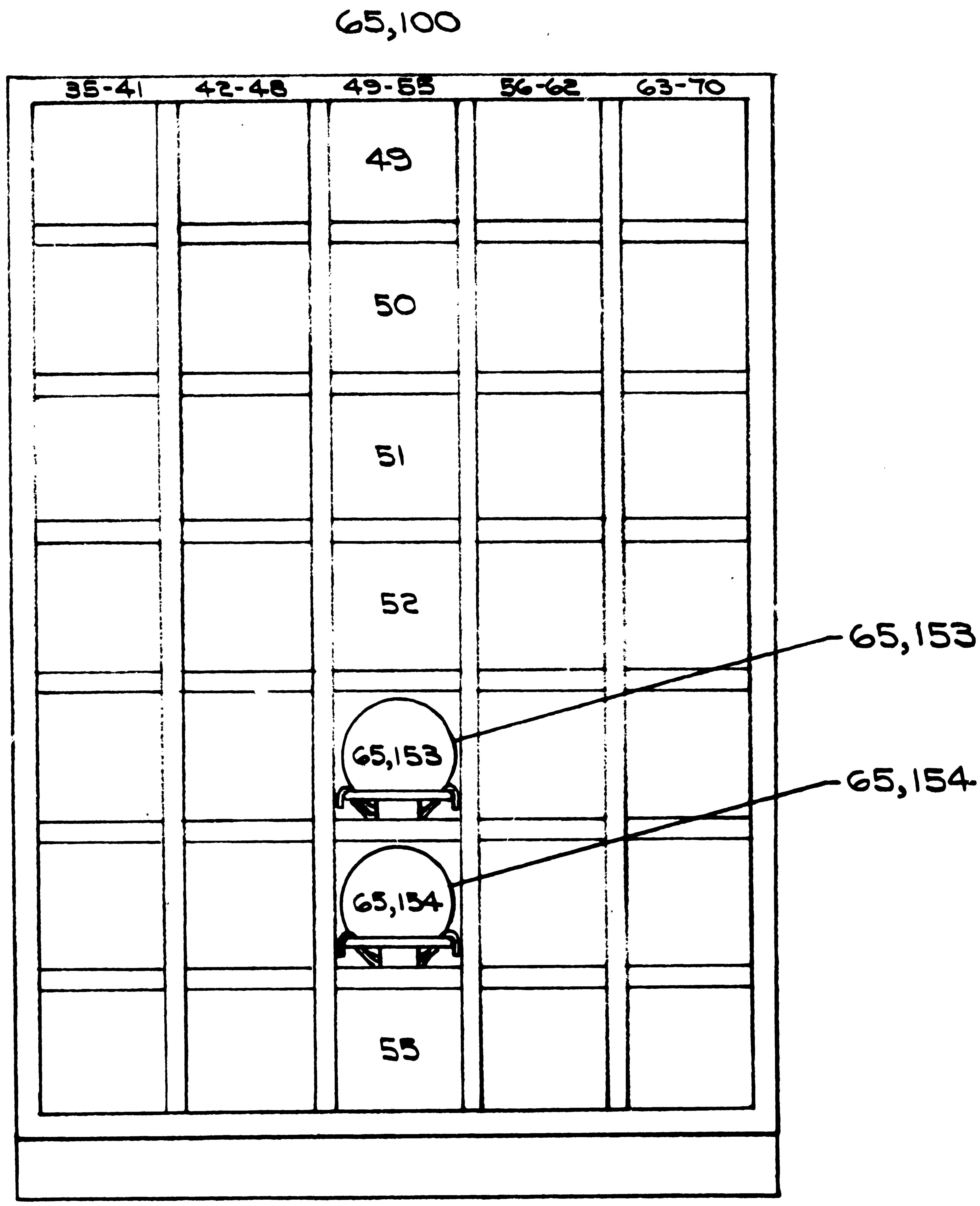

FIGURE I-1

STANDARD FILING

SHOWING LOCATION OF 2 CONSECUTIVE CANS

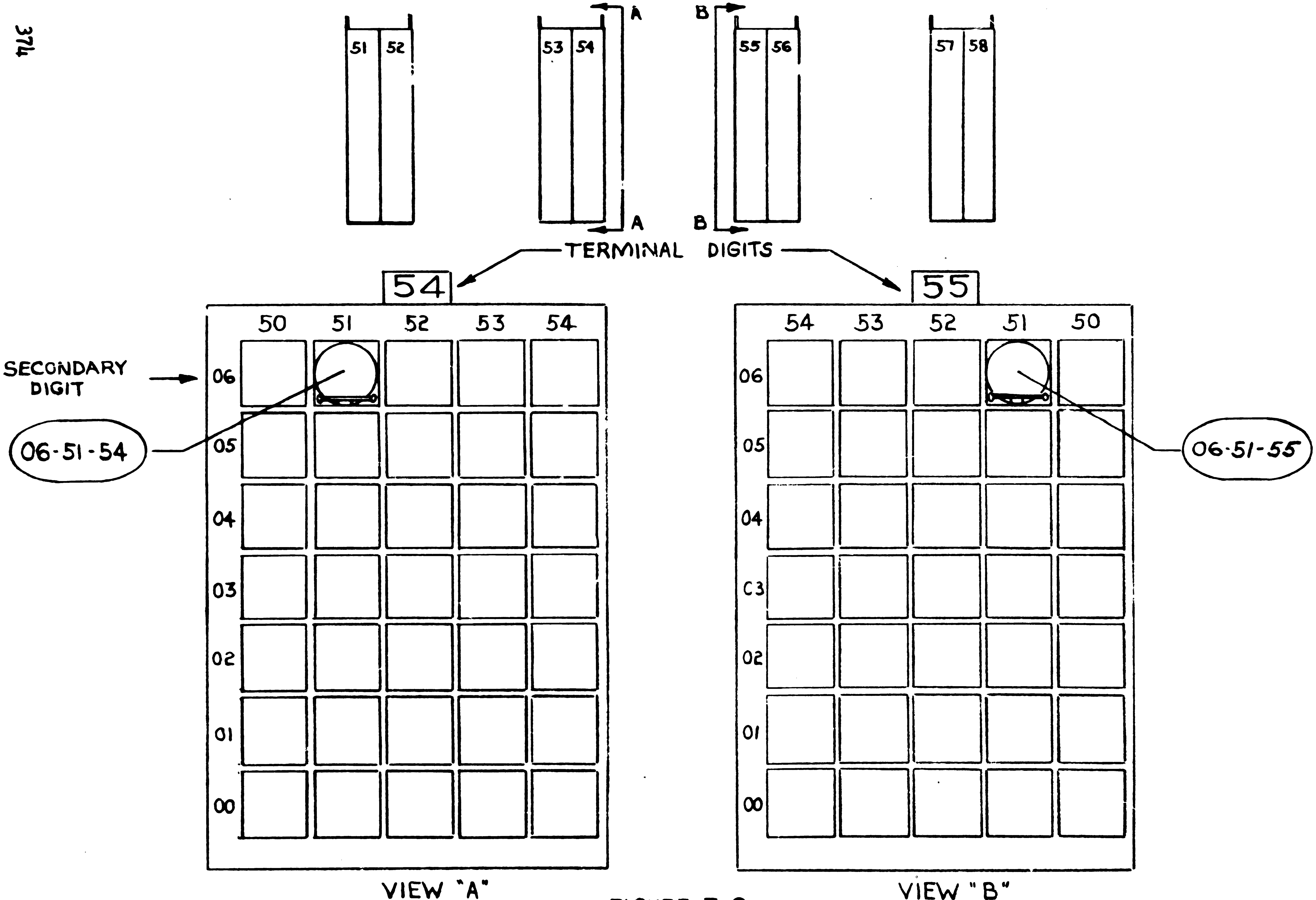

FIGURE I-2

TERMINAL DIGIT FILING

SHOWING LOCATION OF 2 CONSECUTIVE CANS

of the 54th bank of files. 06-51-55 (65, 155) would be located in the 06 horizontal row of the 51st vertical row of the 55th bank of files. Despite the fact that these numbers were assigned to two cans which arrived one after the other, the cans are now physically located in two distinct locations: the 54 (terminal digit) bank of files and the 55 (terminal digit) bank of files.

In terminal digit filing, the first breakdown is into 100 separate sections (which may or may not be physically separate) which are used for filing by terminal digit. These sections are numbered 00, 01, 02...54, 55,...99. Each of the 100 terminal digit sections is in turn broken down into 100 secondary-digit sections which are also numbered from 000...51 ...99. These secondary-digit sections take the form of vertical rows and secondary digit numbers appear over each vertical row of film cans. The final digit section takes the form of horizontal rows within each terminal digit section. To go back to our original example, since the shelves are going to handle 70,000 cans of film, this will require seven horizontal final-digit rows labeled 00 through 06.

B. ADVANTAGES

There are four main advantages to terminal digit filing. One, each of the 100 terminal digit sections expands uniformly. Each time 100 cans arrive at the Reconnaissance Technical Squadron, there will be one new can for each terminal digit group since there is only one can whose terminal digits are 00 — one can 01 — one can 02, etc. Two, the heavy transfer of cans to secondary storage is eliminated. If, for example, 300 cans per day are to be removed from mail storage and transferred to secondary storage, it is possible that three cans can easily be taken out of each of the 100 terminal digit sections in the normal course of a day's work in contrast to the problems of congestion which might arise when attempting to remove 399 cans from one bank of shelves if standard filing were to be used. Three, if individual people were to be assigned responsibility for individual sections of the film storage area, retrieval and refiling would be evenly distributed among the file personnel because the average use of cans from all sections of the file would be approximately the same. Four, misfiles are reduced when returning cans to their proper storage location. This is because the personnel returning cans are only required to keep two digits in their heads at one time.

C. DISADVANTAGES

There is one criticism that can be made of terminal digit filing. If, for example, four rolls of film were flown on the same mission, it would be less convenient for a runner to retrieve these from four separate terminal digit sections than from a single location where film cans might be kept together by mission. It is possible, however, to keep a set of film cans in one physical location if these cans are likely to be required at the same time. This is done by assigning to the four cans (from the same mission) numbers which are 100 digits apart. Normally, cans 06-51-54 and 06-51-55 would be filed in two physically separate sections. If, however, these cans both pertain to the same mission and it was desired to keep them physically together, it would be a simple matter to assign them numbers of 06-51-54 and 06-52-54. This would place these two cans in the same terminal digit section in the same horizontal row, separated by one vertical row.

This method would only be used for the 2, 3 or 4 cans which might go together by virtue of being flown on the same mission. The next mission set of 2, 3 or 4 cans would be assigned the next consecutive number (e.g., 06-51-55) and would be placed in a separate physical area. Control and recording of material storage address number could be accomplished by the computer.

Similarly, if terminal digit filing were not desired, the computer could be used to load the physical storage matrix up evenly even with a monotonically increasing set of material storage addresses.

D. <u>COLOR CODING</u>

One of the most common causes of misfiling is the mental transposition of numbers. In actual practice this might result in can number 06-51-54 being mentally thought of as can 06-15-54. This transposition of numbers is more likely to occur in the actual misfiling of a can than by raising or lowering one number (e.g. can 06-51-54 being filed where can 06-52-54 belongs). It is suggested that color coding be used to help prevent this common cause of misfiling. Ten colors would be used in this system. The numbers which would be coded would be the second number of the secondary digit of each six-digit number. Number 06-51-54 has assigned to it a color which is assigned to the "1" in 51. Can 06-52-54 has assigned to it the color which is assigned to the digit "2" in 52.

The advantage of color coding on the second number of the secondary digit is that all cans in the same vertical column have a common color. Thus, should a can be placed one column to the left or one column to the right of where it actually belongs, the color would make it stand out from the rest of the cans in this column. In order to make the vertical columns stand out even more, it is proposed that the colors of adjacent vertical columns be alternated, one column being light colored and the next column being dark colored, etc. The effectiveness of this approach is revealed even in a black and white photograph, Figure I-3, which illustrates graphically the 06-51-54 and neighboring cans case. A possible set of ten colors in this kind of order is

Second Number of Secondary Digit	Color
0	Red
1	Yellow
2	Dark Green
3	Orange
4	Blue
5	Gold
6	Brown
7	Light Green
8	Purple
9	White

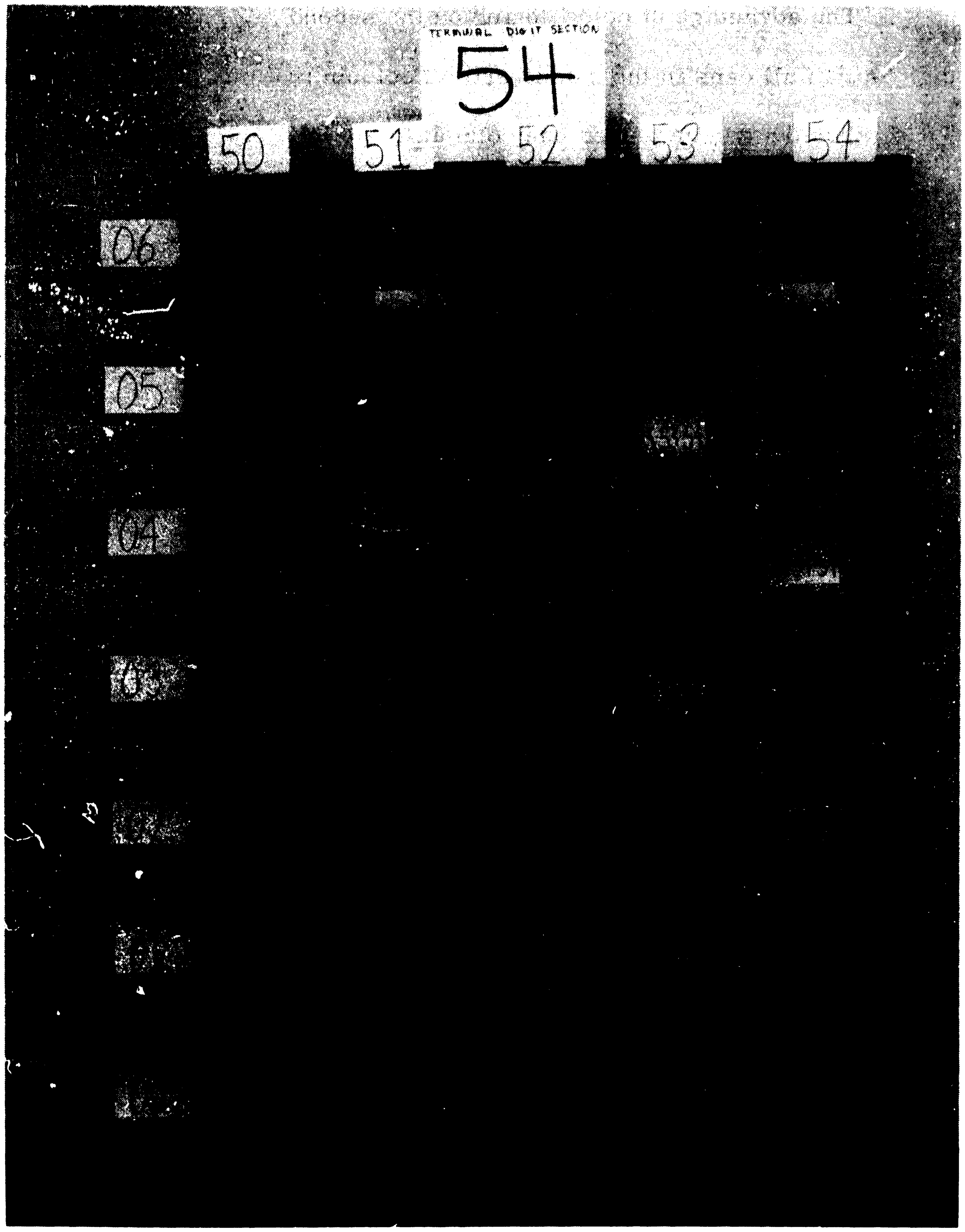

Fig. I-3 Terminal Digit Filing of Roll Film

For testing purposes a small hand labelmaker was used to emboss rasied 1/8-inch high letters on different colored tapes. Some models of these machines are available which will produce 1/4-inch high letters on colored tapes. The tests were run using the 1/8-inch high letters on 1/4-inch high x 2-inch long tape. Although the numbers themselves could not be read until a subject was approximately 5 feet from the film can on which they were placed, the colored background of the tapes can be easily distinguished at a distance of some 30 feet. There was no difficulty encountered at this distance in determining that a film can had been shifted one horizontal row to the left or right because the background color of the label stood out clearly when, for example, a dark-green -labeled can appeared in a row of yellow-labeled cans. Figures I-4 and I-5 illustrate a proper filing arrangement and a misfiling arrangement. The contrast between the label color for the properly filed 06-51-54 can and the improperly filed 06-54-54 can is slight in the black-and-white prints, but is clearly evident in color.

E. SUPPLEMENTARY CONSIDERATIONS

As an additional aid to refiling and inventory control of roll film, it is suggested that each cubile be numbered on the back wall in 3-inch high letters (see Figure I-3, previously presented). This, in conjunction with color coding, will serve to identify which cans belong in which cubicles, as well as showing at a quick glance the specific numbers of those cans of roll film which are out of store.

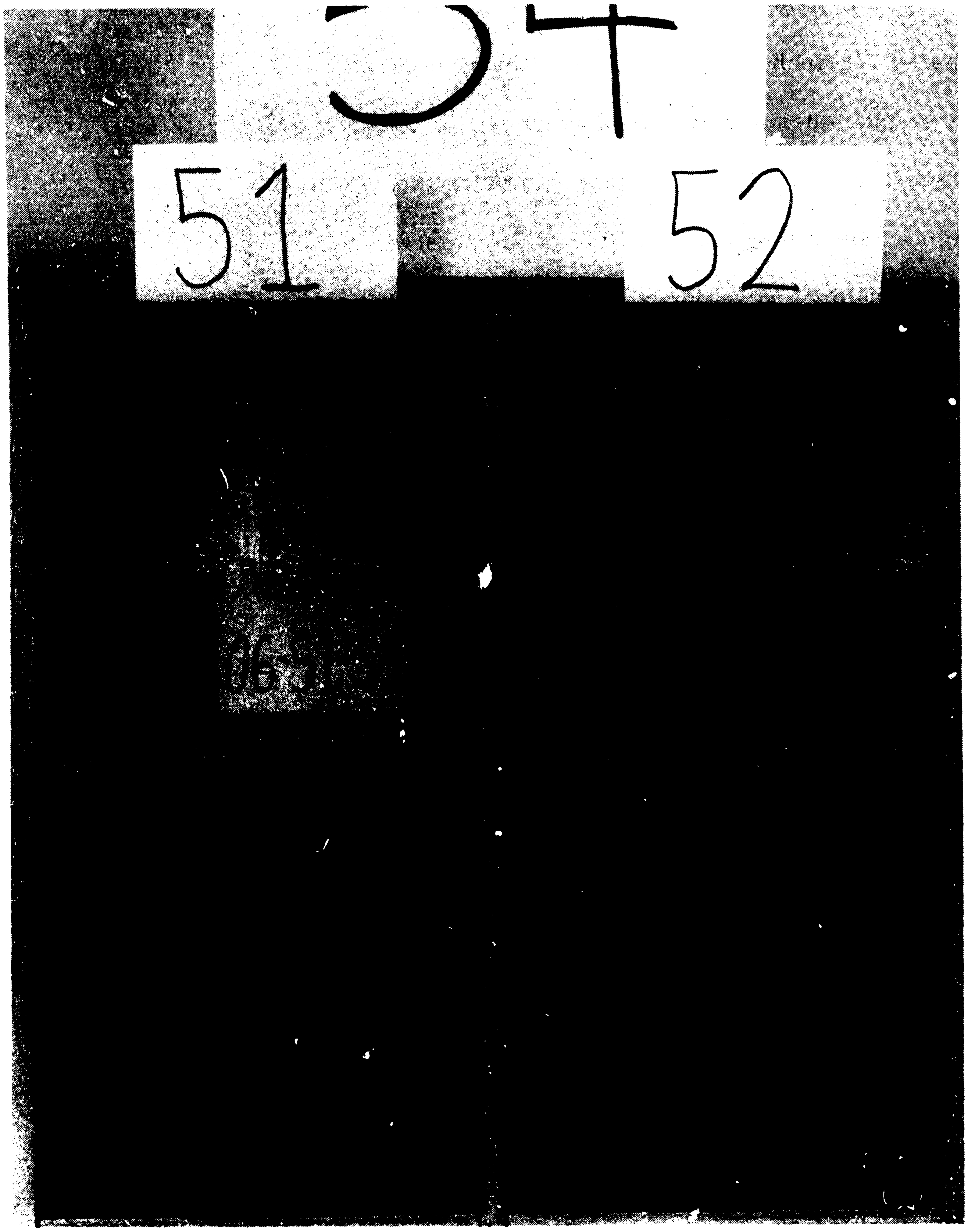

Fig. I-4 Properly Filed Roll Film

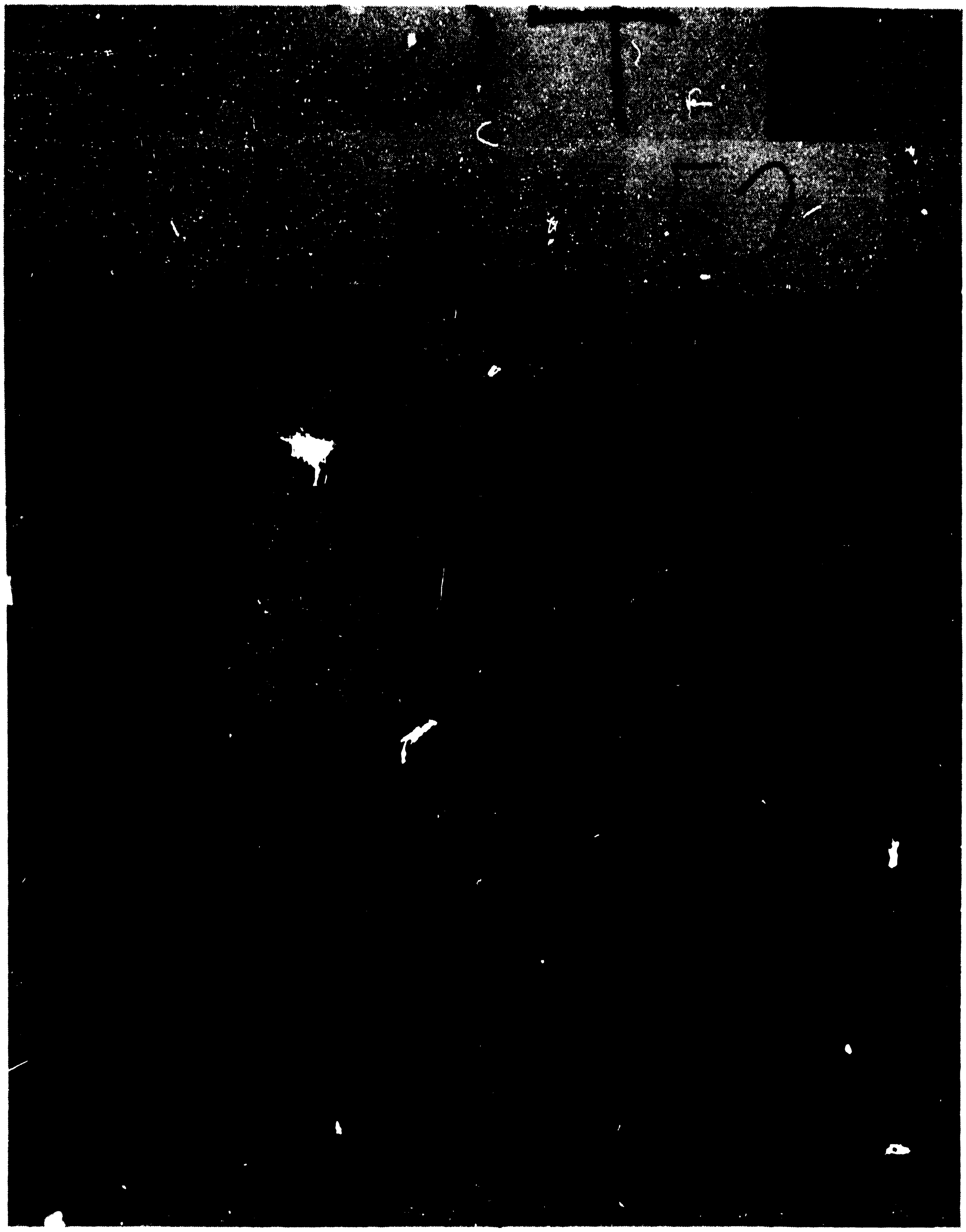

Fig. I-5 Improperly Filed Roll Film

It is important to point out that the same material storage address numbers are continually re-used. When a group of cans becomes transferred to the secondary storage location, the material storage address numbers used by these cans become available for re-assignment. This system eliminates the need for reshuffling the numerical listings over vertical rows, horizontal rows or entire terminal digit sections. It is the function of the can storage warehouse to retrieve a can which has a particular material storage address number. It is of no particular concern to the people retrieving this can what kinds of information are on the film contained within the can. Rather, it must be assumed that the personnel ordering this particular can knew what its content was and are just ordering by material storage address number.

The significant point to be made about this particular numbering system is that the material storage address number serves as a specific position locator. Again using 06-51-54 as an example, 54 means that one must physically go to the 54 terminal digit section; 51 means that within this terminal digit section the 51 st vertical column must be located; 06 means that within this 51st vertical column, the 06 horizontal row must be located. At this point, one is at the exact location of a can. It is not necessary to translate this number into another type of information in order to lead specifically to the file.

This terminal digit filing system allows unlimited expansion using essentially the same numbering system and principle. If, for example, the collection were to double to 140,000 cans of film(from 70,000), the only requirement would be to set up an entire new bank of files of the same size. The files would have the same 100 terminal digits as used previously (00. . . 99); would have the same 100 secondary digits as used previously (00. . . 99); but would have a new series of final digits which would now run from 07 through 13. The same filing system as described previously would be used. For example, if can 135, 154, or in terminal-digit fashion 13-51-54, were to be located, it would be known that any group of cans whose final digits (13 in this case) were 07 through 13 would be in Zone 2, whereas any cans whose final digits were the 00 through 06 would be in Zone 1. Can 13-51-54 would therefore be in Zone 2, in the 54th terminal digit section, 51st column, while can 03-51-54 would be in Zone 1 in terminal digit section 54, 51st column.

To summarize, this particular system of terminal digit filing permits uniform file expansion, less congestion in a given file area when consecutive numbers of a given group are being retrieved, plus the advantage of the numbers specifically the actual storage position.

APPENDIX II

CATALOG
OF
EQUIPMENT MANUFACTURERS

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A. MANUFACTURERS

The following is an alphabetical listing of all manufacturers who responded to Information Dynamics Corporation's requests for information on their products:

1.	Accoway Division, Acco Products	Ogdensburg, New York
2.	Acme Letter File Corp.	New York 13, New York
3.	Acme Visible Records, Inc.	Crozet, Virginia
4.	Acorn Products Co.	Franklin Park, Illinois
5.	Adler Metal Products Corp.	St. Louis, Missouri
6.	Aigner Index Co.	Long Island City, New York
7.	All-Steel Equipment, Inc.	Aurora, Illinois
8.	Alvin & Co., Inc.	Windsor, Connecticut
9.	American Metal Products Corp.	St. Louis 8, Missouri
10.	Angle Steel Incorporated	Plainwell, Michigan
11.	Art Metal, Inc.	Jamestown, New York
12.	Art Steel Co.	New York, New York
13.	Atlas Stencil Files Corp.	Cleveland 10, Ohio
14.	Automatic Transportation Co.	Chicago 20, Illinois
15.	Bankers Box Co.	Franklin Park, Illinois
16.	Barrett-Cravens Co.	Northbrook, Illinois
17.	Barricks Mfg. Co.	Chicago 9, Illinois
18.	Bentson Mfg. Co.	Aurora, Illinois
19.	Borroughs Mfg. Co.	Kalamazoo, Michigan
20.	Bostitch	East Greenwich, R. I.

21.	Brodie Industrial Trucks	Woburn, Massachusetts
22.	Brooks & Perkins, Inc.	Detroit 16, Michigan
23.	Brown (Arthur) & Bro., Inc.	New York 36, New York
24.	Brown (M.) & Co., Inc.	Boston 20, Massachusetts
25.	Browne-Morse Co.	Muskegon, Michigan
26.	Brush (John D.) & Co., Inc.	Rochester 11, New York
27.	Buchan Loose Leaf Records Co.	Clifton Heights, Pa.
28.	Can-Pro Corp.	Fond du Lac, Wisconsin
29.	Catskill Craftsmen, Inc.	New York 22, New York
30.	Cel-u-dex Corp.	New Windsor (Newburgh), N. Y.
31.	Charnstrom (W. A.) Co.	Minneapolis 15, Minnesota
32.	Chesley Industries, Inc.	Farmington, Michigan
33.	Cole-Steel Equipment Co.	New York, New York
34.	Colight, Inc.	Minneapolis 1, Minnesota
35.	Colson Corp.	Chicago 3, Illinois
36.	Columbia Office Furniture	Philadelphia, Pennsylvania
37.	Convoy, Inc., Lennox Distributors Division	Canton 6, Ohio
38.	Cooks , Inc.	Blackwood, New Jersey
39.	Cotterman (I. D.)	Naperville, Illinois
40.	Dancer Stikfile Co.	Houston 18, Texas
41.	DeLuxe Metal Products Co.	New York, New York
42.	Dolin Metal Products, Inc.	Brooklyn 16, New York
43.	Durable Metal Products	Long Island City, New York

44.	Durham Mfg. Co.	Durham, Connecticut
45.	Equipto Co.	Aurora, Illinois
46.	Filing Systems	Salt Lake City 11, Utah
47.	Fortress, Inc.	Baldwin Park, California
48.	Franklin File, Inc.	Loretto, Minnesota
49.	General Fireproofing Co.	Youngstown 1, Ohio
50.	Gillotte (R. P.) Co., Inc.	Columbia, South Carolina
51.	Globe-Wernicke Co.	Cincinnati 12, Ohio
52.	Graff (George B.) Co.	Cambridge 40, Massachusetts
53.	Graphic Systems	Yanceyville, North Carolina
54.	Hall (Gordon L.) Co., Inc.	Greenwich, Connecticut
55.	Hamilton Caster and Mfg. Co.	Hamilton, Ohio
56.	Hamilton Mfg. Co.	Two Rivers, Wisconsin
57.	Harris-Seybold Co.	Boston 10, Mass.
58.	Haskell, Inc.	Pittsburgh 6, Pennsylvania
59.	Hobart Cabinet Co.	Troy, Ohio
60.	Holga Metal Production Co.	Van Nuys, California
61.	H-O-N Company	Muscatine, Iowa
62.	Hubbell (H. L.) Mfg. Co.	Zeeland, Michigan
63.	Interior Steel Equipment Co.	Cleveland 4, Ohio

64.	International Loose Leaf Co. Div. of Capital Industries, Inc.	New York 5, New York
65.	Invincible Metal Furniture Co.	Manitowoc, Wisconsin
66.	Jayem Sales Corp.	New York 1, New York
67.	K - C Metal Products Co., Inc.	Brooklyn 21, New York
68.	Kay-Dee Co.	Lincoln, Nebraska
69.	Keyless Lock Co.	Indianapolis, Indiana
70.	Langley Handling Equipment	Cambridge 41, Massachusetts
71.	Lewbill Industries, Inc.	Scottdale, Pennsylvania
72.	Little Giant Products, Inc.	Peoria, Illinois
73.	Lyon Metal Products	Aurora, Illinois
74.	Magnetic Aids, Inc.	New York 36, New York
75.	Mason & Mueller, Inc.	West Orange, New Jersey
76.	Mayline Co., Inc.	Sheboygan, Wisconsin
77.	Meilink Steel Safe Co.	Toledo 6, Ohio
78.	Memo Flex Division	Dayton 4, Ohio
79.	Metalstand Co.	Philadelphia 15, Pa.
80.	Methods Research Corp.	Staten Island 5, New York
81.	Modern Steel Equipment Co.	Philadelphia 35, Pa.
82.	Momar Industries, Inc.	Chicago 41, Illinois
83.	Monarch Metal Products	New Windsor (Newburgh), N. Y.
84.	Mosler Safe Co. Systems Division	Hamilton, Ohio

85.	Multiplex Display Fixture Co.	St. Louis 7, Missouri
86.	Murphy Mfg. Co.	Louisville 2, Kentucky
87.	National Box and Can Company	Cleveland 4, Ohio
88.	Nega-File Co.	Furlong, Pennsylvania
89.	Northwest Metal Products Co.	Green Bay, Wisconsin
90.	Office Products, Inc.	Detroit, Michigan
91.	Oxford Filing Supply Co., Inc.	Garden City, L. I., New York
92.	Paige Co., Inc.	New York 16, New York
93.	Parent Metal Products, Inc.	Philadelphia 35, Pa.
94.	Parker Steel Products, Inc.	Brooklyn, New York
95.	Plan Hold Corporation	South Gate, California
96.	Pollard Bros. Mfg. Co.	Chicago, Illinois
97.	Posting Equipment Corp.	Buffalo 7, New York
98.	Precision Equipment Co.	Chicago, Illinois
99.	Prevue-Radsell Co.	Chicago 6, Illinois
100.	Pryor Marking Products	Chicago 5, Illinois
101.	Rand McNally & Co.	New York 11, New York
102.	Raymond Corp.	Greene, New York
103.	Record Files, Inc.	Wooster, Ohio
104.	Remington Rand, Div. of Sperry Rand Corp.	New York City, New York
105.	Republic Steel Corp., Mfg. Division	Youngstown 5, Ohio

106.	Robles Packaging Corp.	Mount Vernon, New York
107.	Roll & File Systems, Inc.	Detroit 5, Michigan
108.	Ross-Martin Co.	Tulsa 1, Oklahoma
109.	Royalmetal Corp.	New York 16, New York
110.	Rubbermaid, Inc.	Wooster, Ohio
111.	Schwab Safe Co., Inc.	Lafayette, Indiana
112.	Scott-Rice Co.	Tulsa, Oklahoma
113.	Sengbusch Self-Closing Inkstand Co.	Milwaukee 3, Wisconsin
114.	Shampaine Co.	St. Louis, Missouri
115.	Shaw-Walker Co.	Muskegon, Michigan
116.	Shwayder Bros.,Inc.	Detroit 29, Michigan
117.	SICO, Inc.	Minneapolis 24, Minnesota
118.	Skarnes, Inc.	Minneapolis 6, Minnesota
119.	Smead Mfg. Co.	Hastings, Minnesota
120.	Stacor Corp.	Newark14, New Jersey
121.	Staplex Co.	Brooklyn 32, New York
122.	Steel Fixture Mfg. Co.	Topeka, Kansas
123.	Steel Parts Mfg. Co., Div. of Blackstone Mfg. Co.	Chicago 44, Illinois
124.	Steelcase, Inc.	Grand Rapids, Michigan
125.	Steward (Wm. A.) Co., Rol-a-Chart Division	Mill Valley, California
126.	Strayer Coin Bag Co., Inc.	New Brighton, Pennsylvania
127.	Supreme Steel Equipment Corp.	Brooklyn 32, New York
128.	Systems Mfg. Corp,	Binghamton, New York

129.	TAB Products Co.	San Francisco 11, California
130.	Tiffany Stand Co.	St. Louis 5, Missouri
131.	Towmotor Corp.	Cleveland 12, Ohio
132.	Ulrich Planfiling Equipment Corp.	Jamestown, New York
133.	Union Steel Chest Corp.	Le Roy, New York
134.	Victor Safe & Equipment, Remington Rand Office Systems, Div. of Spe[illegible] Rand Corp.	New York 17, New York
135.	Vidmar, Inc.	Williamsport, Pennsylvania
136.	Visible File Corp.	New York 1, New York
137.	VISIrecord, Inc.	Long Island, New York
138.	Visi-Shelf File, Inc.	New York 7, New York
139.	Vue-Fax Division, Logan Business Products, Inc.	Westbury, New York
140.	Wassell Organization, Inc.	Westport, Connecticut
141.	Watson Mfg. Co., Rol-dex Division	Jamestown, New York
142.	Welham Metal Products Co., Inc.	Michigan City, Indiana
143.	Western Devices, Inc.	Burbank, California
144.	Western Manufacturing Co.	Aurora, Illinois
145.	Wetzel (P. A.) & Son	Chicago, Illinois
146.	Wheeldex & Simpla Products, Inc.	Peekskill, New York
147.	Wilder Mfg. Co., Inc.	Port Jervis, New York
148.	Williams Moduplan Office Furniture Corp.	New York 10, New York

149.	Wolf X-Ray Products, Inc.	Brooklyn, New York
150.	Work-Organizer Specialties Co.	Detroit 9, Michigan
151.	Wright-Line, Division of Barry Wright Corp.	Worcester 6, Massachusetts
152.	Yawman & Erbe Mfg. Co.	Rochester 3, New York

B. FILING EQUIPMENT

The following is an alphabetical list of filing equipment manufacturers arranged by ty[illegible].

1. Electrical File Units

1.1	Mosler Safe Co. Systems Division	Hamilton, Ohio
1.2	Rand McNally & Co.	New York 11, New York
1.3	Remington Rand, Div. of Sperry Rand Corp.	New York City, New York
1.4	Wheeldex & Simpla Products, Inc.	Peekskill, New York

2. Hanging Drawing Files

2.1	Accoway Division, Acco Products	Ogdensburg, New York
2.2	Art Metal, Inc.	Jamestown, New York
2.3	Art Steel Co.	New York, New York
2.4	Atlas Stencil Files Corp.	Cleveland 10, Ohio
2.5	Brown (Arthur) & Bro., Inc.	New York 36, New York
2.6	Brown (M.) & Co., Inc.	Boston 20, Massachusetts
2.7	Dancer Stikfile Co.	Houston 18, Texas
2.8	Gillotte (R. P.) Co., Inc.	Columbia, South Carolina
2.9	Globe-Wernicke Co.	Cincinnati 12, Ohio
2.10	Hamilton Mfg. Co.	Two Rivers, Wisconsin
2.11	Lewbill Industries, Inc.	Scottdale, Pennsylvania
2.12	Momar Industries, Inc.	Chicago 41, Illinois
2.13	Plan Hold Corporation	South Gate, California

3. <u>Horizontal Drawer Files and Card Cabinets</u>

3.1	All-Steel Equipment, Inc.	Aurora, Illinois
3.2	Alvin & Co., Inc.	Windsor, Connecticut
3.3	Brown (Arthur) & Bro., Inc.	New York 36, New York
3.4	Cole-Steel Equipment Co.	New York, New York
3.5	Colight, Inc.	Minneapolis 1, Minnesota
3.6	Hamilton Mfg. Co.	Two Rivers, Wisconsin
3.7	Hobart Cabinet Co.	Troy, Ohio
3.8	Interior Steel Equipment Co.	Cleveland 4, Ohio
3.9	Lyon Metal Products	Aurora, Illinois
3.10	Mayline Co., Inc.	Sheboygan, Wisconsin
3.11	Parent Metal Products, Inc.	Philadelphia 35, Pennsylvania
3.12	Stacor Corp.	Newark 14, New Jersey
3.13	Steel Fixture Mfg. Co.	Topeka, Kansas

4. <u>Mobile Files</u>

4.1	Dolin Metal Products, Inc.	Brooklyn 16, New York

5. <u>Negative Files</u>

5.1	Nega-File Co.	Furlong, Pennsylvania
5.2	Wolf X-Ray Products, Inc.	Brooklyn, New York

6. <u>Open Shelf Files</u>

6.1	Art Metal, Inc.	Jamestown, New York
6.2	Borroughs Mfg. Co.	Kalamazoo, Michigan
6.3	DeLuxe Metal Products Co.	New York 16, New York
6.4	Equipto Co.	Aurora, Illinois
6.5	Holga Metal Production Co.	Van Nuys, California

Open Shelf Files (continued)

6.6	Interior Steel Equipment Co.	Cleveland 4, Ohio
6.7	Lyon Metal Products	Aurora, Illinois
6.8	Monarch Metal Products	New Windsor (Newburgh), N. Y.
6.9	Precision Equipment Co.	Chicago, Illinois
6.10	Record Files, Inc.	Wooster, Ohio
6.11	Steel Fixture Mfg. Co.	Topeka, Kansas
6.12	Supreme Steel Equipment Corp.	Brooklyn 32, New York
6.13	TAB Products Co.	San Francisco 11, California
6.14	Visi-Shelf File, Inc.	New York 7, New York
6.15	Wassell Organization, Inc.	Westport, Connecticut
6.16	Wheeldex & Simpla Products, Inc.	Peekskill, New York
6.17	Yawman & Erbe Mfg. Co., Inc.	Rochester 3, New York

7. Reel Storage

7.1	Monarch Metal Products	New Windsor (Newburgh). N. Y.

8. Rolled Drawing Files

8.1	Borroughs Mfg. Co.	Kalamazoo, Michigan
8.2	Brown (Arthur) & Bro., Inc.	New York 36, New York
8.3	Filing Systems	Salt Lake City 11, Utah
8.4	Hamilton Mfg. Co.	Two Rivers, Wisconsin
8.5	Plan Hold Corporation	South Gate, California
8.6	Roll & File Systems, Inc.	Detroit 5, Michigan

Rolled Drawing Files (continued)

8.7	Ross-Martin Co.	Tulsa, Oklahoma
8.8	Scott-Rice Company	Tulsa, Oklahoma
8.9	Stacor Corp.	Newark 14, New Jersey

9. Shelf and Bin Files

9.1	Angle Steel Incorporated	Plainwell, Michigan
9.2	Borroughs Mfg. Co.	Kalamazoo, Michigan
9.3	Brown (M.) & Co., Inc.	Boston 20, Mass.
9.4	Cole-Steel Equipment Co.	New York, New York
9.5	DeLuxe Metal Products Co.	New York 16, New York
9.6	Dolin Metal Products, Inc.	Brooklyn 16, New York
9.7	Durham Mfg. Co.	Durham, Connecticut
9.8	Equipto Co.	Aurora, Illinois
9.9	Interior Steel Equipment Co.	Cleveland 4, Ohio
9.10	Lyon Metal Products	Aurora, Illinois
9.11	Monarch Metal Products	New Windsor (Newburgh), N. Y.
9.12	Shampaine Co.	St. Louis, Missouri
9.13	Steel Fixture Mfg. Co.	Topeka, Kansas

10. Trays/Tubs and Magnetic Tub Files

10.1	Art Steel Co.	New York, New York
10.2	Brown (M.) & Co.	Boston 20, Massachusetts
10.3	Cole-Steel Equipment Co.	New York, New York
10.4	Jayem Sales Corp.	New York 1, New York
10.5	Monarch Metal Products	New Windsor (Newburgh), N. Y.

Trays/Tubs and Magnetic Tub Files (continued)

10.6	Posting Equipment Corp.	Buffalo 7, New York
10.7	Precision Equipment Corp.	Chicago, Illinois
10.8	Shaw-Walker Co.	Muskegon, Michigan
10.9	Watson Mfg. Co., Rol-dex Division	Jamestown, New York

11. Vertical Drawer Files and Card Cabinets

11.1	Acorn Products Co.	Franklin Park, Illinois
11.2	Adler Metal Products Corp.	St. Louis, Missouri
11.3	All-Steel Equipment, Inc.	Aurora, Illinois
11.4	Alvin & Co., Inc.	Windsor, Connecticut
11.5	American Metal Products Corp.	St. Louis 8, Missouri
11.6	Art Metal, Inc.	Jamestown, New York
11.7	Art Steel Co.	New York, New York
11.8	Bentson Mfg. Co.	Aurora, Illinois
11.9	Brown (Arthur) & Bro., Inc.	New York 36, New York
11.10	Brown (M.) & Co.	Boston 20, Massachusetts
11.11	Browne-Morse Co.	Muskegon, Michigan
11.12	Cole-Steel Equipment Co.	New York, New York
11.13	Colight, Inc.	Minneapolis 1, Minnesota
11.14	Columbia Office Furniture	Philadelphia, Pennsylvania
11.15	Durable Metal Products	Long Island City, New York
11.16	Equipto Co.	Aurora, Illinois
11.17	Fortress, Inc.	Baldwin Park, California
11.18	General Fireproofing Co.	Youngstown 1, Ohio

Vertical Drawer Files and Card Cabinets (continued)

11.19	Hamilton Mfg. Co.	Two Rivers, Wisconsin
11.20	Haskell, Inc.	Pittsburgh 6, Pennsylvania
11.21	Hobart Cabinet Co.	Troy, Ohio
11.22	Holga Metal Production Co.	Van Nuys, California
11.23	H-O-N Company	Muscatine, Iowa
11.24	Hubbell (H. L.) Mfg. Co.	Zeeland, Michigan
11.25	Interior Steel Equipment Co.	Cleveland 4, Ohio
11.26	Invincible Metal Furniture Co.	Manitowoc, Wisconsin
11.27	Jayem Sales Corporation	New York 1, New York
11.28	K - C Metal Products Co., Inc.	Brooklyn 21, New York
11.29	Lyon Metal Products	Aurora, Illinois
11.30	Mayline Co.	Sheboygan, Wisconsin
11.31	Meilink Steel Safe Co.	Toledo 6, Ohio
11.32	Metalstand Co.	Philadelphia 15, Pennsylvania
11.33	Modern Steel Equipment Co.	Philadelphia 35, Pennsylvania
11.34	Monarch Metal Products	New Windsor (Newburgh), N. Y.
11.35	Murphy Mfg. Co.	Louisville 2, Kentucky
11.36	National Box and Can Co.	Cleveland 4, Ohio
11.37	Northwest Metal Products Co.	Green Bay, Wisconsin
11.38	Oxford Filing Supply Co., Inc.	Garden City, L. I., New York
11.39	Parent Metal Products, Inc.	Philadelphia 35, Pa.
11.40	Precision Equipment Co.	Chicago, Illinois
11.41	Record Files, Inc.	Wooster, Ohio
11.42	Ross-Martin Co.	Tulsa 1, Oklahoma
11.43	Shaw-Walker Co.	Muskegon, Michigan

Vertical Drawer Files and Card Cabinets (continued)

11.44	Stacor Corp.	Newark 14, New Jersey
11.45	Steel Fixture Mfg. Co.	Topeka, Kansas
11.46	Steelcase, Inc.	Grand Rapids, Michigan
11.47	Strayer Coin Bag Co., Inc.	New Brighton, Pennsylvania
11.48	Victor Safe & Equipment, Remington Rand Office Systems, Div. of Sperry Rand Corp.	New York 17, New York
11.49	Welham Metal Products Co.	Michigan City, Indiana
11.50	Western Manufacturing Co.	Aurora, Illinois
11.51	Wetzel (P. A.) & Son	Chicago, Illinois
11.52	Wolf X-Ray Products, Inc.	Brooklyn, New York

12. Vertical (Hardboard) Files

12.1	Art Metal, Inc.	Jamestown, New York
12.2	DeLuxe Metal Products Co.	New York, New York
12.3	Hamilton Mfg. Co.	Two Rivers, Wisconsin
12.4	Holga Metal Production Co.	Van Nuys, California
12.5	Monarch Metal Products	New Windsor (Newburgh) N. Y.
12.6	Steel Fixture Mfg. Co.	Topeka, Kansas
12.7	Wolf X-Ray Products, Inc.	Brooklyn, New York

13. Visible Files

13.1	Acme Visible Records, Inc.	Crozet, Virginia
13.2	Art Metal, Inc.	Jamestown, New York
13.3	Art Steel Co.	New York, New York
13.4	Brown (M.) & Co., Inc.	Boston 20, Massachusetts
13.5	Graphic Systems	Yanceyville, North Carolina
13.6	Jayem Sales Corp.	New York 1, New York

Visible Files (continued)

13.7	Magnetic Aids, Inc.	New York, New York
13.8	Memo Flex Division	Dayton 4, Ohio
13.9	Methods Research Corp.	Staten Island 5, New York
13.10	Multiplex Display Fixture Co.	St. Louis 7, Missouri
13.11	Pryor Marking Products	Chicago 5, Illinois
13.12	Robles Packaging Corp.	Mount Vernon, New York
13.13	Steward (Wm. A.) Co., Rol-a-Chart Division	Mill Valley, California
13.14	Victor Safe & Equipment, Remington Rand Systems, Div. of Sperry Rand Corp.	New York 17, New York
13.15	Visible File Corp.	New York 1, New York
13.16	VISIrecord, Inc.	Long Island, New York
13.17	Vue-Fax Division, Logan Business Products, Inc.	Westbury, New York

C. SUPPORT EQUIPMENT

The following is an alphabetical list of support equipment manufacturers arranged by type.

1. Benches

1.1	Brown (M.) & Co., Inc.	Boston 20, Massachusetts
1.2	Equipto Co.	Aurora, Illinois
1.3	Hamilton Mfg. Co.	Two Rivers, Wisconsin

2. Binders (Ring and Post)/Folders

2.1	Accoway Division, Acco Products	Ogdensburg, New York
2.2	Brown (M.) & Co., Inc.	Boston 20, Massachusetts
2.3	Buchan Loose Leaf Records Co.	Clifton Heights, Pennsylvania
2.4	Cooks', Inc.	Blackwood, New Jersey
2.5	International Loose Leaf Co., Div. of Capital Industries, Inc.	New York 5, New York

3. Book Stands and Book Cases

3.1	Borroughs Mfg. Co.	Kalamazoo, Michigan
3.2	Brown (M.) & Co., Inc.	Boston 20, Massachusetts
3.3	Cole-Steel Equipment Co.	New York, New York
3.4	Equipto Co.	Aurora, Illinois
3.5	Globe-Wernicke Co.	Cincinnati 12, Ohio
3.6	H-O-N Company	Muscatine, Iowa
3.7	Interior Steel Equipment Co.	Cleveland 4, Ohio

Book Stands and Book Cases (continued)

3.8	Lyon Metal Products	Aurora, Illinois
3.9	Parent Metal Products, Inc.	Philadelphia 35, Pa.
3.10	Republic Steel Corp., Mfg. Division	Youngstown 5, Ohio
3.11	Royalmetal Corp.	New York 16, New York
3.12	Shaw-Walker Co.	Muskegon, Michigan

4. Boxes

4.1	Acme Letter File Corp.	New York 13, New York
4.2	Acorn Products Co.	Franklin Park, Illinois
4.3	Art Steel Co.	New York, New York
4.4	Bankers Box Co.	Franklin Park, Illinois
4.5	Brown (M.) & Co., Inc.	Boston 20, Massachusetts
4.6	Convoy, Inc., Lennox Distributors Division	Canton 6, Ohio
4.7	Dolin Metal Products, Inc.	Brooklyn 16, New York
4.8	Franklin File, Inc.	Loretto, Minnesota
4.9	Jayem Sales Corp.	New York 1, New York
4.10	Kay-Dee Co.	Lincoln, Nebraska
4.11	Keyless Lock Co.	Indianapolis, Indiana
4.12	Paige Co., Inc.	New York 16, New York
4.13	Strayer Coin Bag Co., Inc.	New Brighton, Pennsylvania
4.14	Union Steel Chest Corp.	Le Roy, New York

5. Cabinets

5.1	Acorn Products Co.	Franklin Park, Illinois
5.2	All-Steel Equipment, Inc.	Aurora, Illinois

Cabinets (continued)

5.3	Angle Steel Incorporated	Plainwell, Michigan
5.4	Art Steel Co.	New York, New York
5.5	Borroughs Mfg. Co.	Kalamazoo, Michigan
5.6	Brown (M.) & Co., Inc.	Boston 20, Massachusetts
5.7	Cole-Steel Equipment Co.	New York, New York
5.8	DeLuxe Metal Products Co.	New York, New York
5.9	General Fireproofing Co.	Youngstown, Ohio
5.10	Globe-Wernicke Co.	Cincinnati 12, Ohio
5.11	Hamilton Mfg. Co.	Two Rivers, Wisconsin
5.12	Holga Metal Production Co.	Van Nuys, California
5.13	H-O-N Company	Muscatine, Iowa
5.14	Interior Steel Equipment Co.	Cleveland 4, Ohio
5.15	Jayem Sales Corp.	New York 1, New York
5.16	Lyon Metal Products	Aurora, Illinois
5.17	Northwest Metal Products Co.	Green Bay, Wisconsin
5.18	Parker Steel Products, Inc.	Brooklyn, New York
5.19	Precision Equipment Co.	Chicago, Illinois
5.20	Shampaine Co.	St. Louis, Missouri
5.21	Shaw-Walker Co.	Muskegon, Michigan
5.22	Vidmar, Inc.	Williamsport, Pennsylvania
5.23	Watson Mfg. Co., Rol-dex Division	Jamestown, New York
5.24	Western Devices, Inc.	Burbank, California

6. Clip Boards

6.1	Brown (M.) & Co., Inc.	Boston 20, Massachusetts

7. Cutters, Punches, Scissors

7.1	Accoway Division, Acco Products	Ogdensburg, New York
7.2	Brown (Arthur) & Bro., Inc.	New York 36, New York
7.3	Brown (M.) & Co., Inc.	Boston 20, Massachusetts
7.4	Buchan Loose Leaf Records Co.	Clifton Heights, Pa.

8. Data Processing Supplies

8.1	Record Files, Inc.	Wooster, Ohio
8.2	Systems Mfg. Corp.	Binghamton, New York
8.3	TAB Products Co.	San Francisco 11, Calif.
8.4	Wright Line, Div. of Barry Wright Corp.	Worcester 6, Massachusetts

9. Desks

9.1	All-Steel Equipment, Inc.	Aurora, Illinois
9.2	Art Steel Co.	New York, New York
9.3	Bentson Mfg. Co.	Aurora, Illinois
9.4	Cole-Steel Equipment Co.	New York, New York
9.5	Durable Metal Products	Long Island City, New York
9.6	Fortress, Inc.	Baldwin Park, California
9.7	General Fireproofing Co.	Youngstown 1, Ohio
9.8	Globe-Wernicke Co.	Cincinnati 12, Ohio
9.9	Haskell, Inc.	Pittsburgh 6, Pennsylvania
9.10	H-O-N Company	Muscatine, Iowa
9.11	Invincible Metal Furniture Co.	Manitowoc, Wisconsin

Desks (continued)

9.12	K - C Metal Products Co., Inc.	Brooklyn 21, New York
9.13	Mayline Co., Inc.	Sheboygan, Wisconsin
9.14	Metalstand Co.	Philadelphia 15, Pa.
9.15	Northwest Metal Products	Green Bay, Wisconsin
9.16	Parent Metal Products, Inc.	Philadelphia 35, Pa.
9.17	Precision Equipment Co.	Chicago, Illinois
9.18	Shaw-Walker Co.	Muskegon, Michigan
9.19	Western Manufacturing Co.	Aurora, Illinois
9.20	Williams Moduplan Office Furniture Corp.	New York 10, New York

10. Easels

10.1	Brown (Arthur) & Bro., Inc.	New York 36, New York

11. Expanding Files

11.1	Brown (M.) & Co., Inc.	Boston 20, Massachusetts

12. File Guides, Indexes and Folders

12.1	Aigner Index Co.	Long Island City, New York
12.2	Brown (M.) & Co., Inc.	Boston 20, Massachusetts
12.3	Buchan Loose Leaf Records Co.	Clifton Heights, Pa.
12.4	Oxford Filing Supply Co., Inc.	Garden City, L. I., New York
12.5	Shaw-Walker Co.	Muskegon, Michigan
12.6	Ulrich Planfiling Equipment Corp.	Jamestown, New York

13. Industrial Trucks

13.1	Automatic Transportation Co.	Chicago 20, Illinois
13.2	Barret-Cravens Co.	Northbrook, Illinois
13.3	Brodie Industrial Trucks	Woburn, Massachusetts
13.4	Brooks & Perkins, Inc.	Detroit 16, Michigan
13.5	Colson Corp.	Chicago 3, Illinois
13.6	Hamilton Caster and Mfg. Co.	Hamilton, Ohio
13.7	Langley Handling Equipment	Cambridge 41, Massachusetts
13.8	Little Giant Products, Inc.	Peoria, Illinois
13.9	Pollard Bros. Mfg. Co.	Chicago, Illinois
13.10	Raymond Corp.	Greene, New York
13.11	Rubbermaid, Inc.	Wooster, Ohio
13.12	Skarnes, Inc.	Minneapolis 6, Minnesota
13.13	Towmotor Corp.	Cleveland 12, Ohio
13.14	Wilder Mfg. Co., Inc.	Port Jervis, New York

14. Labels, Tags, and Tabs

14.1	Cel-u-dex Corp.	New Windsor (Newburgh), N. Y.
14.2	Office Products, Inc.	Detroit, Michigan
14.3	Smead Mfg. Co.	Hastings, Minnesota

15. Ladders

15.1	Cotterman (I. D.)	Naperville, Illinois
15.2	Precision Equipment Co.	Chicago, Illinois

16. Laminators

16.1	Cole-Steel Equipment Co.	New York, New York

17. Light Boxes, Tables, and Vacuum Frames

17.1	Brown (Arthur) & Bro., Inc.	New York 36, New York
17.2	Colight, Inc.	Minneapolis 1, Minnesota
17.3	Holga Metal Production Co.	Van Nuys, California
17.4	Stacor Corp.	Newark 14, New Jersey

18. List Finders

18.1	Brown (M.) & Co., Inc.	Boston 20, Massachusetts

19. Machine Stands (Wheeled)

19.1	Brown (M.) & Co., Inc.	Boston 20, Massachusetts
19.2	H-O-N Company	Muscatine, Iowa
19.3	Steel Parts Mfg. Co., Div. of Blackstone Mfg. Co., Inc.	Chicago 44, Illinois
19.4	Tiffany Stand Co.	St. Louis 5, Missouri

20. Rack Sorters

20.1	Angle Steel Incorporated	Plainwell, Michigan
20.2	Brown (M.) & Co., Inc.	Boston 20, Massachusetts
20.3	DeLuxe Metal Products Co.	New York, New York
20.4	Durham Mfg. Co.	Durham, Connecticut
20.5	Hall (Gordon L.) Co., Inc.	Greenwich, Connecticut
20.6	Haskell, Inc.	Pittsburgh 6, Pennsylvania

20.7	Mason & Mueller, Inc.	West Orange, New Jersey
20.8	Modern Steel Equipment Co.	Philadelphia 35, Pa.
20.9	Murphy Mfg. Co.	Louisville, Kentucky
20.10	Northwest Metal Products Co.	Green Bay, Wisconsin
20.11	Precision Equipment Co.	Chicago, Illinois
20.12	Prevue-Radsell Co.	Chicago 6, Illinois
20.13	Sengbusch Self-Closing Inkstand Co.	Milwaukee 3, Wisconsin
20.14	Steel Parts Mfg. Co., Div. of Blackstone Mfg. Co., Inc.	Chicago 44, Illinois
20.15	Work-Organizer Specialties Co.	Detroit 9, Michigan

21. Rotary Indexes

21.1	Brown (M.) & Co., Inc.	Boston 20, Massachusetts
21.2	Wheeldex & Simpla Products, Inc.	Peekskill, New York

22. Safes

22.1	Brush (John D.) & Co., Inc.	Rochester 11, New York
22.2	Schwab Safe Co., Inc.	Lafayette, Indiana
22.3	Victor Safe & Equipment, Remington Rand Office Systems, Div. of Sperry Rand Corp.	New York 17, New York

23. Signals (Clip on)

23.1	Brown (M.) & Co., Inc.	Boston 20, Massachusetts
23.2	Graff (George B.) Co.	Cambridge 40, Massachusetts

24. Stamps & Numbering Machines

24.1	Brown (M.) & Co., Inc.	Boston 20, Massachusetts

25. Staples & Eyeletters

25.1	Bostitch	East Greenwich, R. I.
25.2	Brown (M.) & Co., Inc.	Boston 20, Massachusetts
25.3	Harris-Seybold Co.	Boston 10, Massachusetts
25.4	Staplex Co.	Brooklyn 32, New York

26. Steel Floor Grating

26.1	Equipto Co.	Aurora, Illinois

27. Stencils, Rules, Lettering Guides, and Templates

27.1	Brown (Arthur) & Bro., Inc.	New York 36, New York
27.2	Brown (M.) & Co., Inc.	Boston 20, Massachusetts
27.3	Mayline Co., Inc.	Sheboygan, Wisconsin

28. Tables

28.1	Acorn Products Co.	Franklin Park, Illinois
28.2	Angle Steel Incorporated	Plainwell, Michigan
28.3	Barricks Mfg. Co.	Chicago 9, Illinois
28.4	Brown (Arthur) & Bro., Inc.	New York 36, New York
28.5	Brown (M.) & Co., Inc.	Boston 20, Massachusetts
28.6	Cole-Steel Equipment Co.	New York, New York

Tables (continued)

28.7	Globe-Wernicke Co.	Cincinnati 12, Ohio
28.8	Hamilton Mfg. Co.	Two Rivers, Wisconsin
28.9	Haskell, Inc.	Pittsburgh 6, Pennsylvania
28.10	Jayem Sales Corp.	New York 1, New York
28.11	Northwest Metal Products Co.	Green Bay, Wisconsin
28.12	Precision Equipment Co.	Chicago, Illinois
28.13	Shwayder Bros., Inc.	Detroit, Michigan
28.14	SICO, Inc.	Minneapolis 24, Minnesota
28.15	Stacor Corp.	Newark 14, New Jersey

29. Tacks, Pins, Hangers, Clips

29.1	Accoway Division, Acco Products	Ogdensburg, New York
29.2	Brown (M.) & Co., Inc.	Boston 20, Massachusetts

30. Tape, Glue,& Machines

30.1	Brown (Arthur) & Bro., Inc.	New York 36, New York
30.2	Brown (M.) & Co., Inc.	Boston 20, Massachusetts

31. Wheeled Carts

31.1	Angle Steel Incorporated	Plainwell, Michigan
31.2	Brown (M.) & Co., Inc.	Boston 20, Massachusetts
31.3	Can-Pro Corp.	Fond du Lac, Wisconsin
31.4	Catskill Craftsmen, Inc.	New York 22, New York
31.5	Charnstrom (W. A.) Co.	Minneapolis 15, Minnesota

Wheeled Carts (continued)

31.6	Chesley Industries, Inc.	Farmington, Michigan
31.7	DeLuxe Metal Products Co.	New York, New York
31.8	Hamilton Mfg. Co.	Two Rivers, Wisconsin
31.9	Lyon Metal Products	Aurora, Illinois
31.10	Monarch Metal Products	New Windsor (Newburgh), N. Y.
31.11	Posting Equipment Corp.	Buffalo 7, New York
31.12	Shaw-Walker Co.	Muskegon, Michigan

APPENDIX III

BIBLIOGRAPHIES OF TECHNIQUES

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APPENDIX IV

DETAILED
RETRIEVAL AND REFILING
TEST DATA

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A. APPROACH DATA

Sheet No.	
1	Individual Walking Ten Feet

Table

RETRIEVAL & REFILING TIMES

Sheet 1 of 31
Date 2/17/64
By JAJ/RDM

Manufacturer ______
Unit Tested ______
Test Description Walking Ten Feet

Material ______
Quantity ______
Size ______
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Sub-ject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Walking 10 feet	TR	A	4.0	4.6	4.4	4.0	4.5	3.6	3.8	3.8	3.5	3.4		3.6
		TR	A	3.5	3.8	3.6	3.8	4.0						3.9	
2	Walking 10 feet	TR	B	3.2	3.0	3.4	3.6	3.8	3.0	3.8	3.0	2.8	3.0		3.6
		TR	B	3.0	2.9	3.2	2.9	3.0						3.2	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport

Comments and Observations

1. Subject A is 6 feet tall.
2. Subject B is 6 feet 4 inches tall.
3. Normal walking pace was maintained for this test.

B. ROLL FILM DATA

Sheet No.				
2	Wooden Shelving, open	Roll Axis Vertical	2 Rows Deep	Front Row
3	Wooden Shelving, open	Roll Axis Vertical	2 Rows Deep	Rear Row
4	Wooden Shelving, compartmented	Roll Axis Horizontal	1 Deep	Grasp by Sides
5	Wooden Shelving, compartmented	Roll Axis Horizontal	1 Deep	Grasp by Handles

Table

RETRIEVAL & REFILING TIMES

Sheet 2 of 31
Date 2/17/64
By JAJ/RDM

Manufacturer Wooden Shelving, open

Unit Tested Roll Axis Vertical

Test Description Retrieval & Refiling of film can standing on end in front position - 4 cans were in rear row and 4 cans were in front row.

Material Roll Film Cans (weighing 20 lbs.)

Quantity 4 cans in rear row; 4 cans in front row

Size 8-1/4 (diameter) x 11-1/2 (height) inches

Subjects A JAJ

B RDM

Test No.	Specific Test Conditions	Test Code	Sub-ject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Subject requested to retrieve front can - walked 10 feet to unit - retrieved can - walked 10 feet back to starting point.	RT	A	10	12	9	11	11						11	11
		RT	B	11	11	11	11	10						11	
2	Subject requested to refile front can - walked 10 feet to unit - replaced can - walked 10 feet back to starting point.	RF	A	11	11	10	11	10						11	10
		RF	B	10	10	11	10	10						10	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport

Comments and Observations

1. Cans were weighted at 20 lbs. to simulate a fully loaded 9-1/2-inch x 500-foot Aerial Film Can.
2. Weight and shapes of cans made them awkward to handle.

Table

RETRIEVAL & REFILING TIMES

Sheet 3 of 31
Date 2/18/64
By JAJ/RDM

Manufacturer Wooden Shelving, open
Unit Tested Roll Axis Vertical
Test Description Retrieval & Refiling of film can standing on end in rear position - 4 cans were in rear row and 4 cans were in front row.

Material Roll Film Cans (weighing 20 lbs.)
Quantity 4 cans in rear row; 4 cans in front row
Size 8-1/4 (diameter) x 11-1/2 (height) inches
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Subject requested to retrieve rear can - walked 10 feet to unit - removed front can, placed on floor, - removed rear can, placed on floor - replaced front can - 10 ft.back	RT	A	24	23	25	23	25						24	26
		RT	B	25	28	29	28	30						28	
2	Subject requested to replace rear can - walked 10 feet to unit - placed rear can on floor removed front can, placed on floor - replaced rear can - replaced front can - 10 feet back	RF	A	23	24	21	22	21						22	23
		RF	B	23	25	23	25	24						24	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport

Comments and Observations

1. Cans were weighted at 20 lbs. to simulate a fully loaded 9-1/2-inch x 500-foot Aerial Film Can.
2. Retrieval of can in rear row complicated by need to first remove can in front row.
3. Weight and shapes of cans made them awkward to handle.

Table

RETRIEVAL & REFILING TIMES

Sheet 4 of 31
Date 2/18/64
By JAJ/RDM

Manufacturer Wooden Shelving, compartmented
Unit Tested Roll Axis Horizontal
Test Description Retrieval & Refiling of cans from compartments 32 inches and 58 inches from floor - pulling cans out by grasping sides.

Material Roll Film Cans (weighing 20 lbs.)
Quantity 1
Size 8-1/4 (diameter) x 11-1/2 (height) inches
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Subject requested to retrieve "High" or "Low" can - walked 10 feet to unit - retrieved can - walked 10 feet back to starting point.	RT	A	(H) 12	(L) 11	(H) 12	(L) 11	(H) 13						12	12
		RT	B	(L) 11	(H) 13	(L) 13	(H) 13	(L) 13						13	
2	Subject requested to replace "High" or "Low" can - walked 10 feet to unit - replaced can - walked 10 feet back to starting point.	RF	A	(H) 11	(L) 10	(H) 11	(L) 9	(H) 12						11	12
		RF	B	(L) 13	(H) 14	(L) 11	(H) 12	(L) 14						13	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport ; (xx) - High or Low from Floor

Comments and Observations

1. Cans were weighted at 20 lbs. to simulate a fully loaded 9-1/2-inch x 500-foot Aerial Film Can.
2. Weight and shapes of cans made them awkward to handle.

Table

RETRIEVAL & REFILING TIMES

Sheet 5 of 31
Date 2/19/64
By JAJ/RDM

Manufacturer Wooden Shelving, compartmented
Unit Tested Roll Axis Horizontal
Test Description Retrieval & Refiling of cans from compartments 32 inches and 58 inches from floor - using handle on front of cans to pull out.

Material Roll Film Cans (weighing 20 lbs.)
Quantity 1
Size 8-1/4 (diameter) x 11-1/2 (height) inches
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Average Time Both
1	Subject requested to retrieve "High" or "Low" can - walked 10 feet to unit - retrieved can - walked 10 feet back to starting point.	RT	A	(H) 10	(L) 9	(H) 10	(L) 9	(H) 8						9.2	9
		RT	B	(L) 9	(H) 11	(L) 8	(H) 9	(L) 9						9.2	
2	Subject requested to replace "High" or "Low" can - walked 10 feet to unit - replaced can - walked 10 feet back to starting point.	RF	A	(H) 11	(L) 10	(H) 10	(L) 9	(H) 9						9.8	10
		RF	B	(L) 10	(H) 11	(L) 9	(H) 9	(L) 9						9.6	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport; (xx) - High or Low from Floor

Comments and Observations

1. Cans were weighted at 20 lbs. to simulate a fully loaded 9-1/2-inch x 500-foot Aerial Film Can.
2. Simulating can holder by using handle in can cover - cover taped in place - made handling considerably easier - also made retrieval and refiling easier.

C. MAPS

Sheet No.			Quantity	
6	Acco Products, Division of Natser Corp.	Accoway Open Rack	50	
7	Art Metal, Inc.	Planfile	100	Middle Zone 2 Folders - 50 each
8	Art Metal, Inc.	Planfile	100	End Zone 2 Folders - 50 each
9	Art Metal, Inc.	Planfile	100	Middle Zone 2 Folders - 50 each Misfiles
10	Globe-Wernicke Company	Cello-Clip Map and Plan File	50	1 Wooden Group Holder
11	Globe-Wernicke Company	Cello-Clip Map and Plan File	50	3 Individual Group Holders
12	Hamilton Manufacturing Company	Unit System File with Tracing Lifter	100	Drawer 5
13	Hamilton Manufacturing Company	Unit System File with Tracing Lifter	100	Drawer 5 Misfiled
14	Hamilton Manufacturing Company	Unit System File with Tracing Lifter	100	Drawer 5 Contiguous maps missing
15	Hamilton Manufacturing Company	Unit System File without Tracing Lifter	100	Drawer 5

C. MAPS (CONT'D)

Sheet No.			Quantity	
16	Hamilton Manufacturing Company	Vertical File	100	Removal of rack only, center
17	Hamilton Manufacturing Company	Vertical File	100	Removal of rack only, rear
18	Hamilton Manufacturing Company	Vertical File	100	Individual Map middle of rack
19	Hamilton Manufacturing Company	Vertical File	50	Individual Map middle of rack
20	Plan Hold Corporation	Wall Rack File	100	
21	Plan Hold Corporation	Wall Rack File	50	

Table

RETRIEVAL & REFILING TIMES

Sheet 6 of 31
Date 2/19/64
By JAJ/RDM

Manufacturer Acco Products, Division of Natser Corp.
Unit Tested Accoway Open Rack
Test Description Retrieval & Refiling of individual maps from 50 maps from hanging files which held maps with two Acco Fasteners.

Material Maps
Quantity 50
Size 22 x 27 x 0.005 inches to 24 x 29 x 0.005 inches
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(30) 123	(10) 121	(24) 123	(26) 112	(28) 114						119	128
		RT	B	(45) 168	(22) 135	(20) 119	(40) 149	(5) 107						136	
2	Subject took item from pile - walked 10 feet to unit - refiled item - walked 10 feet back to starting point.	RF	A	(30) 123	(10) 133	(20) 95	(22) 122	(45) 127						120	115
		RF	B	(28) 110	(26) 112	(24) 103	(40) 130	(5) 89						109	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport ; (xx) - No. of Item RT and RF

Comments and Observations

1. Test 1 - Trial 1 - Subject B cut finger on sharp edges of Acco Fastener.
2. Acco Fasteners get deformed during usage, making map removal and replacement difficult.
3. Maps were damaged by sharp edges of Acco Fasteners.

Table

RETRIEVAL & REFILING TIMES

Sheet 7 of 31
Date 2/20/64
By JAJ/RDM

Manufacturer Art Metal, Inc.
Unit Tested Planfile
Test Description Retrieval and Refiling of individual maps which were placed 50 in each of two folders in the middle of the unit in pocket 8, folders 2 and 3.

Material Maps
Quantity 100 (50 each in two folders)
Size 22 x 27 x 0.005 inches to 24 x 29 x 0.005 inches
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Sub-ject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(44) 40	(10) 31	(20) 29	(60) 29	(40) 30						32	30
		RT	B	(56) 30	(48) 26	(80) 27	(90) 27	(52) 24						27	
2	Subject took item from pile - walked 10 feet to unit - refiled item -walked 10 feet back to starting point.	RF	A	(90) 40	(80) 36	(48) 35	(56) 32	(44) 35						36	36
		RF	B	(60) 42	(20) 34	(10) 40	(40) 29	(52) 33						36	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport; (xx) - No. of Item RT and RF

Comments and Observations

1. Test 1 - Trial 1 - Subject B jammed finger in shelf when closing.
2. Test 2 - Trial 1 - Subject B withdrew folder too far and it dropped back in wrong location - Folder should only be pulled out to within approximately 2 inches from end.

Table

RETRIEVAL & REFILING TIMES

Sheet 8 of 31
Date 2/20/64
By JAJ/RDM

Manufacturer Art Metal, Inc.
Unit Tested Flanfile
Test Description Retrieval and Refiling of individual maps which were placed 50 in each of two folders in the rear of the unit in pocket 15, folders 3 and 4.

Material Maps
Quantity 100 (50 each in two folders)
Size 22 x 27 x 0.005 inches to 24 x 29 x 0.005 inches
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(10) 21	(80) 26	(44) 18	(90) 26	(48) 22						23	21
		RT	B	(52) 20	(40) 21	(20) 17	(56) 16	(60) 16						18	
2	Subject took item from pile - walked 10 feet to unit - refiled item - walked 10 feet back to starting point.	RF	A	(44) 42	(80) 42	(48) 45	(10) 37	(52) 31						39	37
		RF	B	(40) 28	(45) 28	(56) 36	(20) 43	(90) 38						35	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport; (xx) - No. of Item RT and RF

Comments and Observations
1. Shelf doesn't facilitate retrieval of items from rear folders.
2. Test 2 - Trials 1 and 2 - Subject A withdrew folder too far.
3. Maps were getting dog-eared, possibly due to insufficient spring tension.

Table

RETRIEVAL & REFILING TIMES

Sheet 9 of 31
Date 2/21/64
By JAJ/RDM

Manufacturer: Art Metal, Inc.
Unit Tested: Planfile
Test Description: Retrieval of maps which were misfiled (within ± 10 of their proper location) from two folders, each containing 50 maps in center of unit, pocket 8, folders 2 and 3.

Material: Maps
Quantity: 100 (50 each in two folders)
Size: 22 x 27 x 0.005 inches to 24 x 29 x 0.005 inches
Subjects: A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(48) 36	(60) 25	(20) 45	(52) 27	(44) 26						32	27
		RT	B	(80) 27	(40) 24	(56) 17	(10) 24	(90) 19						22	
2			A												
			B												

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport; (xx) - No. of Item RT and RF

Comments and Observations

1. This test was run to verify that misfiled maps would cause an increase in retrieval time for any particular equipment configuration.

Table

RETRIEVAL & REFILING TIMES

Sheet 10 of 31
Date 2/21/64
By JAJ/RDM

Manufacturer: Globe-Wernicke Company
Unit Tested: Cello-Clip Map and Plan File
Test Description: Retrieval and Refiling of individual maps from Wooden Group Holder which held 50 maps.

Material: Maps
Quantity: 50
Size: 22 x 27 x 0.005 inches to 24 x 29 x 0.005 inches
Subjects: A JAJ; B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Average Time Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(26) 105	(10) 98	(30) 112	(28) 97	(5) 88						100	89
		RT	B	(40) 99	(22) 74	(20) 70	(24) 63	(45) 78						77	
2	Subject took item from pile - walked 10 feet to unit - refiled item - walked 10 feet back to starting point.	RF	A	(10) 85	(45) 99	(24) 99	(5) 84	(28) 86						101	96
		RF	B	(40) 77	(30) 115	(20) 99	(22) 107	(26) 105						91	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport; (xx) - No. of Item RT and RF

Comments and Observations

1. Reference table required for removal of maps from group holder.
2. Maps tear when pulled over threads of screws holding group holder together.
3. Test 1 - trial 1 - Subject A - maps became disarranged, requiring rethreading over screws.
4. Maps became dog-eared from placing group on table for removal of single sheet.
5. Test 2 - trial 5 - Subject B - maps became disarranged, requiring rethreading over screws.

Table

RETRIEVAL & REFILING TIMES

Sheet 11 of 31
Date 2/24/64
By JAJ/RDM

Manufacturer: Globe-Wernicke Company
Unit Tested: Cello-Clip Map and Plan File
Test Description: Retrieval and Refiling of individual maps from 50 maps which were supported by three (3) individual group holders.

Material: Maps
Quantity: 50
Size: 22 x 27 x 0.005 inches to 24 x 29 x 0.005 inches
Subjects: A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Average Time Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(72) 110	(95) 132	(74) 104	(76) 135	(60) 99						107	112
		RT	B	(55) 94	(80) 120	(78) 98	(90) 140	(70) 85						116	
2	Subject took item from pile - walked 10 feet to unit - refiled item - walked 10 feet back to starting point.	RF	A	(55) 92	(78) 115	(60) 100	(80) 134	(72) 85						105	103
		RF	B	(70) 96	(76) 94	(74) 95	(90) 131	(95) 90						101	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport ; (xx) - No. of Item RT and RF

Comments and Observations

1. Individual group holders more difficult to remove from rack than wooden group holder.
2. Too many loose pieces - assembly and reassembly complicated by need to hold screw with one hand at same time other hand is attempting to screw on nut.
3. Maps become disarranged easily, requiring rethreading of each screw holding group holders.

Table

RETRIEVAL & REFILING TIMES

Sheet 12 of 31
Date 2/24/64
By JAJ/RDM

Manufacturer Hamilton Manufacturing Company
Unit Tested Unit System File with Tracing Lifter
Test Description Retrieval and Refiling of individual maps from a pile of 100 maps in Drawer 5.

Material Maps
Quantity 100
Size 22 x 27 x 0.005 inches to 24 x 29 x 0.005 inches
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(44) 40	(20) 36	(90) 37	(48) 35	(10) 36	(80) 31	(60) 28	(52) 26			33	31
		RT	B	(44) 27	(20) 27	(90) 25	(48) 32	(10) 29	(56) 30	(40) 24				28	
2	Subject took item from pile - walked 10 feet to unit - refiled item - walked 10 feet back to starting point.	RF	A	(10) 21	(48) 23	(40) 24	(44) 22	(52) 23						23	26
		RF	B	(56) 27	(60) 33	(80) 34	(90) 34	(20) 23						30	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport; (xx) - No. of Item RT and RF

Comments and Observations

1. Test 1 - trial 1 - Subject A had difficulty closing drawer with one hand.
2. Test 1 - trials 1 through 7 - Subject B used tracing lifter to remove weight of maps but did not lock in place for map removal.

Table

RETRIEVAL & REFILING TIMES

Sheet 13 of 31
Date 2/25/64
By JAJ/RDM

Manufacturer Hamilton Manufacturing Company
Unit Tested Unit System File with Tracing Lifter
Test Description Retrieval of maps which were misfiled (within ± 10 of their proper location) from pile of 100 maps in Drawer 5.

Material Maps
Quantity 100
Size 22 x 27 x 0.005 inches to 24 x 29 x 0.005 inches
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(52) 36	(44) 70	(90) 49	(56) 39	(48) 72						53	44
		RT	B	(40) 20	(10) 29	(80) 39	(20) 50	(60) 38						35	
2			A												
			B												

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport; (xx) - No. of Item RT and RF

Comments and Observations

1. This test was run to verify that misfiled maps would cause an increase in retrieval time for any particular equipment configuration.

Table

RETRIEVAL & REFILING TIMES

Sheet 14 of 31
Date 2/25/64
By JAJ/RDM

Manufacturer Hamilton Manufacturing Company
Unit Tested Unit System File with Tracing Lifter
Test Description Retrieval of maps which are in order, but 2 maps higher and 2 maps lower removed - Drawer 5.

Material Maps
Quantity 100
Size 22 x 27 x 0.005 inches to 24 x 29 x 0.005 inches
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(40) 28	(10) 22	(48) 25	(90) 31	(52) 28						27	31
		RT	B	(44) 30	(60) 39	(80) 31	(20) 39	(56) 33						34	
2			A												
			B												

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport; (xx) - No. of Item RT and RF

Comments and Observations

1. This test was run to see if missing contiguous sheets would appreciably affect retrieval time.
2. Test 1 - trials 2 and 4 - Subject B had trouble with tracing lifter jamming up due to off center lifting.

Table

RETRIEVAL & REFILING TIMES

Sheet 15 of 31
Date 2/26/64
By JAJ/RDM

Manufacturer Hamilton Manufacturing Company
Unit Tested Unit System File without Tracing Lifter
Test Description Retrieval and refiling of individual maps from a pile of 100 maps in Drawer 5.

Material Maps
Quantity 100
Size 22 x 27 x 0.005 inches to 24 x 29 x 0.005 inches
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(10) 17	(48) 16	(56) 20	(44) 17	(52) 18						18	21
		RT	B	(60) 24	(80) 24	(90) 24	(40) 23	(20) 24						24	
2	Subject took item from pile - walked 10 feet to unit - refiled item - walked 10 feet back to starting point.	RF	A	(52) 25	(40) 20	(48) 21	(56) 22	(10) 20						22	25
		RF	B	(20) 28	(44) 28	(90) 25	(80) 26	(60) 32						28	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport; (xx) - No. of Item RT and RF

Comments and Observations
1. Difficult to retrieve or refile maps at bottom of pile.
2. Maps had tendency to move around in drawer; had to be frequently rearranged.

Table

RETRIEVAL & REFILING TIMES

Sheet 16 of 31
Date 2/26/64
By JAJ/RDM

Manufacturer Hamilton Manufacturing Company
Unit Tested Vertical File
Test Description Retrieval and refiling of map holder (only) from position 12 (center of rack) - No removal of maps from holder.

Material Maps
Quantity 100
Size 22 x 27 x 0.005 inches to 24 x 29 x 0.005 inches
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Walked 10 feet to unit - removed rack from unit - placed on table - stop.	RT	A	37	39	36	38	42							38
			B												
2	Picked up rack from table - returned to unit - walked 10 feet back to starting point.		A												
		RF	B	38	35	37	32	40							36

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport ; (xx) - No. of Item RT and RF

Comments and Observations

1. Sharp edges on adjacent holder nuts tear maps, also cut fingers of subjects.

Table

RETRIEVAL & REFILING TIMES

Sheet 17 of 31
Date 2/27/64
By JAJ/RDM

Manufacturer Hamilton Manufacturing Company
Unit Tested Vertical File
Test Description Retrieval and refiling of map holder (only) from position 26 (rear of unit) - No removal of maps from holder.

Material Maps
Quantity 100
Size 22 x 27 x 0.005 inches to 24 x 29 x 0.005 inches
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Walked 10 feet to unit - removed rack from unit - placed on table - stop.	RT	A	53	43	42	41	41							44
			B												
2	Picked up rack from table - returned to unit - walked 10 feet back to starting point.		A												47
		RF	B	53	47	46	45	43							

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport; (xx) - No. of Item RT & RF

Comments and Observations

1. To place holder in last position (#26) in rear of rack requires stretching to reach 36.5", causing subject to strain body, especially with weight of 100 maps (approximately 8 lbs.)
2. Design of cabinet shelf interferes with easy access to 11 of 26 holders in the rack.

Table

RETRIEVAL & REFILING TIMES

Sheet 18 of 31
Date 2/27/64
By JAJ/RDM

Manufacturer: Hamilton Manufacturing Company
Unit Tested: Vertical File
Test Description: Retrieval and refiling of individual maps from 100 maps held in middle of rack.

Material: Maps
Quantity: 100
Size: 22 x 27 x 0.005 inches to 24 x 29 x 0.005 inches
Subjects: A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(10) 155	(44) 158	(80) 132	(60) 137	(20) 143						145	141
		RT	B	(40) 105	(48) 153	(56) 120	(52) 127	(90) 175						136	
2	Subject took item from pile - walked 10 feet to unit - refiled item - walked 10 feet back to starting point.	RF	A	(48) 215	(20) 193	(80) 157	(10) 174	(90) 135						175	169
		RF	B	(60) 215	(40) 135	(52) 156	(56) 159	(44) 148						163	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport; (xx) - No. of Item RT and RF

Comments and Observations

1. Poor manufacturing dimensions - holder can fall out of rack when closing.
2. Wrench slips below nut - complicates removal.
3. Wrench interferes with index card holder.
4. Test 2 - trial 1 - Subjects A and B - maps fell out of folder into bottom of cabinet when closing rack.
5. Test 2 - trial 2 - Subject A - maps were torn by sharp edges of nuts on adjacent holders.
6. Rack doesn't easily accommodate 100 maps per holder - 100 maps are difficult to manage in replacing in cabinet.

Table

RETRIEVAL & REFILING TIMES

Sheet 19 of 31
Date 2/28/64
By JAJ/RDM

Manufacturer Hamilton Manufacturing Company

Unit Tested Vertical File

Test Description Retrieval and refiling of individual maps from 50 maps held in middle of rack.

Material Maps

Quantity 50

Size 22 x 27 x 0.005 inches to 24 x 29 x 0.005 inches

Subjects A JAJ

B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(40) 101	(5) 101	(10) 105	(20) 115	(24) 96						104	105
		RT	B	(45) 125	(22) 96	(26) 95	(30) 108	(28) 105						106	
2	Subject took item from pile - walked 10 feet to unit - refiled item - walked 10 feet back to starting point.	RF	A	(24) 96	(22) 119	(10) 99	(5) 110	(40) 122						109	118
		RF	B	(30) 145	(26) 127	(20) 123	(45) 134	(28) 108						127	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport; (xx) - No. of Item RT and RF

Comments and Observations

1. Operation of unit with 50 maps per holder is much easier than with 100 maps.
2. Jaws of holders easily accommodate 50 maps.
3. Test 2 - trial 1 - Subject B - maps slipped out of holder during refiling - had to be rearranged on table.
4. Test 2 - trial 2 - Subject B - maps were torn by sharp edges on nuts on adjacent holder.

Table

RETRIEVAL & REFILING TIMES

Sheet 20 of 31
Date 2/28/64
By JAJ/RDM

Manufacturer Plan Hold Corporation
Unit Tested Wall Rack File
Test Description Retrieval and refiling of individual maps from group of 100 maps in Plan Hold clamp.

Material Maps
Quantity 100
Size 22 x 27 x 0.005 inches to 24 x 29 x 0.005 inches
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Sub-ject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(10) 56	(56) 78	(44) 59	(48) 50	(52) 49						58	58
		RT	B	(80) 54	(60) 56	(40) 55	(90) 67	(20) 52						57	
2	Subject took item from pile - walked 10 feet to unit - refiled item - walked 10 feet back to starting point.	RF	A	(52) 90	(48) 86	(56) 57	(10) 55	(60) 69						71	73
		RF	B	(40) 72	(20) 75	(80) 75	(90) 77	(44) 70						74	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport; (xx) - No. of Item RT and RF

Comments and Observations

1. 100 maps are difficult to handle easily - maps fequently creased when placing on table for removal of individual map.
2. Nuts must be properly aligned or holder cannot be removed or placed on rack.
3. Design is such that to push individual map into the group is difficult.
4. Test 2 - trial 1 - Subject A - maps fell to floor when placed in rack.

Table

RETRIEVAL & REFILING TIMES

Sheet 21 of 31
Date JAJ/RDM
By 3/2/64

Manufacturer Plan Hold Corporation

Unit Tested Wall Rack File

Test Description Retrieval and refiling of individual maps from group of 50 maps in Plan Hold Clamp.

Material Maps

Quantity 50

Size 22 x 27 x 0.005 inches to 24 x 29 x 0.005 inches

Subjects A JAJ

B RDM

Test No.	Specific Test Conditions	Test Code	Sub-ject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(5) 38	(10) 37	(30) 41	(40) 42	(45) 37						39	36
		RT	B	(20) 33	(22) 33	(24) 34	(26) 30	(28) 36						33	
2	Subject took item from pile - walked 10 feet to unit - refiled item - walked 10 feet back to starting point.	RF	A	(40) 54	(30) 52	(10) 43	(5) 46	(45) 51						49	53
		RF	B	(28) 63	(26) 59	(24) 55	(22) 55	(20) 52						57	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport; (xx) - No. of Item RT and RF

Comments and Observations

1. Test 2 - trial 1 - Subject B - maps become disarranged when holder pulled away - all maps had to be restacked.
2. Maps get damaged in placing on table for removal of single sheet.

D. OVERLAYS

Sheet No.			Quantity	
22	Art Metal, Inc.	Planfile	100	2 Folders - 50 each Numbers not backed
23	Art Metal, Inc.	Planfile	100	2 Folders - 50 each Numbers backed
24	Art Metal, Inc. Laboratory Test Model	Planfile Album	50	Middle Zone One album. Numbers backed
25	Hamilton Manufacturing Company	Unit System File with Tracing Lifter	100	Drawer 5 One pile Numbers not backed
26	Hamilton Manufacturing Company	Unit System File with Tracing Lifter	100	Drawer 5 Two piles Numbers not backed
27	Hamilton Manufacturing Company	Unit System File with Tracing Lifter	100	Drawer 5 Two piles Numbers not backed and misfiled

Table

RETRIEVAL & REFILING TIMES

Sheet 22 of 31
Date 3/2/64
By JAJ/RDM

Manufacturer Art Metal, Inc.
Material Overlays
Unit Tested Planfile
Quantity 100 (50 each in 2 folders)
Test Description Retrieval and refiling of individual overlays which were placed 50 in each of 2 folders in the middle of the unit, pocket 8, folders 2 & 3 - Numbers NOT backed.
Size 25 x 22 x 0.005 inches
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(56) 23	(20) 34	(10) 25	(44) 24	(80) 25						26	30
		RT	B	(40) 36	(60) 34	(90) 36	(48) 35	(52) 25						33	
2	Subject took item from pile - walked 10 feet to unit - refiled item - walked 10 feet back to starting point.	RF	A	(40) 46	(56) 46	(20) 37	(10) 43	(44) 42						43	37
		RF	B	(52) 32	(90) 31	(60) 32	(80) 29	(48) 31						31	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport (xx) - No. of Item RT and RF

Comments and Observations
1. Static electricity complicates retrieval - overlays have tendency to stick together.
2. Accession numbers are difficult to read.
3. Slight scratching noted on overlays.
4. Pulling folder out of cabinet too far causes overlays to bunch up.

Table

RETRIEVAL & REFILING TIMES

Sheet 23 of 31
Date 3/3/64
By JAJ/RDM

Manufacturer Art Metal, Inc.
Unit Tested Planfile
Test Description Retrieval and refiling of individual overlays which were placed 50 in each of 2 folders in middle of unit, pocket 8, folders 2 & 3. Numbers backed.

Material Overlays
Quantity 100 (50 each in 2 folders)
Size 25 x 22 x 0.005 inches
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(40) 20	(20) 22	(60) 26	(56) 27	(44) 24						24	23
		RT	B	(10) 20	(80) 24	(90) 25	(52) 22	(48) 19						22	
2	Subject took item from pile - walked 10 feet to unit - refiled item - walked 10 feet back to starting point.	RF	A	(56) 32	(60) 26	(80) 25	(40) 24	(20) 26						27	28
		RF	B	(52) 30	(90) 26	(10) 25	(48) 32	(44) 34						29	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport; (xx) - No. of Item RT and RF

Comments and Observations

1. White backing on overlay numbers was a definite aid to retrieval.

Table

RETRIEVAL & REFILING TIMES

Sheet 24 of 31
Date 3/3/64
By JAJ/RDM

Manufacturer Art Metal, Inc. & Laboratory Test Model
Unit Tested Planfile & Album
Test Description Retrieval and refiling of individual overlays from group of 50 overlays which were contained in an album which was placed in the middle of the unit. Numbers backed.

Material Overlays
Quantity 50
Size 25 x 22 x 0.005 inches
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Average Time Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(5) 45	(24) 40	(20) 37	(22) 37	(26) 39						40	39
		RT	B	(40) 39	(30) 40	(45) 37	(28) 34	(10) 38						38	
2	Subject took item from pile - walked 10 feet to unit - refiled item - walked 10 feet back to starting point.	RF	A	(10) 42	(28) 40	(45) 42	(30) 35	(40) 37						39	38
		RF	B	(26) 43	(22) 37	(20) 36	(24) 32	(5) 32						36	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport (xx) - No. of Item RT and RF

Comments and Observations

1. Use of album improved scratch problem.
2. Static electricity no problem in retrieval.
3. Improper use of album binder rings may damage overlays.
4. Table required for removal of individual sheets.

Table

RETRIEVAL & REFILING TIMES

Sheet 25 of 31
Date 3/4/64
By JAJ/RDM

Manufacturer Hamilton Manufacturing Company
Unit Tested Unit System File with Tracing Lifter
Test Description Retrieval and refiling of individual overlays from one pile of 100 overlays in Drawer 5. Numbers NOT backed.

Material Overlays
Quantity 100
Size 22 x 25 x 0.005 inches
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Average Time Both
1	Subject handed card with item number - walked 10 feet tc unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(52) 45	(40) 46	(60) 27	(48) 26	(56) 43						37	36
		RT	B	(20) 44	(10) 26	(44) 36	(90) 40	(80) 30						35	
2	Subject took item from pile - walked 10 feet to unit - refiled item - walked 10 feet back to starting point.	RF	A	(80) 37	(60) 36	(48) 41	(90) 45	(52) 37						39	39
		RF	B	(44) 44	(10) 39	(20) 31	(56) 35	(40) 42						38	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport; (xx) - No. of Item RT and RF

Comments and Observations

1. Static electricity causes overlays to stick together, complicating removal.
2. Tracing Lifter must be used to remove weight from sheet being removed.
3. Weight of overlays made operation of Tracing Lifter difficult.
4. Overlays have tendency to slide around in drawer.

Table

RETRIEVAL & REFILING TIMES

Sheet 26 of 31
Date 3/4/64
By JAJ/RDM

Manufacturer Hamilton Manufacturing Company
Unit Tested Unit System File with Tracing Lifter
Test Description Retrieval and refiling of individual overlays from two piles of 50 overlays each in same drawer. Numbers NOT backed.

Material Overlays
Quantity 100 (Two piles of 50 each)
Size 22 x 25 x 0.005 inches
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(10) 31	(56) 26	(40) 27	(52) 32	(90) 43						32	35
		RT	B	(48) 38	(60) 44	(80) 43	(20) 33	(44) 35						39	
2	Subject took item from pile - walked 10 feet to unit - refiled item - walked 10 feet back to starting point.	RF	A	(52) 27	(40) 33	(56) 29	(10) 26	(44) 35						30	36
		RF	B	(90) 45	(20) 45	(60) 38	(48) 43	(80) 35						41	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport; (xx) - No. of Item RT and RF

Comments and Observations

1. Overlays slide around in drawer - piles become intermixed.
2. Overlays in left pile got caught in tracing lifter and were damaged.

Sheet 27 of 31
Date 3/5/64
By JAJ/RDM

Table

RETRIEVAL & REFILING TIMES

Manufacturer Hamilton Manufacturing Company
Unit Tested Unit System File with Tracing Lifter
Test Description Retrieval of individual overlays from 2 piles of 50 overlays each in same drawer, but misfiled (within ± 10 of proper location). Numbers NOT backed.

Material Overlays
Quantity 100 (2 piles of 50 each)
Size 22 x 25 x 0.005 inches
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Sub-ject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(60) 36	(52) 30	(90) 45	(80) 34	(56) 60						41	38
		RT	B	(20) 38	(44) 30	(10) 38	(48) 38	(40) 30						35	
2			A												
			B												

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport; (xx) - No. of Item RT and RF

Comments and Observations
1. This test was run to verify that misfiled overlays cause an increase in retrieval time.

E. PHOTOGRAPHIC PRINTS

Sheet No.			Quantity	
28	Art Metal, Inc.	Planfile Drawer Unit	100	Center of drawer 2 Folders - 50 each
29	Art Steel Company	Steelmaster Filing Cabinet	100	Center of drawer 2 Folders - 50 each
30	Art Metal, Inc.	Open File Shelving	100	2 Folders - 50 each
31	TAB Products Company	Unit Spacefinder	100	2 Folders - 50 each

Table

RETRIEVAL & REFILING TIMES

Sheet 28 of 31
Date 3/5/64
By JAJ/RDM

Manufacturer Art Metal, Inc.
Unit Tested Planfile Drawer Unit
Test Description Retrieval and refiling of individual photographic prints from center section of top drawer - 50 photos placed in each of 2 adjacent folders.

Material Photographic Prints
Quantity 100 (50 each in 2 folders)
Size 9-1/2 x 10 x 0.010 inches
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Average Time Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(20) 17	(10) 18	(90) 15	(56) 18	(60) 19						17	18
		RT	B	(52) 19	(48) 15	(44) 20	(40) 20	(80) 13						18	
2	Subject took item from pile - walked 10 feet to unit - refiled item - walked 10 feet back to starting point.	RF	A	(60) 18	(56) 15	(90) 16	(10) 16	(20) 15						16	16
		RF	B	(80) 15	(40) 16	(44) 17	(48) 21	(52) 14						17	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport; (xx) - No. of Item RT and RF

Comments and Observations

1. Spring tension keeps photos tightly held, thus making fanning within the drawer difficult - folder had to be partially pulled up out of drawer in order to fan photos.

Table

RETRIEVAL & REFILING TIMES

Sheet 29 of 31
Date 3/6/64
By JAJ/RDM

Manufacturer Art Steel Company
Unit Tested Steelmaster Filing Cabinet

Test Description Retrieval and refiling of individual photographic prints from center section of top drawer 50 photos placed in each of 2 adjacent folders.

Material Photographic Prints
Quantity 100 (50 each in 2 folders)
Size 9-1/2 x 10 x 0.010 inches
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Sub-ject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(56) 19	(90) 13	(40) 13	(44) 14	(48) 14						15	14
		RT	B	(52) 15	(60) 16	(80) 14	(20) 13	(10) 14						14	
2	Subject took item from pile - walked 10 feet to unit - refiled item - walked 10 feet back to starting point.	RF	A	(48) 14	(44) 13	(40) 16	(90) 12	(56) 18						15	14
		RF	B	(10) 17	(20) 13	(80) 15	(52) 14	(60) 11						14	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport; (xx) - No. of Item RT and RF

Comments and Observations

1. Photos were not compressed tightly in drawer, thus allowing fanning for easy location.

Sheet 30 of 31
Date 3/6/64
By JAJ/RDM

Table

RETRIEVAL & REFILING TIMES

Manufacturer Art Metal, Inc.

Unit Tested Open File Shelving

Test Description Retrieval and refiling of individual photographic prints from one of two adjacent folders, supported at 2-inch intervals.

Material Photographic Prints

Quantity 100 (50 each in 2 folders)

Size 9-1/2 x 10 x 0.010 inches

Subjects A JAJ

B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(56) 12	(90) 11	(40) 12	(44) 11	(48) 13						12	12
		RT	B	(52) 13	(60) 11	(80) 12	(20) 13	(10) 14						13	
2	Subject took item from pile - walked 10 feet to unit - refiled item - walked 10 feet back to starting point.	RF	A	(52) 11	(60) 13	(80) 11	(20) 11	(10) 11						11	12
		RF	B	(56) 14	(90) 11	(40) 11	(44) 13	(48) 12						12	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport; (xx) - No. of Item RT and RF

Comments and Observations

1. Photos not compressed, allowing fanning for easy location.
2. Spacers at 1-inch intervals would give more support to folders.

Table

RETRIEVAL & REFILING TIMES

Sheet 31 of 31
Date 3/9/64
By JAJ/RDM

Manufacturer TAB Products Company
Unit Tested Unit Spacefinder
Test Description Retrieval and refiling of individual photographic prints from one of two adjacent folders supported at 2-inch intervals.

Material Photographic Prints
Quantity 100 (50 each in two folders)
Size 9-1/2 x 10 x 0.010 inches
Subjects A JAJ
B RDM

Test No.	Specific Test Conditions	Test Code	Subject	Test Number 1	2	3	4	5	6	7	8	9	10	Average Time Each	Average Time Both
1	Subject handed card with item number - walked 10 feet to unit - retrieved item - carried item 10 feet back to starting point.	RT	A	(10) 13	(20) 14	(80) 14	(60) 11	(52) 12						13	13
		RT	B	(48) 13	(44) 15	(40) 13	(90) 14	(56) 12						13	
2	Subject took item from pile - walked 10 feet to unit - refiled item - walked 10 feet back to starting point.	RF	A	(48) 11	(44) 12	(40) 12	(90) 11	(56) 15						12	12
		RF	B	(10) 12	(20) 14	(80) 12	(60) 13	(52) 10						12	

Test Code: (RF) - Refile; (RT) - Retrieval; (TR) - Transport

Comments and Observations

1. Photos not compressed tightly allowing fanning for easy location.
2. Friction causes more than one photo to come forward when pulling from shelf.