WADC TECHNICAL REPORT 59-746 960 500

MICROFILM APERTURE CARD SYSTEM

Thomas H. Korte
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Directorate of Engineering Standards

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WRIGHT AIR DEVELOPMENT CENTER

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Project 2079

WRIGHT AIR DEVELOPMENT CENTER
AIR RESEARCH AND DEVELOPMENT COMMAND
UNITED STATES AIR FORCE
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

400 – February 1960 – 22-602

FOREWORD

This report was initiated by the Directorate of Engineering Standards, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio. The research and development work was undertaken by the Directorate of Engineering Standards after completion of a feasibility study by the Remington-Rand Division of Sperry-Rand Corporation in conjunction with the Directorate of Engineering Standards. The report of the study was written by Charles J. Hyle of Remington-Rand.

The study confirmed the theory of the Directorate of Engineering Standards that the solution to the overall engineering drawing handling problem was the combination of microfilm and automatic data processing into a single, integrated, automated, system. Mr. Andrew G. Adman and Mr. Marvin G. Toll of the Directorate of Engineering Standards worked in close cooperation with the industrial engineers of Remington-Rand in reducing the theory to concrete evidence, and arranging that evidence in intelligible report form. The report carries no contractor number.

The evolution of the system and production of the hardware was conducted under ARDC Research and Development Project 2079. The project was assigned to the Directorate of Engineering Standards, Wright Air Development Center.

One of the authors, Mr. Thomas H. Korte, was project engineer.

Sincere appreciation is expressed for the generous assistance and cooperation rendered by Colonel Charles F.H. Begg, Director of Engineering Standards and his staff. The cooperative effort of the Department of the Army in the person of Mr. Frank Borden, and the Department of the Navy through Mr. George Hamp is also deeply appreciated.

The cooperative and material effort of several commercial organizations contributed greatly to the success of this R&D venture. The names of the individuals and their employing facilities are as follows:

Henry Leuke, Remington-Rand, Dayton, Ohio for systems guidance and no-cost loan of equipment

Mr. D.W. McArthur, Filmsort Company, Pearl River, New York for technical assistance and no-cost supplies

Mr. C.J. Cardona, Cardo Company, North Hollywood, California for capable and generous engineering assistance

Messrs. Giles Wilkinson, William Townsend, and Robert Kennedy, Recordak Corporation, Washington, D.C. and Dayton, Ohio for permission to reprint their glossary, as well as for rent-free use of certain equipment

Messrs. Peter DeFlorez, Edward Smith, Frank Anastasio, and Wallace Fields, DeFlorez Company, Englewood Cliffs, New Jersey for their engineering ability as well as for their patience during the initial design phases of the electronic microfilm camera

The Ozalid Corporation, Johnson City, New York and the Three M Company, Minneapolis, Minnesota for use of illustrative photographs

Without the able assistance of each of the above mentioned people and concerns, the success of the project would have been infinitely more difficult of achievement.

The initial probing investigation leading to the R&D project was begun in 1953. The project termination date was November 1959. Individual dates for completion of R&D phases are contained in the applicable sections of the report.

ABSTRACT

This report defines the work accomplished under ARDC Research and Development Project 2079. It explains in detail a new method for the storage, reproduction, and distribution of engineering drawings and associated data. This new method is known as the Microfilm Aperture Card System. It combines the advantages of microfilm with the operational precision and speed of automatic tabulating equipment (EAM). The system overcomes the problems of excess storage-space and shipping-weight as well as the problems of high-cost and low-output-rate formerly associated with comprehensive handling of engineering drawings.

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:

Charles F.H. Begg

CHARLES F.H. BEGG
Colonel, USAF
Director of Engineering Standards

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OTHER DEPT. OF DEFENSE ACTIVITIES

Air Force

Cys	
5	Hq USAF Wash 25, D.C.
10	ARDC (RDR) Andrews AFB Wash 25, D.C.
2	AFBMD (Maj Boland AF Unit Post Office Los Angeles 45, Calif
2	AFCRC (Mr. Battles) L.G. Hanscom Fld Bedford, Mass
2	AFFTC Edwards AFB, Calif
2	AFMDC Holloman AFB, N. Mex
2	AFMTC Patrick AFB, Fla
2	AFSWC (Maj Holwell) Kirtland AFB, N. Mex
2	APGC (Mr. R.S. Wogan) Eglin AFB, Fla
2	Arnold Engr Dev Cen Tullahoma, Tenn
2	RADC (Mr. Gutman) Griffiss AFB, NY
25	ASTIA Arlington Hall Sta Arlington 12, Va
5	ADC Ent AFB Colo Springs Colo
5	ATC Randolph AFB Tex
5	AU Maxwell AFB Ala
5	CONAC Mitchel AFB NY
5	MATS Scott AFB Ill

Cys	
5	SAC Offutt AFB Nebr
5	TAC Langley AFB Va
5	USAFSS San Antonio Tex
5	USAFA United States Air Force Academy Colo

ARMY

10	Department of the Army Washington 25, D.C.
10	Signal Equipment Support Agency Fort Monmouth, New Jersey

NAVY

10	Department of the Navy Washington 25, D.C.
10	Bureau of Aeronautics ATTN: Miss Ruth Christie Washington 25, D.C.

OTHER U.S. GOVERNMENT AGENCIES

2	Library of Congress
2	National Bureau of Standards Washington 25, D.C.
10	Aeronautical Standards Group Washington 25, D.C.

NON-GOVERNMENT INDIVIDUALS AND ORGANIZATIONS

1	Mr. Carl Nelson Bell Laboratories West Street New York, New York

Cys	
1	Mr. Wm. Magill Western Electric Co. Kearney, New Jersey
2	Mr. Robert Franciose General Electric Co. Schenectady, New York
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1	Mr. C.J. Cardona Cardona Co. 6857 Farmdale Ave. North Hollywood, Calif
4	Mr. Giles Wilkinson Recordak Co. Washington, D.C.
1	Mr. Peter DeFlorez DeFlorez Co. Inc. 200 Sylvan Ave. Englewood Cliffs, N.J.
1	Dr. Vernon D. Tate Executive Secretary National Microfilm Association P.O. Box 386 Annapolis, Maryland
1	Mr. Richard deBronkhart Ozalid Division General Aniline & Film Co. Johnson City, New York
3	Dr. John Dessauer Haloid-Xerox Corp. Rochester, New York
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1 Mr. Russell Ellsworth
Datagraphic Systems Inc.
850 Pico Blvd.
Santa Monica, Calif

5 Engineering Societies Library
29 W. 39th Street
New York, New York

CHAPTER I - GENERAL

CHAPTER I - GENERAL

ILLUSTRATIONS

1. PROLOGUE:

a. Solutions must be sought for problems. Such problems exist or have an insidious way of developing by themselves. This section of the report is devoted to a brief delineation of the evolution of a system which solves a problem, and the research and development required to make the evolved system operational. The purpose of this report is to acquaint the reader with a solution to a problem--The Microfilm Aperture Card System.

b. The Microfilm Aperture Card System is a new concept in the storage, reproduction, and distribution of engineering drawings. This new system has been developed by the Directorate of Engineering Standards, Wright Air Development Center, Air Research and Development Command.

2. THE PROBLEM:

a. The problem, simply stated is the inability to distribute the mass of engineering data required by modern air and space vehicles, in a timely manner, using antiquated machinery and methods. Engineering intelligence conceived and refined by engineers, is set forth on engineering drawings. An original engineering drawing is in existence for one purpose, that of being duplicated in order that the intelligence contained thereon may be transmitted to whosoever may require it. The simple problem of timeliness and mass then expands to one of timeliness, mass, storage, retrieval, reproduction, and distribution. Add to the foregoing the requirement of maintaining an acceptable level of drawing legibility regardless of the generation of the reproduction, and the problem is well defined.

b. It is unfortunate that the rapidly advancing state-of-the-art of the Air Force's military weapons and sustaining equipment has not, in the past, been matched with an equally advanced technology for dissemination of engineering data. The present day methodology can be defined as that of 1900 AD vintage, employing the blueprint machine and its resultant full size paper prints.

c. Prior to the advent of World War II the requirement for engineering drawings within the Air Force was relatively low. All drawing reproduction was accomplished at Wright-Patterson Air Force Base and the distribution was made to Field Service Depots. The principal methods used to reproduce engineering drawings were vandyking and blueprinting. First the original drawing was duplicated in a vandyke machine which yielded a translucent printing master. This was then duplicated as many times as necessary by means of a blueprint machine which yielded opaque reference prints. Basically, the old system work flow was as follows: vandyke drawing copies from the United States aircraft industry-this included aircraft, engines, accessories, electronics, and ground equipment-were furnished to the Air Force Central Drawing Repository and thence to the users through the blueprinting department at WPAFB. The methods and equipment were capable of satisfying the Air Force requirements for engineering drawings.

d. Participation of the United States in World War II caused a sharp increase in the requirement for engineering drawings. The available equipment was overtaxed. Blueprinting and vandyking were the only means available for mass reproduction of engineering drawings. The backlog of requests for drawings continued to rise. The only avenue of approach to meet the challenge was to attempt to overpower the requirements with more machines and more people. Twenty-seven blueprint machines were installed at WPAFB and operated around the clock by three, eight-hour shifts. The demands for engineering drawings continued to rise. Forty-two commercial reproduction companies were engaged full time to assume the load. Ten million square feet of blueprints were produced and distributed weekly, but despite this gigantic effort, much time elapsed between receipt of the drawing from the manufacturer and eventual receipt of the print by the using activity. During this time constant search was made for a means of breaking this monstrous backlog. The most promising approach seemed to lie in the direction of microfilm. It was believed that microfilm, due to its comparatively insignificant bulk and light weight could be rapidly airborne to those areas requiring data.

3. EARLY PLANNING:

a. An archieval microfilm program had been initiated at Wright-Patterson AFB in 1941 for the protection of rapidly deteriorating drawings of Air Force equipment. This archieval program, per se, was not suitable for use as a method of producing and distributing active engineering data but it was a place to start. Day and night effort was expended in modifying and converting it into a useable system.

b. The final plan evolved called for the use of 100 ft rolls of thirty-five millimeter microfilm and book-form paper indexes. Each roll contained an average of 750 drawings. The index contained drawing numbers in sequence, reference to the roll on which each drawing was recorded, and information pertinent to the drawings on the film. This system was partially successful in that great quantities of drawings were distributed in a minimum of time, using minimum shipping space. Microfilm sets were maintained in current status with the latest revisions of the drawings by periodically refilming new and revised drawings on new rolls. The new rolls continued the sequence of the basic set. The paper index was revised by creating new sheets which listed the revised drawings. The addition of new rolls of film and new index sheets to the basic issue, eventually led to confusion. The only method of alleviating the confusion was to periodically refilm the entire drawing file in current status and instruct the user to discard previous issues. This was workable but expensive.

c. The factors preventing the roll microfilm system from becoming an unqualified success were threefold:

(1) Limited availability of viewing equipment.

(2) Inability to keep the file current with drawing revisions in a practical manner.

(3) Nonavailability of a practical or readily available means of making quantities of enlarged paper prints from microfilm.

Microfilm itself, however, still remains as the most feasible means of modernizing the drawing reproduction system and its associated handling problems. In view of the increasing complexity of our air-space vehicles, and the increasing number of engineering drawings required to support them, a new drawing reproduction and handling system was no longer a desire, it was mandatory. In order to employ microfilm as the medium, the obvious answer was to discover or develop a method of handling frames of microfilm individually.

4. SYSTEM EVOLUTION:

a. With an established roll microfilm system in operation, its advantages and disadvantages could be qualitatively assessed. Desirable features were studied and retained to form the basis for the system to be developed. Consideration was given to mounting individual frames of microfilm in commercial 2 x 2 inch slide holders, using commercially available production equipment. This approach was soon discarded. While the microfilm frames, and the drawings contained thereon, were established as entities, an impossible filing, identification, and retrieval situation was created. It was now apparent that the known properties of microfilm would have to be combined with a proven system of data storage and retrieval. The EAM tabulating card, the most generally known method of electro-mechanical data handling, was studied and eventually proved to be the most acceptable and easily adaptable medium for the purpose intended. By using an EAM card as a holder for a frame of microfilm, the individuality of the drawing was established; by punching and interpreting information pertinent to the drawing on the face of the card, identification was assured; by using standard punch card machinery, retrieval was not only guaranteed but the process was accelerated many hundred-fold over the manual method. The microfilm insert is a reproducible master in itself, so all that remained to be done was develop equipment to mount the frames of film into the cards, make enlarged paper copies of the microfilm, and make duplicate copies of the film after mounting.

b. Now let us consider the results of research in comparison with the problem to be solved. By using the aperture tabulating card drawing file mass is reduced to approximately two percent of the mass of a full size drawing file; a large variety of commercial storage cabinets is available, and storage is no problem after the mass has been reduced; retrieval and timeliness are solved completely by use of high speed automatic tabulating equipment; reproduction and duplication equipment, and formulation of a system for Air Force-wide implementation remains to be developed.

5. THE NEW SYSTEM:

a. Recognizing the need, the Directorate of Engineering Standards assumed responsibility for the development of this completely new concept

in the handling of engineering drawings--The Microfilm Aperture Card System--. An account of the research and development effort is set forth in this final report. It is the end result of much planning, research, development, testing, and evaluation.

b. First of all what is a microfilm aperture card? A microfilm aperture card is a common, ordinary tabulating punch card. A rectangular hole or aperture is die-cut into this card. The hole is edged with a narrow, transparent adhesive ledge. To this adhesive ledge is affixed a segment, or frame, of microfilm containing a transparency of an engineering drawing. Factual information pertaining to the drawing, such as drawing number, drawing revision, security classification, et cetera, is punched into the card and automatically printed along the top edge. Figures 1 and 1A are illustrations of complete aperture cards in the Remington-Rand and IBM formats. These microfilm aperture cards will be used to replace our current vandyke reproducibles and blueprint reference files. We will continue to generate paper prints when needed but we will do it by enlargement from the microfilm.

c. It was foreseen that this new medium of engineering drawing handling would be employed throughout the Department of Defense, not only by the Air Force. For that reason certain standardized procedures had to be established. Together with the standard practices, a basic economy had to be built into the system. A minimum number of standardized reduction ratios, at which drawings will be filmed, is an absolute necessity in devising a system such as this. Upon this selection depends economy of operation, ability to interchange data between services, and practicability of implementation. Two reduction ratios were selected, 16-1 for drawings up to and including "C" size or 17 x 22 inches; and 29-1 for drawings larger than 17 x 22 inches. This selection was made for two reasons:

(1) It permitted the design of print-back equipment containing only one optical unit, rather than a turret system.

(2) The resultant enlarged prints would fit on sensitized paper which was already stock listed in the Federal System.

The enlargement ratio selected for enlarging print-back is 15-1. Almost full size prints are yielded by the film made at the 16-1 ratio, while slightly larger than half size prints are produced from the film exposed at the 29-1 ratio. Commercial study and practical application was used to advantage in final selection of the half-size print. Several of the larger aircraft manufacturers had studied the possibilities and then installed the practice of employing half-size shop and reference prints. It was determined that the use of legible, half-size prints is advantageous in many ways in addition to the reduced cost of preparation. Acceptance of the change from full size prints is simply a matter of communication and education. A vigorous educational campaign within their own plants has paid off handsomely for many commercial organizations.

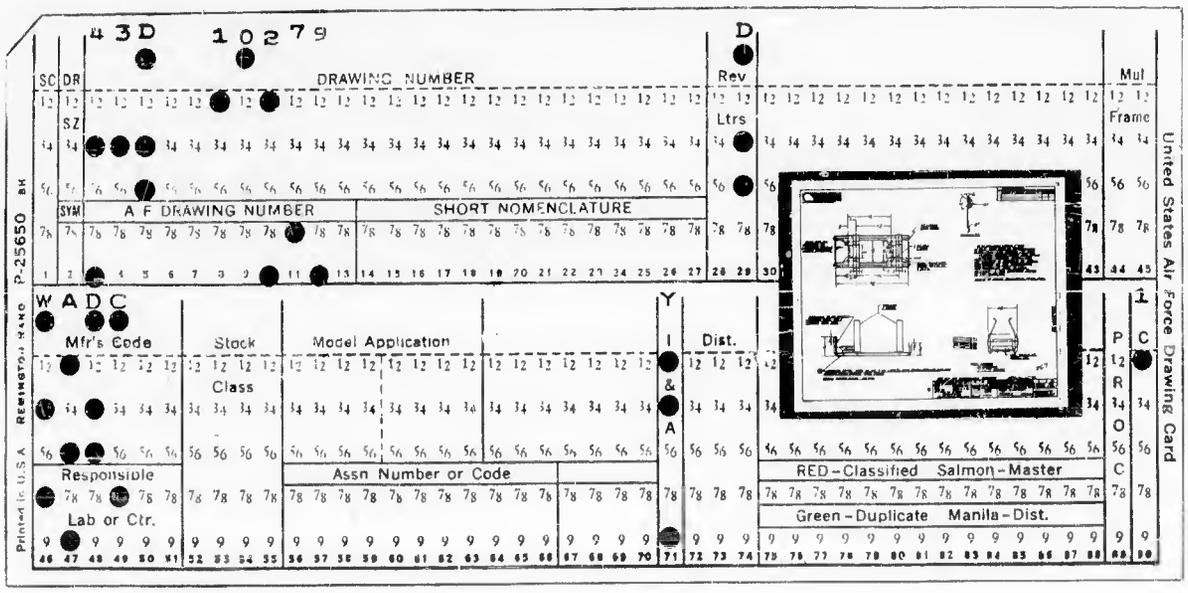


Figure 1. Remington Rand Format

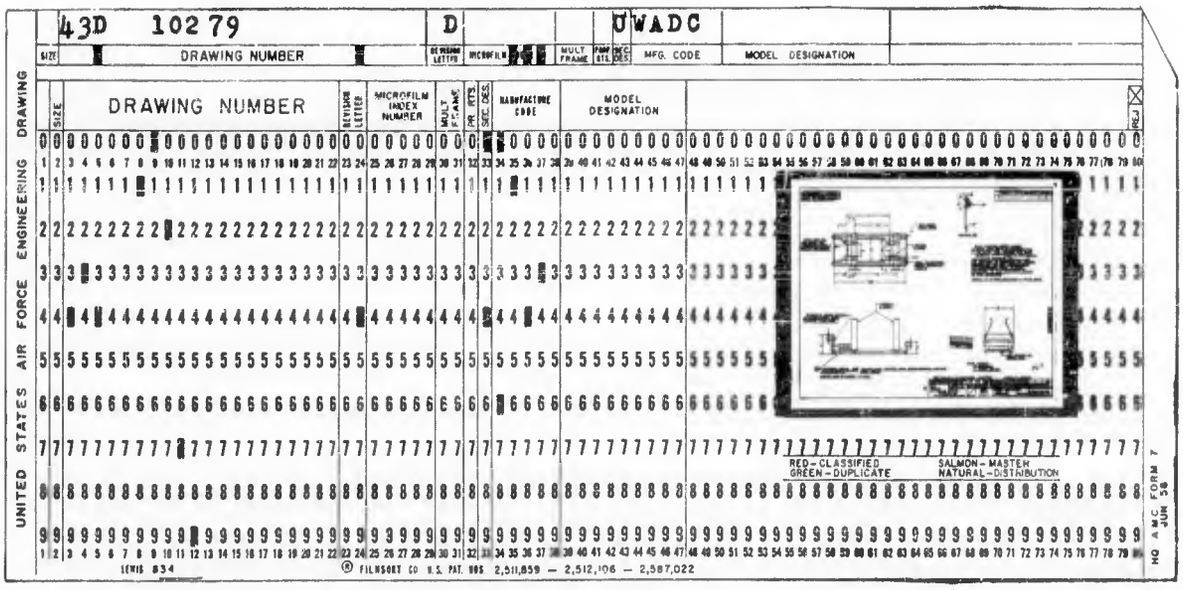


Figure 1A. IBM Format

There are no technical drawbacks to using the same techniques within government agencies. It is relatively simple for modern microfilms to clearly record and separate characters as small as one thirty-second of an inch or lines one sixty-forth of an inch apart. In terms of resolution, modern microfilm will separate two hundred lines per millimeter. It is realized that there will be some poor drawings on film in the new system as there are poor drawings on paper in the present system. This is a function of drafting practices and the enforcement thereof rather than the fault of the system. Therefore, acceptance of the system by government agencies depends upon the efficiency of communications and education.

d. The new system will operate basically as follows: instead of furnishing full size vandykes of drawings by contract, the aircraft and supporting industries of the United States will furnish microfilm and punched tabulating cards to the central Air Force automation control. From these, master microfilm aperture cards will be generated for the Air Force Central Drawing Repository.

e. The master aperture cards will be reproduced as many times as required and then will be distributed to the using activities. Commercially available microfilm viewers can be used for reading the film, or if a maintenance activity requires a reference or shop print, such a print can be reproduced in one minute or less on equipment now available. If a large number of prints is needed, as in the case of multiple procurement bid sets, the multiple prints can be made faster and more economically than ever before. The new system will provide engineering drawing support in potential emergencies, as well as satisfy routine needs during nonemergency operation. Emergency support is realized by employing a reproducible drawing in microfilm form adapted to existing automation equipment.

6. ADVANTAGES OF THE NEW SYSTEM:

a. Now let us consider some advantages of the new system. Normally when planning and developing a system that will function adequately in case of emergency conditions, cost is of minor consideration. In this case, however, the operating cost of the system is one of its more attractive facets. It was stated earlier that the microfilm aperture card will replace the vandykes so let's compare prices. The average size vandyke, or drawing, in the Air Force system is three and one-half square feet in area. This average size vandyke costs the Air Force one dollar and seventy-five cents. A completed aperture card of the same drawing will cost approximately fifteen cents. This saving is in the cost of master reproducibles only.

b. There is also a monetary savings in facilities, personnel, and equipment. Connected with this economy is the addition of speedier service. Today, one blueprint machine requires a minimum crew of three people. The high speed printer used for making multiple bid set copies in the new system will require only one person. The first models of these high speed printers

will have a work output equivalent to three blueprint machines, thus one person is doing the work of nine. Admittedly the one person involved must be more highly skilled than a blueprint machine operator, but the salary of one skilled person is only a fraction of the salary of nine unskilled people. Furthermore, the new printer requires only electrical service, while blueprint machines require electrical, water, and sewer connections. The new printer occupies approximately one fourth of the cubic area occupied by one blueprint machine. As the state-of-the-art progresses the output rate of these new printers will increase. The reduction in operating costs and increase in speed are not the only benefits derived from the new system. The storage space for drawings in the Air Force Central Repository is reduced from the 25,000 square feet necessary under the present system to 500 square feet required by the new system. File duplication is eliminated because the microfilm aperture card file combines the locator card file, the reference file, and the reproducible file into one compact unit, occupying only two percent of the area of a single paper print file.

c. Legibility of the end item, which in this case is the print of a drawing sent to a prospective bidder or the man in the shop, is inseparably a function of the legibility of the original drawing made by the draftsman. However, due to the utilization of proper supplies for the end item desired, and due to the fewer intermediate steps necessary the new system does offer end prints of considerably increased legibility. After having completed the necessary steps or generations of reproduction to get a print into the hands of a prospective bidder, fifty percent of the legibility of the original drawing is lost under the present system, while approximately ten percent will have been lost under the new system. The loss in legibility may appear to be an insignificant factor when related to new, sharply defined, drawings where a loss of fifty percent still yields entirely satisfactory working prints. Unfortunately most of the drawings used in the Air Force are not new. The minimum gain of forty percent in legibility to a great extent means the difference between being able to positively read a drawing or discerning and adducing that which might be on a drawing.

7. NECESSARY R&D:

a. In order to put this new system into operation it was necessary to determine what equipment would be required. In some areas handling equipment did not exist. This was a pioneering effort. It is true that equipment has existed for many years in the automation phase to which the drawing phase was to be joined, but in order to complete the system, development of certain other equipments was necessary. In order to visualize the equipment requirement, it was necessary to consider the many probable applications in the complex Air Force. Knowing full well that the success or failure of a theoretically profitable system hinged on the equipment developed, procurement exhibits were carefully written and contracts were initiated for prototype hardware. The tests of the prototype machines were highly encouraging and dictated to a large extent the configuration and mechanism of the final items needed to meet Air Force requirements.

b. A complete listing of the equipment developed under ARDC Research and Development Project 2079, The Microfilm Aperture Card System, together with photographs and detailed explanations are contained in the next section of this report.

c. As previously stated, commercial equipment of the type required for Air Force implementation of the microfilm aperture card system did not exist at the time that the original R&D effort was initiated. However, during the past two years many new commercial items have been marketed which have reduced the number of items requiring Air Force development. Furthermore, the impetus imparted to development of the aperture card system by governmental participation, has awakened industry to the fact that microfilm is the coming medium. Industry is now demonstrating such an interest in equipment necessary in the handling of microfilm mounted in tabulating cards, that the market of available equipment is expanding into the type of competition normally expected of American industry. The end result is that the modern engineering drawing handling system described in this report can look forward to constantly improving items of equipment which will continue to enhance the system for years to come.

d. As this final report is being written, the most important item worthy of note, is the fact that now, today, all of the equipment necessary to permit immediate and complete Air Force-wide implementation of the Aperture Card System is available for procurement. It is available through GSA schedule, government specification, or off-the-shelf commercial inventory.

8. CONTRACTOR SERVICE:

Realizing that contractor services might be desirable to certain Air Force installations for the creation and/or duplication of microfilm aperture cards, a test contract was let for the purpose of insuring that industry had the capability of supporting this new Air Force requirement. The contract resulted in the satisfactory creation of approximately 400,000 microfilm aperture cards. The data and experience thus gained provided material aid in preparation of the final microfilming specification. Today, every major microfilming service company offers complete aperture card service.

9. INTRODUCTION TO REPORT:

The following sections in this report attempt to provide a complete summary of the equipment development; recommended method and techniques for converting the Air Force Central Drawing Repository; application of the new system to various Air Force organizations; available commercial equipment; and the supplies available both commercially, and currently carried in Air Force supply inventory. Should additional or more specific information be required, it may be obtained by writing to the following address:

WADC (WCXE)
Wright-Patterson AFB Ohio

CHAPTER II - EQUIPMENT DEVELOPMENT

CHAPTER II - EQUIPMENT DEVELOPMENT

ILLUSTRATIONS

CHAPTER II

EQUIPMENT DEVELOPMENT

INTRODUCTION.- This chapter of the final report on the Microfilm Aperture Card System presents a complete listing of all of the equipment developed under ARDC Project 2079. Photographs of each item, together with a short description, appear in sequence by task number. Included in this chapter is a partial list of items developed commercially to support aperture card installations. Some of these items are now competitive to the government developed equipment. It must be acknowledged that the list of commercial equipment is not complete. It is expanding and changing daily, and would be a full time job to maintain a current file.

Since this is primarily a technical account of the progression of ARDC Project 2079, accent will be placed on government developed equipment. Commercial developments will be described as necessary to lend continuity to the narrative.

Before equipment development could be undertaken, certain guide lines had to be established, certain variables had to be converted to constants, and whenever possible, standard federal stock listed supplies had to be considered in order to satisfy one of the keystones of the system, i.e., economy of operation.

An ad hoc committee was formed which included representation by the three departments of the Armed Services. The purpose of this committee was to ascertain requirements; resolve or compromise differences; establish common interpretations of specific areas; and establish common ground rules. The three well known sizes of microfilm, 16mm, 35mm, and 70mm were considered and subjected to tests. The 35mm was accepted as having the greatest number of inherent advantages and presenting the least number of obstacles to overcome. Not the least of the inherent advantages of 35mm film is its universal availability and its international use as a media for disseminating intelligence. The international attribute is particularly valuable because it was foreseen by the committee that interchange of data between friendly nations would be facilitated. Another variable is the infinite number of reduction ratios available when converting engineering drawings to microfilm. In order to standardize procedures and orient the thinking relative to development of the projection equipment required to produce paper prints from microfilm, the reduction ratios of 16-1 and 29-1 were selected as having the greatest merit. All drawings measuring 17 x 22 inches, or smaller, would be filmed at the 16-1 ratio while all drawings larger than 17 x 22 inches would be filmed at the 29-1 ratio. The above formula permitted the use of a single enlargement ratio in the projection printing equipment. The enlargement ratio of 15-1 would yield essentially full size prints of the smaller drawings and half size prints of the larger drawings. The sheet size of the finished print could now be calculated, so all that remained of the problem was to fit standard, federal stock listed photo paper and associated processing chemicals into the picture. The 18 inch wide by 350 ft long rolls of rapid photocopy paper

in the federal supply system finished the picture admirably. Thus, economy was fostered without compromise of ideals. Less painstaking effort in the selection of reduction and enlargement ratios could well have forced the procurement of a non-standard paper, thereby abetting added expense rather than economy.

Another area of general acceptance resulting from the meetings of the ad hoc group was the selection of the size of the aperture to be placed in the tabulating card and the location of the aperture in the card. The resulting card format, now known as the Military Standard Aperture Card, has been so generally accepted that industrial giants such as Bell Telephone, Western Electric, and the General Electric Company, in addition to the aircraft and engine industries have accepted it for internal use. This unified position on card format permits interchange of engineering data between the services without the necessity of procuring specialized equipment.

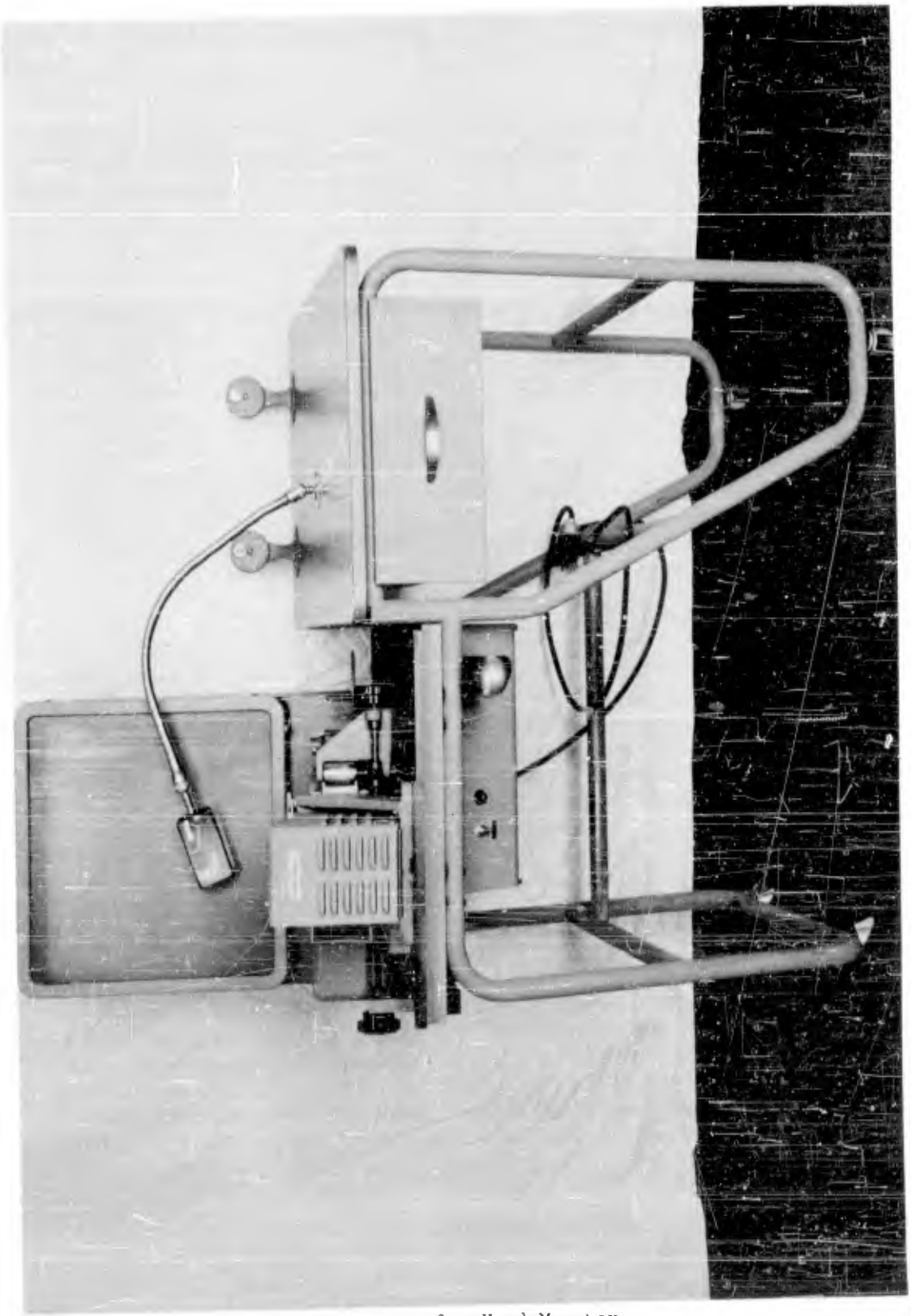


Figure 2. Hand Mounter

1. HAND OPERATED MICROFILM MOUNTER (SEMI-AUTOMATIC) TASK 20790

a. OBJECTIVE:

This task had the objective of developing an item of equipment to permit hand mounting of 35mm microfilm frames into EAM aperture cards. A quantitative objective of 125 mounting operations per hour was initially established.

b. DESCRIPTION:

The item resulting from this task, (see Figure 2) is a low output rate mounter used principally for mounting master negative film where possible machine damage must be completely eliminated, and visual coordination between film and interpreted aperture cards must be maintained. The film is positioned one frame at a time and the operator manually positions the unmounted aperture card, triggers mounter thus completing operation of mounting one card. The estimated production output for this machine when operated by a trained operator is 125 cards per hour. This item, known as Filmsort Model F603.6 is currently available from Filmsort distributors.

c. DEVELOPMENT SUMMARY AND BACKGROUND:

The initial contract for construction of a hand mounter, awarded under an exhibit embodying minimum design requirements, resulted in production of prototype equipment. Evaluation of the prototype mounter at WADC was followed by complete revision of the original design exhibit. A second contract was awarded for construction of three service version hand mounters which, after testing and evaluation, were accepted without modification. Conversion of engineering drawing data to the medium of card-mounted microfilm requires that minimum equipment be provided for integrating the film with the card supports. The production hand mounter developed under this task is designed to cut microfilm from rolls and to affix the individual film frames to adhesive mounts in aperture cards. While fulfilling the minimum equipment requirement for such film mounting, the hand mounter is intended to occupy primarily a support role, with the great bulk of film-to-card mounting being accomplished on automatic equipment such as that developed in Task 20793, this project. Prototype and service version equipments developed under this task were delivered to WADC, March and December 1955, respectively. Final acceptance has been made on both items.

d. REQUIRING ACTIVITIES:

This hand mounter will be required by all Air Force activities generating aperture card mounted microfilm. The only reason for non-use of this item is in the event that an Air Force activity elects to employ commercial contract services for the mounting operation.

e. AVAILABILITY:

This item is commercially available from all Filmsort distributors through GSA schedules.

f. SURVEY OF SIMILAR EQUIPMENT:

The Navy Department and the Army Signal Corps have obtained similar models of this mounter from the Filmsort Co. The main difference being that the Air Force model is actuated by a hand operated lever, while the other services item is actuated by a push button switch. This switch actuates an electrically controlled mounting stroke. Recently the manufacturer of this equipment (Filmsort) notified WADC that company R&D has resulted in many improvements to these mounters. All new improvements are incorporated into the series of mounters offered on GSA schedule. Filmsort is the only known source of aperture card mounting equipment.

g. TASK TERMINATION DATE:

Task 20790 covering this item was terminated by Management Report dated 17 Jan 1958 (MR-6).

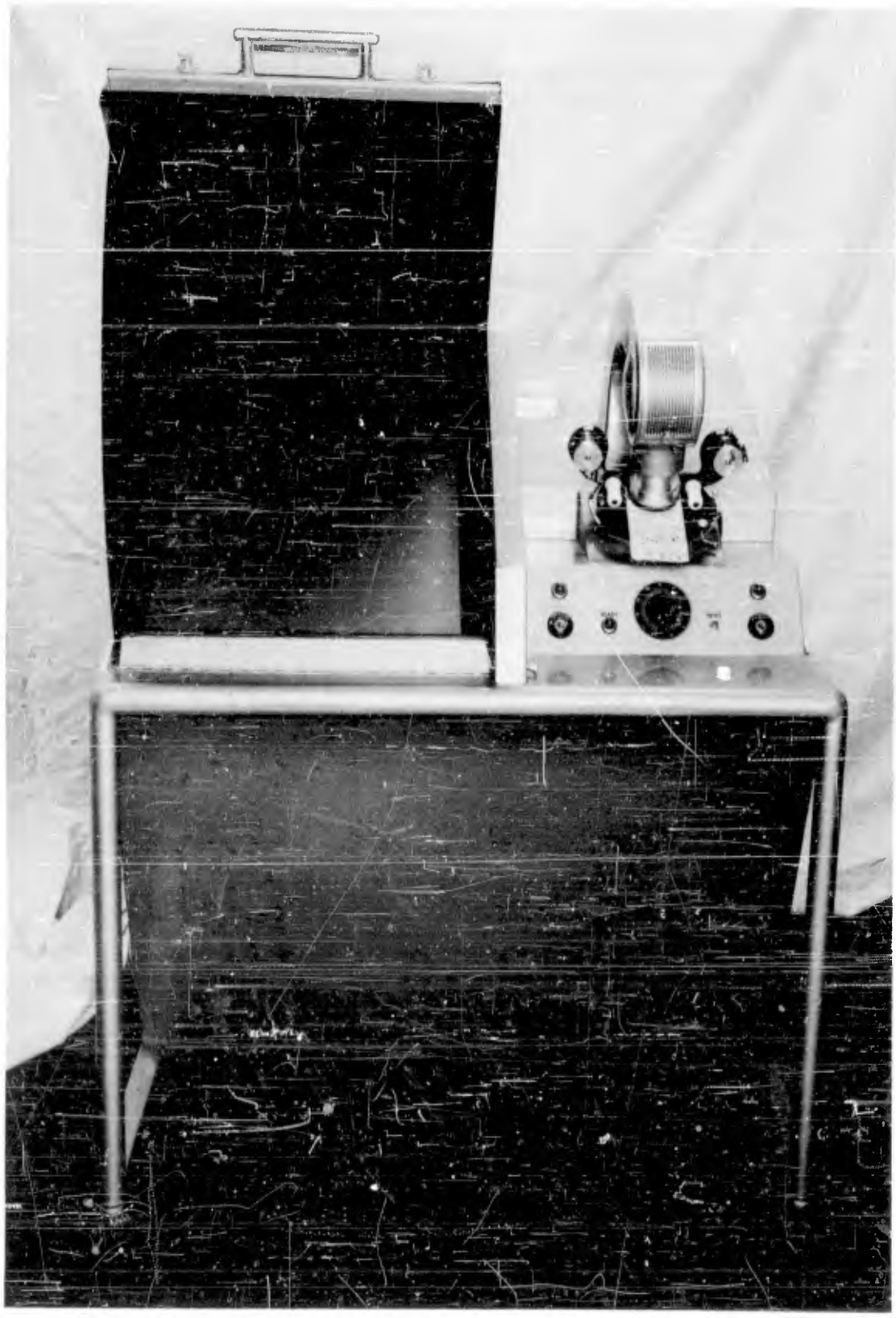


Figure 3. Cardo Viewer-Enlarger

Figure 4. Photostat Viewer-Enlarger

2. MICROFILM ENLARGER-PRINTER (VIEWER-ENLARGER) TASK 20791

a. OBJECTIVE:

The objective of this effort was the development of equipment which would combine in a single unit the viewing and photographic enlarging facilities required for routine microfilm handling. Upon implementation of the aperture program there will be a broad requirement for such equipment at all installations preparing or using microfilm engineering data. An original design objective was the development of a low cost item capable of using existing Air Force stocked items (paper and chemicals), thus alleviating the need of introducing additional stocks into the Air Force supply system.

b. DESCRIPTION:

This task resulted in the standardization of two items of equipment. These are identified as PRINTER-PROCESSOR-VIEWER, MICROFILM EN-44A, Specification MIL-P-26293(USAF)--(see Figure 3); and PRINTER-PROCESSOR-VIEWER, MICROFILM EN-45A, Specification MIL-P-26294(USAF)--(see Figure 4).

Each of these items combine into a single unit viewing and photographic enlarging capabilities. They make 18" x 24" photo paper prints from double frame 35mm microfilm containing engineering drawings. Designed for use primarily with microfilm mounted in Filmsort aperture cards, provision for accommodating roll microfilm is also included to furnish maximum versatility. A tab card containing the microfilm is placed in a projection head and the image is projected onto 18" x 24" viewing screen. If a print is desired, suitable controls are provided which will automatically expose, advance, cut, and process the paper into a final stabilized 18" x 24" copy of the desired engineering drawing. Both of these items utilize standard stock listed photographic chemicals. While the two items standardized as a result of this R&D task are similar they differ as follows:

EN-44A		EN-45A
	-DIMENSIONS-	
41"	Width	32"
56"	Length	58"
48"	Height	70"
425 lbs	Weight	1400 lbs

EN-44A	EN-45A
-CHEMICAL CAPACITY-	
4 gallons	30 gallons
-AUXILIARY FACILITIES REQUIRED-	
Electric Service: 110 Volts AC 60 Cycles 15 Amps 1 PH	Electric Service: 110 Volts AC 60 Cycles 15 Amps 1 PH Chemical Mixing Tanks: 2-15 gallons each-minimum Nearby access to building sewer facilities
-PRINTING TIME-	
Each Print: 45 seconds	First Print: 2-1/4 minutes Each Successional Print: 15 seconds
-TYPE OF PRINT-	
Hard Copy Only	(1) Hard Copy (2) Transparent copy (for subsequent reproduction in blueprint and ozalid facilities if desired
-INTENDED USE-	
A low rate printer for making reference prints only	A medium rate printer for making reference prints and translucent copies for later use in blueprint reproduction

c. DEVELOPMENT SUMMARY AND BACKGROUND:

Prototype equipment adequate to demonstrate feasibility, was constructed by Remington Rand under subcontract to Dexter Folder Co. After rewriting the design exhibit to incorporate desired improvements, follow up contracts were awarded for construction of service version viewer-printers. Contract awarded to Cardo Co. called for construction of an improved automatic version of the viewer-printer in addition to a manual model also to be constructed by Photostat and Remington Rand.

Delivery and acceptance of service version equipments were as follows: Photostat---Received 13 May 1957, accepted 28 May 1957; Remington Rand---Received 27 Apr 1957, rejected; Received 3 Dec 1957, accepted 11 Dec 1957; Cardo Manual---Received 9 Dec 1957, accepted 19 Dec 1957. "In house" test and relative evaluation of each equipment has been accomplished. As a result of these tests and evaluations, the most desirable features of all the items were incorporated into the EN-44A and EN-45A printers, which were then standardized for Air Force use.

Figure 5. Viewer-Enlarger - Service Test Model

A service test model of the viewer-enlarger. It uses specially coated paper 17 inches wide by 20 yards. Uses special developing solutions. Opaque viewing screen.

d. REQUIRING ACTIVITIES:

In current vault operation, reproduction of engineering drawings for all required distribution purposes is accomplished on standard blueprint machines producing full size paper copy from vandyke masters. Because of its bulky nature, blueprinting equipment cannot be installed in the immediate area of the drawing vaults but must be placed in special facilities some distance away. When the microfilm aperture card system is implemented, blueprint machines will be entirely replaced by other types of reproduction equipment. It is planned that the viewer-enlarger equipment developed here will be used to fulfill all "in-house" requests for drawings (i.e., the limited copies required at an installation for engineering evaluation, minor maintenance, etc.). Bid set preparation and other multiple reproduction requirements, also to be disengaged from the cumbersome blueprint methods, will require new equipment of an automatic type, which will be considered under a different task heading (20795).

Viewer-enlarger equipment, as the name implies, is intended to serve a dual purpose....as a reproducing machine and also as an auxiliary film viewer. The viewer-enlarger is to be one of the most widely used items of equipment in the new aperture program. It will be required in quantity to fulfill drawing requests at the central vault, and also the equipment will be distributed to all AF installations that require engineering drawing data. Compact design will permit the viewer-enlarger to be operated adjacent to microfilm card files, avoiding the necessity for transporting file copies to other work areas. An additional advantage to the new equipment lies in the fact that reproductions will be only about one half the size of original drawings, which will permit a substantial saving in present paper consumption and in storage requirements.

Summarizing the potential of the viewer-enlarger in the new system operation, it is expected the equipment will: (1) Replace blueprint machines for preparation of "limited copy" reproductions, (2) Eliminate the need for specialized location of reproduction equipment, (3) Save wasted time in transporting original prints to some centralized blueprint department, (4) Combine the abilities of a viewer for checking the drawing detail (a reference file) with the abilities of a blueprint department (reproduction) into a compact unit, and (5) Reproduce drawings to half scale to save paper and space.

Figure 6. 3-M Reader-Printer

(1)

3-M BRAND MICROFILM READER-PRINTER

Minnesota Mining & Mfgr. Co.
St Paul, Minnesota
Max view & print size: 8½ x 11"
Table-top Model
Employs special paper & chemicals
Status: In Production.

(2) MICROMATIC VIEWER-ENLARGER PROCESSOR

Microline Products Ozalid Div.
General Aniline & Film Corp
Johnson City, New York
Viewing Screen: 24 x 36"
Max. Print Size: 18 x 24"
Special paper and chemicals
Status: In Production.

Figure 7. Micromatic Viewer-Enlarger

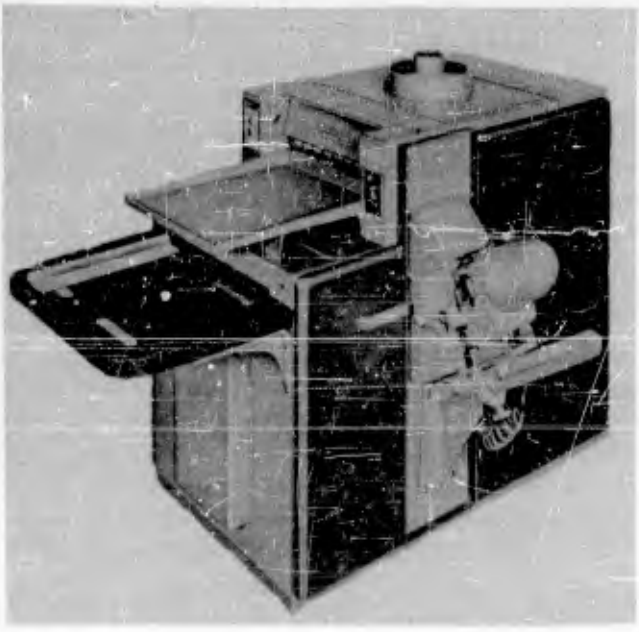


Figure 8. Copytron 1000

(3) COPYTRON 1000

Chas. Bruning Co. Inc.
Mount Prospect, Ill.
Electrostatic Printer
Max. Print Size 18 x 24"
Viewing Screen: 4 x 5"
Special paper
Special Chemicals
Status: In Production.

(4) RECORDAK VIEW-PRINTER

Recordak Corp.
415 Madison Ave.
New York, New York
Viewing Screen 17 x 22"
Print Size: 18 x 24 and
12 x 18
Paper: Standard Stock Listed
Chemicals: Standard Stock
Listed
Similar to AF Standard EN-44A
Status: In Production

Figure 9. Recordak View-Printer

e. AVAILABILITY:

This task was originally initiated because equipment was neither available commercially nor from government sources to fill the need for a microfilm viewer-enlarger. Action has been initiated for procurement of the item as defined by specification.

f. SURVEY OF SIMILAR EQUIPMENT:

As stated in the previous paragraph, there was no similar equipment at the time of task initiation. In recent months, however, similar items resulting from commercial development have been placed on the market. Activities desiring to establish a microfilm aperture card system may wish to investigate these items further by contacting the manufacturer.

In addition to the four items above, which are being marketed at the time of release of this report, several other manufacturers are planning to market equipment soon. This includes:

(1) Haloid-Xerox Inc.
Rochester, New York

An enlarging printer utilizing cut-sheets of paper and the Xerox electrostatic printing system.

(2) Keuffel and Esser Co.
New York, New York

An enlarging-printer utilizing diazo paper as the reproduction medium.

g. TASK TERMINATION:

Task 20791 covering this equipment was terminated by Management Report dated 5 September 1958. (MR-12)

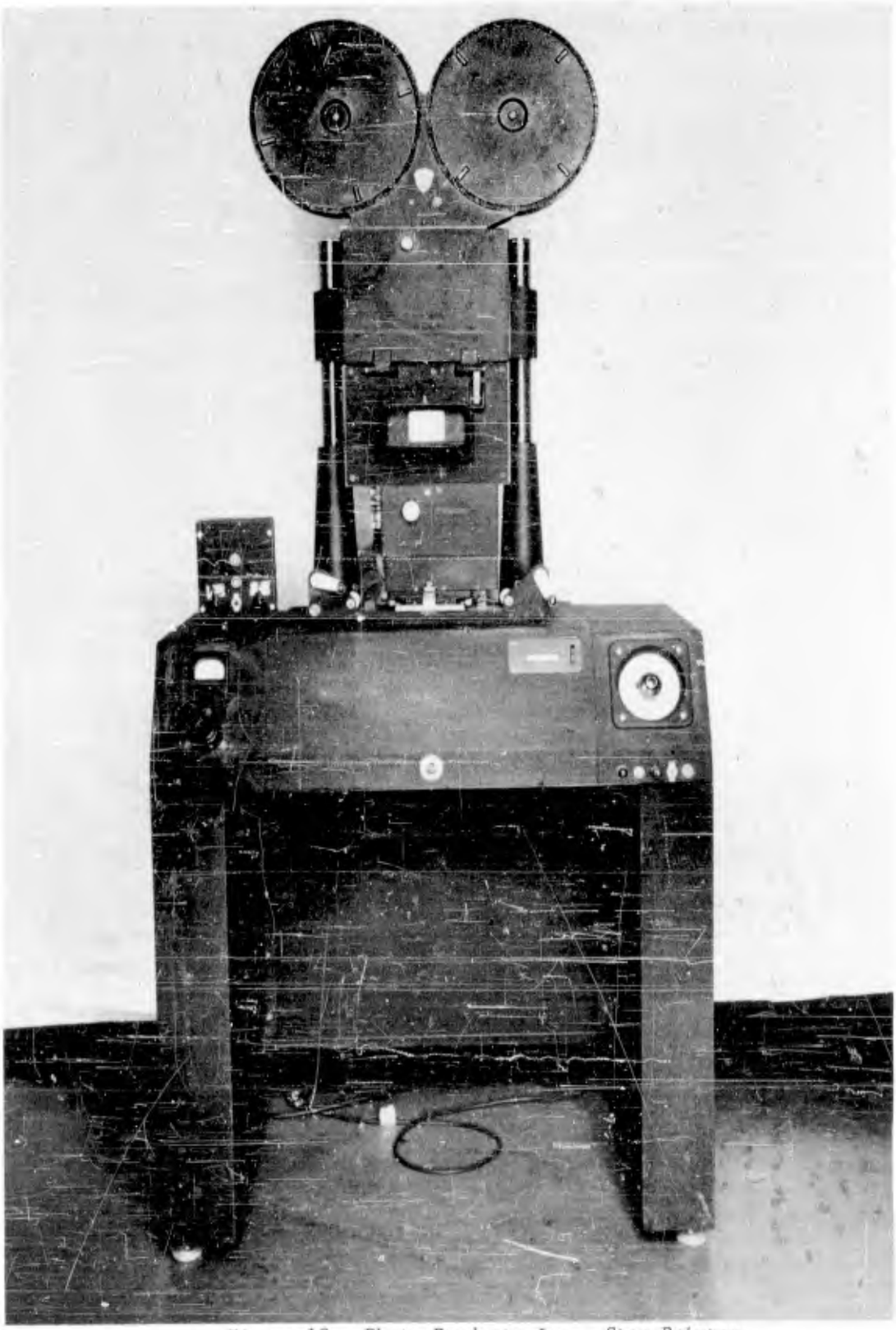


Figure 10. Photo Products Inc. Step Printer

3. MICROFILM STEP PRINTER - TASK 20792

a. OBJECTIVE:

The objective of this task has been to develop an instrument which would have the following capabilities: (1) produce a balanced microfilm copy from film of varying densities; (2) erect images on copy film to permit identical mounting for positive and negative film; (3) enlarge or reduce image size so as to fit the card aperture; (4) place triggering bars between frames for use on the automatic film to card mounter; and (5) print single or multiple copies of each microfilm frame.

Although the original purpose of this task was to develop final type equipment for Air Force use, revised plans call only for development of prototype equipment to establish feasibility. Further development can be made under commercial auspices as required.

b. DESCRIPTION:

The item of equipment resulting from the development task is a desk-style printer (see Figure 10). The desk itself contains the light source, timer, exposure sensing meter control panel and master film holder. Two shafts arise from the rear of the desk which support the lens system, exposure sensing cell, platen, movement equipment, and 100 ft magazine. All motors, brakes, electrical, and mechanical components are in a closed compartment on the rear of the photographic station compartment. A small inspection window used for centering the film to be copied is in the front of the printer at operator eye-level.

c. DEVELOPMENT SUMMARY AND BACKGROUND:

Development of the optical step printer was undertaken to provide capability for upgrading existing Air Force roll microfilm to permit its conversion to aperture card system use. This film was not prepared under the standards established for the card program and required modification in one or more of the areas indicated in the equipment capability requirements outlined under above objective. There was no intention, however, of promoting the development of service type equipment since AF requirement for the step printer extended only to the conversion of existing non-standard film to card mounted form.

A contract was awarded 31 Aug 1954 to Photographic Products Inc., for development and construction of the optical step printer. The completed development model equipment was delivered Feb 1956 for testing and evaluation by WADC. Feasibility of the step printer concept was established, and future development will be left to commercial interests.

d. REQUIRING ACTIVITY:

The only AF activity requiring this item of equipment is the Central Air Force Repository.

e. AVAILABILITY:

Not Applicable.

f. SURVEY OF SIMILAR EQUIPMENT:

There is no known similar equipment.

g. TASK TERMINATION:

Task 20792 covering this equipment was terminated by Management Report dated 17 Jan 1958. (MR-6)

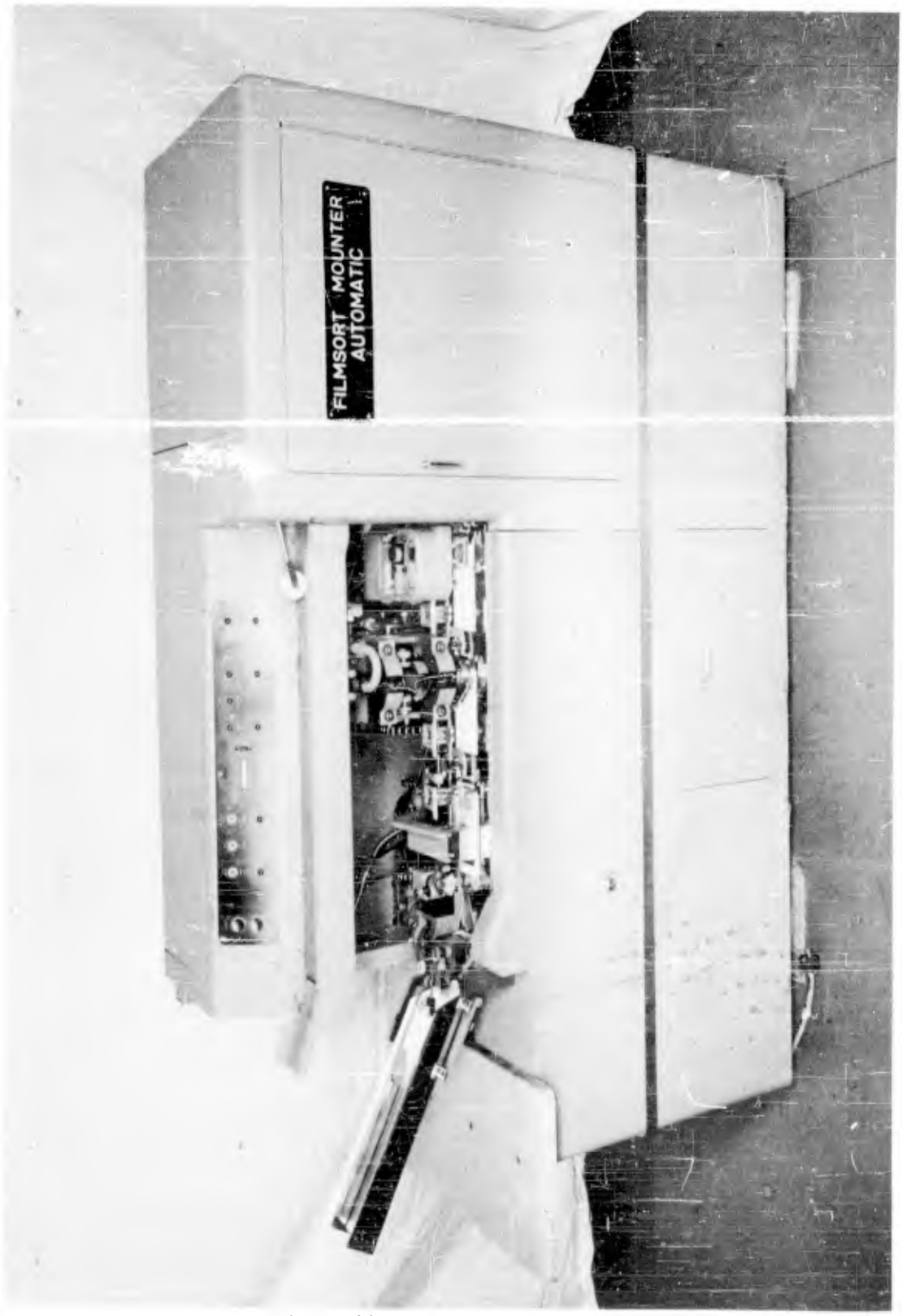


Figure 11. Automatic Mounter

4. AUTOMATIC MICROFILM MOUNTER - TASK 20793

a. OBJECTIVE:

The objective of this task was the development of a workable tool for automatic mounting of microfilm frames into EAM aperture cards. Design speed objective of 2000 mountings per hour was initially established. Primary use of the automatic mounter will be made by Air Force contractors, who will be required to supply microfilmed drawing data in card mounted form.

b. DESCRIPTION:

This item of equipment (see Figure 11) provides a high speed automatic microfilm-to-aperture card mounting capability. Its intended use is for contractors doing large scale mounting and for the central AF drawing vault. Production output for this machine is 2000 cards per hour. This item, known as Filmsort Model F603.7 is currently available from Filmsort distributors.

c DEVELOPMENT SUMMARY AND BACKGROUND:

In order to effect rapid conversion of the extensive backlog of paper copy drawing data to card mounted microfilm, adequate capability must be provided not only for the microfilming aspect of such an operation but also for rapid automatic mounting of the microfilm frames into EAM aperture cards. Complete substitution of microfilm for vandykes and blueprints will require the effort of a high speed automatic mounter to prepare finished aperture cards (containing mounted film) in production distribution quantities.

An R&D contract was awarded to Filmsort on 7 Sep 1954. The automatic film mounter was delivered to WADC January 1956 and after "in-house" testing and evaluation was accepted 12 Jul 1956. With only slight design refinements the mounter will fulfill service version requirements.

The equipment was operated in a support role for preparation of aperture card decks sent to the OCAMA test site. During this extensive operation, the equipment performed satisfactorily.

d. REQUIRING ACTIVITY:

The only Air Force activity requiring this item of equipment is the Central Air Force Repository.

e. AVAILABILITY:

This item is commercially available from all Filmsort distributors through GSA schedules.

f. SURVEY OF SIMILAR EQUIPMENT:

The Navy Department has procured a Filmsort automatic mounter and tested this equipment as part of its development of a microfilm aperture card program. There is no other known source of this or similar item.

g. TASK TERMINATION:

Task 20793 covering this equipment was terminated by Management Report dated 17 Jan 1958. (MR-6)

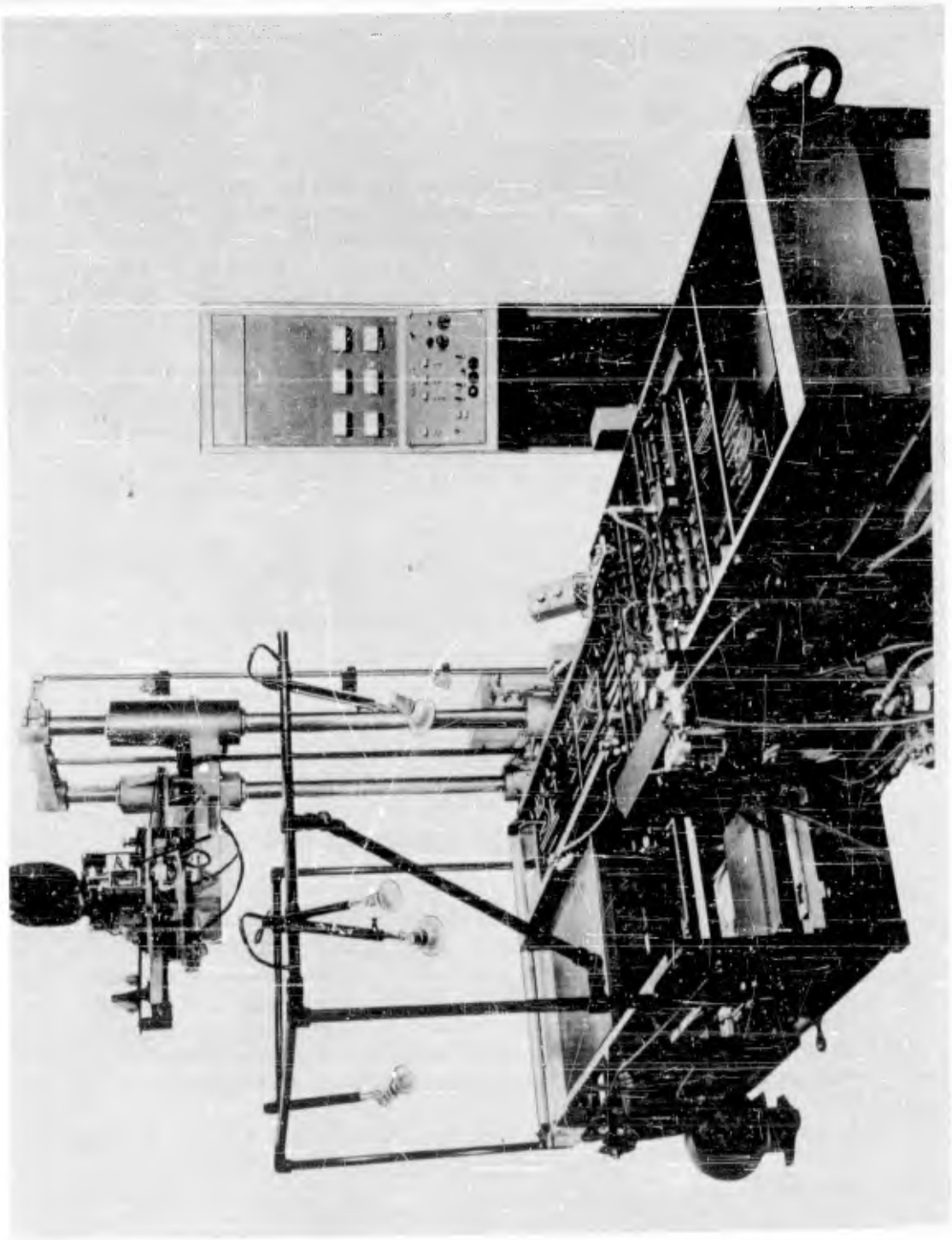


Figure 12. DeFlorez Camera

5. HIGH SPEED AUTOMATIC MICROFILM CAMERA - TASK 20794

a. OBJECTIVE:

The objective of this task was to develop a high speed item of equipment for microfilming which will automatically feed, film, and restack drawings at a rate of 1000-2000 per hour. This equipment was developed strictly for AF use, being required to facilitate implementation of the aperture card program by conversion of existing paper copy drawings to microfilm.

b. DESCRIPTION:

This item was designed for high speed automatic microfilming of large volumes of engineering data (see Figure 12). It provides capability to feed, determine exposure, film, and restack engineering data automatically. It was designed for conversion of the AF vault from paper to microfilmed engineering data. Magazine holds either 100 ft or 1000 ft rolls of microfilm. Output rate is 1200 exposures per hour. The item is 14 feet long, 11 feet high, weighs 2½ tons. It has a push button programming console and electronic remote control system.

c. DEVELOPMENT SUMMARY AND BACKGROUND:

A contract was awarded for development of the high speed camera under an equipment exhibit prepared at WADC. Contractor approach in developing the equipment included a preliminary engineering study phase to establish feasibility and determine mechanical design and following this, a fabrication and test phase to prepare the finished hardware item.

Development of an automatic camera was undertaken because of the extensive need for microfilming capability to convert the AF engineering drawing vault to the aperture card system. Approximately 3 million drawings held in the AF vaults required conversion. After completion of the automatic camera, it was installed at WPAFB, Ohio, where it is being utilized to convert the full size drawings of the AF Drawing Repository to microfilm.

Award of a contract for the high speed camera was made to DeFlorez Co., 25 April 1956. Delivery of the camera for testing was June 1959.

d. REQUIRING ACTIVITIES:

The only Air Force activity requiring this item of equipment is the Central Air Force Repository.

e. AVAILABILITY:

The only item required by the Air Force is currently available.

f. SURVEY OF SIMILAR EQUIPMENT:

There is no known similar item of equipment in existence or planned.

g. TASK TERMINATION:

Task 20794 covering the development of this item was terminated by Management Report dated 23 Nov 1959. (MR-18)

Figure 13. Haloid Xerox Printer

6. HIGH SPEED MICROFILM PROJECTION PRINTER - TASK 20795

a. OBJECTIVE:

This task had as its objective the fabrication of a high speed projection printer to prepare paper copy enlargements of microfilmed drawings. The basic equipment had already been developed under Navy auspices and needed certain modifications and refinements to suit this requirement. Upon implementation of the aperture card system, there will be a need for high speed printers at all AMA's and depots having responsibility for the reproduction of procurement data bid sets.

b. DESCRIPTION:

This item of equipment (see Figure 13) is designed to provide a high speed drawing reproduction capability. It will be required by Air Force activities responsible for the production of engineering data bid sets. It produces enlarged paper prints, maximum size 24" x 30", by the electrostatic process. This item will reproduce from either microfilm aperture cards or roll microfilm. The estimated output is 5000 drawings per day. Basically, this item is a continuous xerography machine, having a selenium coated drum traveling at a fixed speed of 20 lineal feet per minute. The image formed on the drum is transferred to 24" wide paper. Its output is approximately equal to 3 or 4 blueprint machines. This machine is equipped with a cutting and stacking device to facilitate preparation of bid sets for procurement use by the AMA's and depots of the Air Materiel Command.

c. DEVELOPMENT SUMMARY AND BACKGROUND:

A system to maintain active engineering drawing data in microfilm form must also include facilities to provide for rapid duplication of the drawings as print enlargements in order that the data be available for distribution. Under contracts let by the Navy Department, the Haloid Co. developed a successful high speed microfilm printer which uses photoelectrostatic system of reproduction. In this process a latent image is formed on an electrostatically charged surface constructed of a special material that loses its charge in proportion to the intensity of the light at any given point. The latent image is developed by contacting the differentially charged surface with a resinuous powder, and the image is fixed by fusing this powder into a paper support. In the Haloid Xerox Printer, the image must be transferred from a metal drum, which is coated with the active material, to a paper roll on which the image is fixed. This printer has the very desirable feature that high quality prints are produced on ordinary paper stock.

A contract was awarded 20 May 1957 to the Haloid Co. as low bidder on the development proposal. The equipment constructed by Haloid is based on the previous design of a 24 inch printer but incorporates a cutter and stacker to permit automatic cutting of finished prints. This item was completed and delivered to WADC on 8 Aug 1958. As a result of having satisfactorily completed required tests, the item was finally accepted by WADC, 26 Sep 1958.

d. REQUIRING ACTIVITIES:

This high speed electrostatic printer will be required by those AMA's and depots responsible for the production of large quantities of bid sets. Additionally this item can be utilized by any organization having large volume requirements for drawing reproduction.

e. AVAILABILITY:

This item is available from the Haloid Xerox Company on GSA schedules. The item may be purchased outright or rented. The following information is presented as an aid in any decisions on the part of using organizations concerning whether to purchase or rent this equipment:

(1) WCXE management personnel investigated the different approaches to obtaining similar printers for use by the Air Force when the aperture card system is implemented.

(2) The first approach is outright purchase of the equipment. On 17 Jun 1958, the Haloid Xerox Company provided the following purchase prices based on quantity purchases:

Quantity	Unit Price
1-4 incl.	$177,000. ea
5-9 incl.	$170,000. ea
10-14 incl.	$157,000. ea
15 or more	$140,000. ea

Additionally, a contract for maintenance costs $900.00 per year plus parts.

(3) The second approach investigated was the rental of the equipment. A model 24 Copyflo Xerox projection printer, with cutter and stacker (identical to the machine now in WCXE) rents for $3400.00 per month or $40,000 per year. This

rental figure is comparable to punch card rental agreements, the rental price of the 24 inch Copyflo projection printer includes service and parts by the nation-wide Haloid Xerox organization. Expendable supplies such as developer powders, light bulbs, and selenium drums are excluded from the rental service cost. Rental appears to be the better approach for the following reasons:

(a) It eases the problem of funding for outright purchase.

(b) All new improvements to the equipment will be included in this rapidly expanding field.

(c) As the equipment ages it will be automatically replaced by new units.

(d) It solves the problem wherein multiple units are needed for certain times of the year and only one unit is required for the remainder of the year.

(e) It solves the problem wherein one unit is needed for part of the year and is not needed for the remainder of the year.

(f) Ammortization, survey, and replacement of expensive units cease to be a problem.

(g) The stock-piling of expensive replacement parts will not be required.

(4) In comparing the purchase versus rental plans, the latter seems to have all of the advantages both tangible and intangible. Close scrutiny of the rental system is advocated when implementation of the system is planned, particularly in view of the fact that it is offered on GSA schedule.

(5) One of the greatest advantages of rental equipment was intentially eliminated from the above discussion. It is worthy of separate mention and is placed under the heading of advanced planning. When becoming involved in a system such as the aperture card microfilming program, the technology of which is rapidly expanding into the commercial field after the original impetus imparted by government agencies such as the Air Force, wholesale purchase of very expensive equipment may limit the ultimate exploitation of the system. At the present time, and foreseeable for the next two years, the 24 inch Copyflo printer with cutter and stacker is undeniably the finest and most advanced piece of equipment in its field.

But who is to say that in three, four, or five years a totally unknown reproduction principle will not be developed which will obsolete the best that the present day can offer. It is factually known that better equipment is on the drawing boards, or in embryo development stages, but practical application is at least 4 years away. It would be financially unfeasible to be caught with two or three million dollars worth of procured equipment when advanced design or principle can cause instant obsoletion.

f. SURVEY OF SIMILAR EQUIPMENT:

Other than the Navy development noted above, for essentially the same item, there is no continuous equipment of this kind available commercially or being developed through R&D efforts of the Department of Defense.

g. TASK TERMINATION:

Task 20795 covering this item was terminated by Management Report dated 27 Jan 1959. (MR-14)

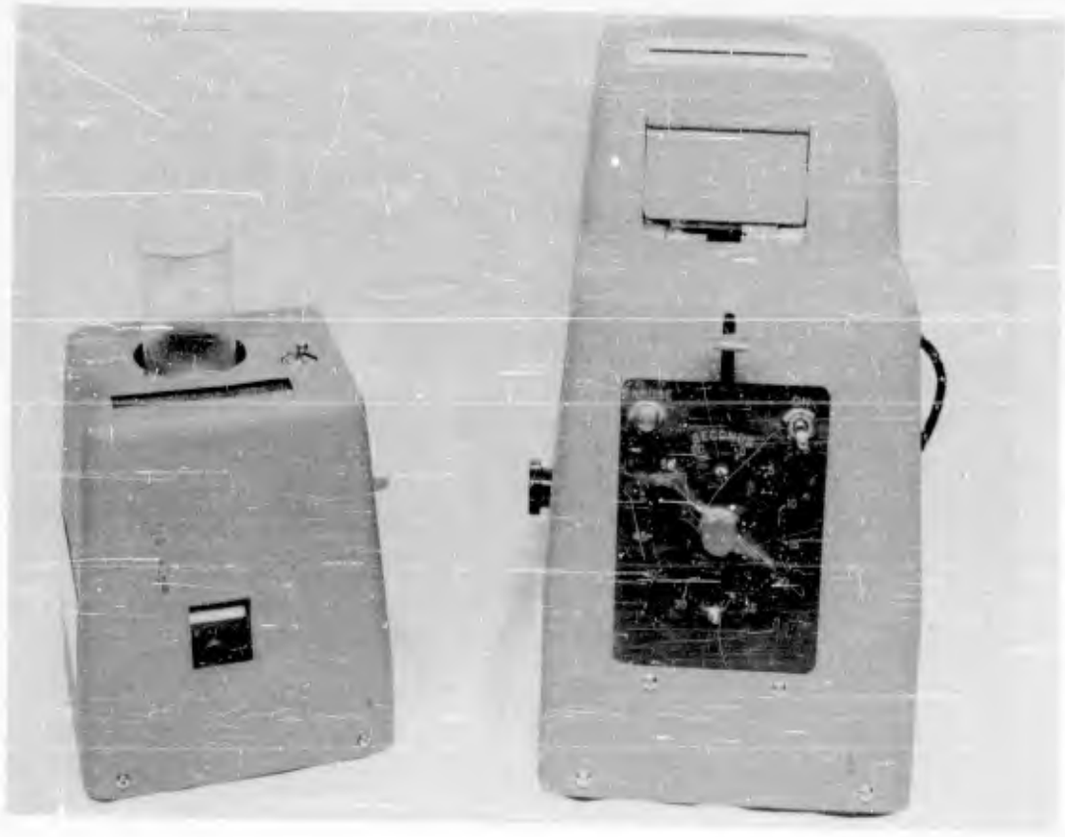


Figure 14. Filmsort Card Printer

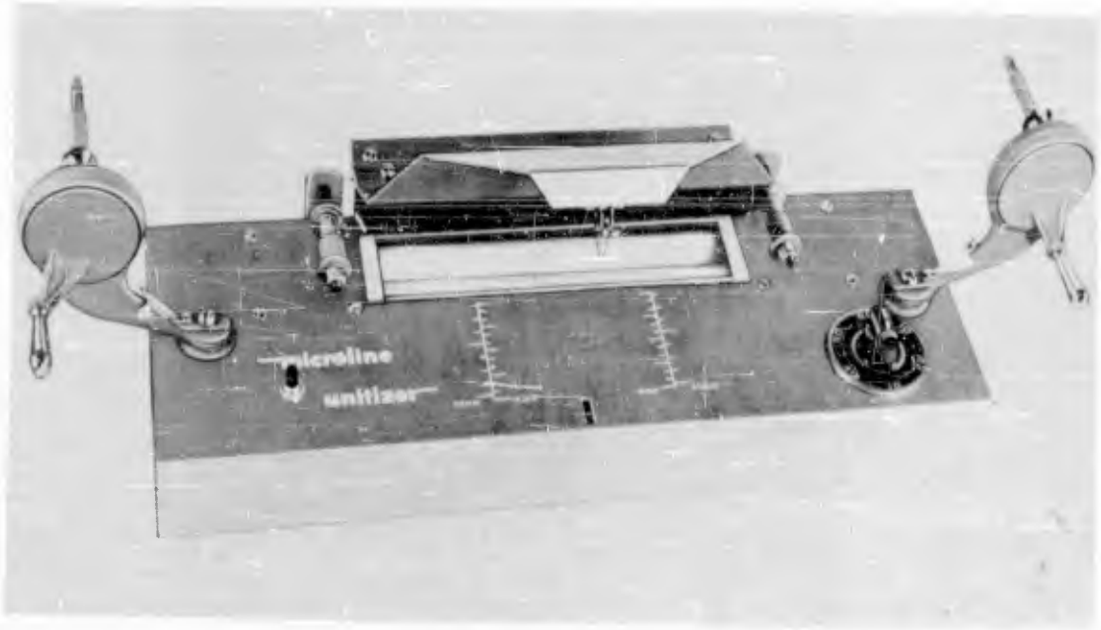


Figure 15. Microline Card Printer

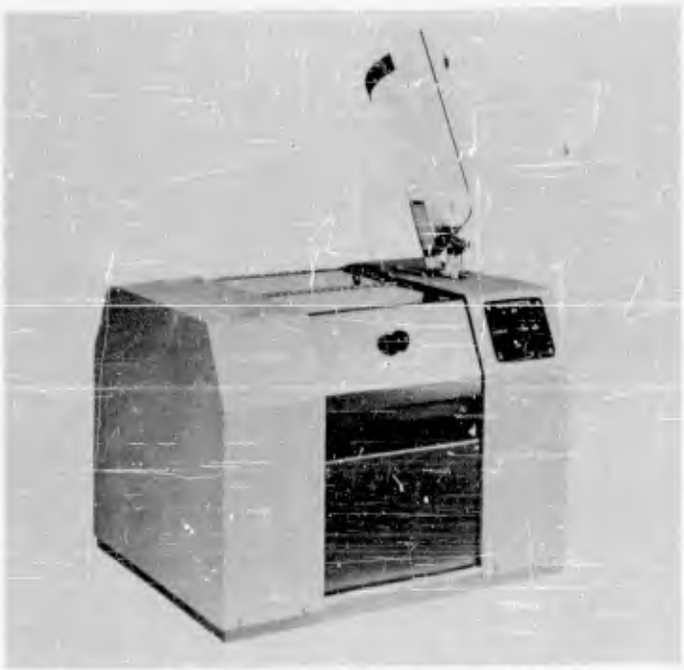


Figure 16. Microline Printer Section

Figure 16A. Microline Developer Section

7. CARD-TO-CARD MICROFILM PRINTER - TASK 20796

a. OBJECTIVE:

The card-to-card printer is intended to provide a means for quick and convenient duplication of microfilm by the transfer of an image from a coded file card to premounted blank film.

Although the original purpose of this task was to support development of new equipment it was later described to accept commercially developed equipment some of which had been evaluated by the Signal Corps and Navy as part of their R&D program. A low volume printer manufactured by Technifax Corp. (Duplicard Printer) has already been tested and a report issued by the Signal Corps; while testing of an automatic version of the card-to-card printer (developed by Filmsort Corp.) is still being carried out by the Navy. A report on the Filmsort printer should be available from the Navy.

Several other card-to-card printers have been marketed commercially which adequately fulfill the requirements for which the task was initiated; thereby negating the need for Air Force R&D in this equipment field.

b. DESCRIPTION:

Basically, the card-to-card printers (see Figures 14 and 15), are items of equipment into which an aperture card containing a frame of microfilm is placed together with an aperture card containing a blank frame of unexposed diazo microfilm. The object being to create an additional microfilm aperture card. The exposure is made in 30-45 seconds and then the diazo card is placed in some sort of ammonia chamber for image development. This development requires an additional 30-45 seconds, resulting in the creation of a duplicate card in 1½ minutes.

c. DEVELOPMENT SUMMARY AND BACKGROUND:

Under the present system for handling engineering drawing data, the procedure followed when it becomes necessary to furnish a reproducible copy of a drawing to support procurement or depot requests is to prepare a duplicate reproducible (vandyke), which is then used for quantity reproduction. In this way, the master drawing is preserved in the vault files. In the new microfilm aperture card system it will also be necessary to furnish a working copy of the filmed drawing for this same purpose. The card-to-card printers will provide means for conveniently duplicating a master file card by reproducing the microfilmed drawing image on a diazo film blank that is already mounted in an aperture card. The master film card will be returned to the files and the diazo duplicate will be used as required. Master cards will thus remain in file and will not be subjected to undue wear.

As stated in paragraph 7.a. above, the Air Force R&D effort on this task was terminated due to the availability of commercial equipment. However, two of the commercial items were procured by the Air Force for test and evaluation. Following is a summary of that evaluation:

(1) One item was procured from the Microline Sales Group of the Ozalid Division, General Aniline and Film Co., Johnson City, New York. This printer costs $99.00 and is extremely basic and austere. The work produced by this printer is equal to that produced by printers costing 6 to 10 times as much. Printing time is about one and one-half minutes. Developing time is approximately one minute.

(2) The second printer was obtained from the Filmsort Division of the Dexter Folder Co. through one of the equipment distributors. This printer costs approximately $600.00. It has the refinements and workmanship expected of a $600.00 item. It is easier to operate and presents a finished appearance but produces no better results than the previously mentioned printer. Printing time is about 45 seconds to 1 minute. Developing time is about thirty seconds.

(3) Comparison:

Results.- Equal

Speed.- Comparable

Operation.- Filmsort product is much easier for inexperienced personnel to operate.

Appearance.- Microline printer is not as attractive but it does the job satisfactorily.

Special Features.- The developing chamber of the Microline printer requires periodic charging with liquid ammonia. Some rather strong vapors escape into the room when charging the unit and when inserting or removing printed aperture cards. The developing chamber of the Filmsort printer utilizes a reservoir of dry ammonia crystals. A metering lever is depressed when inserting a a card for development. No vapors are evident during operation.

Maintenance.- Little or no maintenance should be required on either printer over long term operation.

Cost of Operation.- The Microline printing light is a slimline fluorescent tube available for about seventy-five cents. Burn-out time is unknown. The Filmsort printing light is a commercially available sunlamp. Price is about $9.00. The heating element to vaporize the ammonia in the Microline printer is a common twenty-five cent incandescent bulb. The vapo izing element in the Filmsort printer is a wi wound heater element comparable to an aut obile cigar lighter. Probable cost is $2.50.

Conclusions.- If appearance and a slight amount of free ammonia vapor are not important and the operating personnel will devote a little time to practicing on their equipment, the $99.00 Microline printer is recommended. If appearance, odor-free operation, and instant operation by inexperienced personnel are the important factors, the $600.00 Filmsort printer is recommended.

d. REQUIRING ACTIVITIES:

Card-to-card printers will be required at all installations preparing duplicates of microfilm aperture cards.

e. AVAILABILITY:

This task was originally initiated because there were no equipments available commercially or from the other military departments which would answer the need for a microfilm card-to-card printer. However, recently several items have been marketed. Listed below are those known at the time of this writing. Activities desiring to establish a microfilm aperture card system may investigate these items further by contacting the manufacturers:

(1) UNITIZER
Microline Sales Group
Ozalid Division
General Aniline and Film Co.
Johnson City, New York

(2) UNIPRINTER, MODELS 075 and 085
Filmsort Division
Dexter Folder Co.
Pearl River, New York

(3) TECHNIFAX CARD-TO-CARD PRINTER
Technifax Corp.
Holyoke, Massachusetts

f. SURVEY OF SIMILAR EQUIPMENT:

A new entry into the card-to-card printing field is the item developed and marketed by the Ozalid Division of General Aniline and Film Corp. It is faster than the two printers described in paragraphs c.(1) and c.(2) but is considerably larger than either. As will be noted in the photographs (see Figures 16 and 16a) the printer and developer units are separate. Aqua ammonia is the developing agent.

g. TASK TERMINATION:

Task 20796 covering this equipment was terminated by Management Report dated 5 Sep 1958. (MR-12)

8. PREPARATION OF APERTURE CARDS - TASK 20797

MOUNTING OF APERTURE CARDS BY CONTRACT SERVICES - TASK 20798

Neither of the above tasks involve the development of equipment. Work performed under the tasks is described in the appropriate section of this report.

CHAPTER III - SYSTEM APPLICATION

CHAPTER III - SYSTEM APPLICATION

ILLUSTRATIONS

SECTION I

RECOMMENDED METHOD AND TECHNIQUES FOR CONVERSION OF THE CENTRAL AIR FORCE VAULT TO MICROFILM-IN-APERTURE CARDS

ILLUSTRATIONS

CHAPTER III

SYSTEM APPLICATION

INTRODUCTION.- In the development of a system such as the Microfilm Aperture Card System, with its diversified applications, certain handling and procedural techniques are evolved that are perfectly clear in detail only to those familiar with the step by step development.

This chapter of the report offers those techniques to the ultimate user of the system in order that false starts may be prevented. This chapter permits operating regulations to be written without the necessity of experimentation.

It must be borne in mind that although the use of microfilm aperture cards achieves its objective more quickly and economically than the vandyke-blueprint-diazo system, user philosophy must undergo some radical revision.

The departure of the new drawing support media and its associated equipment from the old familiar standbys of the past half century will undoubtedly cause some confusion or personnel resistance. By divorcing present thinking from all previous procedures; by accepting the new procedures and techniques; by assiduously avoiding the trap of attempting to make the new system work with the old operating routines; the unqualified success of this modern system is assured.

SECTION I

RECOMMENDED METHOD AND TECHNIQUES FOR CONVERSION OF THE CENTRAL AIR FORCE VAULT TO MICROFILM-IN-APERTURE CARDS

1. INTRODUCTION:

This part of the final report recommends a method of converting the Central AF Engineering Drawing Repository, hereafter referred to as the "Vault," from its present form in full size paper copy and roll microfilm to a form consisting of individualized microfilm frames mounted in coded, apertured tabulating cards. It was prepared particularly for the purpose of converting the Central AF Repository; however, this recommended procedure can be followed for the conversion of any large volume drawing file. Operations involved in the conversion to a microfilm aperture card system are reducible to four main tasks, which are as follows:

a. Convert paper drawing into microfilm.

b. Mount microfilm into aperture cards.

c. Code punch non-aperture, tabulating cards and transpose data to aperture cards.

d. Assemble system aperture card deck.

The above tasks are arrangeable into several logical orders of operation. The sequence as given represents one of the possible task arrangements and is the one recommended for accomplishing the bulk of the conversion work under this plan. Individually, the tasks may be accomplished by either of two methods-(a) by using in-house capability or (b) by letting a commercial contract. In either method there may be several different approaches to the detail work in each task. In addition, many arrangements are possible for subdivision of task detail between internal and contractor capabilities. A minute accounting of the many possible combinations and subdivisions of task work has not been undertaken in the preparation of this report. However, every attempt has been made to examine the more workable systems and arrangements that may be applied to the vault conversion. Presented in this report are specific recommendations incorporating the most promising of these methods.

2. GENERAL:

a. THE VAULT:

After conversion, the vault should consist of negative microfilm mounted in aperture cards for active use. Reserve files of microfilmed drawings should be maintained in 1000 foot roll

form. These reserve copies will be photographic positives or negatives obtained directly from filming or from film duplication. The positive or negative characteristic of the reserve copy will depend entirely upon the final decision of the operating agency in the matter of distributing silver or diao film. (See Figures 18 and 19.)

b. SINGLE DECK JUSTIFICATION:

Although additional aperture decks will be required in the near future for field use, either from reserve positive film copy or from duplicate negative copy, it is recommended that this not be undertaken during the actual vault conversion. For one, there would be a duplication of effort in the vault conversion, particularly in the manual (i.e., hand fed) key punching operation. Therefore, in order to provide for the possibility of multiple copy for field distribution purposes, it is recommended that the duplicating master film be maintained in rolls and that the non-aperture decks from which vault aperture cards are reproduce-punched, be retained for creation of multiple distribution cards. Availability of commercial high and low speed card-to-card printers will provide an additional insurance capability for distribution purposes.

c. VAULT CONTENT QUANTITATIVE:

A recent inventory of the vault revealed that there are approximately 2,700,000 active paper drawings and over 1,000,000 active, current duplicates on roll microfilm. These figures represent primarily the contractor files and account only for drawings now held in the vault. Additional drawings will be received during the course of the vault conversion which should be considered in any projected work calculations. The number of such drawings received will depend upon promptness on the part of Headquarters AMC in converting equipment contractors to aperture cards in lieu of vandykes. The active roll film now available, both contractor and Air Force, will be converted to the aperture card system; however, obsolete, inactive, and limited standard film should be left in present roll form. Only about 1,700,000 of the drawings in the current paper file will actually require filming. Detailed procedures to be used in filming, as well as the methods for EAM coding, are presented in Figure 17 of this report.

d. PREPARATION OF APERTURE DECKS FROM VAULT MICROFILM:

Of the active vault microfilm that is selected for conversion to the aperture system, the rolls having wide spaced frames can be programmed for direct processing into cards, while the

narrow spaced rolls will first be duplicated on the optical step printer or similar device - to wide space the frames, to prepare appropriate mounting copy. Prior to mounting, standard tabulating cards, (blind cards) will be punched from the Microfilm utilizing a viewer or microfilm index to extract data. Then the all important merging of drawings with the appropriate punch data will be carried out.

3. CONVERSION OF VAULT TO MICROFILM IN APERTURE CARDS:

a. VAULT CONTENT, QUALITATIVE:

The vault is now comprised of contractors' and Air Force sections containing engineering drawings in paper copy form and on 35mm nonperforate roll microfilm. In the paper file are housed a variety of drawings of both positive and negative image type The principal drawing specie is the negative vandyke, constituting approximately 80% of the file, but varying numbers of the following types of prints are also represented: positive brownlines, positive sepias, positive autopositives, positive vellums, negative sepias, negative blueprints. Certain of these drawings (most particularly the vandykes) may be of either a direct-reading or indirect-reading type (image is read correctly through the back of the drawing using transmitted light). The nature of image reading--whether direct or indirect--is an important factor in determining the positioning of drawings for microfilming (whether drawing posture is to be face up or face down). The microfilm portion of the vault consists almost entirely of negative copy in 100 ft rolls. Of the total complement of active, limited standard, obsolete, and inactive copies in the roll microfilm files, only the active is of importance in the vault conversion. About 55% of the active copy has a 2 inch frame spacing format which will enable it to be mounted directly into aperture cards. The remainder of the roll film is made up with narrow frame spacings and will require appropriate duplication before it will be suitable for aperture mounting. Merging will be accomplished on the collating reproducer by "operator-controlled match punching." By this system, correct sequencing of tab and aperture cards is maintained by the operator making periodic visual checks on the work. The easily visible frame numbers that appear on all vault microfilm are a material aid in this sequence checking. Without such conspicuous reference numbers it is much more awkward to check the progress of reproduce punching since a viewer must then be employed to read the drawing number itself. When properly coded and interpreted, the aperture decks will be purged of superseded drawing copy and then sequenced by use of collating and sorting equipment. Microfilm that is damaged

during reproduce punching, as well as that damaged by automatic mounter jam-ups, will be discarded. Retakes of this film will be accomplished by filming the corresponding paper copy or duplicating the master film, as appropriate. In the method just described for the conversion of roll film to aperture decks, no attempt is made to separate superseded and current film. These are separated only after the aperture decks have reached a finished state. The superseded cards are retired.

4. SCREENING, PREPARATORY TO MICROFILMING:

Work preparatory to mounting present microfilm into aperture cards will also provide a basis from which to screen the paper file to eliminate those drawings that are already on film. According to present estimates about 1,040,000 drawings should be purged from the paper file by this screening process. (See Block 26, Figure 17).

5. PROGRAMMING DRAWINGS FOR MICROFILMING:

Filming will best be done by sectioning the vault into areas, (probably Aircraft, Engines, Accessories, and Miscellaneous) and then concentrating on one area at a time. In this way, disruption of normal vault activity will be held to a minimum. The work will be further programmed as follows: (a) by contractor; (b) by size group - A, B, C, etc; and (c) by drawing image types (negative and positive, direct-reading and indirect-reading types). For operation of the high speed automatic camera, groups of small contractors will be consolidated to give a minimum 4 hours continuous running time within any one size group. It is necessary to avoid repeated changes of size on the high speed automatic camera inasmuch as there is an estimated 15 minute changeover time for drawing size adjustment.

6. MICROFILMING TECHNIQUE:

Since there is such a variety of drawing types in the paper file, it will be necessary to take some pains to sort drawings prior to microfilming in order to insure uniform film copy being obtained. It is particularly desirable that film copy to be mounted into aperture cards should be the same as the roll film now in the vault. Figures 18 and 19 depict graphically the filming and duplicating requirements necessary for preparing the desired copy. For direct-reading negative type paper drawings, either of two microfilming procedures may be used. The drawings may be filmed in the normal "face up posture," but it will then be necessary to go through additional duplication steps in order to produce negative film copy which is equivalent to present film stocks. If, on the other hand, the drawings

are turned face down and filmed through their backside (substage lighting), duplication of the original positive will suffice to produce negative film of the desired type. The latter filming procedure is recommended as being the most economical. While there will be some loss in image sharpness as a result of the "backside" filming, this loss will be less than otherwise introduced by multiple duplication. Indirect-reading positive copy will also require face down filming but indirect-reading negative and direct-reading positive will be filmed in the customary way. In sorting and arranging stacks of drawings for microfilming, direct-reading and indirect-reading prints may be intermixed (provided print direction of individual drawings is in accordance with the preceding analysis), but negative and positive prints must be kept separate. This separation is required to facilitate later collation of positive and negative microfilm into separate files.

7. FILE ORIENTATION:

As stated in paragraph 2.a,...."after conversion, the vault should consist of negative microfilm mounted in aperture cards." This is a simple statement but many false starts and the waste of much time and money can result if a file is not thoroughly analyzed prior to actual work initiation. Since every aperture card in the vault will, at one time or another, be duplicated by contact printing to yield a size for size image on film, or will be enlarged to paper prints by means of automatic projection printers, a useable negative file must be insured. For all aperture cards to be indiscriminately useable without sorting, a uni-directional file must be established. The uni-directional feature of a card mounted microfilm file is directly comparable in major importance to the homogenity of film characteristic within a file, (all negative film or all positive film). A brief description of this application of uni-directional is:

> A right reading image on the film is presented to the viewer when the aperture card is held with the printed side facing the viewer; likewise the film base on every mounted card is facing in the same direction. (Towards or away from the face of the card, but not intermixed.)

The logic of establishing and maintaining a file wherein all film is either positive or negative, and all film images read in the same direction as well as present the emulsion side in the same direction, is apparent when the contact

printing techniques of printing emulsion to emulsion is visualized. It is immaterial whether the right reading image occurs when the emulsion faces the front of the card (as is generally the case with diazo duplicate negative) or when the emulsion faces the rear of the card (as is generally the case with silver negative film) as long as the entire file is the same.

Proper orientation within the aperture requires the drawing number of the image to be in the lower right hand corner of the aperture except in the case of sectionalized roll drawings, when the drawing number will appear in the upper right hand corner of the aperture.

A uni-directional, homogeneous, properly oriented file is relatively simple to achieve when all camera film is made from original drawings. However, considerable manipulation of original copy and interim duplicating facilities is required to achieve a first class file, when necessity dictates the use of the conglomerate master paper file of which the vault is composed. The technique of microfilming direct reading vandykes (by far the largest group of vault master drawings) must be altered from the heretofore employed techniques in order to avoid excessive steps of subsequent reproduction and the associated loss of legibility.

Figures 18 and 19 are included in this report to be used as a guide by administrative and operations personnel, and as a trouble shooting chart by quality control personnel.

8. EQUIPMENT PREFERENCES FOR ROLL AND FLAT SIZE DRAWINGS:

It is considered advisable that roll drawings be microfilmed for the most part on Model C cameras rather than the high speed automatic camera. This recommendation is made in view of the fact that with automatic camera, operating at high speeds, the customary frame coding cannot be placed on each film frame by the operator, nor is there now any device on the camera to do this coding automatically. The absence of an identifying code on the film may be serious in the case of roll size drawings inasmuch as multiple frames not containing a drawing title block will be left without any means of identification. There is a significant danger that these unmarked frames can be misplaced and lost during the mounting and reproduce punching operations. Furthermore, there will always be the similar risk of loss or misplacement of reproductions prepared from the film for bid sets, distribution or maintenance use. Therefore, it is recommended that

roll drawings be filmed manually on the Model C's. It should be noted that using the high speed automatic camera for flat drawings exclusively will have the advantage that highest operating speeds can be maintained. The filming of flats will be accomplished at a sustained rate of 1000 frames/hr.

9. DUPLICATION OF MICROFILM:

Film will be duplicated commercially. Most of the master microfilm resulting from filming vandykes (about 90%) will be positive copy and will yield a negative duplicate (Figures 18 and 19). The negative film will be used as mounting copy while the positive film will be retained in a master roll file if silver duplicate film is distributed. The positive film serves no further purpose after duplication if distribution of diazo film is contemplated.

10. SOURCE DOCUMENT FOR KEY PUNCHING:

a. GENERAL:

Key punch information will be obtained from a combination of data sources. The drawing itself either before or after microfilming will be used to supply much of the information needed. Additional data sources are Drawing Locator Cards; Stock Class Guide; Parts Application Data Lists (PADL); and Numerical Index of Drawings (NID).

b. RECOMMENDATION ON MODEL APPLICATION DATA:

A study was conducted to determine time and manpower requirements for preparation of the engineering drawing index. This study indicated that compilation of Model Application Data would consume 85-90% of the total manpower required for the indexing job. Considering the expense that this implies and in view of the fact that there is some question as to the volume of use of Model Application Data, it is recommended, that such a compilation not be undertaken. Additional justification for elimination of model application data in vault conversion program---the PADL, the only source for complete cross application, was eliminated as a document by Headquarters AMC decision. The presently available Spare Parts Application Data List (SPADL) is of no use because spare parts constitute less than 40% of the complete item. Under the new system, when information is actually required for a particular drawing, it will be extracted from appropriate PADL's or NID's.

Eventually, tab coded cross application data will be phased-in as new aperture cards are received from contractors and old drawings are superseded or retired.

11. MOUNTING MICROFILM INTO APERTURE CARDS:

a. GENERAL:

Microfilm will be mounted with both automatic and manual equipments, using nonpunched cards in the former case adding the punch coding after mounting, and prepunched cards in the latter.

b. AUTOMATIC MOUNTER:

The bulk of the mounting task for the vault conversion will be accomplished on this equipment. Since microfilm will be mounted into blank aperture cards, it should be possible to operate the mounter at its maximum sustained rate of 1000 cards per hour. Film that is damaged by the automatic mounter will be collected into "retake lots" and the appropriate drawings refilmed. The out-of-sequence microfilm will not be returned to the automatic mounter, but will be programmed into manual equipment, as noted below. The automatic mounter will be used for high speed regular sequence mounting only.

c. MANUAL MOUNTERS:

Mounting to be accomplished on the manual equipment will consist of (1) support work (remounts on damaged work and mounting of out-of-sequence revision items) and (2) regular sequence mounting, preferably of roll size drawings. Support work should be given the higher priority in programming the hand mounters but it is probable that the equipment will not be fully occupied by this work. In programming regular sequence mounting, roll size drawings are to be given preference because they can benefit from the special handling that is provided by the use of manual equipment. The sustained mounting rate for manual mounters is approximately 125 frames per hour per mounter.

d. MOUNTING PREPUNCHED APERTURE CARDS:

It is planned to prepunch aperture cards for mounting on the manual equipment. This procedure is being suggested because checks on film and card matching can be accomplished routinely during the hand mounting operation (a film reader is built into the mounter). Code punching which will precede mounting in this case, will be unfettered by matching requirements and therefore will be accomplished more quickly.

12. PREPARATION OF CODED DRAWING INDEX AND TRANSPOSITION TO APERTURE CARDS:

a. GENERAL:

EAM work required for the vault conversion consists of (1) key punching and (b) reproduce punching and interpreting. Key punching will be done on standard tabulating (blind) cards, from which the information will be transposed by means of a reproduce punch machine to aperture cards already mounted with film. At first glance the use of an extra deck of blind or non-aperture cards appears to be a waste of money. However, a study has proven that there is a variable error rate between 2 and 10 percent in the use of the key punch. The cost of blind cards is approximately one-tenth the cost of aperture cards.

b. SEQUENCING OF TAB AND APERTURE DECKS IN REPRODUCE PUNCHING:

The punching of aperture decks will involve the transfer of coded information from standard tab cards to aperture cards containing mounted microfilm. Because film is already in the aperture cards there must be proper sequencing of the two decks during reproduce punching to insure that film is mated with its proper, coded description.

c. REPRODUCE PUNCHING INTO BLANK APERTURE CARDS:

An exception to the usual match punching procedure will be made on all work where film mounting is programmed through manual equipment. In such cases, film and code matching can be most easily and accurately accomplished during the film mounting, an operation which will now follow rather than precede the reproduce punching. Punching into blank cards will, of course, be more rapid than the usual match punching. Such altered procedures are expected to be used in support type work (replacement of damaged or mispunched cards and preparation of cards for revision drawings) as well as in regular sequence work. Roll size drawings will be preferentially programmed under these procedures in order to give them the double advantage of individual frame and code matching, and complete elimination of film loss due to mismounts or jam-ups.

13. ASSEMBLY OF SYSTEM APERTURE DECK:

a. COLLATING OF COMPONENT APERTURE DECKS:

After completion of all mounting, code punching, and interpreting , the aperture deck components will be merged into a grand system file. This collating task will bring together, for

example, the decks assembled at the start of the vault conversion from the then existing roll film files, the decks prepared from drawings in the vandyke file, and the aperture decks prepared from the new drawings received during the course of the conversion itself. To accomplish this assembly of decks, collating and high speed sorting equipment will be required.

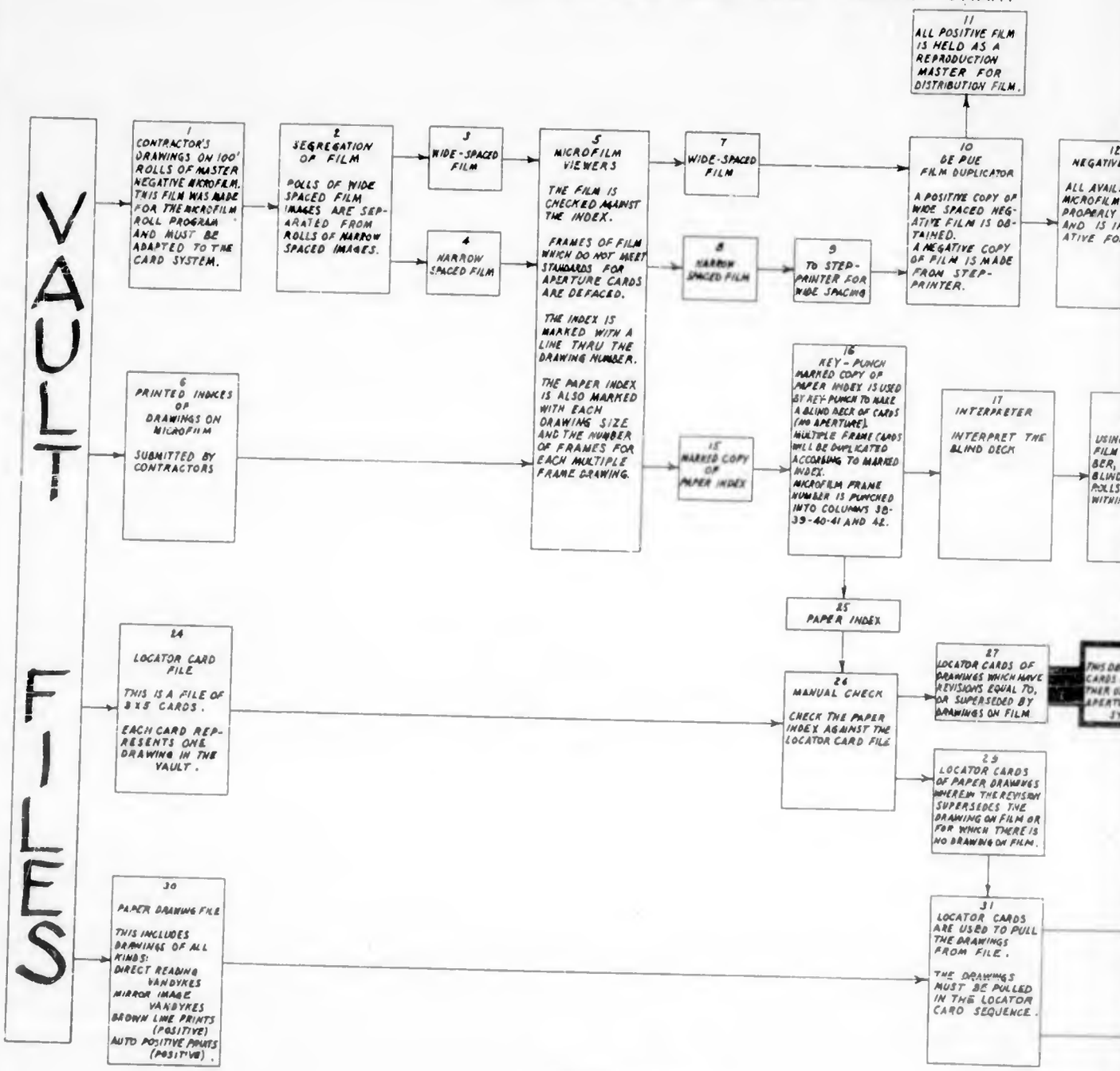
b. PURGE AND FINAL SEQUENCING OF THE SYSTEM DECK:

The system deck will be screened to remove all obsoleted and superseded drawings, revisions, and supplements. Issues to be removed arise from either of two sources: (1) introduction by way of noncurrent roll film (from the vault roll file) or (2) accumulation during the period of the conversion as a result of normal drawing supersession and obsoletion. The purged system deck will be sequenced for final use.

14. SUMMATION:

The conversion of the vault files to aperture card mounted microfilm is an intricate procedure. There are no short cuts in many of the operations. To prepare for ultimate mechanization, it is first necessary to exploit to the fullest, the capabilities of the human brain and human ability. Only when that has been accomplished, can the benefits of high speed, errorless, mechanical, and electrical operation be realized. As an aid in accomplishing the numerous manual and mechanical functions unavoidably associated with vault conversion, Figure 17 is included in this report. Figures 18 and 19 are for administrative guidance and quality control trouble shooting. Figure 20 is a breakdown or detail flow chart depicting the method of normal work flow within the vault files after implementation. This figure refers only to that portion of the vault responsible for contractor drawing file maintenance. Figure 21 is corollary to Figure 20 except that Air Force drawings received from ARDC centers is the subject matter rather than contractors' drawings. Figure 22 is a flow chart, representative of the orderly manner in which the remainder of vault responsibility may be discharged after system implementation.

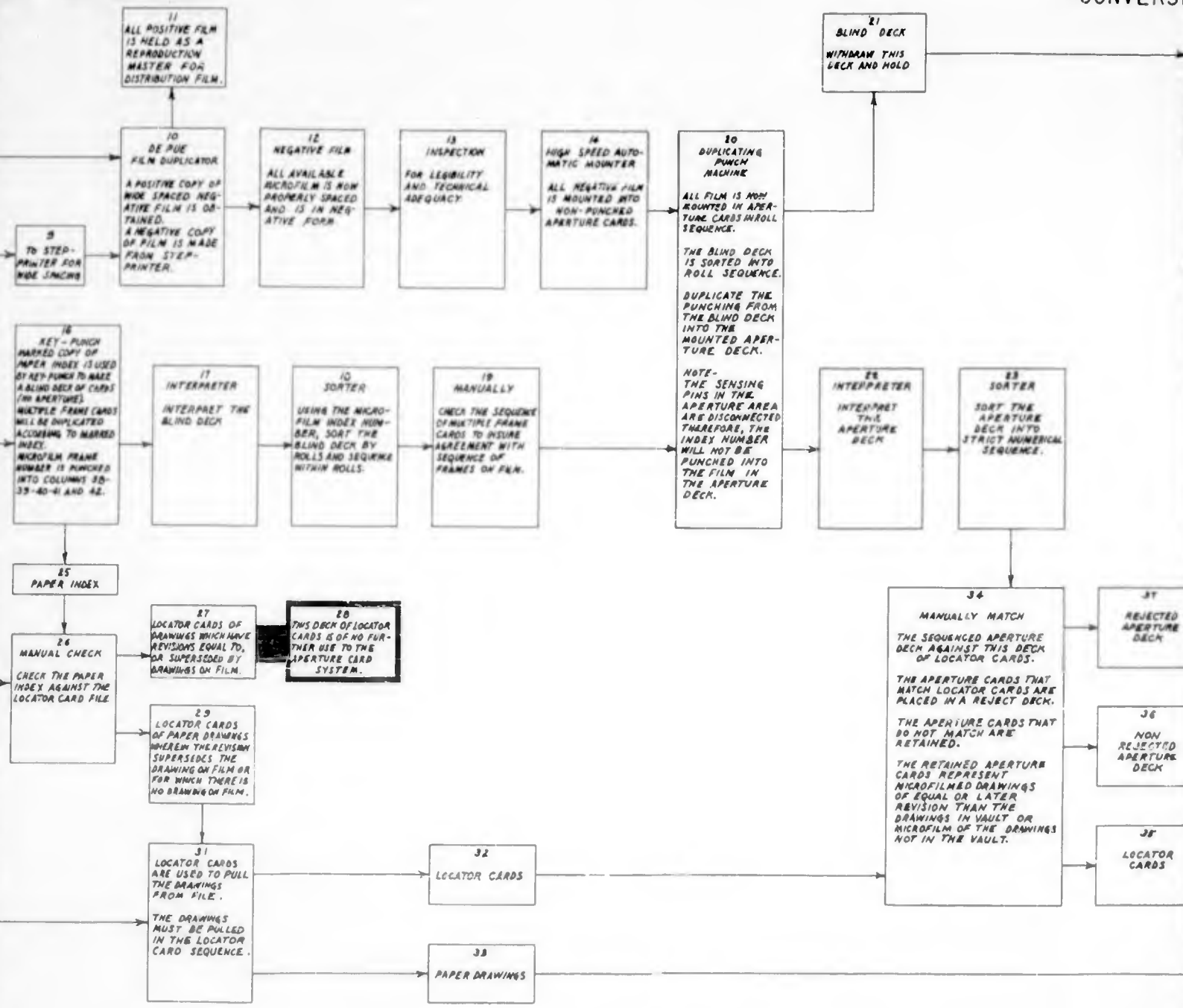
CONVERSION OF VAULT FILES MASTER CHART



1

LES MASTER CHART

CONVERSI



2

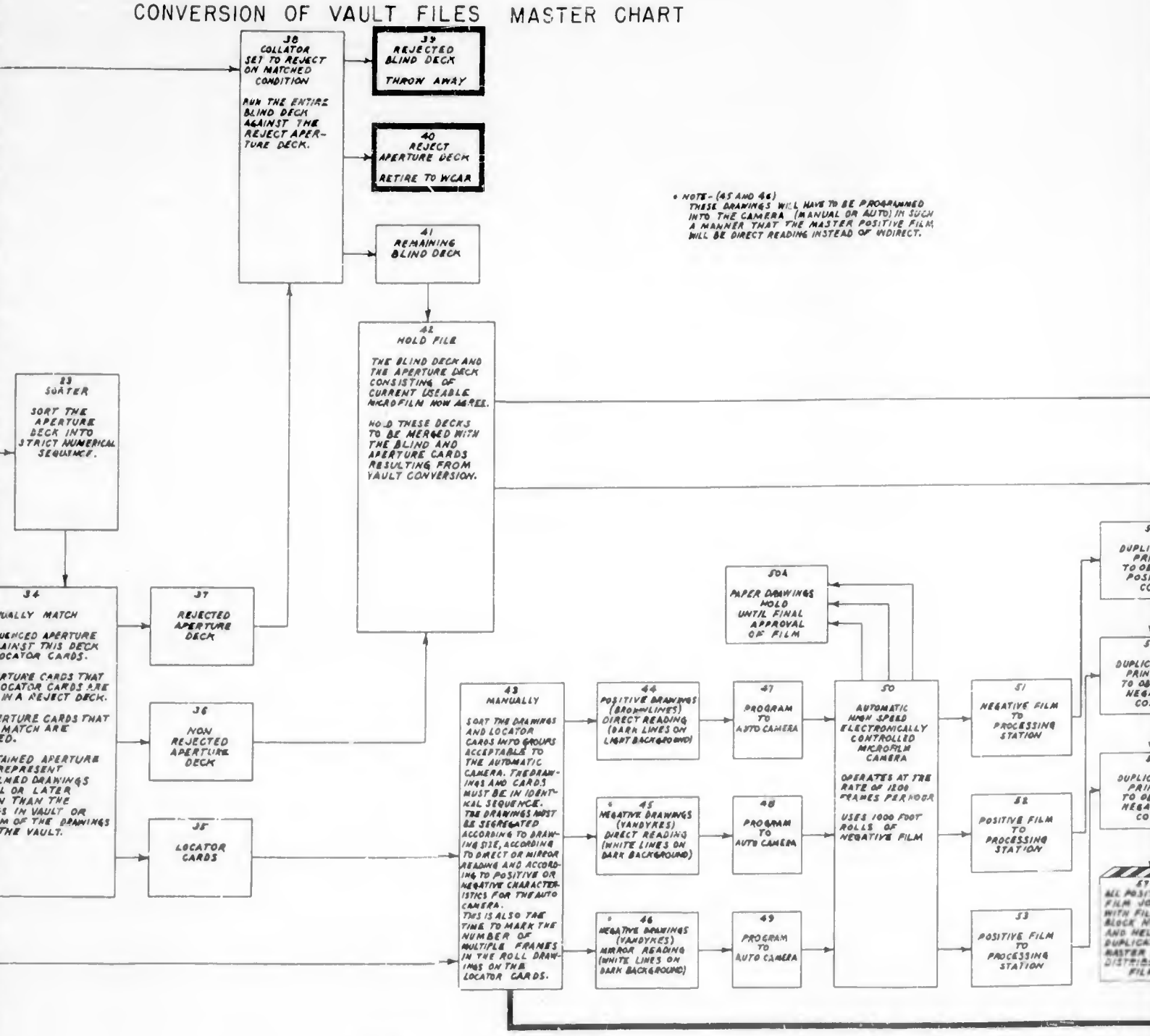
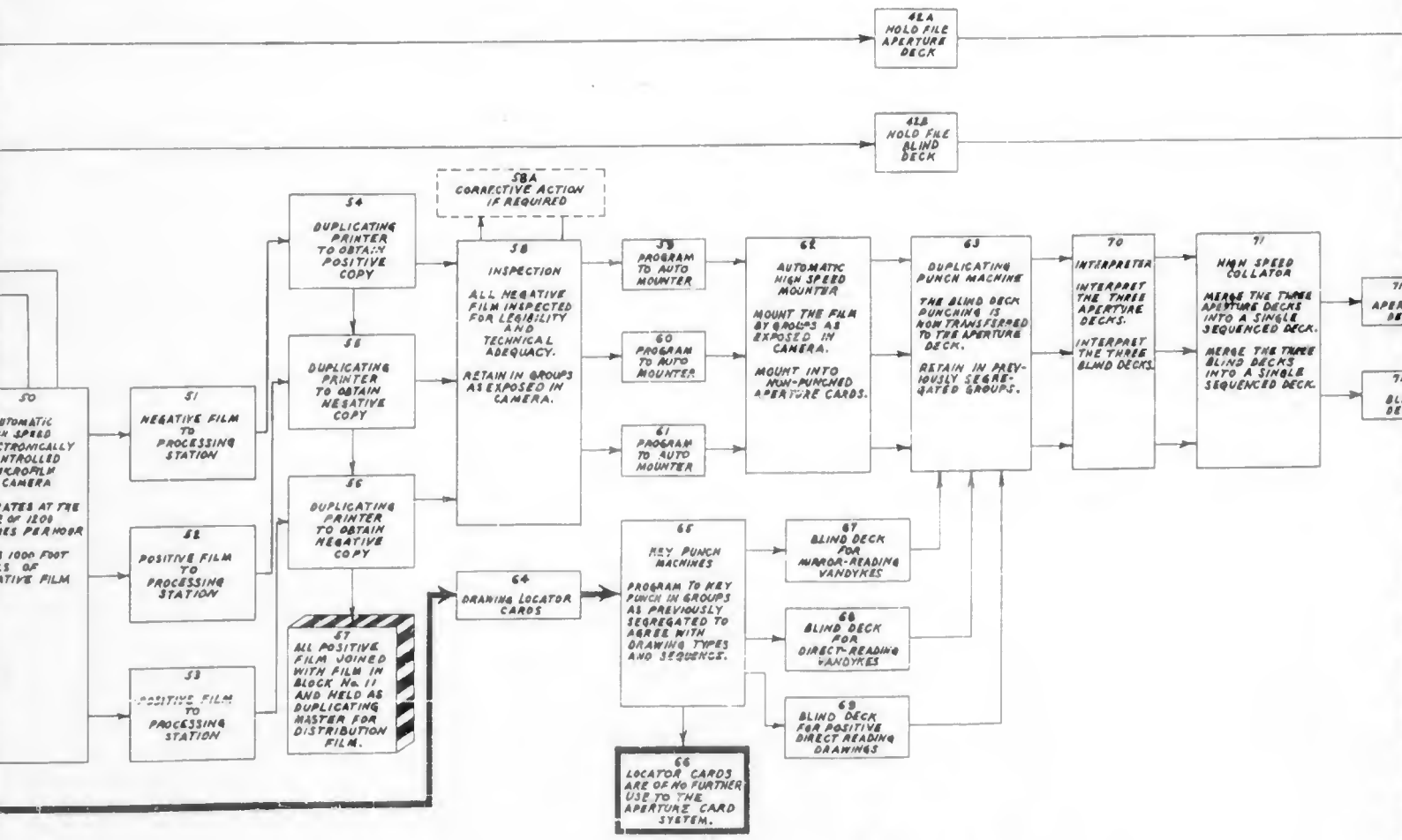

CONVERSION OF VAULT FILES MASTER CHART
38 COLLATOR SET TO REJECT ON MATCHED CONDITION
RUN THE ENTIRE BLIND DECK AGAINST THE REJECT APERTURE DECK.
39 REJECTED BLIND DECK
THROW AWAY
40 REJECT APERTURE DECK
RETIRE TO WCAR
41 REMAINING BLIND DECK
42 HOLD FILE
THE BLIND DECK AND THE APERTURE DECK CONSISTING OF CURRENT USEABLE MICROFILM NOW AGREE.
HOLD THESE DECKS TO BE MERGED WITH THE BLIND AND APERTURE CARDS RESULTING FROM VAULT CONVERSION.
* NOTE - (45 AND 46) THESE DRAWINGS WILL HAVE TO BE PROGRAMMED INTO THE CAMERA (MANUAL OR AUTO) IN SUCH A MANNER THAT THE MASTER POSITIVE FILM WILL BE DIRECT READING INSTEAD OF INDIRECT.
23 SORTER
SORT THE APERTURE DECK INTO STRICT NUMERICAL SEQUENCE.
34
UALLY MATCH
UENCED APERTURE AIN'ST THIS DECK OCATOR CARDS.
RTURE CARDS THAT OCATOR CARDS ARE IN A REJECT DECK.
IRTURE CARDS THAT MATCH ARE ED.
TAINED APERTURE REPRESENT LMED DRAWINGS L OR LATER N THAN THE S IN VAULT OR M OF THE DRAWINGS THE VAULT.
37 REJECTED APERTURE DECK
36 NON REJECTED APERTURE DECK
35 LOCATOR CARDS
43 MANUALLY
SORT THE DRAWINGS AND LOCATOR CARDS INTO GROUPS ACCEPTABLE TO THE AUTOMATIC CAMERA. THE DRAWINGS AND CARDS MUST BE IN IDENTICAL SEQUENCE. THE DRAWINGS MUST BE SEGREGATED ACCORDING TO DRAWING SIZE, ACCORDING TO DIRECT OR MIRROR READING AND ACCORDING TO POSITIVE OR NEGATIVE CHARACTERISTICS FOR THE AUTO CAMERA.
THIS IS ALSO THE TIME TO MARK THE NUMBER OF MULTIPLE FRAMES IN THE ROLL DRAWINGS ON THE LOCATOR CARDS.
44 POSITIVE DRAWINGS (BROWNLINES) DIRECT READING (DARK LINES ON LIGHT BACKGROUND)
* 45 NEGATIVE DRAWINGS (VANDYKES) DIRECT READING (WHITE LINES ON DARK BACKGROUND)
* 46 NEGATIVE DRAWINGS (VANDYKES) MIRROR READING (WHITE LINES ON DARK BACKGROUND)
47 PROGRAM TO AUTO CAMERA
48 PROGRAM TO AUTO CAMERA
49 PROGRAM TO AUTO CAMERA
50A PAPER DRAWINGS HOLD UNTIL FINAL APPROVAL OF FILM
50 AUTOMATIC HIGH SPEED ELECTRONICALLY CONTROLLED MICROFILM CAMERA
OPERATES AT THE RATE OF 1200 FRAMES PER HOUR
USES 1000 FOOT ROLLS OF NEGATIVE FILM
51 NEGATIVE FILM TO PROCESSING STATION
52 POSITIVE FILM TO PROCESSING STATION
53 POSITIVE FILM TO PROCESSING STATION

Figure 17

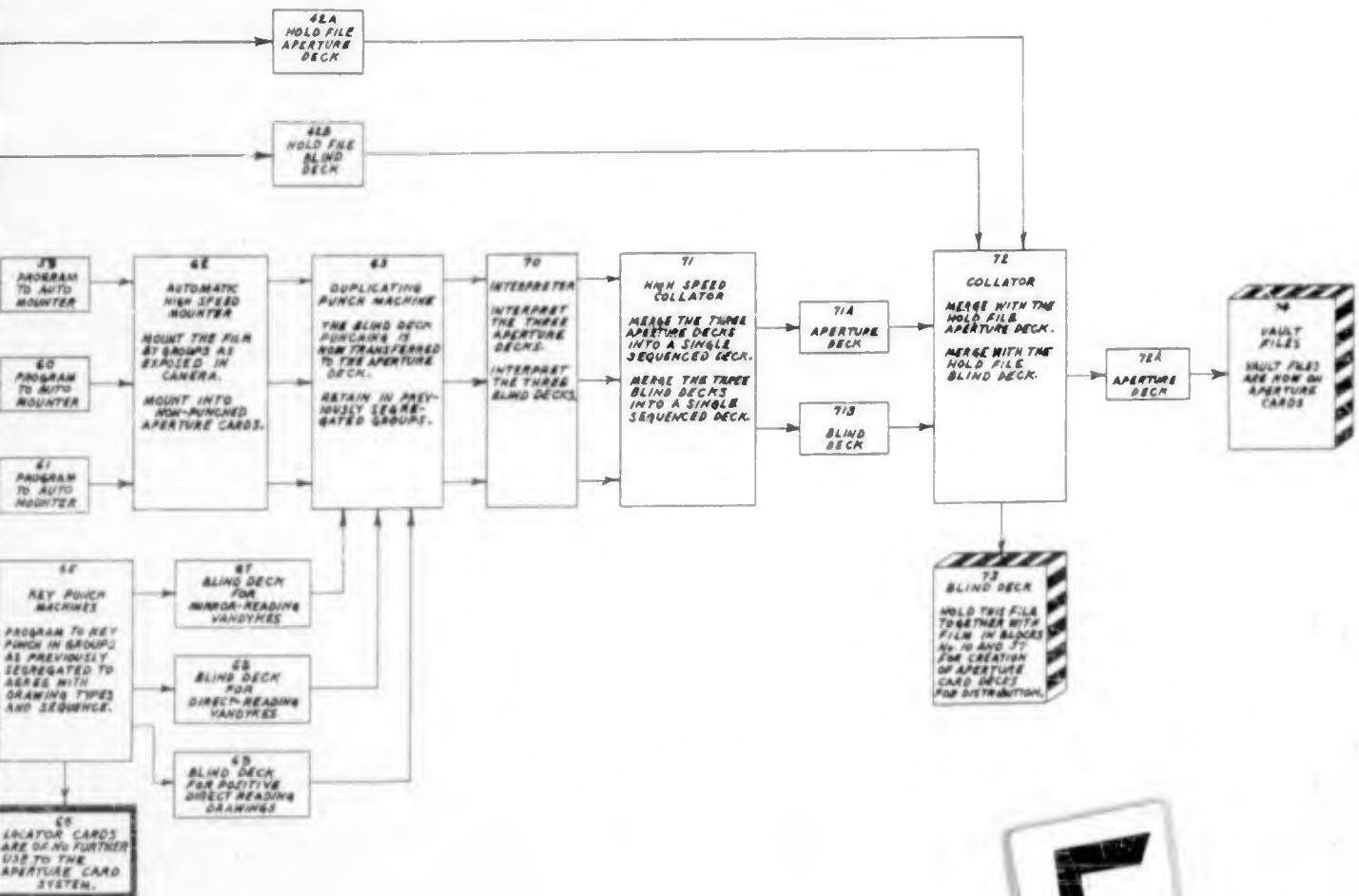
3

CONVERSION OF VAULT FILES MASTER CHART

PROGRAMMED
UTO) IN SUCH
OSITIVE FILM
F INDIRECT.



CONVERSION OF VAULT FILES MASTER CHART



5

APERTURE CARD S
SILVER NEGATIVE FILM FILED
SILVER NEGATIVE FILM

I

VAULT MICROFILM (CONTRACTORS) NOW IN ROLL FORM.
THIS TYPE OF FILM AND THIS REPRODUCTION SEQUENCE WILL BE EMPLOYED 95% OF THE TIME AFTER THE ENGINEERING DATA PORTION OF EQUIPMENT CONTRACTS HAVE BEEN AMENDED FOR MICROFILM REQUIREMENTS.

II

MICROFILM MADE FROM VANDYKES.
DIRECT READING VANDYKES FILMED FACE DOWN.
INDIRECT READING VANDYKES FILMED FACE UP.
(THE VANDYKE ITSELF IS ALLEGEDLY THE FIRST GENERATION)

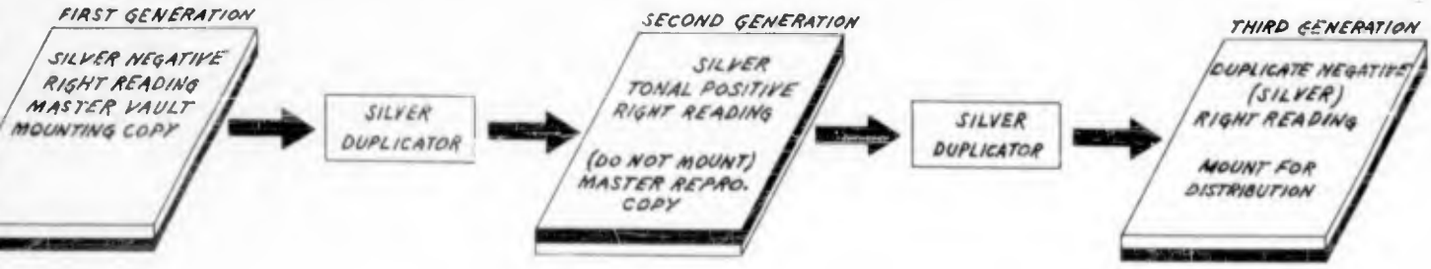
III

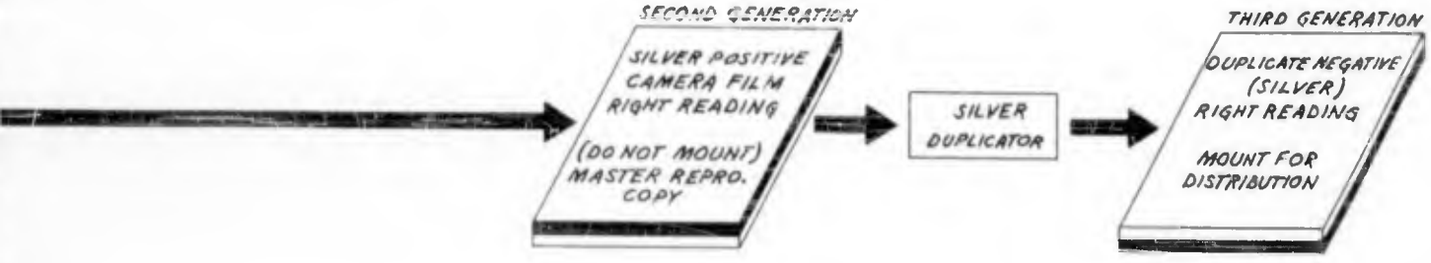
MICROFILM MADE FROM POSITIVE DRAWING COPY SUCH AS AUTOPOSITIVES AND PHOTOCOPY POSITIVES.
DIRECT READING COPY FILMED FACE UP.
INDIRECT READING COPY FILMED FACE DOWN.
(THE POSITIVE REPRODUCIBLE ITSELF IS ALLEGEDLY THE FIRST GENERATION)

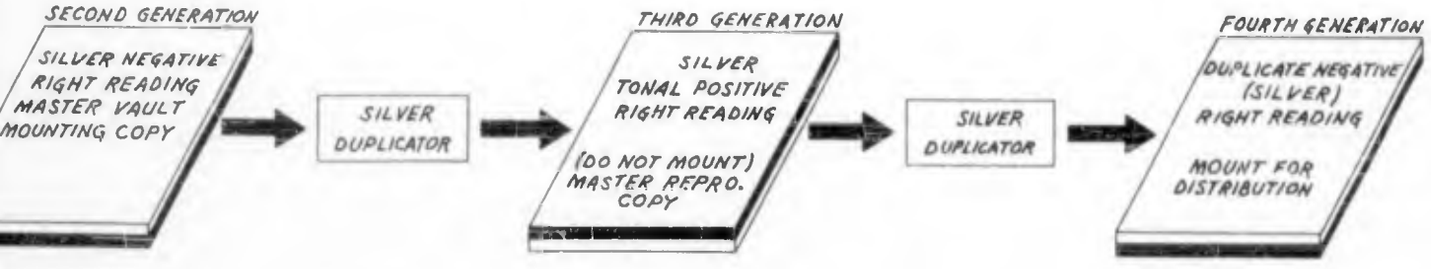
NOTE:
NEGATIVE FILM IS RIGHT READING WHEN VIEWED THRU THE FILM BASE.
POSITIVE FILM IS RIGHT READING WHEN VIEWED FROM THE EMULSION SIDE.

Figure 18

APERTURE CARD SYSTEM
TIVE FILM FILED IN MASTER VAULT
NEGATIVE FILM DISTRIBUTED







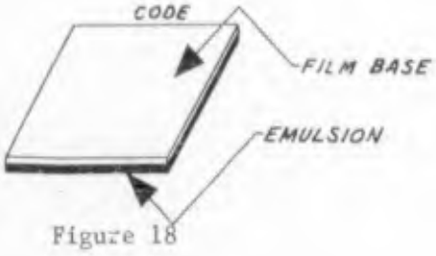


Figure 18

1

APERTURE CARD SYS
DIAZO NEGATIVE FILM FILED IN
DIAZO NEGATIVE FILM DIS

I

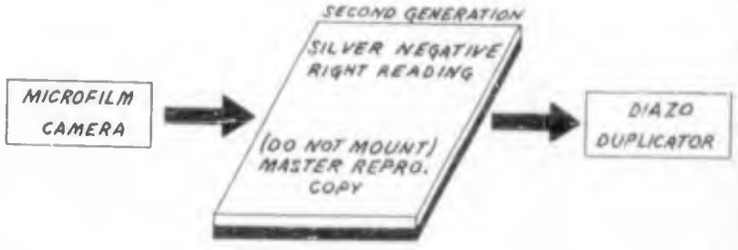
VAULT MICROFILM (CONTRACTORS) NOW IN ROLL FORM.
THIS TYPE OF FILM AND THIS REPRODUCTION SEQUENCE WILL BE EMPLOYED 95% OF THE TIME AFTER THE ENGINEERING DATA PORTION OF EQUIPMENT CONTRACTS HAVE BEEN AMENDED FOR MICROFILM REQUIREMENTS.

II

MICROFILM MADE FROM VANDYKES.
DIRECT READING VANDYKES FILMED FACE DOWN.
INDIRECT READING VANDYKES FILMED FACE UP.
(THE VANDYKE ITSELF IS ALLEGEDLY THE FIRST GENERATION)

III

MICROFILM MADE FROM POSITIVE DRAWING COPY SUCH AS AUTOPOSITIVES AND PHOTOCOPY POSITIVES.
DIRECT READING COPY FILMED FACE UP.
INDIRECT READING COPY FILMED FACE DOWN.
(THE POSITIVE REPRODUCIBLE ITSELF IS ALLEGEDLY THE FIRST GENERATION)



NOTE:

NEGATIVE FILM IS RIGHT READING WHEN VIEWED THRU THE FILM BASE.
POSITIVE FILM IS RIGHT READING WHEN VIEWED FROM THE EMULSION SIDE.
DIAZO FILM NEGATIVE WILL BE REVERSE READING, BUT DUE TO THE LACK OF AN EMULSION ON DIAZO FILM, IT MAY BE REVERSE MOUNTED (IMAGE TO ADHESIVE) IN ORDER TO PROPERLY ORIENT THE FILM IN THE CARD.

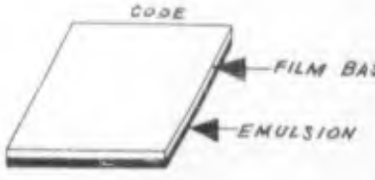
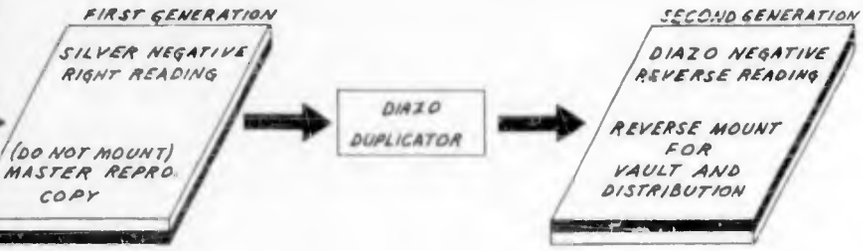
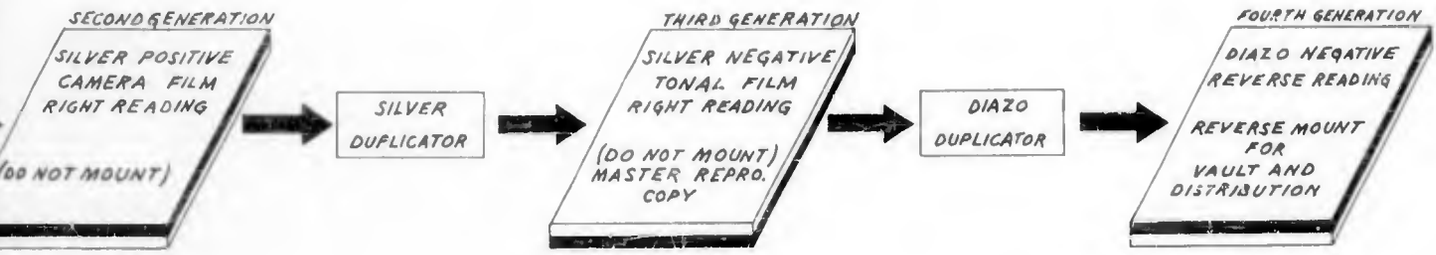
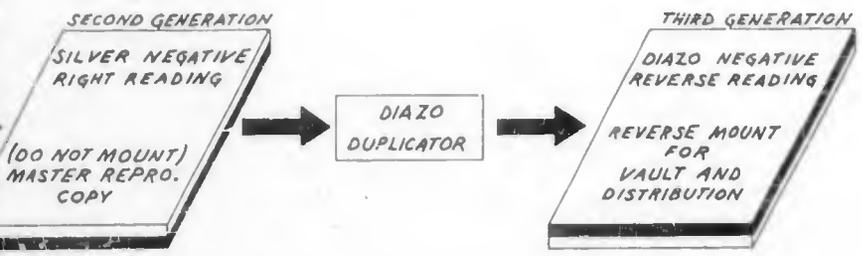


Figure 19

APERTURE CARD SYSTEM
TIVE FILM FILED IN MASTER VAULT
NEGATIVE FILM DISTRIBUTED







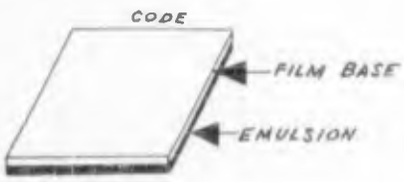


Figure 19

2

VAULT FILES OPERATION
AFTER IMPLEMENTATION OF
APERTURE CARD SYSTEM

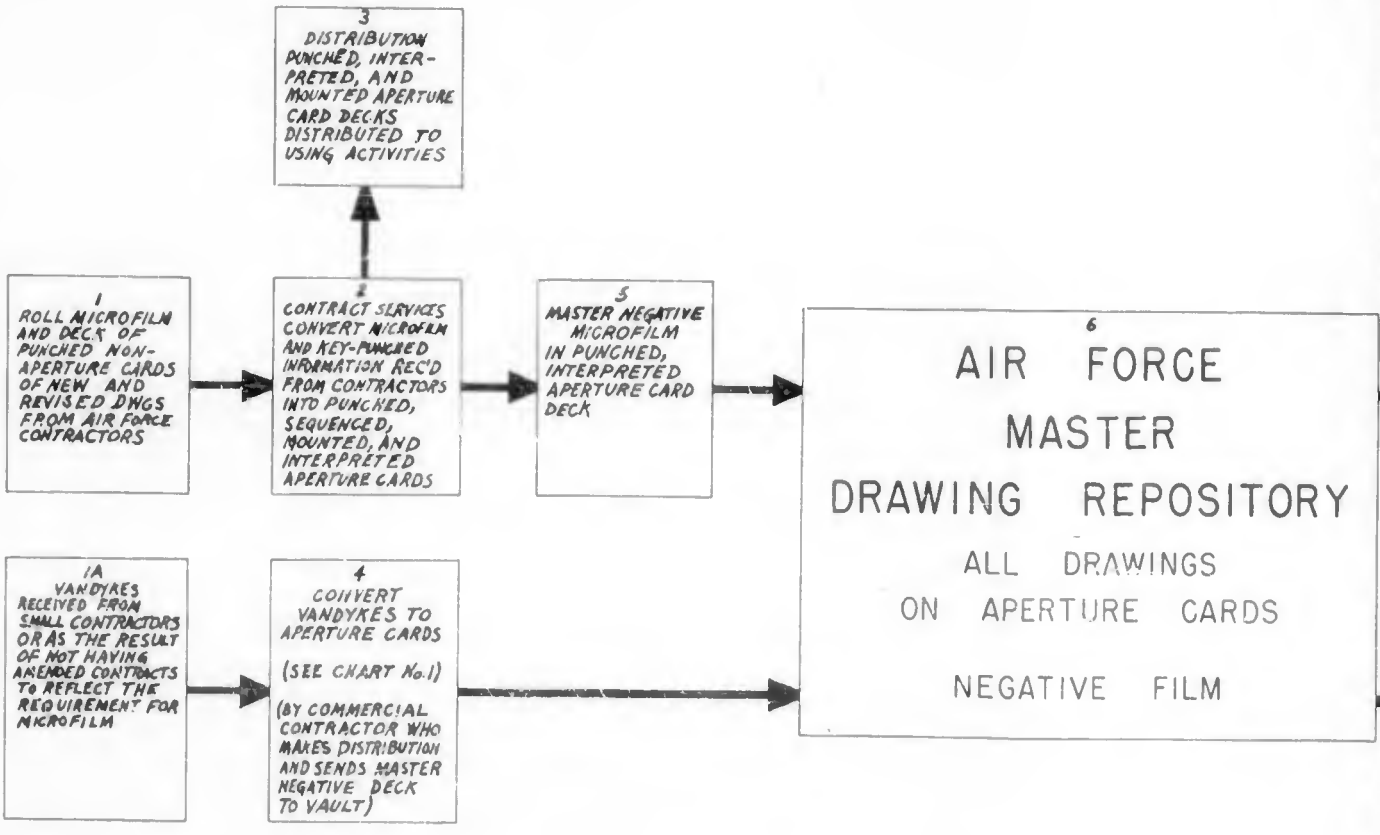


Figure 20

1

VAULT FILES OPERATION AFTER IMPLEMENTATION OF APERTURE CARD SYSTEM

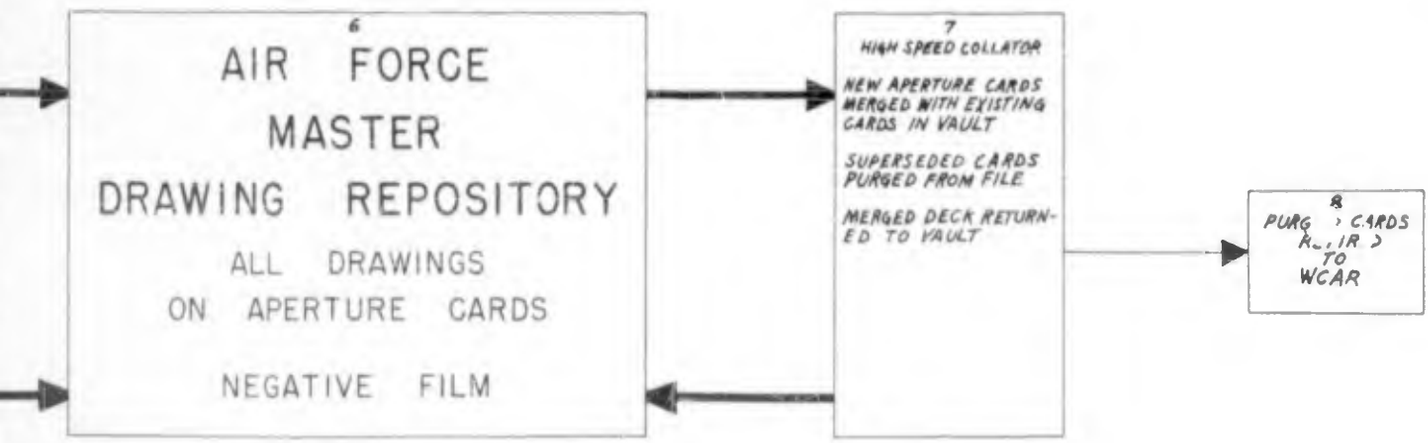
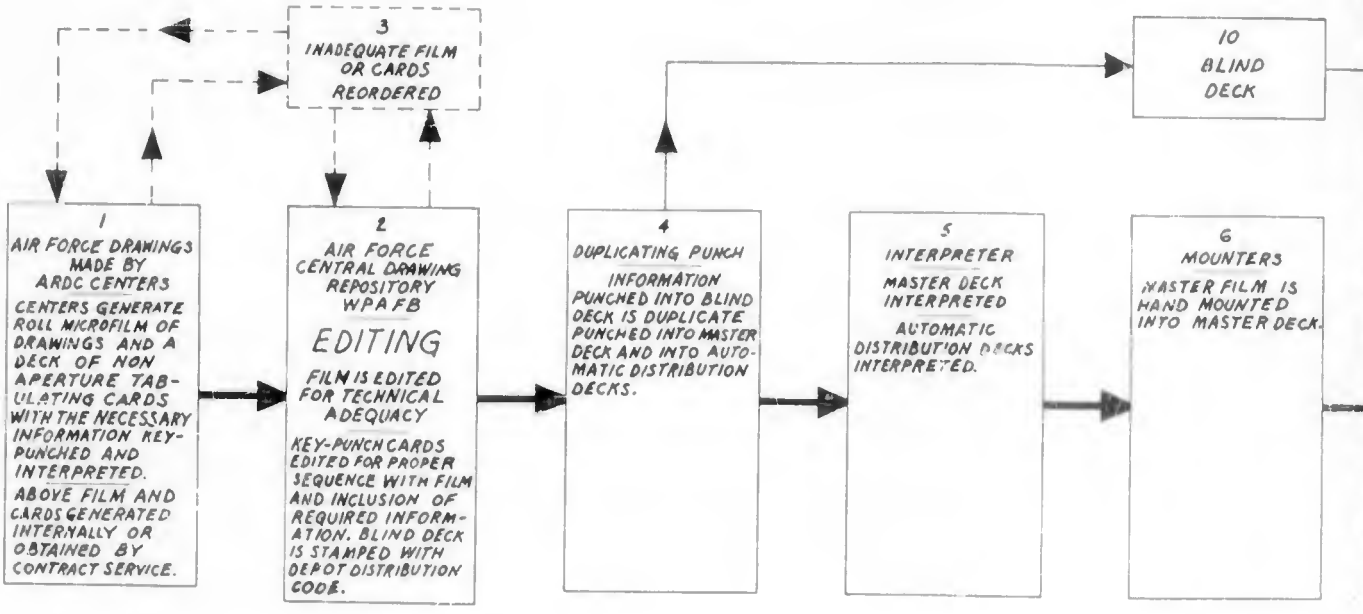


Figure 20

2

MICROFILM OF ARDC CEN
(EXCEPT WADC)
GENERATED AIR FORCE DRA



NOTE:
THE USE OF THE EXISTING RUBBER STAMPS IN THE VAULT TO DESIGNATE DEPOT CODE FOR AUTOMATIC DISTRIBUTION IS ADVOCATED INSTEAD OF KEY-PUNCHING THE CODE BECAUSE WHEN DEPOT RESPONSIBILITY CHANGES IT IS ONLY NECESSARY TO OBLITERATE THE OLD CODE AND STAMP THE NEW.

Figure 21

MICROFILM OF ARDC CENTER
(EXCEPT WADC)

GENERATED AIR FORCE DRAWINGS

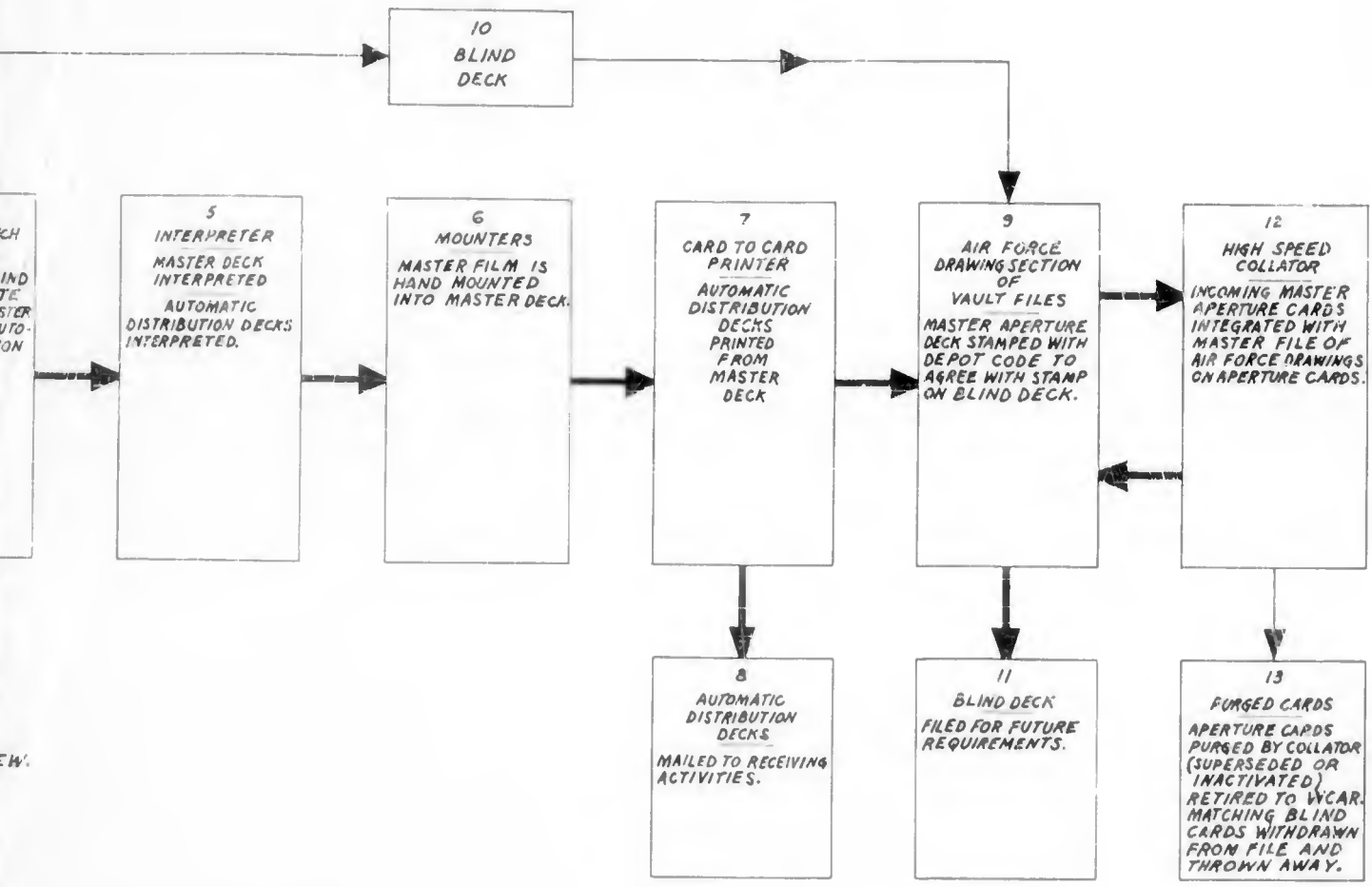


Figure 21

VAULT FILES OPERATION
(100% APPLICATION OF APERTURE

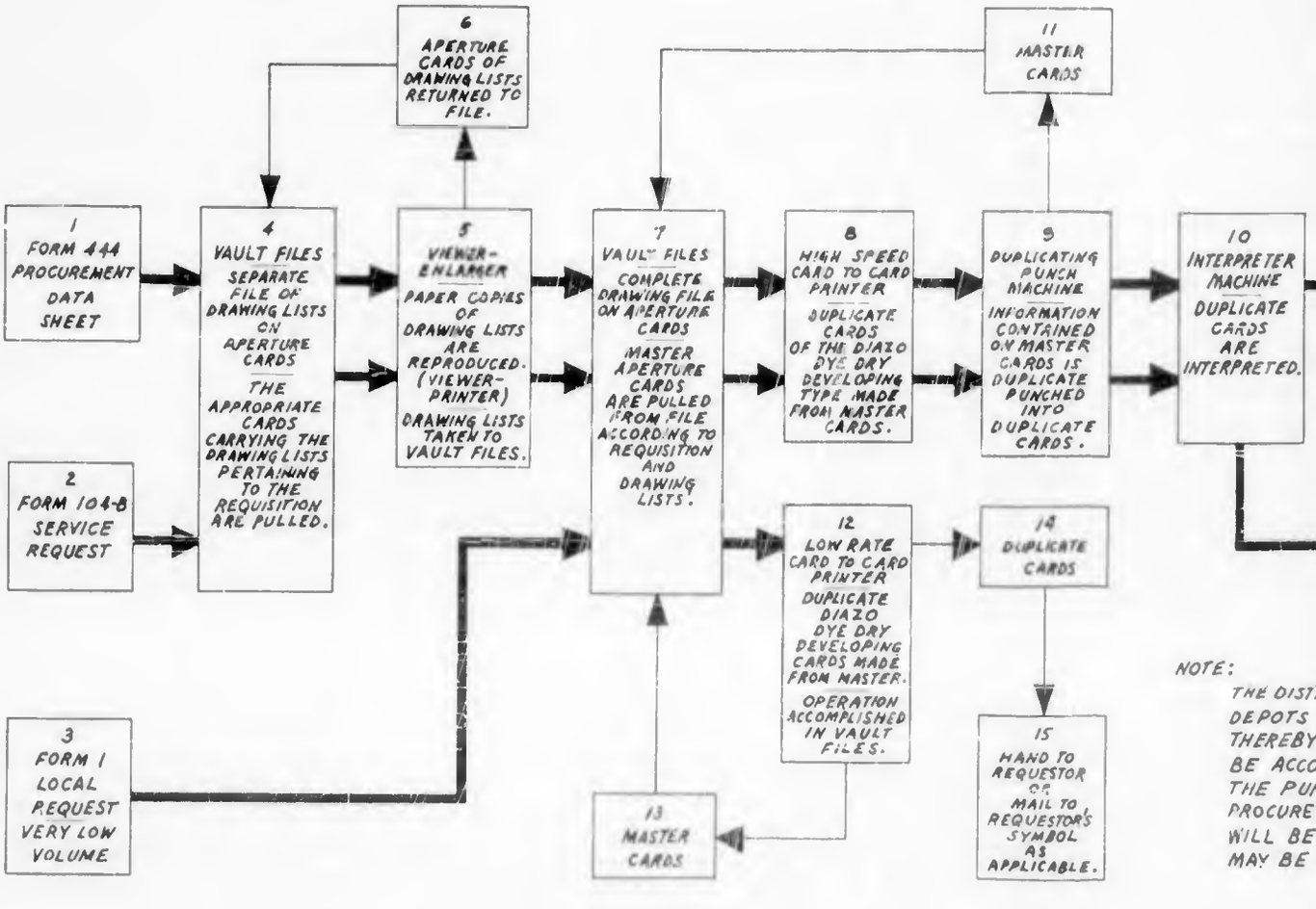
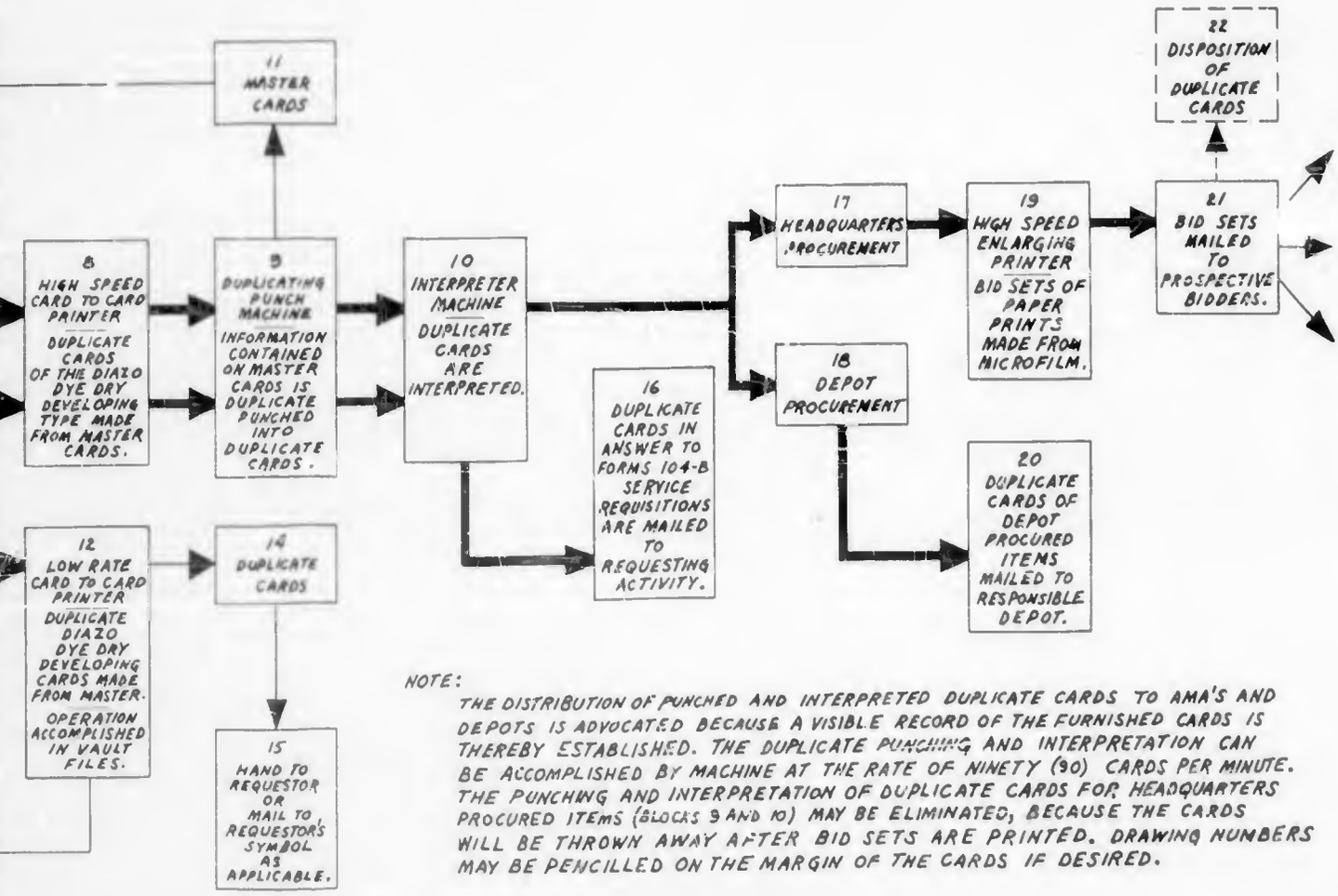


Figure 22

1

VAULT FILES OPERATION
APPLICATION OF APERTURE CARDS)



NOTE:
THE DISTRIBUTION OF PUNCHED AND INTERPRETED DUPLICATE CARDS TO AMA'S AND DEPOTS IS ADVOCATED BECAUSE A VISIBLE RECORD OF THE FURNISHED CARDS IS THEREBY ESTABLISHED. THE DUPLICATE PUNCHING AND INTERPRETATION CAN BE ACCOMPLISHED BY MACHINE AT THE RATE OF NINETY (90) CARDS PER MINUTE. THE PUNCHING AND INTERPRETATION OF DUPLICATE CARDS FOR HEADQUARTERS PROCURED ITEMS (BLOCKS 9 AND 10) MAY BE ELIMINATED, BECAUSE THE CARDS WILL BE THROWN AWAY AFTER BID SETS ARE PRINTED. DRAWING NUMBERS MAY BE PENCILLED ON THE MARGIN OF THE CARDS IF DESIRED.

Figure 22

2

SECTION II

MICROFILM APERTURE CARD SYSTEM ADOPTION BY THE CENTERS OF ARDC

ILLUSTRATIONS

SECTION II

MICROFILM APERTURE CARD SYSTEM
ADOPTION BY THE CENTERS OF ARDC

1. INTRODUCTION:

This section of Chapter III is devoted to the methods of installing and operating the microfilm aperture card system in the Divisions of the Air Research and Development Command. A complete section is allocated to the Air Research and Development Command because it is a drawing-generating Command as well as a drawing-using Command. The operation of other components of the Department of the Air Force, at command level with regard to engineering drawings, is analogous to either the procedure described in this section, or the procedures outlined in the section pertaining to AMA's and Depots of the Air Materiel Command.

In writing this report every effort was made to anticipate varied local conditions in the areas of ARDC Centers. By application of one of the proposed operational procedures and one or more of the variants, installation of the aperture card system should be relatively simple. It is believed that the information contained herein will provide an adequate basis for planning, programming, and implementation.

The microfilm aperture card system has been developed to replace the outmoded and inadequate method of drawing handling (vandykes and blueprints) now in effect. The Directorate of Engineering Standards of the Wright Air Development Center is the System and Equipment Development Agency under ARDC Research and Development Project 2079. The Cataloging and Standardization Division of Headquarters Air Materiel Command has been designated as the System Implementation Agency.

The transfer of responsibility for production microfilm from WADC to AMC (letter dated 3 January 1954), also transferred the responsibility for and custodianship of the specification governing production of microfilm for the aperture card system. Originally written in draft form by WADC as MIL-M-4875, it has since been rewritten by Headquarters AMC and the Navy Bureau of Aeronautics as MIL-M-8857(ASG). Printed copies of the specification dated 1 November 1958, are available from Hq AMC.

When the aperture card system is implemented throughout the Air Force, those activities both service and commercial now furnishing vandykes--or equivalent to Headquarters AMC in support of procurement, maintenance, and supply, will be required to furnish negative microfilm and a deck of electric accounting machine cards in lieu thereof. In turn, Headquarters AMC will no longer furnish vandykes and blueprints to procuring activities. A deck of aperture cards will be furnished.

To install and operate the aperture card system, the acquisition of some specialized equipment is necessary. A complete accounting of everything required for installation of the system will be outlined on the following pages.

A question with broad implication is immediately asked when ARDC center operation is mentioned. The question is: How much of this expensive equipment will each center be required to purchase? The apparently ambiguous answer of "all or none, or any stage in between," must be given until selection is made of the options in the following paragraphs.

If a center prefers not to use microfilm and can obtain contractor services to satisfy the needs of Headquarters AMC, no equipment whatsoever will be needed. Partial or full use of microfilm will dictate the ascending requirements for equipment, and this portion of the final report is designed to assist in making the decision.

A warning note must be interjected at this time; a note that will have a bearing on the ultimate center decision. After Headquarters AMC has converted the engineering drawing system entirely to card mounted microfilm, they (Hq AMC) will no longer have vandykes in the system. All activities, both government and commercial, requesting contractors drawings from Headquarters AMC or its AMA's and AFD's will receive the drawings in aperture card form. Utilization facilities must therefore be arranged accordingly.

2. GENERAL:

a. Upon Air Force-wide implementation of the microfilm aperture card system, the full size reproducible and the full size blueprint as the prime media for transmittal of engineering drawing information will have been superseded, and for all intent and purpose, will no longer exist.

b. This condition will present two avenues of approach to those Divisions of ARDC required to furnish copies of drawings to Headquarters AMC:

(1) Furnish the required drawings in microfilm form to Headquarters AMC, and continue to use blueprint and white print equipment to satisfy internal Center requirements for drawing reproduction.

(2) Furnish the required drawings in microfilm form to Headquarters AMC and install the microfilm aperture card system for internal Center operation.

c. Regardless of the approach selected, the work may be carried on as a total in-house effort, or may be totally contracted through one of the many reliable commercial contract service organizations. Individual preference and local conditions will dictate the method of preparing the film.

d. There are three basic reasons why full exploitation of the microfilm aperture card system is advocated:

(1) Compatibility.- The Central Drawing Repository at Wright-Patterson AFB will convert entirely to the aperture card system as well as the AMA's and Depots. These installations will require drawings to be submitted in microfilm form, and will distribute drawings in microfilm form.

(2) Speed.- Aperture cards and therefore engineering drawings can be machine sorted at a rate of 900 units per minute; small groups of drawings can be transmitted in an envelope by first class mail; duplicate aperture cards (minus the punched data) can be made in one minute; enlarged paper prints can be made in two minutes; a file clerk has 3000 drawings immediately available in one filing drawer.

(3) Economy.- Average cost of a completed master aperture card is fifteen cents as opposed to the cost of one dollar and fifty cents for the average vandyke. Duplicate cards can be made for three and three quarters cents; an aperture card file, which is in itself a reference file, occupies only two percent of the storage space needed for a full size drawing file; mailing costs for drawings are reduced to a fraction of the cost incurred in shipping vandykes or blueprints; the small size of the average drawing file consisting of a quarter of a million drawings or less, and the small size of the viewing and reproduction equipment permits file maintenance and reproduction to be handled by one person.

3. SYSTEM COMPARISON:

a. Present System.- Under the present system, whereby full size drawing reproductions are transmitted for all purposes, pertinent engineering drawings in vandyke or equivalent reproducible form are forwarded to the Air Force Central Drawing Repository at Wright-Patterson AFB. These reproducibles then become master drawing copy of ARDC Division drawings. The vandykes are immediately duplicated to provide a second reproducible copy which is in turn forwarded to the AMA or Depot responsible for procurement of the item represented by

the drawings. The master reproducibles are placed in file by the Central Drawing Repository where they are available for reproduction on call. The second reproducible, which has been forwarded to a prime procurement activity, is used by that activity or its designated commercial source to make the necessary copies of the drawings in blueprint form for transmittal to prospective bidders. The original pencil or ink drawing is also used by ARDC Divisions to satisfy internal requirements for vandyke reproducibles or blueprint reference prints.

b. New System.- The new system will require ARDC Divisions to send a roll(s) of microfilm and a deck of punched EAM cards to the AF Central Drawing Repository. The microfilm images and the data on the cards will represent those drawings now furnished in full size reproducible form. The microfilm and punch cards will be furnished in accordance with the specification referenced in the introduction to this section of the report. The source for production of the film and cards will be left to the discretion of the Division Commander, as is presently the practice for production of vandykes. The Air Force Central Drawing Repository will combine the film and information on the punch cards into a master aperture card deck, and will duplicate and distribute the drawings in microfilm aperture card form. The recipients of aperture cards will be able to merge, purge, or sequence the drawing file by automatic tabulating equipment or by hand filing as the situation demands.

4. OPERATIONAL COMPARISON:

The previous paragraph, in a general manner, compares the procedure presently being followed with the procedure to be followed upon implementation of the aperture card system. It also outlines those requirements which will be placed on the ARDC Division regardless of the decision of the Divisions relative to internal use of aperture cards. This paragraph will outline in detail the necessary operational requirements for ARDC Divisions. The operational requirements will be grouped into two general categories: (a) ARDC Divisions becoming involved in the microfilming business only to the extent absolutely necessary to satisfy the needs of Headquarters AMC, and (b) ARDC Divisions accepting microfilm aperture cards as the sole means of supplying engineering drawings.

a. Minimum Operational Participation.- Minimum participation presupposes that only the microfilm and punch cards absolutely required by Headquarters AMC will be generated; all copies of drawings required by Division personnel will be reproduced

by blueprint, white print, or vandyke methods. The procedures for internal operation in this case have been established and are functioning, and therefore will not be discussed under this paragraph. Microfilm suitable for mounting in aperture cards and punch cards containing the necessary information can be generated through the efforts of a commercial service organization or through in-house effort.

(1) Obviously, the simpler approach to the situation, and the one requiring the least amount of equipment is that of relying on the abilities of a trustworthy services contractor to accomplish the entire job. After issuance of a call letter type contract, the only effort on the part of Division personnel is that of withdrawing and re-entering the original drawings in the drawing files, spot checking the completed film and cards, and mailing same to the Central Drawing Repository at Wright-Patterson AFB. Unfortunately, this simple approach cannot be applied in every case. Geographical location of certain Divisions resulting in physical isolation from qualified contractor services will preclude the use of this method. If contract services are impractical or unfeasible, in-house effort must be considered.

(2) In-house effort is more exacting in its demands on Division personnel but is more rewarding in that it permits intimate control over the end item. In-house effort places a requirement on a Division for the acquisition of certain items of equipment and supplies. The personnel required in all probability, can be limited to the services of one trained technician and one semi-skilled technician or trainee. This experience factor is not as formidable as it first appears. Complete training of personnel can be accomplished by the Directorate of Engineering Standards, Wright Air Development Center. Acquisition of the equipment and supplies does not present any particular problem. They are available either as Air Force Stock Listed Items, or as items on GSA schedule. The following list will serve as a guide in the procurement of the necessary hardware and expendable supplies:

(a) Microfilm Camera.- The Recordak Microfile C-3 or equal, is the most frequently used camera when microfilm is being prepared for aperture card use. The Microfile C-3 unit has the added advantage of being a stock listed item. Another camera, equally satisfactory for the purpose, is marketed by the

Microline Sales Group of the General Aniline and Film Corp., Johnson City, New York. This camera is imported from Germany and appears on the GSA schedule of the General Aniline and Film Corp.

(b) Residual Hypo Test Equipment.- All permanent record microfilm must be subjected to certain tests prescribed by the National Bureau of Standards. Performance of this test is a critical operation and subcontracting of this test to a responsible laboratory is advocated if at all possible. (See paragraph below on microfilm.)

(c) Microfilm Viewer.- At least one microfilm viewer or reader with an image magnification of approximate 12X is required for quality control. The viewer should be equipped to accept 35mm microfilm on 100 ft rolls as well as microfilm mounted in aperture cards. This equipment is obtainable from many sources in a wide variety of sizes and in numerous price ranges. Equipment manufacturers such as Diebold Inc of Canton, Ohio; Recordak Corporation, Madison Ave, New York, New York; Filmsort Division of Dexter Folder Co., Pearl River, New York; Microline Sales of General Aniline and Film Corp., Johnson City, New York, to mention a few, have microfilm viewers listed in their GSA contract schedules. Many existing readers can be converted from roll film to card or roll.

(d) Microscope.- In order to determine compliance with the image resolution requirement in the specification, a microscope with a 50X magnification is necessary. Several microscopes are listed in the Air Force Supply List. A binocular type eye-piece is recommended.

(e) Densitometer.- The densitometer, used to measure the background density of film is another instrument employed in quality control. The extinction type is not permitted. An electronic densitometer of the Ansco-MacBeth type is required. This instrument is obtainable from Air Force Supply.

(f) Automatic Tabulating Equipment.- In order to generate the deck of punch cards, coded with the proper information, it will be necessary to have possession of, or programmed access to, certain items of punch card equipment. Two basic items, the manual key-punch machine and the interpreter will be required in any event. A third machine, the sorter, will make the

job easier but is not absolutely necessary. Hand sorting of small groups of cards is as effective as machine sorting.

(g) Microfilm.- In order to take the microfilm pictures of the drawings a supply of unexposed, master-negative microfilm is required. Microfilm cameras accept microfilm which is unperforated, 35mm in width, by 100 ft in length. The film must be obtained on camera reels. Two types of this microfilm are obtainable from the Air Force Stock List. One type is dye-back and includes the cost of processing by the manufacturer in the purchase price. The other is grey-back which does not include processing cost. Either type is acceptable, but the dye-back film is recommended for the job because no auxiliary processing source is required, and with reference to paragraph b above, the laboratory will perform the residual hypo test at no cost and will certify to its accuracy.

(h) Source Document.- A typed or handwritten list of the information to be code punched into the cards must be prepared from the original drawings, or from the processed microfilm when viewed on a microfilm reader. A sample form, Figure 24, is furnished as a guide. The completed form is given to the key-punch operator, and the operator in turn creates the deck of punched cards.

(i) Training.- Proper training of key personnel is one of the most valuable assets toward insuring the success of a microfilming program. A certain calibre of microfilming equipment representative tends to minimize the basic skills required in the operation and management of microfilm equipment. The reason for this inverse stress on training is rather obvious.

b. Maximum Operational Participation.- Maximum operational participation is to be interpreted as meaning that all internal operation pertinent to engineering drawings will employ microfilm as the medium. Full scale blueprint reference files will be disposed of, vandyke reproducible files will be eliminated, and original drawings will be used only by the draftsman for addition or deletion of information, and by the microfilm camera operator for making the original microfilm negative. Reference files will consist of microfilm mounted into code punched aperture cards. Microfilm viewers will be used when reference to a drawing is desired, and paper prints,

when desired, will be made from aperture card mounted microfilm by means of a specialized viewer-printer. There are numerous approaches and variants within the approaches when converting an operation to 100% microfilm. Obviously all of the variables cannot be discussed within the limits of this document, so, only the two major possibilities will be outlined. The first step to be taken when changing from full size copy to the more economical microfilm operation, is the conversion of the entire master drawing file to microfilm. This step will be necessary, regardless of the methodology of attainment chosen. A flow chart of detailed procedures, drawn from actual experience, is included in this report as Figure 23.

(1) Contractor Services.- Again a call letter contract with a responsible commercial service establishment is the easiest and probably the quickest way of becoming operational. Conceivably the contract for converting the entire drawing vault to microfilm and the mounting of the film in aperture cards could be an extension of the contract mentioned in paragraph 3.a.(1); or, depending upon local conditions, a separate fixed cost contract for vault conversion could be more economical. A contractor-service contract obviates the necessity of maintaining a sizeable technically trained staff and also eliminates the necessity of acquiring certain items of equipment. The controlling specification, augmented by contractual instructions for local conditions, provides adequate guidance for a qualified service contractor. Those drawings normally microfilmed and submitted to the Central Drawing Repository at WPAFB can be obtained in aperture card form automatically by requesting that the Division be placed on the automatic distribution list of the Air Force Central Drawing Repository. When contractor services are enlisted for actual preparation of the microfilm and aperture cards, a minimum amount of equipment will be required by Air Force installations to support the system. The list is as follows:

(a) Filing Cabinets.- Two types of filing equipment are recommended for maximum efficiency of the normal drawing file. The electrically operated elevator file for high reference rate files and the standard, vertical, EAM tab card file, for low rate files. The electrically operated elevator file is manufactured in several sizes, each size designed for a particular number of filing inches. This type of file is also made by several manufacturers, some of which are listed below:

Wheeldex-Simpla-Dallas Co.
40 Bank Street, White Plains, New York

Diebold Elevator File
Diebold Inc., Canton, Ohio

Remington Rand Elevator and Conve' Files
Remington Rand Div. of Sperry-Rand Inc.
New York, New York

Each of the above sources lists their equipment in the published GSA schedule. The standard, vertical, EAM card files are Air Force stock listed.

(b) Microfilm Viewer.- The microfilm viewer assumes a role of major importance when full size prints are no longer available for reference. The viewers and sources of procurement were listed in paragraph 4.a.(2)(c).

(c) Card to Card Printer.- When operating a system from microfilm aperture cards, the master card should rarely, if ever, be loaned or removed from the master file. Inexpensive duplications can be made and presented to the requestor. After having served its purpose, the inexpensive duplicate card can be destroyed. The small printer used to make the throw-away cards is presently available in three versions as follows:

Uniprinter
Filmsort Division of Dexter Folder Co.
Pearl River, New York

Unitizer
Microline Sales Group General Aniline and Film Corp.
Johnson City, New York

Card to Card Printer
Technifax Corp.
Holyoke Massachusetts

The above printers are available from GSA schedule. The throw-away cards, under the trade name Ref-cards are also obtainable from GSA schedule. The Uniprinter and Unitizer are small compact units that can be placed on top of a card file cabinet or on a corner of a desk top. The card to card printer of the Technifax Corp. is considerably larger, particularly when it is combined with the required developing unit. It is not practical to operate this unit from the top of the card file.

(d) Viewer-Printer.- The viewer-printer is an Air Force developed item to fill the void always present in an active microfilm operation. It is, as the name implies a dual purpose instrument. It is a microfilm viewer, or with the flick of a switch it is a microfilm enlarger. It can be operated in broad daylight. Paper prints are produced from card mounted microfilm in a matter of seconds. It is sufficiently compact to be used in an office, drafting room, or reference file with equal facility. This viewer-printer is a necessary item when operating an engineering drawing service from microfilm.

(2) Total In-House Effort.- The opposite approach to 100% contracted work is, of course, total in-house effort. There are many benefits to be derived from in-house effort, but there are also a few undesirable features. Consideration on the plus side of the ledger include absolute control over the entire system, rapid replacement of missed or illegible frames, immediate correction or replacement of lost or mutilated cards, and ability to maintain file currency within eight hours after a drawing has been changed or a new drawing has been created. Less desirable features of in-house effort include the necessity of obtaining and maintaining a staff of technically trained people, the requirement for a considerable amount of floor space in a suitable location, the necessity of maintaining a considerable quantity of equipment, and the additional administrative work load.

As in paragraph 4.b.(1), the first step to be taken is conversion of the entire drawing vault to microfilm. To do this it is necessary to acquire a microfilm camera capable of doing the job, and a location, adjacent to the drawing vault, suitable for the camera. The camera itself is obtainable from Air Force supply. The location presents more of a problem. It should be as close to the drawing vault as possible to eliminate the possibility of damage to the original engineering drawings during transport; the location should also be vibration free to eliminate resolution problems in the camera itself; and finally sufficient area should be allocated to accommodate the necessary tables et cetera needed to support camera operation. Programmed access to automatic tabulating equipment must be arranged. The source document, Figure 24 is accomplished prior to and at the time of filming. (Microfilm frame number is assigned at the time of filming) As groups of drawings are filmed, the source document is

fed to the key-punch people to produce the deck of nonaperture tabulating cards. The exposed microfilm is sent to the processing station, preferrably a commercial laboratory, where the film is developed and checked for archieval quality.

Upon receipt of the film from the laboratory it is immediately checked for resolution and background density according to the provisions of the specification. An electronic densitometer is used for checking background density while a microscope, preferably of the binocular type is used to check resolution. Both, the microscope and densitometer are obtainable from Air Force supply (paragraph 4.a.(2)(d) and (e)).

The microfilm and the deck of punched cards are now compared. The film is examined on a viewer at a minimum of 12X. The information on the film is compared with the information punched into and interpreted on the cards. The sequence of the film images and cards is also insured.

The deck of cards, after all checking has been completed, is sent to the automatic tabulating machine people where the punched information is machine transferred to aperture cards. Single decks or multiple decks can be generated at this point. If multiple decks are made, the intervening time may be used to have the film duplicated and the required number of copies generated. The duplicate copies must also be negative film because all equipment designed to either make enlarged paper copies from the film, or duplicate the card itself in a card to card printer (paragraphs 4.b.(1)(b) and (c)) operates better with negative film.

Upon completion of all duplication, card and film, the decks of cards and rolls of film are fed into a semi-automatic film mounter. This machine accepts microfilm in 100 ft rolls. Individual cards are inserted, a lever is depressed, and the mounting cycle is complete. A description of the mounter appears in Chapter II of this report. Disposition of the completed decks of aperture cards is now accomplished. Creation of a complete aperture card file eliminates the need for using the master engineering drawing in reproduction equipment. For all intent and purposes the master drawing is placed in a dead file to be resurrected only when revisions to the drawing are necessary. A step by step flow chart of the steps necessary in vault conversion is included as Figure 23 of this report. The

flow chart applies equally well to a contractor service operation, an in-house effort, or combination of the two. A new chart can be devised to meet a requirement by selecting the applicable blocks from the chart and maintaining the progression of events shown. The equipment necessary to support an in-house program, with the exception of desks, tables, typewriters, et cetera, is listed below:

(a) Microfilm Camera.- Same as paragraph 4.a.(2)(a).

(b) Residual Hypo Test Equipment.- Same as paragraph 4.a.(2)(b).

(c) Microfilm Viewer.- Same as paragraph 4.a.(2)(c).

(d) Microscope.- Same as paragraph 4.a.(2)(d).

(e) Densitometer.- Same as paragraph 4.a.(2)(e).

(f) Automatic Tabulating Equipment.- Add to paragraph 4.a.(2)(f), the following: Required, duplicating punch and high speed sorter. Desired, high speed collator.

(g) Semi-Automatic Mounter.- This instrument is a required item and is used to cut the rolls of microfilm into individual frames and mount the frames into aperture cards. This mounter accepts microfilm in 100 ft rolls. Aperture cards are inserted singly. A viewing screen permits the operator to check the information on the frame of film being mounted with the printed information on the aperture card. A single stroke of the actuating lever severs the frame of film and mounts it into the aperture. This item is described in Chapter II and is obtainable from GSA schedule.

(h) Card-to-Card Printer.- A microfilm aperture card file is its own sequenced locator file. In order to maintain the integrity of such a file, the cards should not be removed for any length of time. Therefore, rapid duplication of the card is necessary and is accomplished by means of the card-to-card printer. The instrument is small, and can be conveniently operated while it is resting on a desk top or on top of the aperture card filing cabinet. It utilizes diazo film premounted into aperture cards. The duplicate cards, under the trade name Ref-cards, are available from GSA schedule. This printer is described in Chapter II.

(i) Microfilm.- Same as paragraph 4.a.(2)(h).

(j) Source Document.- Same as paragraph 4.a.(2)(h).

(k) Aperture Cards.- Aperture cards are available from GSA schedule. The standardized format for Air Force application is defined in the controlling microfilm specification referenced in the introduction to this section of the report.

(l) Ref-Cards.- Ref-cards are cheap aperture cards, premounted with diazo film. They are intended as a means of duplicating a master aperture card in the quickest and most economical manner. Ref-cards are obtainable from GSA schedule.

(m) Training.- Same as paragraph 4.a.(2)(i).

c. It was previously mentioned that all of the possible combinations of the microfilm aperture card system could not be discussed within the limits of this report. However, the major guide lines furnished in this and other sections of the report, used as defined or as a combination of defined methods, will insure the installation of an operable system. For a better understanding of the equipment involved, it is suggested that reference be made to the equipment specification section of this report.

CONVERSION
OF
ARDC CENTER
ENGINEERING DRAWING VAULT
TO APERTURE-CARD MOUNTED MICROFILM

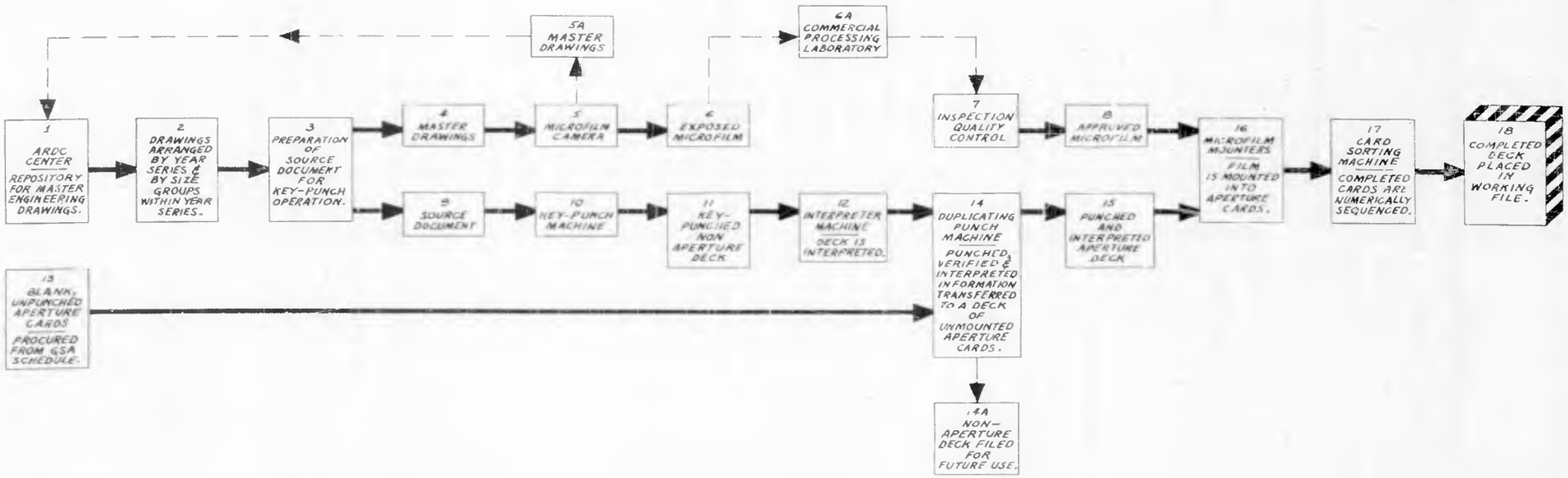


Figure 23.

SITE	DRAWING NUMBER	MUL SHT NO	REV	M/F INDEX NO	MUL FRAME	SEC DES	LAB-CODE OR MODEL-DESIGNATION

Figure 24. Source Document

SECTION III

MICROFILM APERTURE CARD SYSTEM WITHIN AMA'S AND DEPOTS

SECTION III

MICROFILM APERTURE CARD SYSTEM WITHIN AMA'S AND DEPOTS

1. INTRODUCTION:

This section of the final report recommends methods, procedures, and equipments to be used in the implementation and operation of the Microfilm Aperture Card Program in Air Materiel Areas and Air Force Depots. It also recommends the procedures for traffic in aperture cards between Headquarters Air Materiel Command, Air Materiel Areas, and Air Force Depots. This report must, however, confine itself to the broader phases of system use. Assurance has been received from the Headquarters AMC implementation organization, that a supplemental manual to this report will be published, defining the details of operation.

2. BACKGROUND:

An engineering drawing file is necessary in the operation of most Air Materiel Command field installations, particularly in the procurement, maintenance, supply, and cataloging functions. Geographical separation of the functions within certain installations requires multiple files with the attendant multiple space allocations for the files. With floor space at a premium and the number of required drawings constantly increasing, files are often crowded to the point of inefficiency.

In installations responsible for the production of drawing bid sets, the problem of space and crowded conditions is compounded by the necessity of maintaining a third file, a reproducible file. This reproducible file, in addition to its use as a bid set master reproducible, is used also to reproduce prints for local use. The geographical separation of requestors and file location causes delay in transmission of drawings.

3. BENEFITS OF THE APERTURE CARD SYSTEM TO AMA'S AND DEPOTS:

Installation of the Microfilm Aperture Card System will immediately resolve the space and operating problem since only 2% of the space required to house the present blueprint file will be required.

In some instances, due to the previously mentioned geographical separation of functions, duplicate files may still be required. These duplicate files will be small, limited use aperture card files of "shoe-box" size or less.

4. CONVERSION OF FILES:

In order to replace the paper blueprints and vandykes, now in general use in AMA's and AFD's, with the proposed microfilm aperture cards, it will first be necessary to convert the paper drawings to microfilm and mount the microfilm into aperture cards. It is recommended that the conversion of all bulk engineering drawing files be accomplished by the Air Force Central Engineering Drawing Vault at WPAFB where high speed equipment is or will be available to do the job.

Conversion of the files, in brief, within the scope of this report, means that all existing engineering drawings on paper now being used by AMA's and AFD's will be reduced to microfilm aperture cards. The paper drawings, except original drawings, will then be destroyed.

There is one exception to the exclusive use of microfilmed drawings for all reference and reproduction. That exception concerns the use of template or pattern drawings. Reference, work copies, and bid sets of pattern drawings can be made from the aperture cards, but due to the fact that microfilm is not dimensionally stable, it will remain as a requirement that a set of glass cloth or mylar duplicates be made from the original drawings and furnished to the successful bidder.

Until complete conversion of an AMA or AFD to aperture card operation can be completed, that AMA or AFD will receive vandyke reproducible and/or blueprint support under the present system.

5. REQUIRED EQUIPMENT:

The microfilm aperture card system, being new to Air Force installations, will require support equipment not presently in general use. Some of this equipment is Air Force stock listed and some is obtainable from GSA schedule. The list of equipment used in conjunction with a microfilm aperture card file is as follows:

Filing Cabinets
- Manual
- Automatic

Viewers

Viewer-printers (paper)

Card-to-card printers (film)

High Speed projection printer (paper)

A short functional description of the previously mentioned equipment is furnished herewith. For full description, specifications, and photographs refer to Chapter II of this report:

a. Filing Cabinets, Manual.- The manual file recommended for use in the system is the standard, Air Force stock listed tabulating card file. File drawers extend the full height of the file. The lowest drawer is almost at floor level. The researcher must stoop or sit near the floor to use the lower portion of the file. This cabinet is adequate for limited access files but is not recommended for highly active files.

b. Filing Cabinets Automatic.- The automatic files are almost universally operated by electricity. Storage area access is gained by a variable select button control. The bulk of the contemporary electric files employ trays affixed to endless chains. The trays revolve to access position upon command of the variable select control. These files are operated from a seated position.

c. Microfilm Viewers --Card or Roll Film--.- A microfilm viewer is basically a viewing screen and a fixed enlargement projector. There are many types of viewers on the commercial market in an almost endless choice of enlargement ratios. Care must be exercised in selecting the particular type most suited to the particular job. For example, certain viewers will accept aperture cards but have an image enlargement ratio of 8 to 1. This type is unsatisfactory for general use. General use dictates a screen size of approximately 18 by 18 inches with an enlargement ratio of at least 12 to 1. Other viewers have adequate screen size but will accept only roll film. Chapter II of this report presents specific examples of the acceptable type of viewer.

d. Viewer-Printer.- The viewer-printer, as the name implies, is a combination of both, a microfilm viewer and a projection printer. It is capable of being used as a viewer for reference work or as a self-contained projection printer for producing enlarged paper copies from frames of microfilm.

e. Card-to-Card Printer.- The card-to-card printer is used principally to make duplicate aperture cards from the operational file deck. The duplicate card is requested in many instances instead of an enlarged paper copy. Blank, apertured cards premounted with frames of unexposed diazo film are used in conjunction with this printer. The duplicate card has all of the features of the master card, although there is a slight, unavoidable loss in resolution.

f. High Speed Projection Printer.- This printer produces enlarged paper prints from roll or aperture card mounted microfilm. It is designed for quantity production and its prime purpose in the system is the printing of drawings for procurement bid sets.

6. OPERATION:

Each Air Materiel Area or Depot will determine the quantity of microfilm aperture cards needed to replace the present blueprint or reproducible files now being maintained.

The content of the drawing files will continue to be determined from mission support requirements. Upon receipt of the drawing cards, a check should be made to insure that all of the microfilm aperture cards are available, before destroying the blueprint or vandyke file. To accomplish this, a tabular listing of the microfilm aperture cards should be checked against the blueprint or vandyke file and the paper drawings discarded as they are checked from the tabular list.

It is recommended that the microfilm aperture card filing system be established as follows:

Airframe Aperture Cards such as Boeing, Consolidated, Douglas, etc.

Aircraft Engine Aperture Cards such as General Electric, Pratt-Whitney, etc.

Aircraft Accessories by manufacturer.

This system is recommended to coincide with the proposed system of Air Force procurement of microfilm for aperture cards, in which a manufacturer will supply all new and revised drawings regardless of contract in a single package. This will permit servicing the drawing file of a particular manufacturer on a planned rotational basis. The filing of drawings in numerical sequence within a drawing size will no longer be necessary or desirable. All drawings will be the same size after conversion to aperture cards, and a strict numerical sequence is advocated.

It is recommended that each Air Materiel Area or Depot determine the nature and purpose of the type of drawing file needed, such as "Reference Only" or "Reference and Drawing Support File."

Example: If reference to blueprints and the furnishing of drawing copies to requestors is a present requirement, the Air Materiel Area or Depot will need the equipment listed in file Types A and B below:

Type A File. Requirement: Reference Only.
Equipment needed: Microfilm Aperture Card Reader(s).

Type B File. Requirement: Reference and Paper Copy Drawing Support.
Equipment needed: Microfilm Reader(s), Viewer-Printer(s).

Type C File. Requirement: Reference-Multiple Paper Copies (bid sets).
Equipment needed: Microfilm Reader(s), Microfilm High Speed Printer.

Type D File. Requirement: Reference-Furnishing Microfilm Aperture Cards.
Equipment needed: Microfilm Reader(s), Microfilm Card-to-Card Printer(s).

Type E File. Requirement: Reference-Multiple Paper Copies; Individual Print Requests; Microfilm Aperture Card Requests.
Equipment needed: Microfilm Reader(s), Viewer-Printer(s), Card-to-Card Printer(s), High Speed Printer.

Operation: Type A File (Reference File Only):

In most cases when microfilm aperture cards are used for reference work, the Microfilm Reader will suffice. The request called for by drawing number is pulled from file leaving an "out" card marker to show that the aperture card has been removed from file. The requestor signs a charge-out slip for the number of aperture cards received.

When the requestor returns the cards to the file, the charge-out slip is discarded and the aperture cards returned to their proper position in file.

The number of Microfilm Readers required to support a reference file will be determined by the volume of requests for viewing plus the length of time the reader is used by each requestor.

Operation: Type B File (Reference File with Requirement for Furnishing Prints):

Many of the present blueprint files require a reproducible file to support requestors with paper copies of engineering drawings when needed. The microfilm aperture card is used as a reference copy and a reproducible medium, thus eliminating the need for a reproducible file.

To operate a reference file and furnish paper copies of the drawings, a Microfilm Viewer-Printer and a Microfilm Reader will be needed.

The operation of the reference file will basically be the same as the Type A Reference File. The Type B file varies from the Type A file only to the extent that furnishing paper copies of the drawings is a requirement.

The primary purpose of the Viewer-Printer is to furnish enlarged size paper copies of drawings. The viewing facility is secondary

and should be employed sparingly in order that the prime purpose of the equipment may be exploited to the fullest degree. It is not essential that a card reader be used in the Type B file, but is strongly recommended.

The addition of a microfilm reader(s) permits the dual functions of the organization to be accomplished simultaneously.

When paper copies are requested, the applicable card is pulled from file, again leaving an "out" card marker in the file to reflect the missing aperture card.

The aperture card is placed in the Viewer-Printer, positioned and exposed. The paper enlargement is furnished within seconds after the exposure is completed. It is recommended that requestors for paper prints check the drawing on the viewing portion of the Viewer-Printer before the print is made. In many cases, requests are made for prints, without checking the drawing beforehand; thus, the requestor receives a useless drawing copy.

Operation: Type C File (Reference File and Multiple Paper Copies):

The Type C file has only reference work and multiple paper copies (bid set) requirement.

The equipment needed will be a microfilm reader(s) and a High Speed "Dry" Printer. The reference operation is outlined in Type A file.

The major uses anticipated for the High Speed Printer are: printing multiple copies of engineering drawings from the aperture card for distribution to contractors for procurement purposes and printing multiple copies of drawings for internal use.

The production of multiple copies of enlarged paper drawings is as follows: Pull the aperture cards from file and make duplicate cards by means of the card-to-card printer. Return the original cards to file and use the duplicate cards for the multiple printing operation. The duplicate cards are cheap enough to throw away after use. Thus, the master card is not exposed to the possibility of machine damage.

The aperture cards will then be sorted into size groups, such as A size drawings, B size, C size. D size, and roll drawings. The High Speed Printer is programmed to print the desired number of multiple copies. The A size drawings are then printed, followed by the B size, etc.

It is essential that this procedure be followed if full advantage is to be taken of the economy designed into the printer. The enlarged paper copies are cut to size automatically and are stacked. To accomplish this, the scanning stroke of the printer must be adjusted to the drawing size. This is a manual adjustment which can be made in a matter of seconds. Of course the alternate plan of setting the stroke for the largest drawing size can be pursued but this will result in a waste of paper since the smaller drawings will be centered in a large sheet of paper. The High Speed Printer cannot be used effectively when employed to make occasional prints.

Operation: Type D File (Reference Work and Furnishing Microfilm Aperture Cards):

The reference operation is the same as for the Type A file. In many cases, requests for a microfilm aperture card will be made in lieu of a paper print.

The requested drawing card is pulled from file and inserted into the Card-to-Card Printer, along with an aperture card containing a frame of unexposed diazo film. The necessary procedure is followed, and in a matter of 45 seconds a duplicate card is produced which can be handed to the requestor. The duplicate card will perform the same functions as the master aperture card, with the exception that there will be no punched information on the duplicate card. The drawing number is placed on the card in pencil.

Operation: Type E File:

The Type E File has all the requirements of Files A thru D, therefore will require all of the referenced equipment. The systems outlined in Files A thru D remain the same.

7. ORIGINAL DRAWINGS:

Quantities of modification drawings and other AMA generated original drawings exist only at the AMA and are not on file at the Air Force Central Drawing Repository. These original drawings must be converted to microfilm aperture cards in order to be compatible with the new system. The various means of converting local drawing files to aperture cards are discussed in Sections I and II of this Chapter. Selection of one of the outlined plans is recommended.

8. SUMMARY:

The various types of files outlined above can be combined, such as File B with File C, if there is a requirement for such services.

The microfilm aperture card is basically a tabulating card, enabling it to be utilized in EAM equipment. New and revised drawings can be interfiled automatically; for instance, if 500 new drawing changes are received, the entire set of cards is pulled from file and programmed into the EAM collator. Superseded revisions are discarded as new revisions are interfiled.

The ability to handle the cards and therefore the drawings by machine must be approached with caution. In certain instances machine handling can actually slow down the system. In and out filing by machine requires the entire file to be handled, and exposed to possible machine damage. To sort and collate a file of 200,000 cards for the purpose of inserting 50 revised cards is more time consuming than manual insertion. It has been determined that the insertion and removal of 200 cards or less is best accomplished by manual methods. It must also be borne in mind that certain types of EAM equipment must be modified to handle aperture cards, and while in the modified state, the equipment is useless for other purposes.

Since it is anticipated that drawing changes will be forwarded to the Air Materiel Areas and Depots more frequently under the new system thus resulting in numerically smaller groups, the filing of new and revised cards will pose no problems. Periodic conversion of self-generated original drawings will remove the in-house accumulation of drawings from the problem area.

SECTION IV

MICROFILM APERTURE CARD SYSTEM WITHIN OPERATIONAL BASES ZONE OF INTERIOR/OVERSEAS

The application of the microfilm aperture card system in Operational Bases will be essentially the same, with identical choice of options, as previously described in the foregoing sections of this chapter.

Georgraphical location, physical restriction, and availability of utilities present such a vast number of possible combinations of the previously described basic methods that no attempt will be made herein to describe tailor-made installations. A basic system can be selected from this final report, and by describing particular variables, individual installations can be made through channelled requests for assistance.

SECTION V

EQUIPMENT DEPLOYMENT

The deployment of equipment was discussed and presented in chart form in Management Report dated 3 December 1957 (MR-5). Nothing has occurred in the period of time between issuances of MR-5 and the writing of this report to indicate a major change in the deployment proposal. The deployment chart is furnished as a page of this chapter as a matter of convenience, and as an aid to those who read this report but do not have access to the Management Reports on Project 2079.

The equipment designated for a particular type of installation will vary with the degree of participation of the installation and the method by which an organization accomplishes the necessary work. For instance, if all work is done by commercial contract it is obvious that a camera is unnecessary; if the drawings are microfilmed in-house, but film processing and mounting services are commercially contracted, the mounters are eliminated but procurement of a camera is indicated.

Thorough planning for the type of operation decided upon will make it easy to use the chart. No surplus equipment will be on hand nor will there be a lack of proper tools to perform the assigned mission. An extremely valuable document, when selecting equipment, is the illustrated guide to domestic and foreign microfilm equipment published in 1959 by the National Microfilm Association. (See Appendix)

POSSIBLE DEPLOYMENT OF APERTURE CARD EQUIPMENT THROUGHOUT AIR FORCE

DEVEL BY	MICROFILM APERTURE CARD SYSTEM EQUIPMENT	CENTRAL AF VAULT[5]	HQ AMC[5]	AMA's[1]	AMA's[2]	DEPOTS[1]	DEPOTS[2]	HQ USAF	HQ ARDC	ARDC CENTERS	OPERATIONAL COMMAND HQS	OPERATIONAL BASES (C/S)	OPERATIONAL BASES (O/S)	OVERSEAS OFFSHORE F.OC. ACTIVITIES
Com'l	Manual Microfilm Camera	X	X[4]	X[4]		X[4]				X				X[4]
AF	Automatic Microfilm Camera	X												
AF	Semi-automatic Mounter	X	X[4]	X[4]		X[4]				X				X[4]
AF	Automatic Mounter	X												
Com'l	High Speed Card to Card Printer	X	X	X		X								X
Com'l	Duplicard Printer	X	X	X	X	X	X	X	X	X	X	X	X	X
AF	Viewer-Enlarger	X	X	X	X	X	X	X	X	X	X	X	X	X
(AF) (Com'l)	High Speed Projection Printer		X	X		X								
Com'l	Readers	X	X	X	X	X	X	x	X	X	X	X	X	X
Com'l	Files Automatic	X[3]	X[3]	X[3]		X[3]				X[3]				X[3]

X - Indicates probable Requirement (Quantity to be determined by requirement).
1 - AMA's and Depots preparing engineering data bid sets.
2 - AMA's and Depots not preparing bid sets.
3 - Type of files to be determined by Base Commander.
4 - Organization may elect to use commercial facilities rather than procure this equipment.
5 - Transfer of AF Drawing Vault to AMC will combine these two columns.

EQUIPMENT DEPLOYMENT CHART

CHAPTER IV - SUPPLIES AVAILABLE

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SUPPLIES AVAILABLE

INTRODUCTION.- This chapter has as its intent the listing and discussion of the supplies available for the support of the Microfilm Aperture Card System as developed under ARDC Project 2079. The chapter deviates from the narrow path of straight accounting in areas where known industrial development parallels system development and the resultant commercial item may at some time enter the system. A complete listing is impossible of achievement for two reasons. First, it would require tremendous manpower to ferret out all suppliers and items of supply available throughout the world. Secondly, items of supply are under constant modification, and sources change daily. An all inclusive listing might be obsolete by as much as 50% before it left the presses of the publisher. The names of development organizations are mentioned in this chapter where appropriate. If some suppliers have been overlooked, the oversight is not intentional nor is it discriminatory.

In the case of parallel choices of items in this report, the presentations and descriptions will be recounted with no attempt on the part of the writer to bias the decision of the reader.

Likewise, no attempt will be made herein to establish quantities of supplies to be maintained since stockpiling is a direct function of workload.

Supplies such as the silver-sensitized photo papers, negative and positive microfilm, the diazo products, and the aperture cards themselves have accurately predicable shelf lives in the unused state. The Xerox and Electrofax supplies have no inherent rate of self-destruction, and as a result shelf life is not a significant factor in stockpiling. Life expectancy of supplies, when applicable, will be noted in the appropriate paragraphs.

I. MICROFILM:

a. Camera Film.- Camera film is that film which possesses sufficient emulsion speed (sensitivity to light) to enable it to be used as the recording medium in a camera under normal conditions. In microfilm terminology camera film is more often referred to as master negative, or master film. There are two general categories of master negative microfilm in current use. First, the crystal clear film base which has a black dye anti-halation coating applied to the back of the film base (opposite to the emulsion side). This film is known simply as dye-back microfilm. The second general category encompasses the tinted base films or as they are commonly called, non-dye back films. This type of film depends on the carefully controlled spectral tint of the film base itself to provide the desired anti-halation characteristics. Both classes are listed in the Federal Supply System.

(1) Dye-back film:

(a) The dye-back microfilm has been preferred to the exclusion of all other film for many years by critical microfilming activities. The reasoning behind the preference was well grounded. Some microfilm cameras had natural color aluminum platens at the exposure plane. Use of dye-back film made it impossible for the light rays entering the lens to reflect from the bright aluminum platen and cause shadows or halos in the film image. This reasoning is no longer valid, because without exception all high quality microfilming equipment has the camera platen and adjacent metal parts oxidized or anodized a dull, non-reflecting black. This non-reflecting coating does not promote halo effects in the film by internal light scattering. A second reason for preference of the dye-back film is the fact that the film base is crystal clear, permitting short exposure times when duplicating or making prints from the film. This reason has always been on the questionable side since the print back time advantage is measured in factions of a second. Today this matter of preference has been negated for all intent and purpose by the capabilities of modern reproduction equipment and supplies. Indiscriminately intermixed groups of dye-back film images and tinted base film images have been duplicated repeatedly at a single printer setting.

(b) As a general rule, the purchase price of dye-back microfilm also includes the cost of processing at

the vendor's laboratory. This causes the price of dye-back film to be slightly higher than the price of tinted base film, but there are advantages to the purchase-price-processing cost arrangement. The large processing laboratories are equipped with the finest film control equipment obtainable. Excellent film can be produced with a minimum of effort on the part of the organization responsible for the exposure of the film.

(c) The conclusions derived from the use of dye-back microfilm, or the results that can be expected by an organization preparing to enter into microfilming can be summed up as follows: It is an excellent film capable of resolving extremely fine detail, can be held to very rigid quality standards, and has print back characteristics of the highest order. It has a shelf life of one year under minimum storage conditions. The life can be extended six months or more with reasonable precautions. It is entirely suited to the production of microfilm for use in roll form or in aperture cards. It possesses all the qualities necessary for the retention of archieval records.

(2) Tinted base film:

(a) Modern tinted base microfilm exhibits qualities of resolution, contrast, and printability equal to dye-back. A comparison test between tinted base and dye-back film was conducted in-house during the course of Project 2079. The test was conducted for the purpose of determining those factors, if any, which would lead to the recommendation of one type of film over another. The findings indicated that no preferential recommendation could be made.

(b) Normally the purchase price of tinted base film does not include the cost of processing by the vendor. This results in a slightly reduced initial cost when compared with dye-back. The ease of processing of tinted base film (no dye coating to contend with) is conducive to the establishment of a do-it-yourself processing laboratory. This system is advantageous in many instances where only internal application will be made of the processed film. There are a number of inexpensive film processors available on the market to do the job. There is also a very

complete selection of expensive processing machinery available. If, however, the microfilm is to be distributed to other than home-activity users it is financially ruinous to install the necessary processing control equipment in a small, low production laboratory to insure that the finished film will conform to Department of Defense standards.

(c) Due to the slight barrier to the transmission of light rays imposed by the tint of the film base, the ideal print back time for this film is slightly greater than the print back time for clear base. Generally speaking, this is not detrimental because a compromise for both types of film is well within the acceptance limits of modern print films and papers. There has never been a question of the printability characteristics of tinted base film per se. The tint has no effect on resolution nor does it effect the attainable image contrast. The question has always been one of compatibility. Other than for esthetic appearance of a microfilm file there is no valid objection to the interfiling of aperture cards containing dye-back and tinted base film. It is only in rare instances that an organization can financially permit its esthetic preference to take precedence over practicality.

(d) The recent introduction of a new tinted base film (MICROLINE) or more properly, the reintroduction of a discontinued film under a new name, may help to break down the psychological resistance to tinted base film. The tint is much less pronounced but no less effective than that of competitive brands. This factor has no bearing on film quality.

(e) The conclusions derived from the tests and use of this film are the same as those for dye-back. Shelf life and archieval quality are identical.

b. Print Film or Duplicating Film.- Print films, used for creating additional copies of the camera film or master negative, normally fall into three general groups. These groups can be categorized as follows: First, the silver sensitized group, second the diazo dye sensitized group, and third, the new comer to the field, introduced under the names of Kalvar and Kalfax. The Air Force has conducted no research into the Kalfax type film other than preliminary investigation. The Department of the

Navy, Bureau of Aeronautics, is experimenting extensively with Kalfax products. Since the product will not be discussed in this report, it is suggested that if interest exists, contact be made with Department of the Navy, Bureau of Aeronautics, Washington 25, D.C.

(1) Silver Sensitized Print Film: This group of print films is further subdivided into the high contrast type and the tonal type. The tonal type is a recent offering on the market and fills a distinct requirement.

(a) The first film to be discussed is the standard, relatively high contrast, fine grain, print film. It has been used to duplicate microfilm for many years. It has recognized short comings and was used not so much as a matter of choice but of necessity. There was no better silver sensitized film available for the job. This film is still in wide use and will probably continue in use for a considerable period of time. It is perfectly adequate within certain limitations.

Due to its short scale, or high contrast, it is difficult and often impossible to capture the entire range of lines and characters contained on the master film when creating duplicate copies. The slope of the H and D sensitometric curve of this film is simply too steep and narrow to accommodate all of the gradients of the master. If the utilized range of the master film is confined to the limits of the print film, as is the case when filming ink lines on tracing cloth drawings, fine grain print film is adequate. Regardless of the "fine grain" designation, there is considerable fall-off in image resolution on the print film due to the inherent resolution capability of the emulsion.

Unfortunately, however, all drawings microfilmed are not ink on cloth. By far the greatest percentage of drawings are pencil on vellum, and herein lies the trouble. Fine or light pencil lines combined with heavy pencil lines on the same drawing can be reproduced with sufficient fidelity only by a tonal film.

Fine grain print film is inexpensive, which enhances its value as a multiple copy distribution medium. As

a duplicate negative distribution medium it exhibits all of the desirable traits possible. The principal area of trouble has always been the creation of an intermediate print copy between the master film and the distribution copy. Since it is a practical necessity that negative film images be distributed and silver sensitized film is normally a non-reversal film (i.e., a negative master yields a first generation positive print), an intermediate printing master or "work horse" copy is required.

After the density differential between fine lines and heavy lines on the master film has been equalized on the "work horse" copy, no difficulty is encountered in using the reasonably priced fine grain print film for multiple distribution film. The fine grain print film fails in the job of creating an acceptable "work horse" copy. Other than this one failing, the film is adequate; archieval quality is beyond question, as is flexibility of base and its ability to be used in rolls or in aperture cards.

This film is normally packaged in 1000 ft rolls. The rolls are sealed in metal containers. Shelf-life under average conditions is one year. It is stock listed in the Federal Supply System.

(b) The second film in the silver sensitized group of print films is the new tonal print film. This film satisfies the requirement for an excellent intermediate printing master or "work horse" master. It is more expensive than the fine grain print film, but since it will be used only to make the "work horse" printing master from the camera film, the benefits derived from its use relegate the cost factor to an item of minor importance. The tonal quality of this film, and as a consequence the slope of the H and D curve, is so adjusted that every line value contained on the master film can be faithfully duplicated on the "work horse" copy. When duplicating the master on the tonal positive film, sufficient density is added to fine lines that the overall range between fine and heavy lines is compressed to the acceptance scale of fine grain print film. It is then no problem to reproduce as many copies as required on the inexpensive print film, using the tonal intermediate as the printing master.

Why do we need a tonal film with a rather wide acceptance range for shades of black and white when working with line drawings only? Whether or not we care to accept the fact, it still remains that we are dealing in tones or shades when working with pencil drawings. Varying degrees of pencil lead hardness are designed to create tones. Varying degrees of pressure by the draftsman abet the tonal rendition. Each line has its tone value and on a drawing, particularly a large drawing, the range of tones approaches that of a pictoral scene or portrait; albeit confined to small, well defined areas such as lines or characters. The end result is the same whether these tones are sharply separated as in a drawing, or softly graded one into another as found in a portrait. This situation is less prevalent in ink on cloth or ink on paper drawings, because the tone or density of an ink line is essentially the same, be it wide or narrow. Only the area varies. Camera lenses and the film emulsions are basically sensitive to density, not area. Having recognized the drawing as a tonal subject, and having used a camera film capable of recording the tones, a duplicating film capable of accepting all of the recorded tones is necessary in order that many people may have the advantage of viewing the drawings photographed by the camera. The tonal duplicating film must do one additional job. It must equalize the tones of the master negative, or compress the scale, until the entire picture falls within the acceptance range of a low priced distribution film, so that multiple duplication is economically feasible. After many years of attempting to have this film produced in quantity, the desire is now a reality. Its eventual appearance on the market has been either forced, or made profitable, by the wide application of microfilm in government and industry within the past few years. The circle of films in the silver sensitized microfilm series is now complete. The camera master, the tonal intermediate, and fine grain positive now form a complete team, permitting microfilm to be used as the exclusive support for engineering drawings in an active file.

At this writing, the tonal intermediate film is not stock listed in Federal Supply. It is easily obtainable from the Eastman Kodak Co., Rochester, N.Y. The Recordak Corporation, New York, N.Y., or

from the numerous wholesale and retail outlets of these organizations. Eventually, when use rate warrants the need, the film will find its way into the Federal Supply System.

(2) Diazo Sensitized Print Films:

The print, or duplication, films utilizing the diazo dye method of sensitization have been used for many years in the duplication of microfilm. The use and knowledge of these films is not as widespread as that pertaining to silver sensitized films. Apparently the reason for the limited knowledge is due in most part to the comparatively limited availability of the product and limited applications.

The diazo print films share the same film base with the silver sensitized films. The difference lies in the coating which makes it sensitive to light. Dyes in the diazo family of dyes are sensitive to the ultra violet band of the spectrum, and practically insensitive to light rays of lower frequency. This phenomenon permits the unexposed film to be handled with impunity in reduced daylight or under artificial light. The dye is destroyed when exposed to intense ultra violet light such as that emitted by a mercury vapor tube. The dyes are basically invisible until combined with a dye coupler. In diazo films the dye and dye coupler are separated by an inhibitor. An atmosphere of ammonia vapor causes the inhibitor to break down and allows the dye to couple, presenting a color visible to the human eye.

For the purpose of microfilm duplication, when a diazo dye film is exposed to ultra violet light through a printing master, that part of the dye coating not protected by density deposits on the master film is destroyed. It is destroyed in proportion to the density of the master image. Those areas of the diazo coated film protected by density deposits on the master film are not destroyed and form the latent image. Subsequent exposure to ammonia vapor causes the latent image to become a visible image.

It can be readily discerned from this simplified description of diazo film that the diazo sensitized materials are normally self-reversal, that is, a negative master produces negative copy and positive master produces positive copy.

Diazo sensitized film has distinct advantages over silver sensitized film as well as distinct disadvantages. There is no middle course. Some of the principal advantages are:

(a) No darkroom is required for printing and processing.

(b) Generally, the printer and processor is combined into one machine. No processing delay.

(c) For all practical purposes, diazo film has no grain.

(d) Image resolution is not a major problem.

(e) Film processing is essentially a dry process, thus obviating the necessity of having bulky processing equipment.

(f) Production is fast. About 40 minutes from the time a 1000 ft roll is loaded into a printer-processor, the finished film is ready for use.

(g) Intermediate printer between master and copy is eliminated.

Some of the principal disadvantages are:

(a) Diazo sensitized films are of inherent high contrast.

(b) A printing master of better than average quality is required.

(c) The small demand for the continuous printing-processing equipment has kept the price relatively high.

(d) Current consumption is high when compared with silver film printers.

(e) Specialized printing lamps are required.

(f) The dye image is rated at a ten year life, thus eliminating diazo films from the archieval record category.

The tremendous improvements made in the diazo film group in the past decade, and the continuing research being carried on today, will in all probability provoke argument in some of the areas above, which are defined as disadvantageous. This is a healthy situation. As of the

present, however, for government use the National Bureau of Standards does not recognize the diazo type film image as a permanent image (99 years). As a rule the ten years rated life of a diazo image will exceed its usefulness in an active drawing file. Revisions will require replacement before the rated life span can be realized.

For a period of time, encompassing eight to ten years, diazo film was used exclusively in the distribution of Air Force generated microfilm. Approximately one million feet of film was printed and distributed per month. Abandonment of the diazo film distribution was not dictated by inadequacy of the film itself, particularly in view of continual product upgrading, but rather by circumstance. Organizational shift of distribution responsibility, operating space, established operational procedures, and personnel allotment were contributing factors.

The advent of the microfilm aperture card with some of the inherent handling advantages warrants a new, hard, look at the diazo type films. The previously stated improvements in film quality, coupled with the distinct advantage of eliminating one step between producer and user of microfilm is sufficient motivation for re-evaluation. The re-evaluation will reveal substantial savings in material cost and elapsed handling time.

Thirty five millimeter diazo film is normally packaged in one thousand ft rolls. The manufacturers of the film, however, are very cooperative, and willing to package according to customer requirement. There are two known sources of diazo film:

Ozalid Division
General Aniline and Film Corp.
Johnson City, New York

and

Technifax Corporation
Holyoke, Massachusetts

Diazo film of the customer's choice is obtainable in premounted aperture cards from GSA schedule See paragraph 4 of this section of the report.

2. PAPER: Various kinds of paper are indispensible in the operation of the microfilm aperture card system. The system as presently devised and described in this report uses two principal categories of paper for the

production of enlarged prints from microfilm; i.e. sensitized and nonsensitized. Based on the knowledge of aperture card equipment presently in the development stage by industry, several other papers will be discussed as well as their potential relative to the system.

a. Sensitized - coated, photographic.

This category lies entirely within the group of photographic papers having a sensitized coating of silver bromide and/or silver chloride. The printer-processor-viewer, types EN-44 and EN-45 use silver sensitized paper only. This type of paper has been in use for over 50 years. It has been subject to continuing improvement and is thoroughly reliable and predictable in action. It is highly sensitive to normal daylight and incandescent light, and requires the customary precautions during handling and loading. Development is by use of the universally available silver reduction or oxidation developers (metol-hydroquinone), and fixation of image is by solution of the universally available sodium or ammonium thiosulphate salts (HYPO). The papers are standard, Federal stock listed supplies and are commonly, though not properly referred to as "photostat papers." The name "photostat papers" in this instance is a misnomer because the word "photostat" is the registered trademark of the manufacturer of certain types of photocopy equipment and supplies.

This high speed, projection type of photo recording paper is manufactured by the E.I. DuPont De Nemours Corp., Photostat Corp., Haloid-Xerox Corp., and Eastman Kodak Co. The papers are manufactured in several weights and degrees of transparency. All of the papers of this type work equally well with Armed Forces Developers #25 and #4. Average paper weight for reference prints is in the 80-120 gram bracket. The thin paper, best suited for the production of paper reproducibles is 55 gram stock. Each manufacturer markets the paper with the emulsion facing in or facing out and each manufacturer furnishes the paper on standard spools. The printer-processor-viewer has been designed to accept paper with the emulsion facing in either direction. The standard spool of paper, 18 inches wide by 350 feet long is a Federal stock listed item.

b. Sensitized - coated diazo.

The diazo coated papers, being basically sensitive only to high intensity ultra violet light, are not suitable for use in the aperture card equipment now in the system. The advanced stage of development of a projection printer for use with this type of paper indicates that it may be placed on the market within the next two years. It is almost certain to influence users of microfilm due to the very low cost of diazo paper.

The diazo papers are coated with a sensitized layer having the same characteristics as the coating described in paragraph 1.a.(2). Parallel development of the microfilm projection printer using diazo coated paper is being carried on by the Keuffel and Esser Company and the Ozalid Division of General Aniline and Film Corp. Limited inquiries made into the progress of the items being developed suggest that the slow diazo papers now stocked world wide in the Air Force system are not ideally suited for use with the microfilm projection printer. The general opinion derived, after sifting the meager information obtained from this closely guarded commercial development, is that the appropriate diazo papers will be at least twice as fast as the presently available papers. There should be no significant raise in price per unit of paper. Production volume will be the determining factor.

c. Unsensitized - coated.

This type of paper is also separable into two distinct groups. One group for use with a certain type of electrostatic printer as the only compatible support for the prints produced. The other group is one of the many supports upon which prints can be made with another type of electrostatic printer.

(1) The particular method of projection printing and electrostatic image formation known as Electrofax, pioneered by the Radio Corporation of America, employs direct image projection onto specially coated paper. It uses no intermediate "offset" drum. The paper coating is insensitive to light rays in its normal state, but it becomes orthochromatically sensitive after exposure to the triboelectric discharge of a corona grid. The paper is then developed in the manner normal to electrostatic printing processes. The Charles Bruining Co. of Chicago, Ill. is a licencee of RCA in the field of electrofax development. This organization has a limited number of company-developed microfilm projection printers, employing the electrofax principle, in the hands of using activities. Research is continuing on this printer. The paper used by electrofax equipment, which is actually the item under discussion, is useable in its present state of development. It is not perfect. Two types of paper are required by those users having diazo film and silver film in their file. It appears to be a problem of spectral response. Company spokesmen indicate early solution to the problem. Physical characteristics of the paper causing the medium to be undesirable in the past, are rapidly being eliminated. Early production runs of the paper could produce a flexible paper, but the coating was slightly tacky. If the tackiness

were eliminated, the flexibility characteristics were also degraded; the coating becoming very brittle and easy to crack. The last batch of paper, presently being distributed as the production type, indicates that the ultimate goal of producing a flexible non-tacky paper is almost a reality. One hundred percent reliability of the paper is expected momentarily.

(2) The second group of coated but unsensitized papers is commonly known as "duplimat master." It is best known in its cut sheet form as a short or medium run offset plate for office type offset duplicating equipment. The "duplimat master" name is a misnomer since the word duplimat is a registered trade-mark, and the type of paper is manufactured by several companies. The paper itself is available in sheets or rolls and is especially coated to receive a typewritten, drawn, or printed image which in turn can be reproduced many times by means of an offset printer. Another, although lesser known use for the paper is in the production of printing masters by Xerography. Xerography is the registered name for the electrostatic printing method developed by the Haloid-Xerox Corporation. The paper, obtainable in rolls of varying widths, may be fed through the continuous Xerox printers. Microfilm images projected thereon, become printing masters suitable for use on standard offset printers. This method is being used at the present time by many organizations for the multiple distribution of drawings contained only on microfilm.

d. Uncoated - unsensitized.

The high speed microfilm projection printer, Task 20795, uses the Haloid-Xerox system of electrostatic printing in which ordinary sulfite bond paper is normally used as the print support. In fact, cheap wrapping paper has been used successfully in an emergency. This method of electrostatic printing employs the selenium coated offset drum for image formation, and transfers the developed image to a paper web. Normal weight of paper for general use in this method of printing is 20 pound sulfite stock in 2000 ft rolls. No particular care is required in the selection of the paper. The 20 pound stock is recommended because it is readily available from most paper mills; it has ample body to withstand repeated double folds; and has ample tear resistance. Since the process is entirely dry, wet tensile strength is of no consequence. A light weight sulfite bond or rag content paper in the neighborhood of 12-14 pound weight has been used with excellent results in the production of prints when weight

and bulk become factors. Again, the quality of the paper is not significant unless the ultimate use of the light weight print will be as a printing master on blueprint or white print machines. In this case, the sulfite bond will withstand 10-50 passes through the equipment while a better grade of paper, 70-100 percent rag content stock, will withstand upward of 100 passes before deterioration is apparent. Both the 12-14 pound sulfite and 12-14 pound rag stocks are available from paper mills at reasonable cost.

The ultimate in reproducible papers for use with the high speed projection printer is a plasticized drawing vellum, marketed by the Keuffel and Esser Co., Hoboken, New Jersey, under the trade name of "Albanene." This paper by comparative pricing is also the most expensive, although the term "most expensive" may lose its significance and become purely relative for specialized applications.

3. CHEMICALS: In all instances the items developed under ARDC Project 2079 were designed to operate to the greatest possible degree on chemicals presently in the Federal Supply System. This attitude was taken in an effort to promote the greatest possible economy and cause the least amount of trouble when implementing the system.

The developers and fixers used and designated under Armed Forces nomenclature are also available off-the-shelf from various commercial photo-supply houses. Some of the developers, particularly those used in the electrostatic printers, although listed in the Federal Supply System or in appropriate GSA schedules, are proprietary. If local and depot supply should inadvertently become exhausted, sole source procurement is the only resort.

a. Silver Halide Paper and Film Developing Agents.

The developing solutions for use with the viewer-printer-processors are referenced as Armed Forces Developer #25, #4, et cetera, depending upon the degree of print contrast desired. These developers are known commercially as the D-72 type, Dektol type, D-19 type, et cetera. There is nothing special or proprietary about them. In addition to the standard developers, several specially compounded developers in solution or powder form are marketed by DuPont, Ansco, Eastman Kodak, F&R, and many independent producers of photo chemicals. Any vigorous but not harsh working metol-hydroquinone based developer will do the job.

If any semblance of high resolution is to be maintained when developing microfilm, low energy, fine grain, developers of the DK-76-20 type must be used. The best results are obtained,

obviously, by enlisting the services of a reputable film processing laboratory. Satisfactory results can be obtained in emergencies, or for use in total in-house microfilming programs, however, by using a standard, proven, fine grain developer and meticulous quality control.

b. Diazo Film and Paper Developers.

Ammonia Water or Aqueous Ammonia is the only chemical used in the development of the diazo type films and papers. Common household ammonia-water is not satisfactory for the purpose. It is too weak and is unpredictable in its free ammonia content. Technical grade, 26% aqua ammonium, is a Federal stock listed item and is recommended for use with diazo sensitized films and papers.

c. Fixers (Silver halide image).

Standard, stock listed Sodium Thiosulphate (Hypo) provides the best results when using the EN-45A printer, while standard, stock listed Ammonium Thiosulphate is the only type of fixer for use in the EN-44A. The sodium salt is cheaper and slower acting but can be used to advantage due to the greater processing time of the EN-45A. Short, rapid, processing time, such as is designed into the EN-44A requires the use of a rapid fixer of the ammonium salt type. Standard potassium alum hardeners are used in conjunction with both fixers. Both of the above, stock listed, fixers are also available under standard trade names from multiple commercial sources. Either the sodium or ammonium salt fixer in conjunction with potassium alum hardener can be used to fix the image on microfilm. Automatic processing machines employ the slower acting sodium salt while small volume (strip film) processors often employ the faster acting ammonium salt to shorten processing time. Either is satisfactory.

d. Fixer (Diazo Film and Paper).

Diazo materials require no fix.

e. Developers - Xerography and Electrofax.

The dry development of the image in the Xerographic and Electrofax processes requires special powders. The powders are GSA listed but are also proprietary. They are compounded and distributed by the respective equipment manufacturers.

The actual powder, which eventually forms the image, is almost identical for both the Xerographic and Electrofax processes. Basically the powder is a mixture of lamp-black and a low

melting point (300°F) resin. The ingredients are mixed and heat fused. Upon solidification after cooling, the solid is then finely atomized. The method of applying the powder to the latent image is different. In the case of Xerography, a carrier in the form of small glass or plastic balls, is mixed with the powder (toner) and is cascaded over the image formed on the selenium drum.

The powder, having an opposite charge to that of the electrostatic image formed on the selenium drum, is attracted thereto. The small balls or beads are used over and over. Powder (toner) is added to maintain image density. The method of image development in the Xerographic process may be compared to the action of a ballpoint pen. Millions of tiny balls pick up the developing or coloring agent and roll it onto the drum. The powder is consumed in direct relationship to the work output. There is no rule of thumb by which general requirements may be calculated for procurement of the developing powder. Using activities will have to project their needs based on percentage of use. If for any reason Base and Depot supplies are temporarily depleted, the only source from which Xerox developer powder may be obtained is the Haloid-Xerox Corp., Rochester, New York. Shelf life of the powder is indefinite under normal precautionary measures; i.e., cans tightly sealed against humidity and removed from sources of intense heat.

The method of applying the powder to the latent image in the Electrofax process differs considerably from the method used in Xerography. In the Electrofax process there is no offset drum. The image is projected directly onto the specially coated paper thus posing real difficulty if the cascade system of development is contemplated. Instead, the toner particles are thoroughly mixed with a very fine, soft iron powder. A permanent magnet is dipped or rotated in the toner supply and then applied with a wiping motion to the surface of the paper carrying the charged latent image. The toner adheres to the iron particles and the magnet picks up the particles. In effect, a magnetic brush is formed for brushing the developer onto the paper. Strings of iron particles following the lines of force of the magnet are the bristles of the magnetic brush. The magnet is sufficiently powerful to retain the iron dust and prevent transfer of metallic particles to the paper. The developer powder, however, is easily attracted to the electrostatically formed image. The developers for the two electrostatic printing system; i.e., fine beads mixed with powder and iron filings mixed with powder are not interchangeable between systems for obvious reasons. The iron filings would quickly scour the selenium coating from the Xerox drum; the beads having no magnetic

properties would not adhere to the magnet in the Electrofax system. The electrofax powder is obtainable from the Charles Bruning Co., Chicago, Illinois.

4. CARDS - APERTURE AND NON APERTURE: The tabulating card into which the aperture is punched for use in the aperture card system is the standard weight, universally used, punch card. The non aperture card, referenced herein as the blind card or work card, is identical except for the aperture.

a. Cards - Aperture, Unmounted.

Normal procedure for obtaining aperture cards is by use of GSA schedule ordering procedure. The Filmsort Division of the Dexter Folder Co., Pearl River, New York, is presently the sole manufacturer of the aperture card. Filmsort Division, however, is not engaged in retail sales or distribution. Contact with the manufacturer will yield the name of the current distributor through GSA contract and the contract number. It is a futile gesture to state the presently applicable GSA contract herein because the contract number and possibly the supplier will change each fiscal year.

When issuing a purchase request and the subsequent contractual document for procurement of aperture cards it is necessary to specifically itemize certain features. The proper Air Force or Department of Defense form number, denoting the card overprint format, must be stated. The type of aperture and its location in the card, as well as the overall color of the card cannot be ignored. Color striping and corner notching is very important when interchange of card mounted microfilm is contemplated. Color striping and corner notching codes will be repeated at this time as a reader convenience. Cards in which security classified drawings are to be mounted shall be identified by a bright red stripe, one quarter inch in width across the entire top edge of the card. At the time of use, the card will be stamped to conform with AFR 205-1. Classified cards will have no corner cuts.

Those cards into which master negative film (unclassified) is to be mounted, shall be identified by a one quarter inch salmon stripe along the top edge and will have an upper left hand corner cut. A quarter inch green stripe along the top edge will identify those cards carrying the "work horse" or reproduction master film. Green stripe cards shall have an upper right hand corner cut. A plain buff or manila card with no striping, but with an upper left hand corner cut will signify that the film mounted therein is distribution duplicate.

There are two types of apertures used by the Military Establishment for the purpose of mounting microfilm of engineering drawings. They are the "D" aperture and the "XD" aperture. The "D: aperture is, or will be used by every organization within the Military Establishment receiving or distributing microfilm aperture cards of engineering drawings. This aperture is the one outlined by a narrow adhesive ledge. The ledge is protected by a glassine cover until immediately prior to mounting the film. The "D" aperture is designed for use with semi-automatic or hand mounters.

The "XD" aperture will be used by the relatively few activities having fully automatic high speed mounters. This aperture is covered by a full sheet of adhesive, made necessary by certain vacuum controls on automatic mounting equipment. Steel dies punch the necessary square hole into the adhesive sheet at the time of mounting. The "D" aperture cannot be used with fully automatic mounting equipment. The "XD" aperture cannot be used with semi-automatic or hand operated mounters.

b. Cards - Non Aperture.

Non aperture cards are normally procured by the using activity through established supply channels. The non aperture, or blind card, used in the aperture card system introduces another step. The card must be ordered through supply channels and must be withdrawn from the stockpile, but must also be routed to a contractor for the Air Force format overprint. To date, quantities of the overprinted card are not carried as a supply item but are made up by request. This procedure will undoubtedly be changed as implementation of the system progresses. The exact date for this change is not a responsibility of the development agency.

In conclusion, it may be well to issue a warning note. The aperture card as it is received from the manufacturer has a predictable shelf life. That life is one year from the date of manufacture. This date must be stamped or otherwise placed on the carton containing the cards in a conspicuous location. During storage, the adhesive progressively hardens and bonds to the protective glassine. After the year of elapsed time, the adhesive properties of the film retaining ledge have significantly decreased, although with care, it is still useable. When difficulty is experienced in removing the protective glassine cover, the adhesive has reached the point of questionably economy. The film may appear to bond properly but eventually difficulty will be experienced in the form of lost film frames when running the cards through automatic tabulating equipment. In the more advanced stages of adhesive

deterioration, if the glassine cover can be removed at all, the film may fall out of the card after mounting, or may become loose and fall from the card in file. The shelf life warning does not apply to cards in which film has already been mounted. Age appears to strengthen the bond between film and adhesive ledge. After having been mounted for the period of a year, it is almost impossible to remove the film from the card without destroying the card. The recommended method of insuring the continuing receipt and use of fresh cards is by issuance of a call letter contract for the periodical delivery of specified amounts. This method requires a realistic approach to requirement forecasting, but the effort is rewarded by economy of operation.

c. Cards - Aperture, Premounted.

As previously mentioned in the text of this report, card-to-card printers use an aperture card in which a frame of unexposed diazo or calfax film has been premounted. It is obvious that the premounting of the extremely sensitive, wet process, silver film is highly impractical. There are two types of premounted aperture cards, each with its specific reason for existence.

(1) Ref-cards:

The inexpensive ref-card serves a purpose adequately described by its name. It is a reference card. Ref-cards are furnished by the manufacturer with premounted diazo or calfax film of the customer's choice. The ref-card is slightly shorter in the long dimension than a standard tabulating card and it has no tabulating card printed punch format. It is designed strictly for the reference file or as quickly prepared give-away card for reference customer service. Automatic tabulating equipment will not accommodate ref-cards, nor will microfilm equipment utilizing punch card components such as the high speed projection printer and high speed card-to-card printer. Ref-cards are entirely satisfactory when used in microfilm viewing equipment, manual card-to-card printers, viewer-enlargers, et cetera, where card placement is manual instead of automatic. The ref-card is an ideal medium for use when it is necessary to establish and maintain full or partial duplicate reference files.

(2) Tabulating Cards:

The second type of premounted card is the standard automatic tabulating aperture card premounted with diazo film of the customer's choice. This card has

all of the use potential of the master aperture card, and in addition can be quickly printed by means of automatic or semi-automatic card-to-card equipment. Premounted tabulating cards are ideal for use in a system where organizational responsibility includes the distribution of multiple decks of aperture card data or the preparation of multiple bid sets. The multiple decks of cards are ready for mailing to distribution points as they emerge from the printer. There is no lost time in film development or mounting.

When it is necessary to create bid sets by enlarging the prints from microfilm, a duplicate deck of cards for use in the printers saves wear and tear and possible damage to the master deck. It also precludes the possibility of having cards out of file for subsequent requests while the bid sets are being printed. The duplicate deck can be thrown away after having served its purpose.

Premounted aperture cards can be purchased more reasonably than they can be made in-house, except in a few isolated cases. However, if call letter contracts cannot be initiated, or if in-house effort is installation policy, premounted cards can be easily and quickly made. Anyone having access to an aperture card mounter and a roll of film can turn them out at a rate of 200 to 400 per hour. Rate is dependent upon the mounter used.

In conclusion, a note of warning to users of premounted cards: Diazo film in the unexposed state has a shelf-life expectancy of six months. This shelf life can be stretched two or three months under ideal (refrigerated) storage conditions. Do not depend too heavily upon this bonus shelf life.

TEST REPORT - MICROFILM

INTRODUCTION.- Considerable controversy centered around the use of dye-back versus tinted-base microfilm. Staunch advocates of both types of film could present equally convincing arguments in favor of their particular choice.

In order to form an opinion as to the desirability, if any, of one film type over another, one roll each of four different films were run under identical conditions. The films were identified by non-significant characters. The tests were performed by four technicians, each acting independently of the other. The test results were averaged and appear in chart form.

In addition to the resolution tests performed, a print-back test was accomplished to determine whether or not, films of different manufacturing characteristics could be printed at a single machine setting.

THE RESOLUTION TEST:

Camera Conditions:

The same camera head was used for all four films. Identical ambients such as temperature, room light, floor vibration, et cetera, also prevailed. A camera was used in preference to an optical bench to simulate practical rather than laboratory conditions.

Films tested:

Recordak Dye-back, Recordak Tinted-base, Kodagraph Tinted-base, Microline Tinted-base.

Developer:

DK-76-20.

Fixer:

F-5.

Processing:

Automatic.

Density of frame selected for test:

1.20.

Microscope magnification:

50X.

RESULTS:

Film Type	Resolution - Lines/MM
Kodagraph Tinted-base	119.3 Averaged
Microline Tinted-base	117.1 Averaged
Recordak Dye-back	121.1 Averaged
Recordak Tinted-base	119.3 Averaged

CONCLUSIONS:

The superiority of one film over another is so slight that it may be disregarded. Any of the films tested may be used with confidence.

PRINT BACK TESTS: The identical film frames used in the resolution tests were used in the print back test.

Equipment used:

1 each photographic viewer-printer.

1 each electrostatic continuous printer.

Conditions of test:

Each printer was calibrated to yield a perfect print from the clear base negative. All four types of film were intermixed and printed at the fixed time and speed. The operator identified the prints on the back of the paper.

RESULTS:

In all cases the test prints were so closely matched in visual density that they appeared to have been made from the same negative.

CONCLUSIONS:

Intermixed files of approximately the same image density can be printed without sorting.

CHAPTER V - SUMMARY

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1. REVIEW OF ACCOMPLISHMENT TO DATE:

In the summarization of this research and development it is unnecessary to limit the discussion of benefits derived to pure theorization. Tangible evidence of benefit is already in existence due to the establishment of test or pilot installations during development. Some of the pilot operations have proven to be of such value that they are being maintained on a continuing basis. An instance of this nature, is the microfilming of the WADC Air Force engineering drawing file and subsequent mounting of the file into code punched aperture cards. In order to test the system by progressive stages, a duplication service and reproduction service was offered to certain laboratories of the Center. A phone call from a laboratory or a visit to the aperture card file by laboratory personnel resulted in immediate customer service. The desired duplicate aperture cards were made at the rate of one every forty-five seconds. Half size paper prints of the desired drawings were produced in an average time of one minute and forty-five seconds. This contrasted strongly with the four to six week wait for requested drawings via commercial reproduction facilities.

A second example of a pilot service is in procurement support through card mounted microfilm. Procurement bid set requisitions calling for Air Force generated drawings were routed through the microfilm file, and the proper drawing cards were out-filed. The cards were then placed in the high speed projection printer. Bid sets were automatically printed, trimmed, and stacked at the rate of twenty paper feet per minute.

Progressive implementation of the system, involving the entire engineering drawing vault and amendment of data contracts with Air Force contractors, is being effected by Headquarters Air Materiel Command. The procurement of necessary support equipment to be used in phasing AMA's and AFD's into the system is now in its initial stage.

The effort expended in the development of the system and support equipment has caused positive reaction in a large segment of industry. Certain government suppliers have evaluated their own drawing systems and are installing, or have installed the microfilm aperture card system as an internal operation. Manufacturers of equipment are budgeting increasingly greater amounts of their own funds to develop and produce microfilm aperture card support or handling equipment. The government research and development effort was the motivating force that triggered commercial participation. Many minds are now probing the equipment development field.

As a result complete lines of equipment in all price ranges now exist as off-the-shelf items where none existed prior to the government R&D effort. Commercial participation has engendered the healthy competitive pricing for which American business is famous. It has resulted in the rapid development of equipment within the acquisition range of the small user. As previously noted in the text of this report, industrial reaction was so fast that certain tasks within this R&D project were cancelled. The proposed equipment is commercially available.

During the initial study of the microfilm aperture card application it was conservatively estimated that the Air Force could depend on a savings of at least one or two million dollars per year in its engineering drawing program. The present fractional implementation of the aperture card system shows the original estimate to be much more conservative than expected.

Financial and manpower benefits should continue to accumulate as the advantages of the system are proven and become apparent to users and suppliers of additional types of data. Prime exploratory areas exist in specifications, technical orders, technical manuals and report files.

The full size duplication and storage of engineering drawings by means of blueprinting, vandyking, et cetera, became firmly intrenched as the prime means of accomplishing a job over the past fifty years. Its general acceptance was not due to its clear cut superiority. Instead, it was accepted because no one bothered to fully analyze the situation and engage in an all-out effort to find a better, cheaper, more practical way to do the job.

This R&D effort has proven that even a well established system can be obsoleted if it can be replaced with something new and undeniably better. It is understandable that there will be some resistance to the change as is the case in all major revisions to established philosophies. General acceptance is already assured. An educational campaign and cooperative effort will bring about acceptance by the remaining minority. Within the past three years large quantities of microfilm equipment have been installed in commercial service companies where previously, only blueprint equipment had been in use.

It must be realized that all of the latest alleged or actual improvements to the aperture card equipment have not been incorporated into the items developed under ARDC Project 2079. If a cut-off point for inclusion of running changes had not been established, a complete, practical system could not have been evolved. Consistent with having broken the barriers and having developed a workable system, it now behooves management to continually review the improved methods

to prevent the recurrence of stagnation. The continuing improvements to equipment can be assimilated easily by the system under the guidance of the implementing agency after the basic system has been placed in operational status.

The reference to stagnation, however, does not imply that an impasse will be avoided in the presently developed system by simply incorporating the automatic, in-service improvements to machinery and procedures. Complacency must be avoided by vigorous search and pursuit of different and better ways to do the job.

To illustrate the point, reflect momentarily upon what has been accomplished. The need for bulky reproduction machinery, requiring multiple operating crews, has been eliminated. Original drawing reproducibles have been reduced to a fraction of their former size thereby reducing initial cost and speeding manipulation. Storage and shipping space has been reduced in cost and the end product has been streamlined. Automation has been introduced to minimize the ever present possibility of error in a manual system.

It appears that all facets have been explored. It appears that everything associated with engineering drawing reproduction, storage, and dissemination has been either improved, accelerated, miniaturized and/or reduced in cost. This is essentially true. But what about the means of transporting the improved media from point A to point B? This is one area that has not been significantly improved by the microfilm aperture card system. Air and surface transportation continue to afford the sole means of data transfer. More data can be shipped at less cost occupying less space, but at the same speed as before.

In the near future when the plans for space travel, fabrication of space platforms and settlements on the moon or neighboring planets of the solar system have become reality, conventional means of transporting data will be useless. It is not conceivable that precious area in space vehicles will be allotted to full sets of engineering data, nor is it conceivable that vehicles will be tailor-made for transmission of data even for emergency use.

Instantaneous transmission of data through the wizardry of electronics is the answer! This phase was not overlooked in this particular R&D effort but at the time of the feasibility study, electronic storage and transmission equipment could not guarantee operational reliability equal to the method selected.

2. FORECAST OF THINGS TO COME:

The present degree of sophistication of certain required electronic components is adequate for the purpose. Development of others to

meet a particular need could be undertaken with reasonable assurance of success. In some areas it is a matter of modifying and adapting existing equipment, in other areas some degree of development will have to be undertaken. Research in the field of electronic data transmission as part of this project has been relatively limited because once the die had been cast, the development of the aperture card system and its equipment demanded most of the available time. An all-consuming desire to unearth and keep abreast of the latest developments often, as in this case, causes the definitive limits of a project to be exceeded and relegates the eight hour working day to a symbol of minimal requirement rather than actual time expenditure.

Pursuit of provocative articles in trade periodicals, inquiries of available technical representatives, attendance at equipment and theory seminars, all contribute to a shallow but nonetheless real visualization of a super data program; one that is as much improved over the aperture card program, as the aperture card program is improved over the old blueprint and vandyke methods.

Progressive sophistication of a system permits the continued use of many of the presently accepted components, while periodically introducing a limited number of advanced components. For the sake of illustration let us briefly outline two systems using the knowledge acquired to date.

First, a projection of the system developed under this ARDC project. The development of a small, inexpensive television camera is fact, as is the development of a television tube with an image retaining coating. An alternate development, of significance in retaining an image on a television tube, is a memory system located between sending and receiving stations. In either case a static image may be retained as long as desired and erased electronically. The next bit of interest is the hint dropped by a technical representative of a large electronic corporation. It is to the effect that static images, i.e., images which show no motion, may be transmitted via telephone wires eliminating the need for expensive coaxial cable. Finally, the image raster or frequency and density of scan---the 550-560 line raster of commercial television is worthless for projecting engineering drawings. It is too coarse. Now in existence is a closed circuit television with a raster in excess of 1000 lines.

The pieces of the system jig-saw puzzle have now been itemized and the next step is to fit them into place.

In central engineering drawing vault, wherein all drawings are on microfilm aperture cards, the following equipment is set up:

a. Two, three, four, or ?, batteries of small inexpensive television cameras. The camera batteries to be determined by the number of major blocks into which the drawing file is divided.

b. A Private Board Exchange (PBX) telephone system connected to Centers, AMA's, and AFD's.

c. A series of substage lighted film transparency holders, and small card-to-card printers located adjacent to the camera batteries.

In operation, the system would approximate this pattern:

> A call for a drawing from an external point would enter the system through the telephone exchange. The operator would ascertain the drawing desired and make connection with the proper vault section. At the same time, an idle television camera would be switched into the circuit. The vault attendant would, after being advised of the drawing number by the operator, select the master drawing card, duplicate it, and return the master to file for subsequent use. The duplicate card would be placed on a substage lighted transparency holder and would be picked up by the assigned camera for transmission to the requestor. By using separate frequencies for picture and voice, the same long distance lines could carry both. The requestor would have a television receiving set, preferably a 24 inch screen, with the image retaining feature. As soon as the image of the drawing had been received, the telephone lines would be cleared.

There are several approaches being investigated at the present time which will ultimately result in the ability to record the television tube image on paper. The progress of the development and degree of success is not known.

The preceding account was presented in the desired state of completion. Actually, the system would have to be initially operated at short distances with very simple transmission hook-ups. Progressively complex operation would take place as the simpler forms were perfected. Cross-continent transmission by the existing network of beamed microwave stations in lieu of telephone wires should be investigated.

In outlining a second system, much of the development would be closely associated with guided missile and space vehicle development. Telemetry and long distance microwave beaming would be utilized to transmit engineering data to platforms in space. This second system would utilize the multichannel video-tape, now being perfected, as the

storage medium for an entire collection of engineering drawings and/or associated data. The entire drawing vault on multichannel tape would be stored in a computer. The normal voice channel of the video tape would be used for drawing identification, and in operation, for drawing recall by computer request. Revisions to engineering drawings could be placed in the identical location of the old drawing by electronic erasure and replacement.

Television memory tube output would be the same as for the previous system outlined. Refinement of the charactron tube print-out is a promising area for investigation to provide hard copy (paper prints). Wire, cable and microwave transmission could be used to service earth-bound stations while telemetry and high power microwave beaming could be investigated to service stations in space.

Considerable research and development will be necessary to bring this last system to operational status. Due to its association with classified projects, it will undoubtedly fall under the purview of the security classification act, and will be totally or partially classified.

Is this proposal far-fetched? Is it too far in the future to be considered at this time? A glance at the timetable for space vehicle development will answer both questions. It is a realistic proposal and time is of the essence if system readiness is to be coincident with the development timetable of the vehicles it is to serve.

3. CONCLUSIONS:

The microfilm aperture card system as developed under ARDC Research and Development Project 2079 and described in this final report is a modern workable system.

It is a successful attempt to replace a "horse and buggy" engineering data program with a modern system. It is well on its way to full implementation.

Let it not be forgotten that those things which are modern today are the obsolete trouble spots of tomorrow. Crash programs are expensive and wasteful. Proper lead time in the development of an engineering data program to meet the extraordinary demands of a rapidly shrinking future will obviate a last minute crash program, and development can progress in the most economical manner. The proper lead time is now!

The two advanced systems sketched in this summary paragraph are sympathetic. One is the logical outgrowth of the other, just as the intermediate system is a logical projection of the system developed under ARDC R&D Project 2079.

The interest and momentum generated during the course of this project should not be permitted to dwindle. It should be applied immediately to continued research and development.

GLOSSARY

GLOSSARY

Professional people and tradespeople develop a jargon slanguage pertinent to their vocational pursuit and often converse with their fellow workers in this coined language. The microfilm, tabulating card, and photographic fields of endeavor are not exempt from this private language temptation. The microfilm aperture card system embraces liberal portions of the photographic, microphotographic, and tabulating card techniques. Expressions peculiar to each of the three professions have insidiously wormed their way into the everyday vocabularies of the aperture card gentry. In addition to this situation and compounding this literary mayhem, new words and terms have been coined to fit particular instances.

This glossary has been compiled in an attempt to achieve two objectives. First, to initiate the tyro and afford a measure of comprehension for those who lightly touch the aperture card system in the performance of their assigned duties. Second, to present the initial step in standardization of word connotation within the new but lusty aperture card industry in order to foster identical comprehension of written or spoken statements.

A

abrasions - fine dark lines resembling scratches on negatives or prints

acetate, cellulose - a transparent plastic material used for "safety" film base

adhesive (aperture) - a pressure sensitive tacky material for holding film in an aperture card

adhesive "face" - aperture adhesive position in which the tack surface is toward the reverse side of the card. Usually used for mounting negative image silver film

adhesive position - designates adhesive placement on an aperture card (See adhesive "face" and adhesive "reverse")

adhesive "reverse" - aperture adhesive position in which the tacky surface is toward the front side of the card. Usually used for mounting position image silver film

A.D.P. - Automatic Data Processing

air bells - small surface bubbles which keep a photographic solution from treating the emulsion

ammonium thiosulfate - chemical used in rapid fixers

anti-halation - a light retarding coating on back of film to prevent fogging

aperture card - a file or tabulating card with a rectangular hole specifically designed for the mounting of a film image or images

archieval - life duration of film set by U.S. Bureau of Standards (film edge triangle)

ASA - American Standards Association

axis - a line passing through a body or system around which the parts are symetrically arranged

B

backing (film) - an opaque or dye-back treatment to retard light penetration

base (chemical) - a solution which neutralizes an acid to form a salt and water, or the main ingredient

base (film) - the celluloid component which supports the emulsion

bath - any chemical solution used in photography

blanks - a film segment or frame free of image

bleed (line) - a line width change usually due to over exposure or over developing

blister - a small crater-like depression, emulsion separated from film or paper base

blow-back - to enlarge or make an enlargement of an image

blow-up - image enlargement

blueprint - a contact print on photosensitive material, usually white lines on a blue background

brightness - see light

bromide paper - a silver bromide coated paper (emulsion considered fast)

burn in - the act of exposing sensitized material

C

calibrate - to make careful adjustment to achieve a given standard of accuracy

camera head - that portion of a photographic device which contains the optical system and sensitized material

candle power - symbol (C.P.) - a unit of measurement of light intensity

card column - one character position

card feed - a mechanism which automatically passes one card at a time

card field - a predetermined number of columns into which certain information is always entered

centering - to place in the exact middle of a defined area

certification - to confirm, identify, or give protection to a printed item

characteristic curve - a graph plot of density against a logarithin of relative exposure

chopper - a device for cutting paper or film

cinching - the tightening of successive loops of film on a roll

clarity - readability or sharpness of detail

classified - a term used to define document security

coating - a thin layer which is applied to or on a base material

collate - merge or combine by sequence; (such as one large deck of cards from two smaller ones)

collator - a tabulating machine combines or merges files

color blind - sensitized coatings which are not sensitive to specified colors

color sensitive - a sensitized coating which by intent is acted upon when exposed to colored originals

computer - a device which performs arithmetic functions and automatically makes logical decisions based on previous results

condenser (electrical) - a device which stores an electrical charge (also capacitors)

condenser (optical) - a lens system which collects light rays emanating from a source and directs them as directed rays

confusion (circle of) - the minimum area of a focused bright point of light, the size of which determines the maximum definition possible with a given lens arrangement and stop

contact print - a reproduction made by exposure of sensitized material in direct contact with that which is copied

continuous tone - various shades of gray from white to black

contrast - the degree of different black and white (paper) or black and transparent (film)

copy - a reproduction or facsimile of a document (also the act of making a reproduction)

copyboard - a flat level structure used to support documents in the photographic field

core - the central portion of a spool or reel

coverage - that portion of the document plane included in lens field

curl - to warp, set, or tend to roll up

D

deck - file of tabulating cards which constiture desired coverage of a topic

deck (distribution) - a card file which duplicates all or part of a master card file and used for disseminating or decentralizing

deck (dummy) - complete set of tabulating cards containing only punched, coded information (non-aperture)--used as machine handling set for sorting, reproducing, and interpreting in conjunction with an aperture card system

deck (secondary) - see deck (dummy)

deck (slave) - see deck (dummy)

deck (working) - a complete aperture card file which receives the majority of usage for reference and reproduction purposes

definition - lens image clarity or discernable detail

dense - very opaque due to a concentration of material

densitometer - an instrument for measuring density

density (film) - degree of film image opacity

detail - legible marks which define

developer - a solution used to make visible the latent image in an exposed emulsion

developing - the complete process of producing an image on sensitized material by means of chemical agents

diagonal - a line or the dimension between opposite corners of a rectangle, usually of the exposed frame of film

diameter (magnification) - a number indicating the ratio of a linear dimension of the image to the corresponding dimension of the object. Usually written -X

diameter (reduction) - a number indicating the ratio of a linear dimension of the object to the corresponding dimension of the image. Usually written -X

diazo - an organic light sensitive dye, coated on a material, and processed by ammonia fumes or an alkaline solution

diffuse illumination - lighting so arranged that the object is illuminated from innumerable directions or sources

dimensional stability - the quality of retaining dimensions with varying conditions of temperatures, humidity, etc.

direct positive - a positive image obtained directly without the use of a negative

direct reading - that image which is legible in a normal reading position

down time - time during which a piece of equipment is inoperative due to malfunction

drawings (non-reproducible) - an opaque drawing which cannot be used to make copies by any contact (print-through) process

drawings (reproducible) - a translucent drawing which can be used to make copies by any contact (print-through) process

duplicate film - film generated in a camera containing a dual supply of film

E

EAM - Electronic Accounting Machine

E.D.P. - Electronic Data Processing

electrostatic - pertaining to electrical charges and potentials. Now used to identify certain dry process of photography, e.g. Xerox and Electrofax

emulsion - the sensitive coating on photographic materials

enlargement - a print made by projecting an image to obtain an enlarged image on sensitized material

enlarger - device for projecting an image onto sensitized material in larger size

equipment - basic machines or devices through which the end result of a photo project may be accomplished

equipment (auxiliary) - those peripheral machines or devices which supplement basic machines or devices

expiration date - that anticipated date when a material may go from useable to unuseable

exposure - the act of permitting light to fall upon a photo-sensitive material

exposure meter - light sensitive instrument for determining correct photographic exposure

facsimile - a hard-copy reproduction

field - the area within which a document is placed to be photographed

field flatness - the accuracy of a two dimensional plane intended to be perpendicular to the axis of a lens

film advance - the act of moving unexposed film into or away from the exposure gate

film (blue base) - type of film with blue tint in the base stock

film cans - metal container used in packaging and transporting films before processing

film (dye-back) - type of film, a jet black coating applied to the back of film to retard light fogging

film (laboratory pack) - unexposed film which is wound on a plain core (no flange) usually in 1000' length

film, master - that film from the first microfilming of a document

film (narrow dimension) - the width of roll film measured in millimeters; e.g. 16mm, 35mm

film (negative) --film in which the dark portions of the subject appear light and the light portions appear dark

film (perforated) - roll film containing perforations on one or both sides

film (positive) - film in which the dark portions of the subject appear dark and the light portions appear light

film print - a contact copy reproduced from a master film

film (roll) - flexible film, wound on a spool, and normally of 100 ft or 200 ft in length

film (safety) - that film which does not readily support combustion

film speed - the rate at which an emulsion will record an image

film strip - a short strip of processed photographic film usually 16 or 35mm (as opposed to a slide, roll, or sheet of film)

film transport - the mechanical section of a microfilmer which moves the film

film (unitized) - that which is filed or used by individual frame or group of frames under one classification

fixer - the term used for the solution used in the fixing bath

flat-bed - the term applied to microfilm equipment in which the document to be copied rests flat and stationary during exposure

flats - glass, between which processed film is held for viewing in a reader or projector

focal length - the distance from a specified point in the lens system to the focal plane when the lens is focused

focus (automatic) - a device in a camera or enlarger which automatically keeps the objective lens in focus through a fixed range of reductions or magnifications

fog - a dark, hazy deposit over the entire film or paper or portions thereof

format - makeup of a page

frame - an area containing a single image; one drawing, one page, one check, etc.

fuzziness - that which tends to be blurred or illegible

G

generation - a photographic reproduction made from an original or another reproduction

glassine - the material used to protect and preserve the adhesive on aperture cards before film is mounted

glossy print - applied to photographic papers which are heavily coated with gelatin to produce a high sheen

gray scale - a strip of paper or film having a graduated series of tones from white to black

H

halation - blurred effect resembling a halo, caused by reflection of rays of light from the back of negative material

halide (silver) - refers principally to silver bromide, silver iodide, or silver chloride

hard copy - a document or reproduction which can be read without optical aids

hot spot - an area of obviously greater brightness than the surrounding; e.g. the central portion of an unevenly illuminated reader screen

hypo - the popular short form of the compound sodium thiosulphate

hypo (residual) - a measurement of the amount of sodium thiosulfate (fixer) that remains on film after washing

hypo test - a method of checking the washing efficiency of processed film or paper

I

idp - integrated data processing

illumination distribution - the manner in which light is dispersed on a surface

illumination level - the amount of light falling on a surface and measured in foot candles

image - a recognizable pattern

image (latent) - the image recorded by light on the sensitive emulsion, remaining invisible until developed

image spacing - the area between the trailing edge of one image and the leading edge of the next (see image position)

indexing (film) - a time saving photographic system affording rapid reference access to filmed documents

intermediate - that print which is used as a master for further reproductions

interpreter - (1) a tabulating card machine which senses a punched card and prints the information on a card, (2) machine to translate a pseudo code into machine code

K

kalfax - an emulsion sensitive to ultra violet light, coated on a mylar base, and processed by heat

key punch - a manual device which cuts coded holes into tabulating cards

L

lamp house - cover to shield light and heat

latent image - the image recorded by light on the sensitive emulsion, remaining invisible until developed

leader - a strip of film or paper at the beginning of a roll of film and used for threading

lens - one or more pieces of optical glass precisely ground for the purpose of directing light ray by refraction

lens axis - an imaginary line passing through the optical center of a lens

lens tissue - specially prepared paper-like material for cleaning lenses

light - visual radiant energy

light (incident) - the light falling upon a surface

light (rays) - a line or lines of light which represent the direction in which light is traveling

light (transmitted) - the light passing through a medium; transmission is expressed as a percentage; the ratio of transmitted light to incident light

lines per mm - pertaining to resolution, the number of light and dark line pairs contained with 1 mm length (see resolution)

M

magazine - a light tight container which facilitates loading and unloading of sensitized material (see cassette)

maintenance - general up-keep and care accorded a piece of physical property such as equipment, appliances, etc.

matrix - an intermediate transfer medium

memory unit - where information can be stored and addressed (EDP term)

microfilm - (1) the recording of microphotographs on film; (2) a processed photographic film containing microphotographs

microfilmer (planetary) - a microfilming device in which the document is held in a plane and both the document and film are stationary during exposure (see flat-bed)

microfilmer (rotary) - a microfilming device in which the document is exposed through a slot and both the document and the film are in motion during exposure

microphotograph - microscopically small photograph, one requiring magnification to be readible, ant. photomicrograph

microscope - optical instrument used to view minute objects

military "D" - term given to government specified aperture location in tabulating cards

millimeter (symbol mm) - one thousandth of a meter; 0.03937 inches

mirror image - an image which can be viewed right reading only from behind

mounter - device for simultaneously cutting, positioning, and pressing film frames on the adhesive of aperture cards

N

negative - a photographic image on film in which the dark portions of the subject appear light and the light portions appear dark

non-reproducible - see: drawing (non-reproducible)

O

opacity - the ability of a material to keep light from passing through

optical system - combination of lenses and other components through which light passes

overlap - to extend over and beyond causing to obscure (see double exposure)

P

paper (opaque) - paper that will not transmit light through its body

paper (thin) - paper having relatively little depth or extent from one surface to its opposite

paper (translucent) - paper permitting passage of light rays through its body

paper, weight of - that which refers to thickness, size and strength of paper

photocell - an electronic control device sensitive to changes in light intensity

photocopy - a reproduction obtained by the media of photography

photosensitive - the property of being sensitive to the action of visible light

placement - that which refers to position, location, or orientation

plane (film) - that surface or area in space at which the film is positioned at the time it records an image

platen (film) - a device which holds film in the focal plane during exposure

pressure sensitive - that which forms an adhesive bond upon physical contact

print film - a fine grain, high resolving power, yellow dyed positive film used for continuous contact printing

print (projection) - a photographic print made by projection of an image on the sensitized material

printer (card-to-card) - a special device for exposing raw film mounted in an aperture card while in contact with another aperture card containing a film image

printer, contact - an exposing device containing a light source and providing close contact between the object to be reproduced and the sensitized material on which the print is made

processing (film) - the chemical treatment of exposed film to form a permanent visible image

pull down - the amount of sensitized material advanced after exposure

R

ratio - relative magnitude; the linear relation of the original to its reproduction

reader - a device for viewing a micro-image

reduction (variable) - a characteristic of (microfilming) cameras; the ability to produce various sized images of a single original

reel - the device for film storage after it has been exposed and processed

reflex - (1) turned or directed back; reflected as light (2) a process of photographic contact printing wherein the receiving material is placed between the light source and the material being printed

reproduction - a copy facsimile or similar generation from a subject

resolution - the act or ability of rendering visible fine detail in an object (see resolution)

resolving power - the limit of ability of a system, to render fine detail in an object (see resolution)

rewind - a device for winding film from one spool or reel onto another

rotary cut - a precision method of card or paper cutting by use of a turning blade

scanning device - device to move a film image so that different portions may be viewed

scratch - an identification on surface of film

screen (opaque) - flat material on which image is projected and from which it is reflected to the eye

screen (translucent) - flat material on which image is projected and viewed from opposite side

sense - to determine the arrangement of one element of a problem; to read holes in a tabulating card, "machine read"

sensitized - a material such as film or paper which has been coated with a light exposable emulsion

sequence - the order of arrangement

service agreement - a contract which agrees to provide mechanical maintenance for a fixed period of time at a stated charge

sharpness - the degree of line clarity

shelf life - the limited time any sensitized material can be stored and remain useable

shoot - to make an exposure

shot - a single exposure

sort - the operation which arranges a file into desired sequence

spacing - the measurable distance from the end of one frame or image to the beginning of the following frame or image

spectral sensitivity - the variation in response of a photosensitive material to radiation of different wave lengths

spool - a device for holding unexposed sensitized film or paper

stacker - an accessory device attached to a microfilmer to assure sequential document stacking after filming

standards - that which is established by authority for the measure of acceptance

static electricity - stationary charges of electricity

step test - a series of exposures made to determine the optimum exposures of either film or paper prints

step wedge - a series of tones in steps from white to black usually on film or a glass plate for testing purposes

T

tabulating card - card into which coded holes are punched

tabulating equipment - machinery to punch, sense, sort, or check, coded holes in tabulating cards

tape (magnetic) - a narrow roll of flexible material (metal or plastic) which has a magnetic coating

target - an index card or test document used to assist reference or calibrate equipment

title block (drawing) - that space set aside for an identifying legend

transparency - a positive image on a transparent medium such as film or glass viewed by light shining through it

V

vandyke - a negative print composed of white lines on a dark brown background

vault (film) - a place for safe keeping of film

vellum - a translucent parchment type paper used for reproduction purposes

vibration - a quivering or trembling motion or oscillation

view printer - a reader with built in facilities to expose and process enlargements

W

warning device - a visible or audible alarm to inform the operator of a machine condition

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