Reprographic
in
Archives

REPROGRAPHICS IN ARCHIVES

NATIONAL ARCHIVES OF INDIA
NEW DELHI
1988

PREFACE

Microphotography and other reprographic techniques are now increasingly used by archives, libraries, manuscript repositories and other research institutions. Motivation behind these is to provide security to rare and invaluable documents and to save them from frequent handling. Historical research and administrative requirements at times also demand that copies of rare manuscripts, records and out-of-print publications might be acquired on microfilm, microfiche, etc on payment or exchange basis.

National Archives of India started microfilming its collection of records nearly four decades ago and has acquired considerable expertise in the field. Its assistance/advice is also frequently desired by institutions, who wish to set up reprographic units of their own. The present brochure 'Reprographics in Archives' being brought out by the National Archives of India aims at providing comprehensive information of the subject. A select bibliography has been added which, it is hoped, would be useful to all such institutions. The brochure also covers the syllabus approved for the 'Certificate Course in Reprography' conducted by the School of Archival Studies, National Archives of India and will be of help to the trainees of the Course.

I am thankful to Shri P. L. Madan, Retired Assistant Director of Archives for the cover design and to Shri V. V. Talwar, Fellow, School of Archival Studies for preparing the text of the publication.

NEW DELHI

15*th January*, 1988.

R. K. PERTI

Director of Archives
Govt. of India.

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1. INTRODUCTION TO REPROGRAPHY

Ever since the invention of written word, the need for making copies has concerned the efforts of man. In the medieval ages and even later, generally copies were produced by employing scribes. This naturally restricted spread of education, knowledge and information.

The invention of movable types, the type writer and the development of other reproduction systems not only made the copying tasks easier but also facilitated production of multiple copies. Use of reprographic techniques now enables us to obtain exact copies from original documents.

Reprography literally means writing again in place of original.

Re	(Latin)	again
Pro	(Latin)	in place of
Graphos	(Greek)	writing

Some are inclined to look upon the word as a combination of 'repro' from reproduction and 'graphy' from photography which is the technique by which images are produced by the action of light on light-sensitive materials. However, over the course of years, the term has come to cover besides photography other documentary reproduction processes using heat sensitive materials and techniques using static electricity for the production of images. According to the British Institute of Reprographic Technology, "Reprography includes document copying, the reproduction of engineering drawings, microfilm and related techniques, duplicating, office printing and ancillary processes—in other words, every method of producing copies, from any type of original in any quantity and by any process, as a function of business or other administrative operations." The 'Glossary of Micrographics' published by the National Microfilm Association of the United States defines the term as, "The art and science of reproducing documents."

Advantages

The enormous rate at which published and unpublished documentary information is growing, makes it impossible physically and economically for the individual user or institution

to have access to all the material available and it is here that Reprography comes to one's aid. Developments are continuing to make the processes and techniques quicker, simpler, less expensive and requiring less and less technical skill.

Some of the advantages of Reprography are as mentioned below :—

1. **Exact Copies** : Reprographic techniques enable one to obtain from an original document one or more copies in which the text resembles the original in all respects except perhaps in size which may vary as per our requirement. It is thus possible to make faithful copies of complicated diagrams or charts.

2. **Quick Copies** : Reprographic system enables one to obtain copies quickly with hardly any waiting time, for example by thermography one can obtain a copy in four seconds.

3. **Economical** : Reprography is economical as it (i) eliminates human error factor and does not need comparison (ii) cuts down the cost of mailing and disseminating information by reducing the size/bulk (iii) provides for efficient utilisation of space by miniaturing or standardising the size of documents/drawings, ensuring economy in storage space.

4. **Easy Handling** : Reprographic systems produce copies which are easier to handle due to reduction in size, such as the copying of engineering drawings on microfilm.

5. **Permanence** : Some of the reprographic techniques enable one to obtain permanent copies while the original documents may be of a transient nature due to poor quality of paper, ink etc.

6. **File Integrity** : Records on microfilms are in a fixed sequence guarding against misfiling, mislaying, alteration or loss.

7. **Dissemination of Information** : Due to ease of duplication and portability, copies of necessary documents can be made available at different locations for consultation.

8. **Quick Retrieval** : Microfilm can be coded for almost instant retrieval.

Applications

The advantages of reprography, some of which have been listed above, have found many applications.

(i) The major application of reprography has been in the "office copying field". With the increase in cost of typing and the need for copies at short notice, reprography provides an easy and fairly inexpensive means of obtaining quick copies.

(ii) Another important application of reprography in the form of microfilming, is in the protection of the contents of valuable documents i. e. 'security microfilming'. Mankind has lost important documentary material as a result of fire, flood, ravages of insects and war. However, it is now possible to microfilm records and manuscripts of importance and store these microfilms away from the originals so that in case of loss or damage an alternate copy is available.

(iii) Reprographic techniques provide the possibility of 'preserving materials of historical value' even if they are written or printed on poor quality paper which is not likely to last long. Microfilming for preservation is therefore, done for two reasons (a) to protect the records against possible deterioration from constant wear and tear and (b) to preserve the informational contents of records against destruction and eventual loss.

(iv) Reprography enables a library or institution to acquire copies of rare and out-of-print publications and manuscripts. It also facilitates 'inter-library loan' and supply of 'reference copies' to scholars in the form of microfilm or xerox copies instead of the originals.

(v) 'Publications in micro-editions' enable an institution to bring out editions in limited number where printing is uneconomical.

(vi) Microfilm because of its highly reduced size also enables considerable saving in storage space when the originals can be disposed of to make room for fresh acquisitions.

(vii) Another recent application of microfilm has been its use as a 'medium for computer out-put'. This facilitates and reduces the cost of retrieval of information through computers.

The possible applications of reprographic techniques are thus practically endless and their increasing use provides convenience, ease of handling, security, wider dissemination, etc.

Reprography enables the National Archives of India.

(i) to do security microfilming of its records.

(ii) to acquire microfilm copies of any gaps in its series of records from India Office Library & Records, London and Archives of other countries of the world on exchange/payment basis.

(iii) to acquire microfilm copies of rare manuscripts and collection of papers of National Importance.

(iv) to supply xerox copies, photocopies or microfilm copies of its records to the concerned Government Departments, Research Institutions and Schlolars as per schedule of rates of reprographic services approved by the Government.

(v) and to arrange exhibitions on topical subjects when copies of records are used instead of the originals. This has created "archives conciousness" among the public.

2. REPROGRAPHIC SYSTEMS

Reprographic systems fall into the following two main categories :

I. Copying techniques used for the production of one or a few copies of an original document. and

II. Duplicating processes used to produce economically a number of copies of an original.

I. COPYING TECHNIQUES

The processes used for copying may be divided into the following four main groups :—

(A) Silver Halide process
(B) Diazography
(C) Thermography
(D) Electrography.

A. Silver Halide Process

This group employs conventional photography i.e. the action of light on silver halides for the production of copies and can be further sub-divided into the following four processes.

(i) Directly legible optical copying.
(ii) Contact Copying
(iii) Transfer processes and
(iv) Microphotography.

(i) **Directly legible optical copying :** This involves production of copies by employing large cameras using rolls of light-sensitive silver halide paper as in the Photostat machines. Photostat is a trade name of a particular type of equipment and also of the prints produced by this machine. The apparatus is essentially a large camera with a prismatic mirror attached to the lens. The mirror by reversing the image formed by the lens, produces a readable copy in the negative and also enables the copy holder to be used in horizontal position, thus saving space and giving greater speed of operation.

The document to be copied is placed in the copy holder and illuminated by strong mercury, fluorescent or tungesten light. After exposure, the sensitive paper is wound down, cut off and processed. A right reading image is thus produced having white letters on a black back-ground, which when recopied by repeating the process on the photostat machine produces a copy of the original tone. Copies may be enlarged or reduced. Documents upto 40×50 inch can be copied but the largest size of print produced is 18×24 inch.

(ii) **Contact Copying :** The simplest method of copying a document is by placing the original in contact with the light sensitive paper and exposing in a light box. Depending upon the original document and the sensitive material used, the processes in this group may be further sub-divided as follows :—

(a) Copying by (i) Reflex or (ii) Print through techniques on silver halide paper to produce a negative and then a positive copy.

(b) Auto positive or direct positive printing to produce positive copies in one step.

Reflex Copying : This refers to a process which produces a negative by reflection printing on a photographic paper. The particular purpose of the reflex principle is to enable an opaque or double sided document to be copied. It gives a reversed reading master which, when printed by direct transmission will produce a positive copy.

The reflex method consists of placing a sheet of sensitive paper in contact with the original document with the emulsion facing the printed matter. An exposure is made by passing light through the back of the sensitive paper. The light will be absorbed where it strikes the text but will be reflected from the white area of the document. On development it produces a negative (fig. 1).

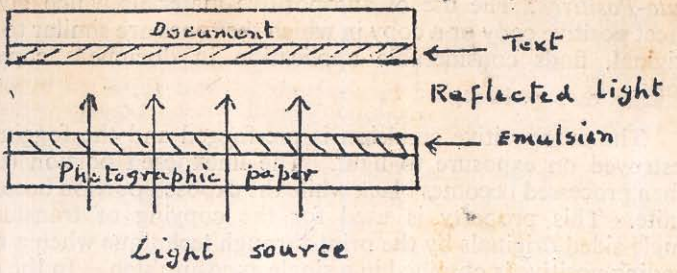


Fig. 1

To obtain a positive copy this negative is placed in direct contact with another sheet of sensitive paper and an exposure is made by passing light through the back of the negative copy. On development it produces a right reading positive (fig. 2).

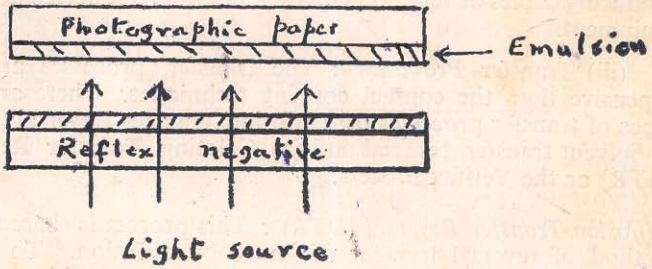


Fig. 2

Print through Technique : Single sided documents which are on thin or translucent paper can be printed directly by transmission and will produce right reading negative, similar to a photostat negative. In this technique, the sensitive paper is placed on the back of the original and the light is passed through the face of the original.

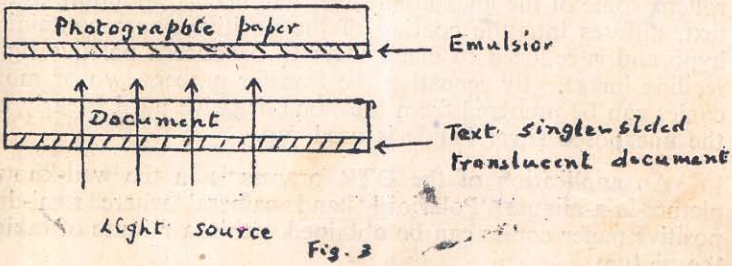


Fig. 3

Auto-Positive : The use of autopositive materials which give a direct positive copy or a copy in which the tones are similar to the original, finds considerable application in document copying work.

The autopositive emulsion is pre-fogged and the fogging is destroyed on exposure to light. The unexposed portion (text) when processed becomes black while the exposed portion becomes white. This property is used for the copying of translucent single-sided originals by the print-through technique when a right reading positive is obtained in a single exposure step. In the case of opaque or double sided originals the reflex principle may be employed to give reverse reading but positive image. By repeating the process with the reverse reading copy, a right reading positive can be obtained.

Contact copying using silver halide papers is a simple process producing copies of very good quality and does not need elaborate equipment.

(iii) **Transfer Processes :** The transfer processes are less expensive than the contact copying techniques. There are two types of transfer processes (a) Diffusion Transfer Reversal (DTR) or Solvent transfer reversal and (b) Gelating Transfer Reversal (GTR) or the Verifax process.

Diffusion Transfer Reversal (DTR) : This process is based on a method of reversal transfer of image by diffusion. To make copies by this method a sheet of negative silver halide paper is exposed by reflex in contact with the original. The exposed negative is passed through a single solution developer together with a positive sheet on which the image is to be transferred. The positive paper is not light sensitive and has a special coating containing hypo and other agents. The hypo in the coating is moistened when passing through the developer solution and while the negative and positive are pressed into contact by rollers, some of the unexposed silver halide corresponding to the text, diffuses into the coating of the positive paper containing hypo and is reduced to black silver to produce a positive right reading image. By repeating the transfer process two or more copies can be prepared from the same negative until nearly all the unexposed silver halide is used up.

An application of the DTR process is in the well-known picture-in-a-minute 'Polarioid hand camera' where semi-dry, positive paper copies can be obtained within a minute of taking the picture.

Geleatin Transfer Reversal (GTR) : The process also known as verifax process has been introduced by M/s Kodak Ltd. The process involves the use of an intermediate negative called the matrix from which upto six copies can be produced on an ordinary unsensitized paper, each succeeding copy growing weaker.

The verifax master has silver halide emulsion in gelatin containing a hardening developer and a dye forming component. After exposure by reflex, development is carried out in an alkaline solution. The development hardens the gelatin in the exposed area while in the unexposed areas (corresponding to the text) the gelatin remains soft and is dyed. The unhardened dye material can be transferred to the copy paper for producing usable copies.

(iv) **Microphotography :** It is the technique of making miniature photographic copies of records, reduced to proportions too small to be read without magnification. They are normally produced on roll film 16 mm or 35 mm in width and are also available on 70 mm roll film, sheet film or opaque cards (for details see chapter on Microphotography).

B. Diazography

Diazography is the technique for the production of direct positive copies of documents, plans and drawings with comparatively inexpensive materials, containing ligth sensitive diazonium compounds.

Certain organic diazo compounds have the property of combining with certain other chemicals to produce coloured dyes of almost any colour. These diazo compounds are also sensitive to ultra-violet and violet radiation which destroy the compound. These two properties of the diazo materials are used in diazography.

To produce a right reading positive copy, a traslucent master in contact with the paper coated with a diazonium compound is exposed to a source of light containing ultra-violet and violet radiation (eg. a mercury vapour lamp) using a print through technique. The translucent master is usually prepare by writing, drawing, typing or photocopying on a translucent material.

Copies can also be made from an opaque master by employing a special reflex-copying technique using a screen containing a fine pattern of opaque and translucent portions. On exposure the radiation transmitted by the translucent background area

(or reflected by the background in reflex copying) destroys the diazonium compounds on the corresponding portions of the coated paper. The remaining unaffected diazonium compounds corresponding to the text or drawing can be developed to form coloured dyes. Thus a positive copy is directly obtained. The process falls into two main classes depending upon the mode of development of the image—

(a) the dry process and

(b) the semi-dry or moist process.

(a) The dry Process : In this process the diazonium salt and the dye forming agent or the coupler are coated on the paper and to prevent their reacting with each other before exposure an acid called a stabilizer is added. After the exposure has been made through the master to be copied, development in the dry process is carried out by passing the exposed diazo paper through hot ammonia vapour produced by heating an aqueous ammonia solution in a tray. The ammonia which is alkaline, neutralises the acid in the coating and allows the diazonium compound to react with the coupler to form the dye image. The colours that can be commonly obtained are blue, black, red and sepia.

Heat Development of the diazo image has also been achieved in recent years. The development of the image in this technique is obtained by passing the exposed paper between heated rollers which activate the chemical reaction required to produce the image.

(b) The Semi-dry or Moist Process : In this process the coupler or dye-forming agent is not coated on the diazo paper but is applied to the surface of the paper after exposure in the form of a developer. The developer is purchased in powder form and mixed just before use.

Relative merits of the dry and moist processes : The dry process while it produces a readily usable dry copy, has the disadvantage that the ammonia vapour used for the development of the image, is offensive. In the moist process this difficulty is obviated. The moist process has also the advantage that the colour of the dye image can be changed as desired by the choice of the developer solution containing the coupler while using the same diazo paper.

Advantages of Diazography : The diazo materials are the least expensive of the photosensitive materials and hence the process is economical where a number of copies are required.

The process also produces direct positive copies. The equipment used is simple and does not need any special operational skill. No dark room arrangement is required. The introduction of faster diazo materials has facilitated its use for enlarging from microfilms to obtain inexpensive hard copy. Diazo microfilm enables a direct positive on film, less expensive than silver halide film and more easily processed than latter.

Disadvantages : The main disadvantage in the diazo process is its inability to reproduce tone and the lack of permanance of the dye image. However, in ordinary use the lack of permanence is no disadvantage as the image can remain useful for many years.

C. Thermography (Non Photographic Process)

Thermography employs heat sensitive paper and infrared radiation for the production of copies. Since this paper is not sensitive to normal light, dark room facilities are not required. The process is a single step dry method of producing copies.

In the well known Thermofax process patented by the 3m Co. (Minnesota, Mining & Manufacturing Co.) U.S.A. the heat sensitive paper is placed in contact with the original to be copied and exposed to infra-red radiation within the apparatus. The white parts of the original reflect most of the radiation but the written text absorbs and convert the radiation into heat. The heat is re-radiated which penetrates through the heat sensitive

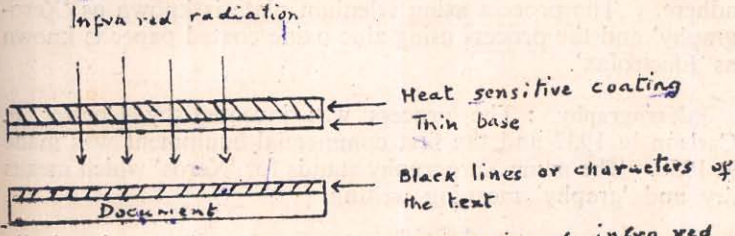


Fig. 4

coating of the paper, producing a positive copy. Copies can be produced from virtually any type of originals opaque

translucent or transparent, printed on one or both sides, but it is necessary in all these cases for the original image being copied to have a carbon or metallic content, otherwise the heat is not radiated and will not reproduce.

Another disadvantage is that the heat sensitive coating of the thermofax material continues to be sensitive to heat and in due course gets darkened. Hence the copies are not permanent. Moreover, the copies obtained by this process are not sharp as compared to other processes because of the difficulty in focusing the heat radiation.

Dry Silver Process : The process was developed by 3MCo. and Asahi Chemicals. In this case the film or copy paper is coated with silver salts and a special catalyst. On being exposed to light through the negative microfilm, the catalyst in the light affected areas gets activated—thus creating a latent image. Development and fixing of the image is done by passing the paper through heat rollers. The pressure and the heat cause the catalyst to react with the silver salts to generate a black silver image. In non-light affected areas the catalyst remains unaffected. The film known as silnova has add-on exposure facilities.

D. Electrography

Electrography or Electrophotography is the name applied to the image forming processes based on the photo conductive properties of some materials, such as selenium or paper-coated with zinc oxide. These materials when electro-statically charged and exposed in a camera or other device, form a charge pattern in the image area to which a pigmented resin can be made to adhere. The process using selenium plate is known as 'Xerography' and the process using zinc oxide coated paper is known as 'Electrofax'.

Xerography : The process was invented by Chester F. Carlson in 1937 and the first commercial equipment was made in 1950. The name Xerography stands for 'Xeros' which means dry and 'graphy' meaning writing.

Xerography uses a photo conductive plate with an electrically conductive backing material such as aluminium coated with selenium. This plate has the property that it can hold an electrostatic charge placed on it for long periods in dark. When exposed to light, the charge will be neutralised in the areas struck by light from the unwritten portion of document, leaving the

charge pattern unaffected corresponding to the text. Oppositely charged developer powder consisting of a pigmented resin is then cascaded over the plate in an enclosed tray. Some of the powder adheres only to the charged or image area of the plate, which is then transferred to paper to produce a copy. The transferred image is fixed by heat or vapour fusion.

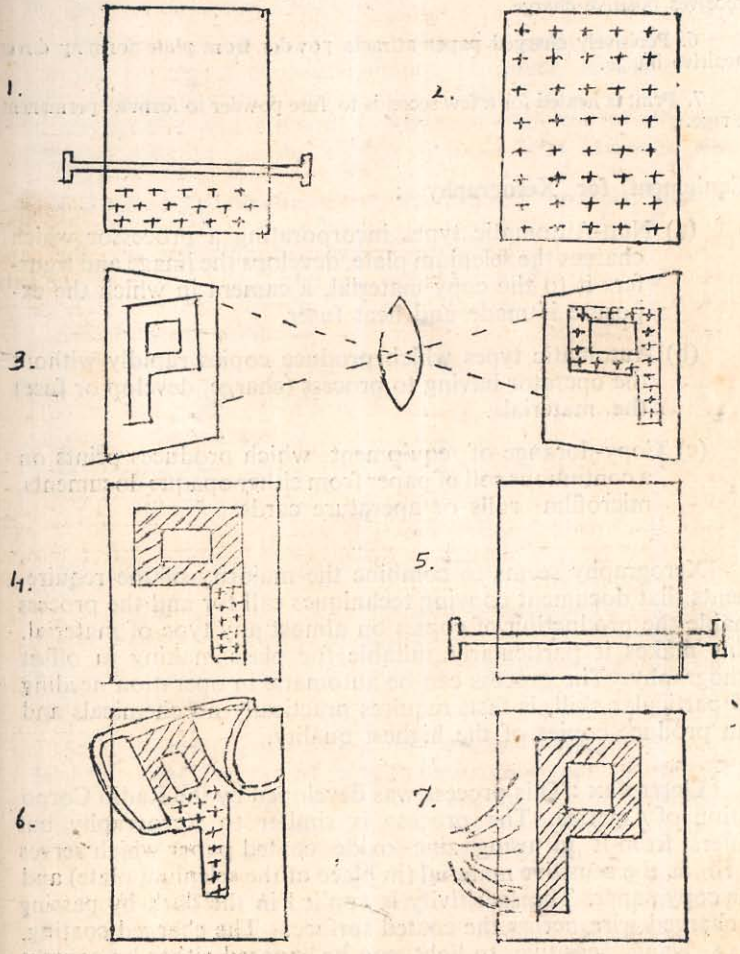


Fig. 5

1) selection
2) Amp. & Processing

1. Surface of specially coated plate is being electrically charged as it passes under wires (positive charge).

2. Fully charged plate.

3. Copy (P) projected through lens in camera. Plus marks show projected image with positive charges. Charge disappears in areas exposed to light as shown by white space.

4. A negative charged powder adheres to positively charged image.

5. After powder treatment (4) a sheet of paper is placed over plate and receives positive charge.

6. Positively charged paper attracts powder from plate forming direct positive image.

7. Print is heated for a few seconds to fuse powder to form a permanent image.

Equipment for Xerography :

(a) Non-Automatic types incorporating a processor which charges the selenium plate, develops the image and transfers it to the copy material, a camera in which the exposure is made and heat fuser.

(b) Automatic types which produce copies rapidly without the operator having to process (charge, develop or fuse) the materials.

(c) Copy-florange of equipment which produces prints on a continuous roll of paper from either opaque documents, microfilm rolls or aperature cards.

Xerography seems to combine the majority of the requirements that document copying techniques call for and the process enable the production of copies on almost any type of material. This makes it particularly suitable for plate making in offset lithography. The process can be automatic in operation needing no particular skill, is fast, requires practically no chemicals and can produce copies of the highest quality.

Electrofax : This process was developed by the Radio Corporation of America. The process is similar to Xerography but differs from it in using zinc oxide coated paper which serves both as the sensitive material (in place of the selenium plate) and the copy paper. The sensitivity is applied in the dark by passing a charged wire across the coated surface. The charged coating, then being sensitive to light, can be exposed either by contact or by projectionor in a camera.

During the exposure the areas which are exposed to light are reduced, but the unexposed areas corresponding to the text remain charged (electrostatic image) which can be developed by applying a pigmented resin powder carrying a positive electrostatic charge. This powder is attracted and held by the negatively charged image area. It is then fixed by melting it so that it fuses on to the paper surface and produce a permanent image.

II. DUPLICATING PROCESSES

These processes are chiefly meant for producing fairly large number of copies of a document. However, recent advances providing for built-in automatic devices for repetition of operation in xerography and electrofax processes, the line of distinction between copying and duplicating processes has narrowed down.

Duplicating processes can be broadly grouped into –

1. Hectography (spirit duplication)
2. Mimeography (Stencil duplication)
3. Printing methods
   - Letterpress or relief printing
   - Planographic printing
   - Offset printing
   - Gravure printing
   - Screen printing

1. Hectography (Spirit duplication) :

Simplest and perhaps the least expensive of the duplicating systems, hectography is based on the transfer of a layer of ink or dye with which the original is written or drawn, to an ordinary sheet of paper.

The glazed paper masters are prepared manually or by typewriting by backing up with a special carbon paper. The pressure of typing transfers the wax layer from the carbon paper to the back of the master sheet. This wax layer contains a dye or dyes which are readily soluble in alcohol (hence "Spirit").

Duplication is achieved by bringing the master into contact with the copy sheet, while moist with alcohol, so that some dye is transferred to the copy. There is a limit to the number of copies that can be made from one master. 100-250 copies can be made.

An attraction is that a single master can be made in two or more different colours, the multi-colour copies then being made in a single duplicating action. Hectocarbons are available in a variety of colours—black, brown, blue, green, yellow, red and purple.

2. Mimeography (Stencil duplicating) :

Quite familiar in offices, schools and business houses, duplicators using a stencil give copies of better quality than those given by spirit duplicators. Stencil duplication is sometimes called cyclostyling and in USA is known as mimeography. The process is based on the simple fact that a viscous ink will not permeate through a waxed layer except through perforations created on the sheet. The common master used in mimeography is thus only the waxed stencil on which the matter to be reproduced is "cut" by typing on it (after removing or de-activating the typing ribbon) or writing with a metal stylus with a blunt point. A thick paper backing sheet and a protective tissue come with the waxed stencil sheet supplied by all manufacturers of stencil duplicators.

Corrections in the stencil can be made by using a correcting fluid, which is usually a wax dissolved in acetone, dyed a deep pink to easily locate the corrected areas. Applying the fluid with a tiny brush over the wrong characters leaves a layer of wax which fills-in the wrongly cut perforation or scratch on rapid evaporation of the volatile solvent.

Stencils are usually prepared manually using a typewriter or a stylus. There are also photographic and electronic methods of preparing stencils which make the reproduction of diagrams, tabulations, graphs, etc. by stencil duplication feasible.

Both in the photographic and the electronic methods of producing a stencil, an original has to exist in an acceptable form for the master to be made, unlike the type-cut or hand-written (or drawn) stencil which can be 'created' or composed on the stencil itself in the form in which it is required to be reproduced.

Stencil duplication is capable of giving a larger number of better quality copies than spirit (or hectographic duplication). But technical publications like reports, bulletins, etc. containing plenty of non-text matter like diagrams, are best reproduced by offset litho-printing. Offset lithography has developed into a

convenient and popular tool for business systems as well as for dissemination of information especially of a scientific or technical nature.

3· Printing Methods :

The essential difference between the various printing processes is the means whereby the ink pattern is created and then transferred to the final surface. In one of the processes the inked surface can act directly on the final material. This requires that the design is reverse in order that the final impression is correct reading. In the indirect process the inked surface may act upon some intermediate surface and then transferred to the final surface. In this process, also known as offset, the design must be correct reading on the printing plate in order to finish correct reading.

"Letter press or relief printing" : The oldest printing method relies on the required design being a raised surface. The high parts are inked and the ink transferred under pressure to the final surface. The humbel rubber stamp comes in this category.

It is the traditional technique of printing. Text composition may be manual or semi-mechanical using different fonts of type offering a variety of styles and sizes. The illustrations need engravings to be made photo-mechanically to obtain the so-called 'blocks' which are juxtaposed with the composed types on a page. The letters/types and illustrations form a reverse design which is in relief for transferring the ink. Being in relief, the printing parts are raised above the non-printing background.

The process requires elaborate proof corrections, recomposition and re-alignment.

'Planographic printing' : The process relies on a flat surface and the design is created by compelling some areas to accept ink for transfer while the non-printing background refuses ink. As the design is on the same surface as the non-printing areas, the generic description for the method is 'Planographic' though generally known as 'Lithographic'.

'Offset printing' : The indirect or offset principle involves a first transfer of the ink pattern to a surface which is in the nature of a temporary support for it merely serves to carry ink from the printing pattern on to the final article.

In reprographic applications it is the offset lithographic process which has developed fast and proliferated into a variety of machines and gadgets for quick and easy reproduction for dissemination. The major steps in this process involve : (1) preparation of the original material called "copy" (2) preparation of a printing master (3) the actual printing and (4) finishing operations. The second step of preparing the master can be done in one of several ways making use of one or other of the modern systems of reprography. The conventional method, which incidentally ensures a high quality of reproduction, involves making a high contrast negative of the copy through a process camera and then using this to prepare a photographically sensitized printing plate.

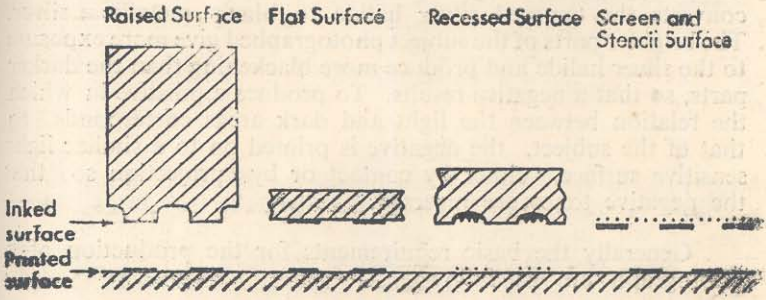
Copy preparation involves not only composition but also the alignment of various segments of the original matter like headings, sub-headings, abstracts, footnotes, diagrams, etc.

Modern methods of composition do away with the use of metallic types as used for letter-press printing. Electrically operated typewriters enable preparation of text matter having uniformity of impression and colour, which cannot be ensured in manual typing.

Offset masters can also be produced by almost all the copying systems in reprography—by the silver diffusion processes, by diazo transfer, by xerography or electrofax. Special, thick and tough paper stock is required for the masters. These give satisfactory copies upto a few thousands.

'Gravure printing' : As against the relief or embossing of the printed areas in letter press, the gravure process (intaglio method) has the print area scooped out or recessed into the surface of the printing plate. Usually etched copper cylinders are used in rotary machines and it is more appropriate to call the process rotogravure. Text and line matter are etched out by exposing the sensitized metal through a positive film transparency and then treating the unexposed and hence unhardened print areas by a chemical etching bath. Ink is applied over the processed and finished cylinder generously and a sharpedged 'doctor' blade scrapes out all ink from the surface leaving little ink wells in the etched depressions. Sheets of paper sucessively coming into contact with the cylinder under gentle pressure absorb a thin film of ink to yield the reproduction. Very high quality of tonal reproduction with good rich depth of colour is possible by this process.

Screen printing : Finally there is the method of applying ink to the object by forcing it through openings cut in a sheet or stencil. Stencilling in an elementary form is in wide use in crude designs, for letterings on crates and other packages. For more intricate designs the stencil is supported on a fine mesh of silk, nylon thread or metal wire; hence screen printing and the reference to silk screens.



The printing methods outlined above make use of an original work of an artist/designer in creating a printing block or plate. Reprography is helpful when the task is to reproduce in quantity the original work. Photo reproduction processes have enabled printing techniques to be less dependent on the artist to create the actual printing surface which will be used to control the ink transfer. The field of photography applied to the production of printing surface is referred to as 'photo-mechanical' work. This is where the interests of printing and reprography have much in common.

3. PHOTOGRAPHY

Photography is the process of forming a visible image by the action of light or other form of radiation on sensitive surfaces. In its traditional sense photography uses the action of light on silver halides to bring about a change which may be at first invisible but can be brought out by the action of a developer which converts the exposed silver halide to black metallic silver. The brighter parts of the subject photographed give more exposure to the silver halide and produce more blackening than the darker parts, so that a negative results. To produce a positive in which the relation between the light and dark areas corresponds to that of the subject, the negative is printed on to a similar light sensitive surface, either by contact or by projection so that the negative tones are reversed.

Generally the basic requirements for the production of a photograph are as follows :—

1. The camera which takes the picture
2. The light sensitive material
3. Illumination for the subject
4. Processing chemicals and an arrangement for processing
5. A contact printing or projection device for the production of positive.

1. The Camera

The old term 'Camera obsucra' or darkened chamber is now shortened into camera. An early version was a small building with a lens and rotating mirror or prism, in the roof which projected a natural-colour image of the surrounding country side on to a table. The image produced was of low intensity and the room had to be darkened to make it sufficiently visible.

Another version of the genuine 'Camera obscura' was the device to produce an image by lens and mirror on a sheet of paper and trace it by means of a pencil.

The early cameras used in photography were generally of the box type until 1860 when the folding bellows camera was introduced. Since than there has been a constant improvement in the design of cameras and the modern miniature camera can be called a master piece of engineering.

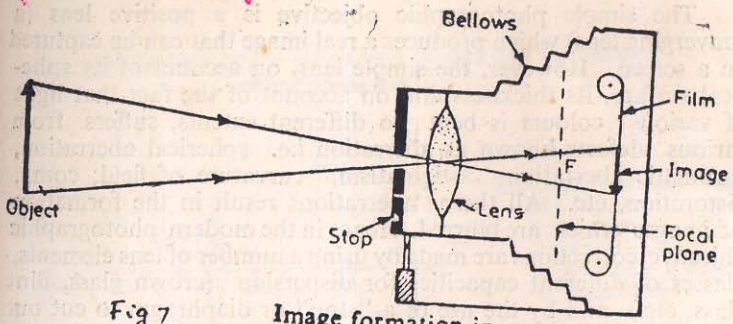
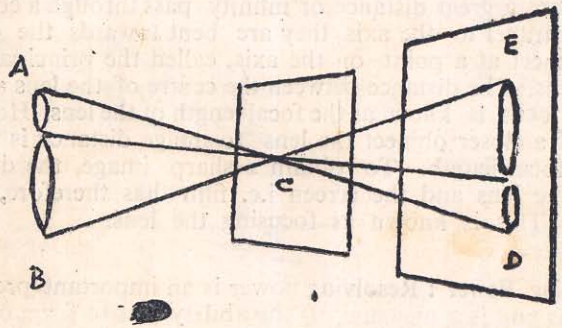


Fig 7 Image formation in a camera

Fig. 7

Essentially a camera is a light proof box with a lens to form a sharp image of the subject, a shutter and a diagragm to control the duration of the exposure and the brightness of the image, and a fixture for positioning the sensitive film or plate.

'Lens and its characteristics' : A picture can be made in a light tight box without a lens but having a very small hole on one side (the pin hole camera). The image obtained with such a camera is however very dim and not very sharp. Hence a lens which can produce a brighter and sharper image is used.



AB — object

C — Pin-hole

DE — Image

Fig. 8

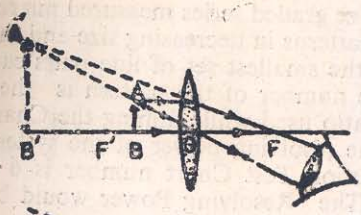
The simple photographic objective is a positive lens (a converging lens) which produces a real image that can be captured on a screen. However, the simple lens, on account of its spherical surface, its thickness and on account of the fact that light of various colours is bent to different extents, suffers from various defects known as aberration i.e. spherical aberration, chromatic aberration, astigmatism, curvature of field, coma, distoration, etc. All these aberrations result in the formation of images which are blurred. Hence in the modern photographic objective corrections are made by using a number of lens elements, glasses of different capacities for dispersion (crown glass, flint glass, etc.) and by the use of a "stop" or diaphragm to cut out the peripheral rays. However, as correction for one defect enhances another defect, a perfect lens i.e. a lens which can give a sharp image under all conditions cannot be obtained. The lens design is therefore, a compromise keeping in view the purpose for which it is to be used such as copying, enlarging or long distance photography. Hence a lens which is meant for a specific use say enlarging, cannot give the best results when put to some other use, say in landscape photography.

'Principal focus and foc al length': The straight line about which the lens is symmetrical is called the axis. When rays of light coming from a great distance or infinity pass through a converging lens parallel to the axis, they are bent towards the optical axis and meet at a point on the axis, called the principal focus of the lens. The distance between the centre of the lens and the principal focus is know as the focal length of the lens. However, in case of a closer objnect the lens to image distance is greater than the focal length. To obtain a sharp image, the distance between the lens and the screen i.e. film has therefore, to be adjusted. This is known as focusing the lens.

Resolving Power : Resolving power is an important property of the lens and is a measure of the ability lens to form distinct images of fine detail. It is specified in terms of the maximum number of lines per mm. that the lens can reproduce as separate images.

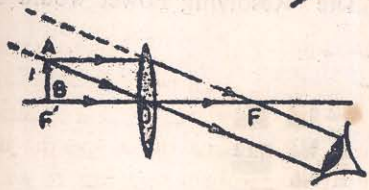
In Photography resolving power depends both upon the lens and photographic sensitive material. The over-all resolving power of a system is obviously less than the resolving power of either of its components (i.e. the lens or the photo sensitive

Formation of the image by a convex lens for various object positions



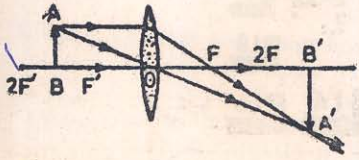
(a)

(a) *Object between O and F'*
The image is
1. virtual
2. erect
3. behind the object
4. magnified



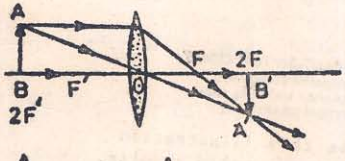
(b)

(b) *Object at F'*
The image is
1. virtual
2. erect
3. at infinity
4. highly magnified.



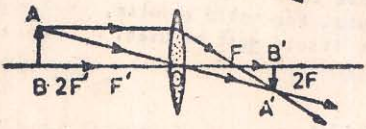
(c)

(c) *Object between F' and 2F'*
The image is
1. real
2. inverted
3. beyond 2F
4. magnified.



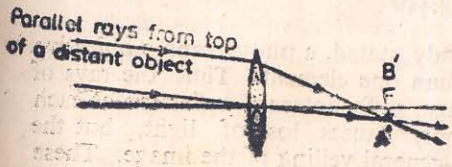
(d)

(d) *Object at 2F'*
The image is
1. real
2. inverted
3. at 2F
4. same size as object



(e)

(e) *Object beyond 2F'*
The image is
1. real
2. inverted
3. between F and 2F
4. diminished

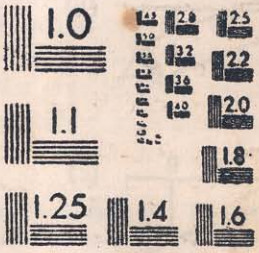


(f)

(f) *Object at infinity*
The image is
1. real
2. inverted
3. at F
4. highly diminished.

material). Resolving power is measured by photographic Resolution Test Charts developed by the U.S. National Bureau of Standards.

A Resolution Test Chart consists of horizontal and vertical lines and spaces arranged in a size graded series measured microscopically. The Chart has 26 patterns in decreasing size and the pattern in the Chart in which the smallest set of line pairs can be distinguished is noted. The number of the pattern is then multiplied by the Reduction Ratio used while filming the Chart and the resultant number is the resolving power of the system in lines per mm e.g. if Resolution Test Chart number is 6·3 and Reduction Ratio is 20, The Resolving Power would be $6 \cdot 3 \times 20 = 126$.



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No 2)

NOTE: Do not use this illustration for making tests. For valid results, the test chart itself must be used.

Fig. 10

'Lens Coating' : As already stated, a photographic objective generally consists of more than one element. Thus the rays of light before forming the image, suffer internal reflection at each of the surfaces. This not only causes loss of light, but the scattered light also causes a general veiling of the image. These defects are eliminated in the modern lens by coating the lens surfaces with a metallic fluoride. This coating is called blooming and practically all multiple element lenses are treated this way.

'Lens hood' : An important piece of equipment to be used with the lens, the lens hood, prevents rays of light from beyond the field of view from striking the lens and causing internal reflections which degrade the image.

'Diaphragm': In most lenses the amount of the light when the shutter is open can be controlled by means of a device known as the diaphragm. Usually the diaphragm is made of a set of blades which by sliding over each other can be made to close down gradually from a fully open position, as required. Such a diaphragm is known as iris diaphragm.

A diaphragm performs three main functions :

1. In combination with the shutter it controls the amount of light that is admitted through the lens and affords a control of the exposure.
2. It cuts off the marginal rays which suffering aberration would blur the images.
3. It determines the depth of field.

'Relative aperture and image brightness' : The size of the image formed by a lens depends upon its focal length, the size varying as the square of the length. With the increase in focal length and the image size, the image brightness is reduced. The brightness also depends upon the size of the diaphragm. Image brightness varies according to $\left(\frac{d}{f}\right)^2$ when 'f' is the focal length and 'd' is the diameter of the aperture. The fraction $\frac{d}{f}$ therefore, gives a measure of the light gathering power or speed of the lens and the value $\frac{f}{d}$ is called the focal number of the lens. Image brightness therefore, varies inversely as the square of focal number. When the focal number is increased, image brightness diminishes and the duration of the exposure has to be increased.

'Depth of field' : It is the range of distance between which sharpness is maintained at a particular focus. It depends upon the distance focused and the size of the diaphragm opening (aperture). As the aperture is reduced, the depth of field increases. So also when the object focused is at a distance, the depth of field is more than when the object is near.

2. Light sensitive Materials

The sensitive materials employed in photography are the plates, film and paper. These consist of a base of glass, flexible plastic sheet or paper respectively on which is coated an emulsion consisting generally of a suspension of silver halides in gelatin.

Base : The glass supports are preferred for optical clarity, their flatness, and freedom from dimensional changes when processed. Film supports which for many years consisted of cellulose nitrate which is highly inflammable and liable to self-ignition, now-a-days consist generally of a thin flexible transparent optically uniform sheet of cellulose acetate which is called 'safety film' on account of its slow burning property. In recent times increasing use is being made of polystyrene, poly-carbonate and polyester films in view of their mildew, moisture and moth resistant properties.

Photographic paper is made from rag stock or from wood pulp specially prepared free of chemical impurities with high wet strength. It is usually coated with baryta (barium sulphate) to impart a high reflectance.

'Emulsion' : The photographic emulsion which is actually the sensitive material, consists basically of a suspension of silver halide crystals in gelatin. The silver halides used are the chloride, the bromide and the iodide. During manufacture chemicals are added to control the sensitivity or speed, contrast and fog, to harden the gelatin and to sensitise the film to the desired wave lengths of light. A non-sensitive gelatin over-coat may also be given to prevent abrasion while handling film. There is a sub-stratum between emulsion and support which ensures perfect adhesion between these two. The film or plate also has an antihalation backing to prevent internal reflection in the thickness of the base. Antihalation coating disappears during processing.

Diagrammatic cross-section of film

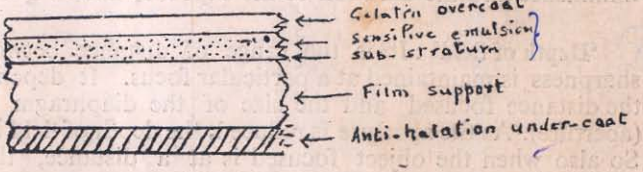


Fig. 11

'Colour Sensitivity' : The silver halides are normally sensitive only to ultra violet, violet and blue but they can be sensitised to other wave lengths by adding to the emulsion special dyes usually of carbocyanine and merocyanine class. This is known as optical sensitising. In order to represent tone values, the photographic emulsion must respond to all wave lengths to which the eye is sensitive i.e. from wave length 3900-7600 A (violet to red colours).

Non-sensitised emulsions are known as ordinary, blue sensitive or colour blind emulsions while those in which sensitivity has been extended upto green/yellow are known as orthochromatic. Panchromatic emulsions give a good tone rendering of coloured objects and are particularly useful with incandescent lamps. Orthochromatic films which reproduce red as dark, are used in commercial and industrial photography and in the graphic arts. Colour blind films are used for duplication on film. The sensitivity of filims can be extended to the near infra-red region and such infra-red films have many applications in criminology.

'Grain' : The term 'grain' is used to describe the mottled or grainy appearance of the image observed in projected prints. It is due to non-homogeneity of the silver deposit in the negative which is a direct consequence of the clumping of silver halide grains and the scattering of light within the emulsion. Graininess may result from lack of temperature control and excessive contrast. It also depends upon the nature of the developer and increases with the time of development.

Graininess is a matter of concern wherever a negative image must be greatly enlarged as in minimature camera work. It is more noticeable with fast emulsions than with slow. It is therefore, desirable to start with a slow film in which graininess is inherently low and use a normal developer.

'Speed' : Speed is a measure of the sensitivity or response to light of a photographic material. It may be defined as the least exposure which can be given to obtain an acceptable result. The speed of a material is expressed in terms of various systems, the DIN (Deutsche Industrie Norman), the Weston, A.S.A. (American Standard Association) or B.S.I. (British Standard Institution) Ratings.

'Resolving Power': As in the case of lens, the resolving power of photographic material is an important characteristic and is the maximum number of lines per mm that the material can

record distinctly and distinguish fine detail. For archival use the emulsion of negative micro-film should be capable or resolving at least 125 lines per mm and preferably 160 lines per mm.

Resolving power depends upon (i) type of emulsion (ii) Lens/focussing (iii) Contrast or optical quality of the subject photographed (iv) spectral quality of light (v) processing and image density. The response of film to light depends to some extent on temperature and humidity.

For high resolution, highly corrected low aperture lens is used with slow extra fine grain film.

Contrast : In general, the term refers to the degree of differentiation between different tones. Contrast depends upon many factors such as exposure, development, the type and composition of sensitive material, etc. A high contrast emulsion would record small differences in the brightness of the original as an appreciable difference in the negative, e.g. the high contrast film used in microfilming can produce good contrast between the text and the back ground.

'Latitude of a Film' may be defined as the ability of the film to record bright and dark objects and still differentiate between each intermediate tone in the object. Expressed numerically, it is the ratio between the brightest and darkest object that can be recorded with reasonable fidelity.

'Exposure latitude' : It is the interval between the least and greatest exposure that produces satisfactory result, the development time being varied for compensation.

3. Source of Illumination in Photography

The most important source of illumination in photography is of course, daylight. Other artificial sources of light such as tungsten lamps and arc lamps are also commonly used. Flash bulbs which generate light by the rapid combustion of some materials such as thin aluminium or magnesium foil or wire in oxygen. or electronic flash which produces a high intensity illumination by an instantaneous electric discharge between the electrodes in a gas filled tube are often used in photography. For special applications such as the photography of charred or faded documents, sources of infra-red or ultra violet radiation are used.

'Filters in photography' : Filters are used in photography to modify the light falling on the subject or passing through the camera lens by placing them over the lamps or on the camera lens.

Filters in black and white photography are mainly used on the camera lens :

(i) to correct the imperfect colour rendering by the sensitive materials which are more responsive to blue and violet radiation. The filter used is of light or medium yellow colour and acts by cutting out partially the blue radiation from the subject photographed. Such filters are called correction filters.

(ii) to change (brighten or darken) the reproduction of certain colours for special effects eg. the use of a deep red filter to darken the blue sky in a picture or the use of a deep yellow filter to lighten the background and darken the text in copying a yellowed document with blue text and

(iii) to take pictures by using selected radiation such as infrared or ultra violet in criminology.

Types of filters : Filters are generally of three types :

(i) Gelatin filters produced by dyeing gelatin to the required colour and using the gelatin either seperately or sandwiched between glass plates. Gelatin filters are easy to make and inexpensive but suffer damage by abrasion.

(ii) Glass filters prepared by coloured glass are much more robust than gelatin filters, but the range of colours in which they can be produced is limited.

(iii) Liquid filters are solutions of certain coloured chemicals in suitable glass cells. These are specially useful in scientific work where special filter effects not obtainable with the ready made gelatin or glass filters, may be needed.

Filters Factors : Filters act by absorbing part of the light reflected by the subject and this naturally has to be compensated for by an increase in exposure. The increase is given by the filter factor.

4. Processing of Photographic Materials

Processing refers to the various steps that lead to a usable image after exposure. When a photographic emulsion is exposed to light, an invisible change called the latent image is produced. This effect of exposure is made visible by development in a chemical reducing agent which converts the affected silver salts to silver while leaving unexposed portions as they were. The blackening due to the formation of silver depends upon the amount of exposure received by the emulsion. After development, the unchanged silver halide is removed by treatment in a solution of sodium or ammonium thiosulphate, also known as hypo and ammonium hypo respectively, which also fixes the silver image. Before fixing, a dilute acid stop bath is also commonly used to neutralize the alkali carried over from the developer. A hardening bath to prevent the softening of gelatin may also be used before or after development. After fixing, the photographic material is washed thoroughly to remove all residual chemicals which may affect the life of the image either by staining or causing the image to fade. Finally the material is dried, if possible in warm air circulation.

Preparation of solutions

Choice of chemicals : The developing, fixing and other solutions are usually prepared according to the formula recommended by the manufacturers of the photographic film, plate or paper, for use with their materials as these would give the best results that can be obtained. Great care is taken in using the correct chemicals and choosing only those chemicals which are of sufficient purity for photographic purposes. This is ensured by purchasing materials made by well known manufaturers of such chemicals.

'Weighing' : An ordinary pair of scales will generally serve for weighing chemicals but when small quantities are to be measured a sensitive balance will be needed. Dry chemicals are weighed on a sheet of paper while deliquescent chemicals need a container for weighing.

'Measuring out solution' : For measuring liquids, graduated jars and other liquid measures are always used.

'Making up the solutions' : The way the solutions are to be made up depends on the nature of the substance. Some chemicals dissolve easily and some only with difficulty. Generally, warming the solution makes the chemical dissolve quickly. However,

the temperature is generally kept below 45°C (115°F) as some chemicals undergo changes above this temperature and become useless. The chemicals are always dissolved in the order indicated in the formula and each chemical is completely dissolved before the next one is added. Before use, the solutions are allowed to cool.

'Water for the solutions' : While the use of distilled water would be ideal for making up the solutions, it is neither necessary nor economical for ordinary work. Generally filtered water that is considered potable is sufficient for the purpose.

'Storage of Solutions' : Photographic solutions are generally kept in stoppered glass bottles. Developing solutions which can get easily oxidised are kept in full bottles so that as little air as possible is available for the oxidation to take place. The developing agents being sensitive to light are kept in dark brown or amber coloured bottles.

'Processing equipment' : For developing and fixing generally dishes and tanks are used. These are made of corrosion resistant materials. Though initial expenditure may be high stainless steel equipment prove economical in the long run. PVC (Poly-vinyl-chloride) materials are also finding increasing use in the manufacture of dishes and tanks.

Development :

'Dark room lighting' : Development has to be always carried out in non-actinic light, i.e. light which has little or no effect on the emulsion. Complete darkness is necessary in some cases such as when panchromatic material is being used. When using photographic paper generally red or yellow illumination can be safely used.

'Photographic developers' : Photographic developers are chemical solutions containing a number of different compounds so proportioned as to produce the controlled reduction of exposed silver halide grains. During reduction the exposed silver halides are reduced to metallic silver, the invisible latent image formed by exposure being converted into a silver deposit or visible image. Developing solutions normally contain components which can be classified according to their functions into the following heads :

- Developing agents
- Preservatives
- Activators
- Restrainers

Occasionally, developers are encountered which contain less than four components. In these cases one of the components exhibits more that one function. In other cases additional components are added according to the result desired.

Developing agents : Developing agents are selective chemical reducers usually organic compounds which possess only sufficient energy to reduce exposed silver halide. Reducers which are too energetic are undesirable. To obtain desired results many formulae contain two or more reducers. Organic reducers that are good developing agents include amidol, glycin, hydroquinone, metol and para-aminophenol. However, the developing agents mainly used are hydroquinone and metol.

'Preservatives' : Since developing agents in solution are readily oxidised by air, it is necessary to protect them from premature oxidation due to contact with the air or dissolved oxygen. The preservative most commonly employed in photographic developers is sodium sulphite (Na_2SO_3). Sodium bisulphite ($NaHSO_3$) and potassium meta bisulphite ($K_2S_2O_3$) are added as extra preservatives. Frequently, in a solution containing two developing agents, one agent acts to preserve the other against aerial oxidation. Example of this is metol preserving amidol and hydroquinone preserving metol.

Other preservatives, many of which are used with sodium sulphite are stannous chloride, mannitol, sorbitol, salicyclic acid, etc.

'Activators' : Activators also known as accelerators, are compounds that increase the activity of developing agents. Since the rate of development is largely a function of the pH of the solution an alkaline salt is added to bring about the desired pH. Each developing agent has pH limits, within which it functions satisfactorily. Metol develops at a pH of 6, while hydroquinone requires a pH of 9. Low alkalinities are necessary for some effects as fine grain development.

The alkalies most widely used are sodium carbonate, the borates (sodium metaborate and borax) and trisodium phosphate.

'Restrainers' : Unless developing solution contain restrainers, the developed images are fogged to a greater or lesser degree depending upon the characteristics of the emulsion, the developing agents and the alkalinity of the developer solution. The addition of small amounts of restrainers produces a marked differential in the developer for exposed silver halide grains.

The presence of alkaline restrainers such as potassium bromide, potassium iodide or sodium chloride in developers lowers the ionisation or the corresponding silver halides, reducing the concentration of the silver ions and consequently restrains development. The addition of alkaline bromide permits longer development, which in turn produces a higher contrast and also acts as fog preventives.

'Solvent' : Water is used as a solvent in photographic developer. Its purpose is to dissolve the different chemicals and to provide the required dilution.

Fixing : The latent image formed during exposure is developed in the photographic developer to produce a visible image. At this stage in processing the emulsion still contains unexposed and undeveloped silver halides which would darken if exposed to light. The main function of the fixing bath is to remove the unexposed silver halides from the emulsion without affecting the developed image and thereby to make the image permanent.

A suitable fixing bath for silver halide emulsion must meet several requirements :

(i) it must dissolve the unexposed silver halide completely,

(ii) it must not affect the gelatin or the emulsion support and

(iii) it must not affect the silver grains of the developed image.

Like the developer, the fixing bath also contains a number of ingredients which are hypo, acetic acid, sodium sulphite, and potassium alum.

'The Fixing agents' : Sodium thiosulphate and ammonium thiosulphate are the standard fixing agent, and are in use for a long time.

'Acid' : Acetic Acid is added to the fixing bath to neutralize the alkaline developer that might be carried in by photographic material. To maintain acidity 'boric acid' powder is also added.

'Preservative' : To retard the decomposition of the fixing bath which would occur in the acidic environment, sodium sulphite is added.

'Hardener' : To avoid the excessive swelling and softening of the emulsion during the subsequent washing, potassium alum is used, thus preventing the emulsion from physical damage.

'Washing' : A final wash is required to remove all traces of hypo and residual silver salts from the fixing bath so that the film can be preserved. Washing must be in running water free from bacteria and suspended or dissolved impurities.

'Drying' : The film is dried in a dust free atmosphere, taking care that there are no water spots on the film.

Time, Temperature and Agitation

All chemical action depends upon the concentration of the chemicals used, the duration for which the chemicals act, the temperature at which the reaction takes place and the agitation of the solutions. In processing, therefore it is very important to adhere to the recommendations of the manufacturer on these points. The optimum recommended temperature is 22—25°C. High temperature may cause the gelatin to soften thus causing scratches etc. and the low temperature may slow down the action of the chemicals considerably. Therefore, to obtain consistently good results higher and lower temperatures are generally avoided.

Reduction and intensification

Reduction refers to the technique of reducing the density of the image chemically, dissolving part of it by using oxidizers such as potassium permanganate or potassium ferricyanide Intensification refers to methods of increasing the density of an image, usually by the deposition of silver, mercury or other compound.

Toning

Photographs are normally produced in black, white, and shades of gray. By special treatment called toning, the colour can be modified by the use of special developers or by solutions which convert the silver image into silver compounds.

'Sensitometry' :

Sensitometry may be defined as the measurement of the sensitivity of the photographic materials and is primarily concerned with the study of the effect of exposure and development on a light sensitive emulsion. It involves (i) the exposure of a

sensitive material to illumination of a known intensity for a known time (ii) development under suitable precisely controlled reproducible conditions (iii) measurement of the density produced by densitometers and (iv) interpretation of the results by means of a characteristic curve.

In sensitometry, exposure is the product of intensity of illumination (I) and time of exposure (t) i.e. It and is expressed as meter-candle-second. The term density (D), a measure of light stopping power is logarithm of opacity and is defined as the ratio of incident light (I) to that to the transmitted light (I') i.e. $D = \log \left(\frac{I}{I'}\right)$

In plotting the characteristic curve, the value of the logarithm of exposure and opacity are used. The curve was originally plotted by Hurter and Driffield (known as H & D Curve) for the measurement of the speed of the emulsion.

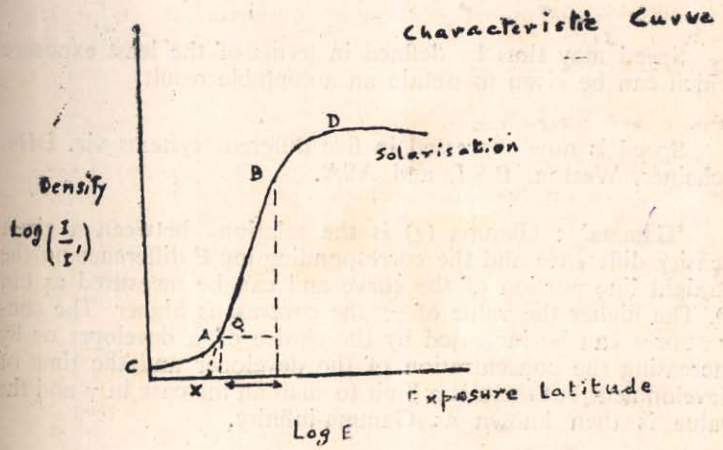


Fig. 12

When a characteristic curve is plotted, it is observed that the shape of the curve is always similar to the one in the figure with the following salient features :

(i) The straight line portion AB shows the region of correct exposure because density is directly proportional to the log E,

(ii) In the lower portion of the curve the direct proportionality does not exist. CA region is referred to as under-exposed region or 'Toe' of the curve.

(iii) In the upper portion of the curve B to D, the rate of increase of density decreases. This region is known as over-exposed region or 'Shoulder' of the curve

(iv) In the portion beyond the shoulder there is an actual fall in density on further increase in exposure which is known as 'Solarisation'.

When the straight line portion BA of the curve is extended to meet the exposure axis, the point of intersection (X) is termed by Hurter and Driffield as the 'INERTIA POINT'. Since this point remains independent of the time of development they regarded it as 'Characteristic of the Material'. Hurter and Driffield therefore, defined the speed of a photographic material as the reciprocal of inertia multiplied by 34

$$\text{H \& D speed} = \frac{34}{i}$$

Speed may thus be defined in terms of the least exposure which can be given to obtain an acceptable result.

Speed is now expressed in five different systems viz. DIN, Scheiner, Weston, B.S.I. and ASA.

'Gamma' : Gamma (γ) is the relation between a given density difference and the corresponding log E difference on the straight line portion of the curve and can be measured as tan Q. The higher the value of γ, the contrast is higher The contrast or γ can be increased by the choice of a developer or by increasing the concentration of the developer and the time of development but there is a limit to such an increase in γ and the value is then known as Gamma-infinity.

5. Positive Printing & Enlargement

Negatives provide the primary records in black and white photography and in some cases, such as in document reproduction work, they may be used as such. However, generally a positive copy, which resembles the original in tone, is required. This positive is prepared from the negative either by contact printing or by projection printing with an enlarger.

'Contact printers' : These are boxes containing lamps and a glass top on which the negative can be placed. A sheet of printing paper is placed in contact with the negative, emulsion side to emulsion side. To ensure good contact, a platten or lid with springs, air bellows or spongy material, is used over the paper. The exposure timers or photoelectric cells which automtically regulate the exposure, may also be used.

'Projection printers' (enlargers) : These are optical projection equipment consisting of a lamp house, a condenser or diffusing arrangement to give uniform illumination, a carrier for the negative, a lens designed to give optimum performance at low magnifications, focussing arrangement for obtaining a sharp image at the desired magnification, and a column or support for the whole arrangement. Some enlargers use an autofocus arrangement in which the focus varies when the magnification is changed, always giving a sharp image. Accessories used are a timer, and an easel to hold the photographic paper.

4. MICROPHOTOGRAPHY

The process of making photographs on a greatly reduced size is called microphotography. Microphotographic or microfilm copies of documents are reduced to such an extent that they can be read only by magnification. A microphotograph may therefore, be loosely defined as a photographic image requiring optical aid to make it legible.

Almost every human activity is accompanied by records, correspondence and other documentary materials. As records pile up office space shrinks. Problems of retrieval take on frightening proportions and wear and tear threatens valuable originals. Microfilming is therefore, resorted to either for reasons of security, space saving, portability, ease of duplication, authenticity or to obtain facsimile copies. In some countries microfilm copies are accepted in courts as primary evidence in lieu of original documents. The advantages and applications of various reprographic processes including microfilming have been discussed in detail in the chapter 'Introduction to Reprography'.

1. 'HISTORY OF MICROPHOTOGRAPHY'

The History of microphotography almost goes hand in hand with that of photography. Soon after the photographic process was discovered, the advantages of its applications for reducing the size of copies of documents were realised. It was John Benjamin Dancer an Englishman, who is generally credited with the first microphotograph. Dancer who was an inventor, scientist and optical manufacturer, in 1839 reduced a 20″ document to an image 1/8″ in length. The writing was visible under a 100 × microscope.

Microfilming first came into prominence during the Franco-Prussian war in 1870 when carrier pigeons were used for taking messages into the besieged city of Paris—thus keeping the city in touch with outside world. This was not the first use of microfilm but it was perhaps the most fascinating and ingenious one and became the high light of microfilm history.

This creative and daring method of communication was the result of the research and efforts of Rene Dagron, a French

Chemist and portrait photographer. Dagron received a patent in 1859 for a process of microfilming. During the war because of his microscopic pictures, Dagron was asked by the French Govt. to reproduce despatches in photographic reduction that could be attached to pigeons and flown across the Prussian front into Paris.

Dagron proved to be as much an adventurer as an inventor. He and several colleagues left Paris by balloon, along with homing pigeons and his microcopying apparatus. He intended to fly outside enemy lines but instead his balloon was blown into territory held by the Prussians. However, he managed to escape capture and ultimately arrived safely in Toures where he organised the return air mail service to Paris.

He photographed military despatches and a variety of journals. He reduced photographically an abbreviated version of these documents on to film. The film was placed into tubes and attached to pigeon legs. On reaching Paris, the microfilms were placed between glass and projected on to a screen in darkened room. The films were later exposed by projection on sensitised paper and when developed, a copy of the original document was made.

After Dagron's dramatic and clever application of micro photography, there was a lapse of 60 years in which microfilm existed mainly as a novelty. The process however, attracted the attention of librarians and scientific workers as it held out the promise of making available a large volume of information scattered throughout various libraries and scientific establishments. Microcopying received its greatest impetus by the marketing of the famous miniature camera, the Leica in 1924 as it could be easily adapted for microfilming.

Then in late twenties George McCarthy, a New York Banker and first President of the Recordak Corporation gave a detailed conception on the application of microfilming in banks and offices in general. As a result, the Recordak developed the first instrument for the rapid microfilming of cheques and other materials in banks. Then came the war in which one of the greatest application of microfilming, the V-mail began. This war also brought to focus the importance of microfilming vital records for security.

II. MICROFORM FORMATS

Microform is a general term which covers all forms of micro-images on a transparent or opaque base known as (i) micro-transparencies and (ii) micro-opaques.

'Micro-transparencies' : They have a transparent base and can be read by transmitted light. They can be made in the following forms

Roll microfilm
Unitised microfilm
Microfilm strip
Aperture Card
Jacket
Microfiche
Ultrafiche
Holograph
Magnetic tape
Video disc.

Roll Microfilm : It is the basic form with microimages in linear array. Standard film widths are 16 mm, 35 mm, 70 mm, and 105 mm. Most microfilm produced to-day of archival materials is on 35 mm film with a standard length of 30.5 metres. The film may be unperforated or perforated along one or both edges. Non-perforated film is preferable for maximum utilisation of the useful area of the film. Occasionally 70 mm or even 105 mm film is used for the reproduction of large engineering drawings and plans that cannot be microfilmed satisfactorily on 35 mm film.

16 mm film is also now being widely used as it can be loaded into casettes or cartridges and is suited for easy retrieval. It can be cut into appropriate lengths and inserted into jackets or attached to transparent sheets to produce masters for microfiches.

Roll microforms are ideal for recording the information in sequential forms which are not updated frequently. It is ideal for filming newspaper files and manuscripts. The number of images that can be accommodated on a roll of film will vary with the reduction ratio, the size of the documents and the image placement on the film. There are two accepted image placements for film with the lines of the text running along the length of the

film (comic arrangement) or along the width of the film (cine arrangement). Bureau of Indian Standards have brought out a standard on the subject "IS 9550-1980, Guidelines for placement of images in roll microfilm".

Advantages

1. A lot of material in moderate reduction can be supplied in this format.
2. Secondary distribution is economical.
3. Containers can be coded to facilitate retrieval from the file and individual reels indexed to speed up searching within.
4. The film itself can be coded for fast retrieval.
5. It can be viewed on a variety of economical readers.
6. Hard copy prints can be easily made on a reader printer or by photo enlargement.

Disadvantages

1. It is difficult to update, to revise or delete the documents already filmed.
2. Film to film copies of individual documents are not easily made.
3. The use of one roll can tie up hundreds of documents.
4. Special containers are needed for mailing.
5. Once removed from their boxes, the reels contents are difficult to identify.

'Microfilm Cartridge' : A microfilm cartridge is a closed container of 16 mm film (or magentic tape) designed for loading and unloading in a reader, projector or recorder without prior threading or rewinding. It does not have a take-up reel.

Cartridges protect the film from finger-prints, dust and other possible damages as they are used. The use of cartridge however, limits the choice of readers/reader-printers for study etc of the contents of the roll.

'Microfilm Casette' : A double-spindled cartridge is called a casette. Each casette contains both the supply and take-up reels making it un-necessary to touch or rewind the film, thus providing additional protection to the handling of roll microfilm.

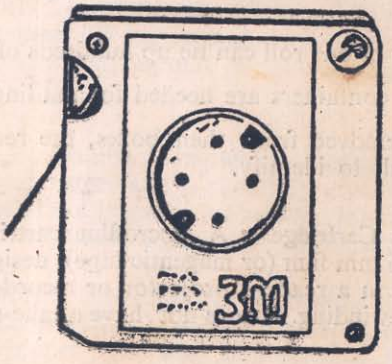
Casettes are usually unsuitable for retrieval system as the indexing techniques which rely on counting or measuring from the start of the film, cannot be conveniently applied to casettes.

Single Spool Film Containers

Standard (open) 16mm reel

35mm/16mm reel

Fig. 13



Cartridge

Fig. 14

High Capacity Cassettes

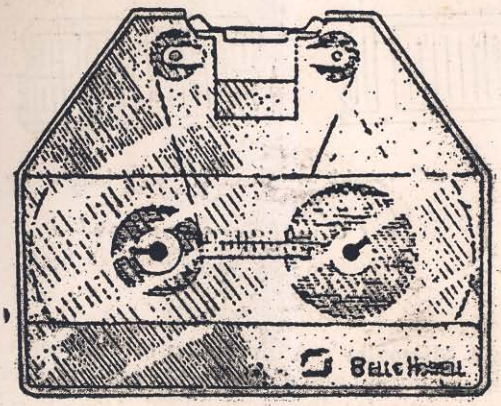


Fig. 15

Standard Image Placements

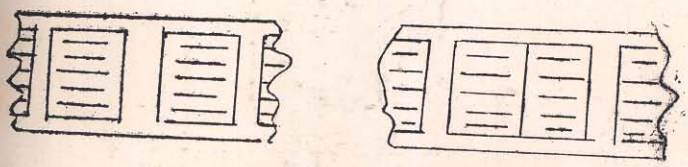
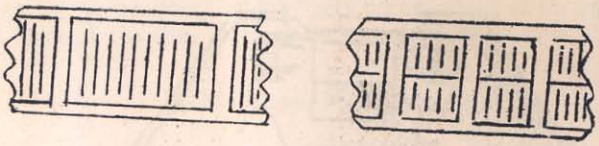


Fig. 16



Text at right angles to the length of the film

(Cine arrangement)

Fig. 17

Unitised Microfilm : A microfilm in roll form contains a large number of images and it does not usually have a ready means of locating a particular document image. Therefore, to facilitate easy search of a document the roll can be split into small lengths, each of which becomes a unit. They are referred to as unitised microfilm.

Unitised microfilm is prepared from roll microfilm and is usually in the form of 'Microfilm strip' which contains 6 frames. The first frame usually contains the title of the document and can be read by the naked eye. The other five frames may each contain two pages of the document, thus giving ten pages per strip.

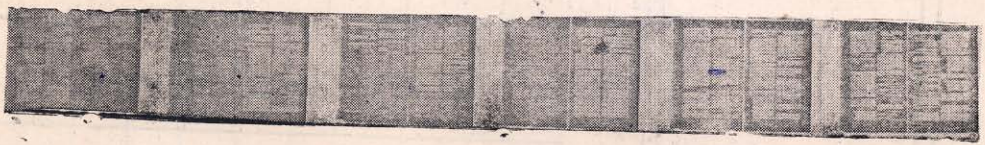


Fig. 18

'Aperture cards' : An aperture card is an opaque card measuring 187.25 mm × 82.5 mm ($7\frac{3}{4}'' \times 3\frac{1}{4}''$) with an aperture at the right hand side for mounting or inserting a single 35 mm frame. The cards contain information about the contents of the image. Punch cards can also be used as aperture cards for mechanical sorting. The aperture card is mainly used in engineering applications.

Aperture cards are delivered ready mounted by some cameras. They can also be produced by filming on 35 mm film roll and mounting the frames individually into cards.

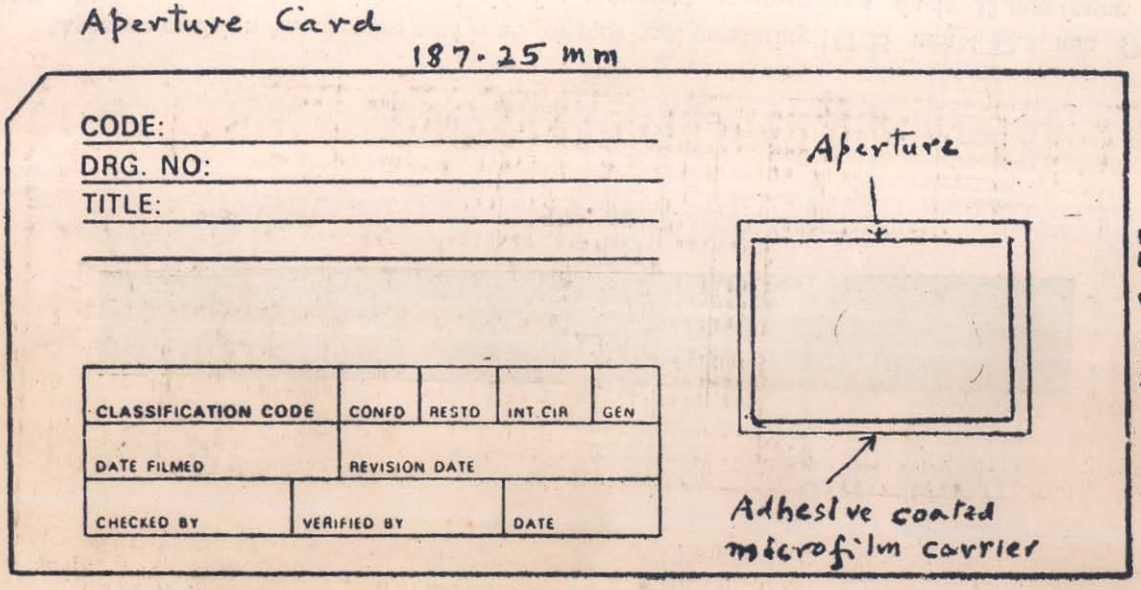


Fig. 19

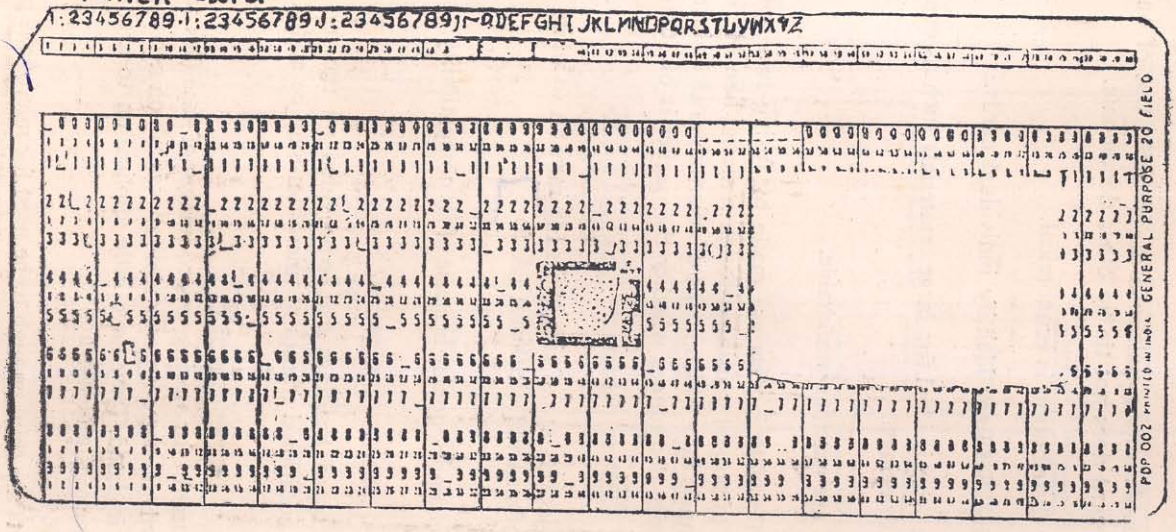

Punch Card
1:23456789 1:23456789 J:23456789 JKLMNOPQRSTUVWXYZ
PDP 002 PROVIDES A GENERAL PURPOSE 20 FIELD

Fig. 20

Advantages :

1. Aperture cards offer a unit record approach. Use of one aperture card does not tie up other documents.

2. Secondary distribution is economical.

3. Eye-readable headings identify individual cards.

4. The image size is ideal for large materials such as engineering drawings.

5. The cards are machine searchable.

'Jacket' : Microfilm jackets are made by fusing two optically clear sheets of polyester using a tough material like Mylar, thus making channels into which strips of microfilm can be inserted. The channel size determines whether the jacket is of 16mm, 35 mm or 16/35 mm.

16 mm or 16/35 jackets are of size 105 × 148 mm (A 6) while 35 mm jackets are of size 148 × 210 mm (A 5)

The former size is more popular because of its compatibility with microfiche.

Eye legible typed headings can be provided on the top of each jacket and additional frames of microfilm may be added to the jacket.

Jackets are useful for storing micro-images of case files such as hospital records or current personnel records which are active and need to be updated. They have little application to archives which are non-current and not active.

Some jackets are thin enough to be used for microfiche production.

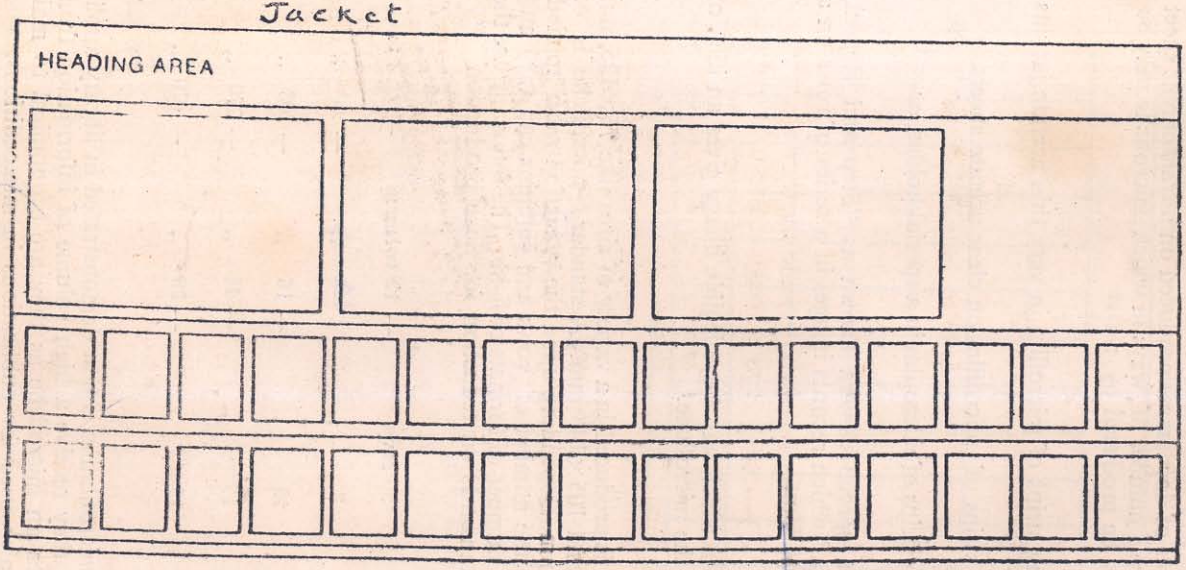


Fig. 21

'Microfiche' : A microfiche consists of a number of rows of reduced images of documents produced on a transparent sheet of film. There are a number of ways in which microfiche may be made. They may be produced by :

(i) inserting strips of microfilm in very thin acetate jackets

(ii) taping strips of microfilm on clear acetate sheets

(iii) placing strips of microfilm in a special holder, or

(iv) using a special camera known as "Step and Repeat Camera" which records images in a series of rows on a sheet of film.

The heading area which has a eye legible image gives an idea of the contents of the microfiche.

Microfiche is produced in a variety of sizes like 75 × 125 mm 90 × 120 mm and 105 × 148 mm. A standard microfiche is of size 105 × 148 mm. Depending upon the reduction ratio applied on the camera, the number of rows and columns can vary and accordingly the number of formats of fiche. The following are the international standards on reduction for fiche production.

18.2 × reduction,	5 rows	— 12 columns	— 60 frames
24 × ,,	7 ,,	— 14 ,,	— 98 ,,
42 × ,,	13 ,,	— 16 ,,	— 208 ,,
48 × ,,	15 ,,	— 18 ,,	— 270 ,,
	15 ,,	— 28 ,,	— 420 ,,

The utility of microfilming is best demonstrated in library applications, where they receive a high volume of information from external sources on microfiche as they are economical to mail. Microfiche is also used for publications in microeditions.

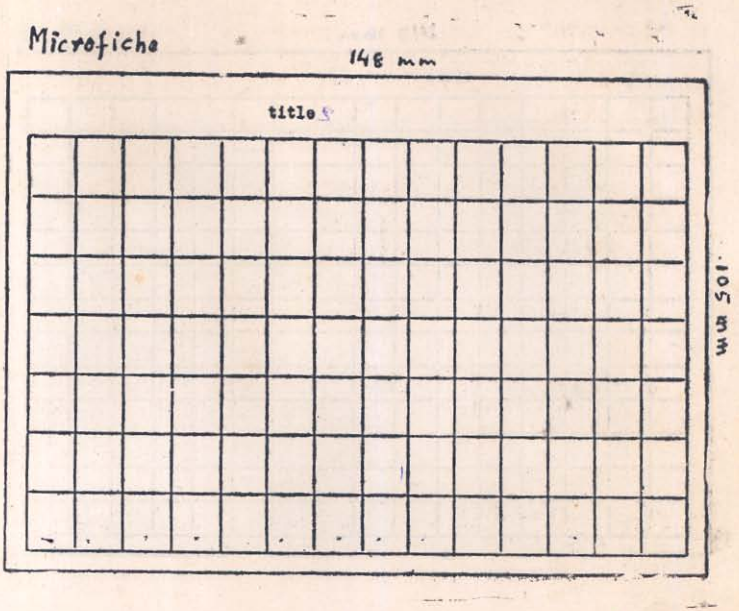


Fig. 22

number of frames	98
number of rows	7
number of columns	14
reduction ratios	24 times from $8\frac{1}{2}'' \times 11''$ 25 times from A4
frame limits	10.0×12.5 mm

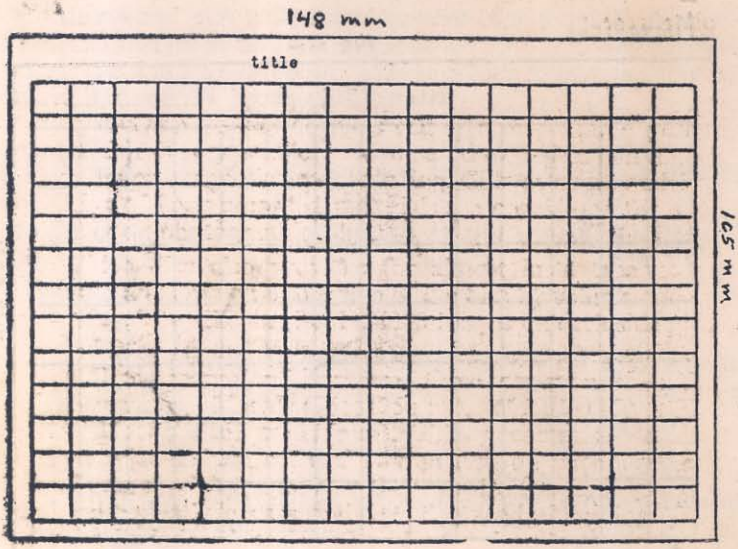


Fig. 23

number of frames	208
number of rows	13
number of columns	16
reduction ratio	42 times
frame limits	8.75 × 7.00 mm

Ultrafiche : With advances in the quality of microfilm, it is now possible to reduce a document over 100 times and still get an enlargement blowback without significant loss of detail. The ultra-fiche shown below carries 3280 images of $8\frac{1}{2}'' \times 11''$ original size at a reduction of 150 X. In an ultrafiche extreme care has to be taken in preserving such minute images from every possibility of scratches which impair legibility.

Primary uses for ultrafiche include parts and maintenance manuals, microfilming book collections etc.

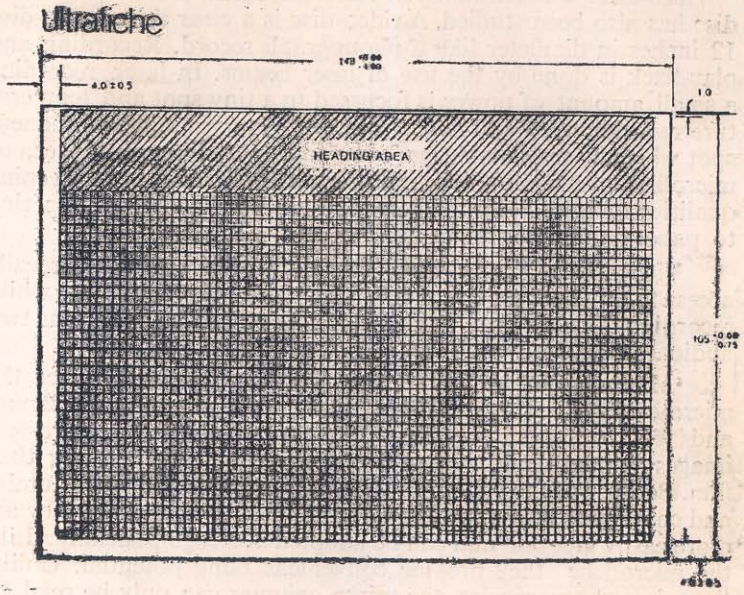


Fig. 24

'Holograph' : Holography is a type of lensless photography in which laser beam is used to produce three dimensional photographs of an objecct on photographic film which can be played back and reproduced just like recorded sound. Holograms being essentially light waves can reduce information to incredibly tiny dimensions approximating the wave length of light used. It has far greater potential capacity of storing information than a two dimensional paper or conventional film. This depends upon the storage depth in the silver emulsion layer.

Data storage in holography could in theory record all the materials in the Library of Congress U.S.A. on a medium about the size of a sugar cube.

Holography which also offers speed of access may some day outstrip all existing methods of information storage.

'Magnetic tape' : A tape coated with a magnetic material on which usual images are electronically recorded with or without sound, in the form of electro-magnetic signals. These recording are meant for short term use, are erasable and are usually made on reusable media.

Video-disc: The feasibility of storing archival material on video disc has also been studied. A video-disc is a clear thin plastic disc 12 inches in diameter like a phonograph record. Recording and play-back is done by the use of laser beams. In laser recording a small amount of power is focussed to a tiny spot and temperature raised hundreds of degree creating a very minute permanent spot which is very stable as compared to writing on paper, or microfilm or magnetic tape recording. Colour, audio and keeping qualities of laser recorded materials are considered for superior to paper or photographic film.

Video disc also provides for almost instantaneous recall/access to any item on either side of the disc by using a code while recording. The disc can hold 54000 images on each side plus two audio tracks.

'Micro-opaques' : There are three common sizes for the micro-opaques, 3″×5″ (75×125 mm), 6″×9″ (150 × 225mm) and 6½″×8½″ (165 × 215mm). They comprise micro-text images printed from rolls of 16 mm film on paper rather than film. Because of the paper base they are stronger and more durable and consequently less susceptible to damage by handling. They are more easily indexed and can be adopted for edge-punching. Like the microfiche they provide convenient filing potential. Unlike the microtransparencies, the micro-opaques can only be read by reflected light. The following are the three types of micro-opaques.

(i) **Micro-card** : It is of 3″×5″ (75×125mm) in size and consists of a number of rows of reduced images of documents reproduced on an opaque card by photographic process. Two microcards may be laminated back to back to give a two sided microcard.

(ii) **Microprint** : It differs from microcard in two important aspects. Firstly, it is a large card being 6″×9″ (150 ×225 mm) in size and secondly, it is printed by photolithography and therefore, has an ink, and not a photographic image. Each card of microprint can contain 100 images with an eye-readable bibliographic entry along one side.

(iii) **Microlex** : The cards are approximately of 6½″ × 8½″ (165×215mm) in size and contain 200 pages on one side of the card, produced by conventional photographic methods. Two cards may be laminated back to back, thus having a card containing 400 pages.

An interesting feature in the card is the decimal arrangement contained on the left side and on the top of each sheet. This gives immediate access to any page on the card.

Each microform be it microfilm, microfiche, micro-card or microprint has its advantages and disadvantages. The basic reasons for more than one microform is the vast difference in the physical characteristics of documents and the subsequent function of the microform. It is therefore, essential to select a system most suited to the needs of a particular organisation. Roll microfilm is however, the most versatile and best suited microform for the reproduction of archival materials and has in fact, become standard for micro-reproduction in archives.

Limitations of Microfilming :

The advantages offered by microfilming are varied and numerous but it has some limitations as well. Some of the disadvantages of microfilming records are :

(a) Microfilms cannot be read with the unaided eye and require microfilm readers.

(b) prolonged use of microfilm readers produces strain on the eyes.

(c) unlike the paper documents, re-arrangement, insertion or deletion of images on microfilm is not feasible.

(d) simultaneous consultation or comparison of two or more images is not possible.

(e) compared to paper documents microfilm requires more rigid conditions for storage and care in handling for long term preservation.

(f) It is not always possible to obtain a perfectly legible or usable microfilm copy.

(g) the intrinsic value of a document is lost in the film copy.

(h) there is a danger that microfilming will be used as a substitute for a thorough appraisal/disposal of records; and

(i) unless quality standards are adhered to, the microfilm produced may not serve its purpose.

However, taking an overall view of the disadvantages and the various advantages briefly reviewed, microfilming has been found to be of great advantage. Microfilming which was initially used only to save storage space and to provide security to the contents of valuable originals, now finds many more applications in science and industry and as a work tool it has a vast and exciting future.

III. MICROPHOTOGRAPHIC PROCESS, EQUIPMENT AND RAW MATERIALS

Microfilming is the technique of producing photographic images of documents on a highly reduced scale, in which form they are readable only by the use of a projector or other optical device. They are normally produced on 16 mm or 35 mm film with the help of cameras specially designed for filming documents which are exposed one by one in proper order. When a roll is completed, the negative is processed and is known as a 'master negative'. This can be used for reference but is usually employed for preparing a positive in a printer. From the negative, positive enlargements on photographic paper can also be prepared using the usual photographic enlarging equipment and technique.

Microfilm Equipment :

To prepare a microfilm and copies from it, the following equipment is required.

1. Camera for exposing the microfilm.
2. Processor for developing the exposed microfilm
3. Inspection equipment/Reader for checking film quality.
4. Microfilm printer for making film copies for reference and distribution purposes.
5. Enlarger/Reader Printer/Zerox machine for preparing hard copies on paper.

1. Camera :

The cameras used in microfilming are of two basic types, the flat-bed camera and the Rotary camera.

(a) The Flat bed Camera : This camera, also called planetary or overhead camera photographs a document in a stationary position as it lies on a copyboard. The film advances automatically by one frame length after each exposure has been made. The work of positioning the document, moving the camera head upward and downward to adjust the field coverage and reduction ratio for the type and size of film in use, adjusting

the light intensity, operating the camera shutter and removing the document from the field are generally done manually, although automatic exposure metres and motor driven devices to raise or lower the camera head are also available.

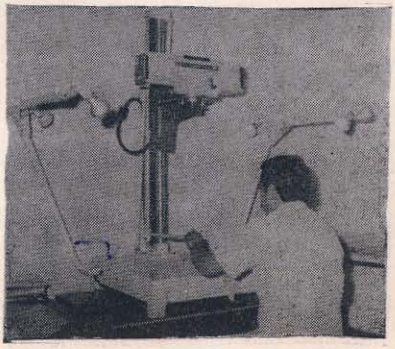


Fig. 25

Most flat bed cameras use 35 mm film although by use of an adapter it is possible to use 16 mm film. There are also cameras employing only 16 mm film. Step and Repeat cameras used for making microfiche are also planetary cameras. They produce an image superior in quality to an image produced by a rotary camera as the object is not in motion during the filming process. Reduction ratio on these may vary from 5:1 to 30:1. The essential microfilm camera for the archives is the 35 mm flat bed camera with a film unit capable of safe loading and unloading in daylight and rotating through 360°.

The planetary camera can handle fragile records, bound volumes, oversize records and news papers. For bound volumes usually a book cradle is used.

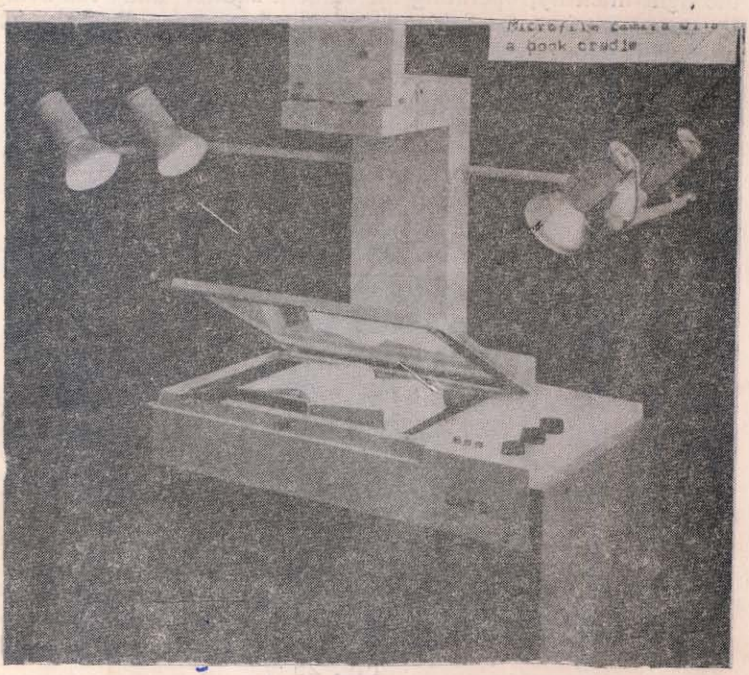


Fig. 26

Flat bed cameras should not be installed near windows or other sources of variable light. White walls close to the camera which might result in uneven illumination of the copy area, should be covered with black cloth or dark brown wrapping paper.

(b) **The Rotary Camera :** In this camera both the document and film move in synchronism during the exposure. Since the document is photographed as it passes a narrow slot or aparture, cameras of this type are also referred to as "flow Cameras".

A rotary camera consists basically of a camera unit, a paper moving and guiding mechanism and light controls, all of which are enclosed in a light tight cabinet. Documents are fed into the camera either by hand or by an automatic feed attachment, through a slot in front of the cabinet. The width of this slot varies in different models from 23.7 cm ($9\frac{1}{2}''$) to 43.2 cm (17″)

most cameras equipped with 27.9 cm or 30.5 cm (11" or 12") with slots. While documents of any length can be filmed the maximum width of a document that can be filmed is determined by the width of this slot.

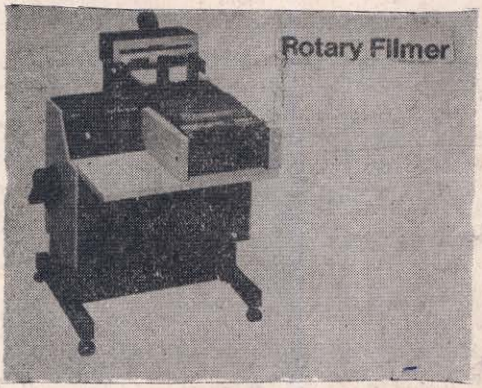


Fig. 27

Most rotaries use 16 mm film although there are some which use 35 mm film. Some rotaries will photograph only one side of a document (standard method), others will photograph both sides simultaneously side by side. There are other variations as well. These cameras are ideal for rapid microcopying of loose, flat documents generally in good condition such as cheques, drafts, card indexes, punch cards, etc and not for copying fragile and large documents, stitched files, books and volumes.

New Developments :

1. Planetary microfilm cameras are now available which create film for automatic retrieval of information A single, small plastic cartridge, containing a 16 mm-30.5 m microfilm can contain 3000 pages of A4 size (210×297 mm) documents. Image "blip" address marks for electronic retrieval are automatically recorded at each exposure. An index of the recorded micro-images for later retrieval is maintained in the computer data file. Image address of cartridge number and blip number assigned to each information batch together with their corresponding key-words are registered. When the keywords of the desired information are fed in the computer it searches the data file and

displays the image address cartridge number and blip number on the screen. The indicated microfilm cartridge is loaded in the image retrieval unit and selected blip number is entered on the key board. The unit searches and locates the information by either displaying on the projection screen or printing on plain paper.

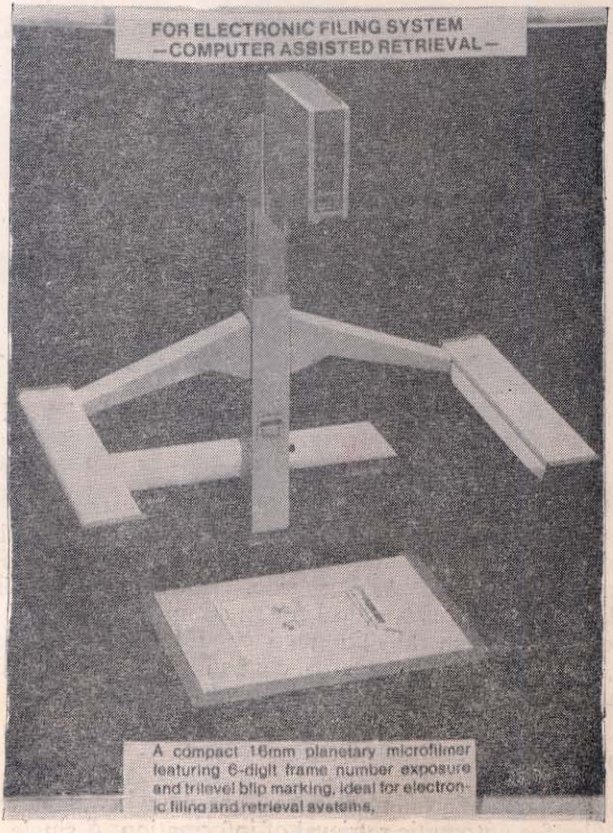


Fig. 23

2. The computer output microfilmers convert data direct from magnetic tape into plain language micro-images without the need of paper intermediaries. The computer data on magnetic tape or any other magnetic data is converted into images which are displayed on the face of a cathode ray tube (CRT) and photographed on to microfilm. The microfilm can record the displayed information on 16 mm, 35 mm or 105 mm film widths at an incredibly high speed.

3. **Mavica :** The filmless video 35 mm still camera has been developed by Sony Corporation of Japan which instead of film employs a charge coupled device (CCD) for recording a photographic scene that is then stored in a magnetic erasable disc. The novel camera is aptly labelled Mavica (Magnetic Video Camera). The recorded pictures may be transmitted over telephone lines or viewed on a television screen with the use of a playback unit. Work is said to be under way to develop a copy hard picture. The application of this development in micrographics is not far off.

Processing Equipment : Processing refers to the various steps i. e. developing, fixing, washing and drying that lead to a usable image after exposure. The processing of microfilm can be done on (i) manually operated equipment which consists of a spiral on which the film is generally hand loaded and processed using the required solutions, washed and dried on frames (ii) Semi-automatic equipment in which the film is loaded on to electrically operated spool in a tank for processing for the desired duration and then dried separately and finally (iii) automatic processing equipment which though more expensive provides automatic control on various development processes producing processed films of archival quality for long term use and storage. In addition, with automatic equipment high output can be achieved.

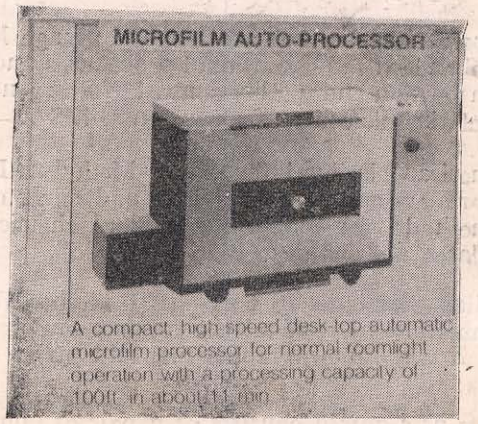


Fig. 29

The processing room must have water supply and drainage facilities and preferably be air-conditioned.

Standards have been laid down for processing of microfilms and a reference to the following will be helpful.

Indian Standards IS 3083—1966 (Revised 1983) Code of practice for processing of Microfilms.

Microfilm Inspection Equipment : The purpose of film inspection is to determine whether the completed microfilm is an adequate substitute for the records filmed and meets the recommended requirements of quality control for which standards have been set by organisations such as the International Standards Organisation (ISO), American National Standards Institute (ANSI) and the Association for Information and Image Management (AIIM), formerly the National Micrographics Association (NMA).

For ensuring archival quality of processed microfilms for permanent storage it is to be ensured that residual processing chemicals and residual silver salts which are likely to bring about deleterious changes are completely eliminated. Tests to evaluate the residual hypo and silver salts in the processed film have been specified (Appendix II). The following standards may be refered to

1. Association for Information and Image Management, "Standard for operational procedures and practices—Inspection and quality control of first generation silver gelatin microfilm of Documents, MS 23—1983".

2. American National Standard—Methylene Blue Method for measuring thiosulphate and silver densitometric method for measuring residual chemicals in films, plates and papers, PH 4.8—1985".

3. Indian Standards IS 6212—1971 Method for the determination of residual thiosulphate in processed black and white photographic film and plates.

The equipment required consists of a pair of lint free cotton white gloves, a light box inspection set for 16 and 35 mm roll microfilm, a pair of film rewinds, a magnifying glass,

a microscope, a densitometer, a microfilm reader and residual hypo and silver salts test meterials.

Fig. 30

During inspection other factors to be considered are background density, density variation of the images, focus, blurred images and base fog. These factors contribute to the legibility of the images and should be within the acceptable limits.

Microfilm Quality Standards

Quality Category	Filming Density Standards	Variation acceptance (Based on original document quality)
below 19× Reduction . .	·80—1·20 (ideal 1·00)	+0·20
19× Reduction & above .	·70—1·00 (ideal ·85)	—·10/+0·20

Microfilm Readers : A microfilm reader is a projection or viewing device used to magnify the microfilm image to a readable size. The reader must be adopted to the varied forms of microcopies—film roll, film strip, microfiche or microcard.

Readers for opaque microcopies or microcard are based on the principle of episcopic projection. The reading surface is usually a ground glass screen.

Fig. 31

Readers should be simple to operate, ensure scratch free use of micro-copies and give a sharp image of uniform high light intensity. Variable magnification and focusing arrangements are also desirable.

Splicing Equipment : If filming errors or omissions are found in the micro-film on inspection it is necessary to make retakes. These retakes may be put in the film by splicing.

A splice is a joint made by cementing (a lap splice), or by welding (a heat splice). A splice should be properly aligned and securely bonded to withstand use in a reader or duplicator.

In the cement splicer, the two sections to be joined are cemented together by means of an overlap. A good cement d splicer takes more skill and time to complete and it is usually suitable for acetate base film. The equipment required is a splicer, rewinds, film scraper and blade, tripod magnifier and film cement.

A heat or butt weld splice usually takes less skill, There is no overlap, less image loss and it can be used with both acetate or polyester base films. An overlap splicer is quite inexpensive

a butt weld splicer known as ultrasonic splicer is fairly expensive. Splicer may be obtained which will handle both 35 mm and 16 mm film.

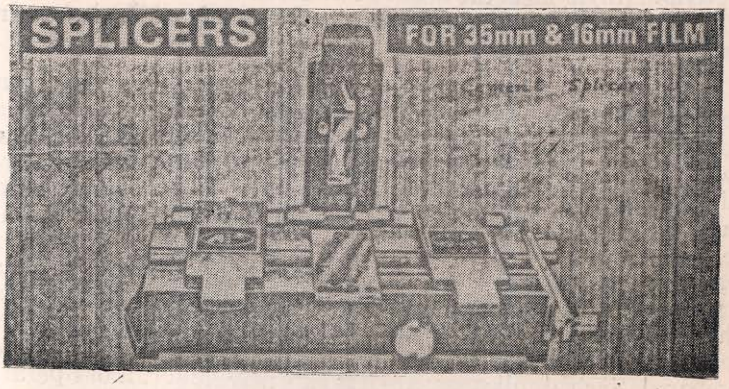


Fig. 32

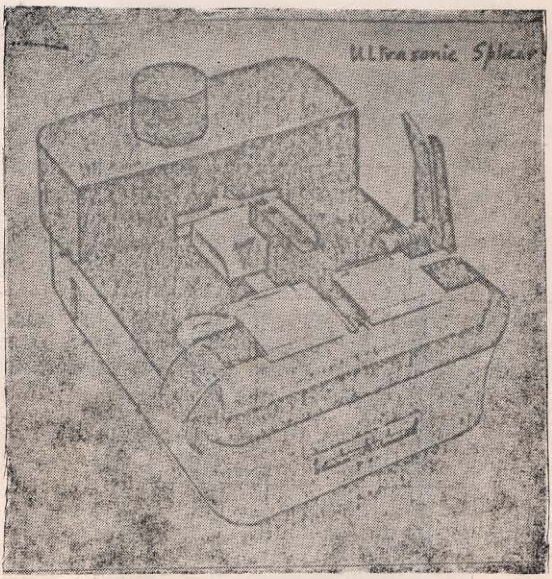


Fig. 33

Microfilm Printers : Duplicates of microfilms are needed (i) to provide both a security and reference copy (ii) to provide for the distribution of a film of interest to a number of institutions and (iii) to meet the needs of individual scholars for copies. The machine used for makihg copies from microfilms is known as Microfilm Printer.

The duplicating machine for making microfilm copies (in roll or microfiche form) in silver, diazo or vesicular provides contact between master and the copy film as they pass together over the exposing roller. Duplicators for preparing silver copy-film from master negatives are expensive and require dark room facilities. The duplicate copies also need to be processed separately, in a microfilm processor. Silver copies are mainly used for preparing security and reference copies only. Silver halide films are now available which produce copies of the same polarity as the original microfilm. For making copies for dissemination or for research scholars etc. diazo or vesicular film copies may be prepared. Such duplicators are less expensive and can be operated in ordinary room lighting and processing is usually part of the same machine.

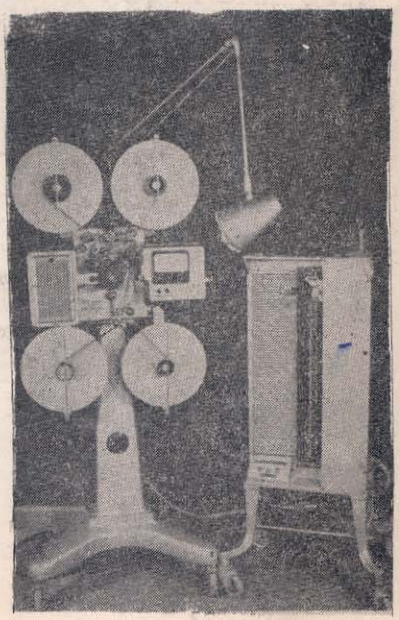


Fig. 34

Reader Printer : A reader printer combines the functions of a microfilm reader and a printer. The enlarged image is projected on to a screen of opaque glass. Simply a button is pressed to get a print of the desired image. Some machines will handle both 16 mm and 35 mm rolls as well as unitised cards with interchangeable lenses to provide for different magnification of images.

A reader printer makes use of rapid development photographic paper or electrostatic process using coated or plain paper to obtain a copy developed, fixed and dried in a matter of seconds.

Zinc Oxide & plain paper.

A universal-type reader-printer that accepts microfilm in various formats — fiche, jacket, roll (16/35mm), cartridge, aperture card.

Fig. 35

Enlarger : An enlarger is the reverse of a camera. It is an optical device, usually operated in a dark room, for projecting a microfilm image in an expanding cone on to photographic paper which is developed after exposure to get an eye legible copy. The enlarger can be raised or lowered depending upon

R-90

the size of enlargement required. Enlargers are available that have been specially, designed for roll microfilm. It is however, possible to adapt an enlarger of the type generally used, for 35 mm roll microfilm.

A photographic print produced by an enlarger is more expensive than a print produced by a reader printer.

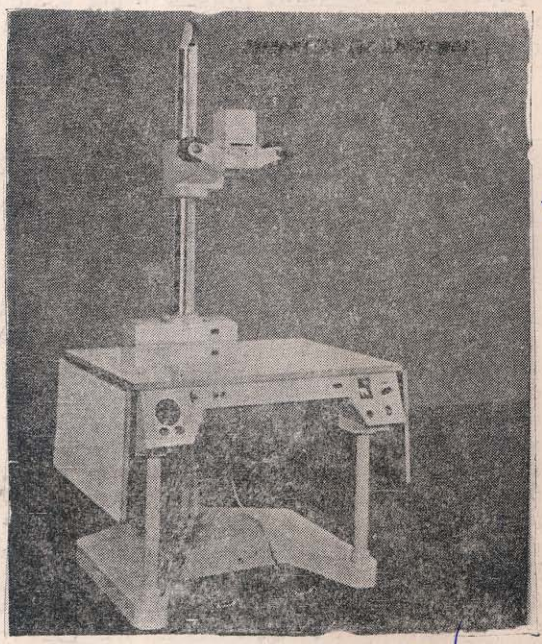


Fig. 36

Xerox Machine : Xerography employs the photoconductive properties of certain materials such as selenium. A selenium plate when electrostatically charged and exposed in a camera forms a charge pattern in the image area to which a pigment powder can be made to adhere. It is then transferred by contact on to a sheet of coated, or plain paper, followed by fusing the powder permanently in the paper surface. The advantage of this process is that it allows documents to be reproduced without the intervention of a negative and excellent copies can be prepared.

Manual and automatic xerox machines providing for reduction/ enlargement and same size copying are available. Auto-

matic plain paper copiers are preferable on account of their high out-put and low recurring cost of copies produced.

Fig. 37

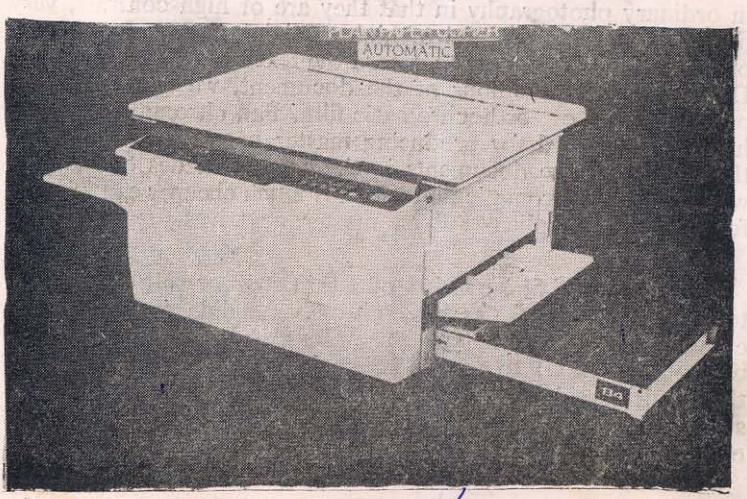


Fig. 38

Most of the microfilming equipment detailed above is not available indigenously and has to be imported against foreign exchange. However, some of the equipments like microfilm Readers and Xerox copiers are now being manufactured in India.

A list of the firms both Indian and Foreign dealing with the equipment is given in Appendix V.

Miscellaneous Items :

Besides the above, other accessories like film dryer, water cooler, dark room accessories, inspection tables, rewinders, film storage cabinets would be needed.

'Raw Materials and their special features' :

The microfilm in use to-day is of three main types :

(i) Silver halide emulsion type

(ii) Ozalid diazo type

(iii) Vesicular type.

Silver halide emulsion type film :

For microfilming the films used are different from those used in ordinary photography in that they are of high contrast, very fine grain, slow speed and of high resolving power. By the use of such film it is possible to record the text clearly and distinctly. Depending on the colour of the document, we can use either panchromatic or orthochromatic film. Pan chromatic film is however, favoured for producing master negative as it renders the colours of the documents in the correct shades of the grey while the orthochromatic film which is much cheaper can be used for preparing duplicates from master negatives.

This type of film consists of a thin strip or roll of cellulose tri-acetate or polyster as base with silver halide photo-sensitive emulsion coated on one side. The film also has an anti-halation under-coat (AHU) to prevent internal reflection of light. Usually the emulsion side has little or no gloss while the non-emulsion side is very glossy. The film is known as 'Safety film' on account of its slow burning property.

Standards have been laid down for the film to be used for archival microfilming.

1. American National Standard specification for photographic films for archival records, silver-gelatin type on cellulose estar base PH 1.28—1984.
2. American National Standard specification for photographic films for archival records, silver gelatin type on polyster base PH 1.41—1984.

The exposed film is developed with an organic developing agent to produce a silver image essentially black with reversed polarity and is then fixed in a bath and washed with water to remove residual chemicals.

'Ozalid or diazo type film' :

This type of film has a cellulose acetate base with a diazo dye (diazo compound and coupler) either incorporated into the film base or coated on the base. The diazo dye is sensitive to ultra violet rays. The diazo microfilm is available both in roll and sheet form.

The original microfilm is placed in contact with the diazo film and ultra violet light is allowed to pass through the transparent areas of the original so decomposing the diazo compound. The exposed diazo film is then placed in ammonia vapour. A visible azo dye is formed in those areas where the diazo compound and coupler remain unaffected on the film. The image produced is of the same polarity as the film from whi h it is copied. The image produced is however, not considered of archival permanence, as light and moisture can eventually destroy the image. The process is mainly used for preparation of duplicate copies.

Vesicular type film :

This type of film commercially sold under the name of 'Kalvar' or 'Xidex', is developed by heat. The film has a polyster base and diazonium type emulsion. When exposed to ultraviolet light through the original or master negative microfilm, the diazo compound decomposes at the exposed areas releasing minute bubbles of nitrogen. The film is then processed by heat (115°C). The gases released cause internal pressure and interact with the softened base to form light scattering structure which forms the image. Final fixing is done by a second exposure to ultra violet light to decompose the residual diazonium salt.

Vesicular film has better keeping quality as it does not contain azo dye image which gets faded on exposure to sunlight or ultra-violet light.

Many other vesicular films have been introduced in recent years and among them is the 3 M company dry silver film. In this case the film is coated with silver salts and a special catalyst. On being exposed to light through the negative microfilm the catalyst in the light affected areas gets activated thus creating a latent image. Development and fixing of the image is done by passing the film through heat rollers. The pressure and heat cause the catalyst to react with the silver salts to generate a black silver image. In non-light affected areas the catalyst remains unaffected.

At this time, these films are not considered suitable for producing archival quality films for permanent preservation.

Diazo/Vesicular/Silver Film Comparison Chart

ELEMENTS	DIAZO	VESICULAR	SILVER
Polarity	Same	Reverse	Same as well as reverse. Direct print silver film is used for same polarity and silver positive print film for reversing polarity.
Resolution	Capable of reproducing resolution very close to original negative.	One line-pair pattern will be lost in comparison to the original negative.	One line-pair pattern will be lost in comparison to the original negative when using silver positive print film. A loss of one and a half linepair will occur when using direct print silver film.
Cost Comparison	About half the cost of silver film.	About half the cost of silver film.	About twice the cost of diazo and vesicular film.
Processing	Wet-uses ammonia; requires ventilation for ammonia fumes. Can be handled in room light for a limited period.	Dry-requires only light and heat for processing. Can be handled in room light for a limited period.	Wet-requires photographic safe light conditions, using standard photographic chemicals i.e. developer, fixer and water.

IV. MICROFILMING PROCEDURES—GENERAL GUIDELINES

Archival filming is generally concerned with materials that have permanent value and every affort has to be made to produce a camera negative of the highest quality. Since the records in an archives are generally not uniform in size and are often in poor physical condition, they require considerable arrangement and checking before filming. General guidelines have therefore, been developed by some larger institutions like the Library of Congress and the National Archives and Records Service of the United States of America. They are :

1. Specifications for the microfilming of newspapers in the Library of Congress, 1972.
2. Specifications for the microfilming of books and pamphlets in the Library of Congress, 1973. and
3. Specifications for microfilming manuscripts, 1980.

Two British Standards are also available on the subject :

1. BS 5487—Specifications for 35 mm microcopying of newspapers.
2. BS 6313—Specifications for 35 mm microcopying of serials.

A typical filming procedure will require the following steps

(i) Selection of records for microfilming.
(ii) Arranging and processing the records.
(iii) Insertion of identification targets.
(iv) Retrieval Systems—Cataloguing and indexing.

Each step is important to ensure the integrity of records, the quality of completed film and to facilitate its storage and retrieval for use.

'Selection of records for microfilming' :

In selecting records for microfilming it is desirable to film an entire series of records or a significant sub-series than to film only a selection. The reasons for this are :

1. The filming of selected items from a series will often destroy the integrity of a series i.e. the inter-relationship that one document has to the others in the same series.

2. The filmed selections may give an imperfect or distorted picture of events and may be taken as censoring of the collection, based on the judgement of an individual.
3. It is usually cheaper and easier to microfilm an entire series than to select items for microfilming from that series.

'Arranging and processing the records' :

Before any series of records are filmed it is essential that their arrangement is perfected. Every effort should be made to find missing documents and insert them into their proper places before filming is started. The records also need to be processed before they are filmed and this includes pagination, flattening, separation of stuck-up sheets, unbinding of volumes, mending and removal of staples, clips, pins or other fasteners. Wherever possible , the documents should be microfilmed before they are repaired.

The following rules in general, should be observed :

(i) Indexes, registers, lists and other finding aids should be filmed before the records they relate to

(ii) Blank pages should not be filmed

(iii) Endorsement numbers and other data appearing on the back of individual documents should be filmed before the text of the document

(iv) Enclosures should be filmed immediately after letters/ records

(v) Duplicate papers, disposal items, or records of no value should not be filmed if they can be easily separated from the records.

'Division into rolls' :

After the records are properly arranged and processed they should then be divided to correspond to projected microfilm rolls so as to make the film produced readily usable. Whenever possible these rolls should be about 100 ft (30.5 meters) long but should never exceed 110 ft (33.5 meters). A roll may be a little shorter than 100 ft.

The number of images that can be placed on a 100 ft (30.5 meters) roll of film varies with the degree of reduction, the size of the records and the placement of the images on the film. The filing arrangement and subject matter will usually determine

the dividing points. The following principles may be observed wherever they are applicable :

(i) In chronological series of unbound records the break should be made systematically at the end of the year, half year, quarter or month.

(ii) Records which are arranged alphabetically the break should be made, as far as possible between letters of alphabet.

(iii) In series of bound volumes or case files the break should be made at the end of a volume or case file.

(3) **'Identification targets' :**

To make the film easily usable it is essential that appropriate identification targets are given. Targets are also used to identify or to separate documents or groups of documents on the film. The following practice should be followed :

(i) Each roll should begin with the target 'START'.

(ii) The name of the institution with date of filming and the name of the person undertaking the filming

(iii) Copyright notice

(iv) Identification of the series

(v) Reel No. ————————

(vi) Identification of the contents of the roll ie., Volume/ File No. with date starting at page .....and ending at page .....

After 25 feet filming

(vii) Three zebra targets

Flash I

Three zebra targets

(viii) After next 25 feet filming

Three zebra targets

Flash II

Three zebra targets

(ix) After next 25 feet filming

Three zebra targets

Flash III

Three zebra targets

(x) After next 25 feet filming

END

Reel No.

Continued on Reel No.

Exposures

(xi) Special targets at appropriate places e.g.

a. Pages ..... blank

Not filmed

b. Pages ..... faded/smudged/missing

c. A spacer is provided when a new folder/manuscript is microfilmed.

(xii) Start of Retakes

Retake certificate indicating the material being refilmed, Reel No. and volume/file/manuscript No.

Special precautions :

1. When filming material where the page being filmed is smaller than the one underneath and where there is overlapping and the page is semi-transparent, a white/black paper or card-board should be placed under the page to outline it clearly and to block out the extraneous material which might interfere with the general clarity of the material being filmed.

2. Many maps, charts and documents because of their size are filmed in sections with an overlap of atleast 1" (2.5 cm) between adjacent sections. A card showing the sequence in which the sections appear is useful. Where possible, the title of the map etc. and the reduction ratio should be included in the first frame.

3. While filming printed materials, it is necessary to include the cover, the title page and the non-printed pages on which there may be writing.

4. **Retakes :** (1) Inspect film as soon as possible after processing to detect any defects from processing or filming which will include identification of targets, density, resolution, image orientation, mechanical failures, fog, missing material, shadows and legibility.

(2) When making retakes, the exact volumes and pages must be indicated with each retake. If there are several retakes from the same volume or series and each is numbered, the reference need not be repeated with hcae

individual retake. Pages improperly filmed must be refilmed, together with the page preceding and the page following.

If pages from relatively short documents were omitted in the original filming the entire document should be refilmed and then spliced into the reel.

One page before and after the retake should be left to allow space for splicing.

(A) 'Retrieval Systems' :

Cataloguing and indexing of 'microfilm collection' :

As the microfilm collection grows, it is essential to have catalogue cards of the microfilm collection for easy and quick reference. These catalogue cards may be placed adjoining the research room. The following information may be included in the card :

1. Name of the institution/agency.
2. Name of the collection/Title on the microfilm.
3. Location of the original (Date & Place) i) Nature
4. Owner of the original.
5. The place and date of microfilming.
6. Accession number.
7. Nature of the film (Negative/positive).
8. Contents of the roll with dates, length/number of exposures.
9. Serial No. and total number of rolls for a particular series of records.
10. Placement of the film.
11. Note that the film is original or reproduction.

Indexing :

Roll films can be indexed in a number of ways for a quick information retrieval.

1. **Flash Card System** : For indexing of films, flash index points are provided at each 25 feet of the microfilm roll. The points represent 'primary division' of the roll and this helps in listing and subsequent location of the contents of the microfilm. A spacer is provided when a new folder/manuscript is microfilmed. This represents 'secondary division' of the microfilm.

Each microfilm roll container label/carton should identify the record series, sub-series and contents of the roll (with dates) for each 25 feet length of the roll, as well as an indication of "retakes" spliced in the film roll.

A sample of one of these labels is shown below :—

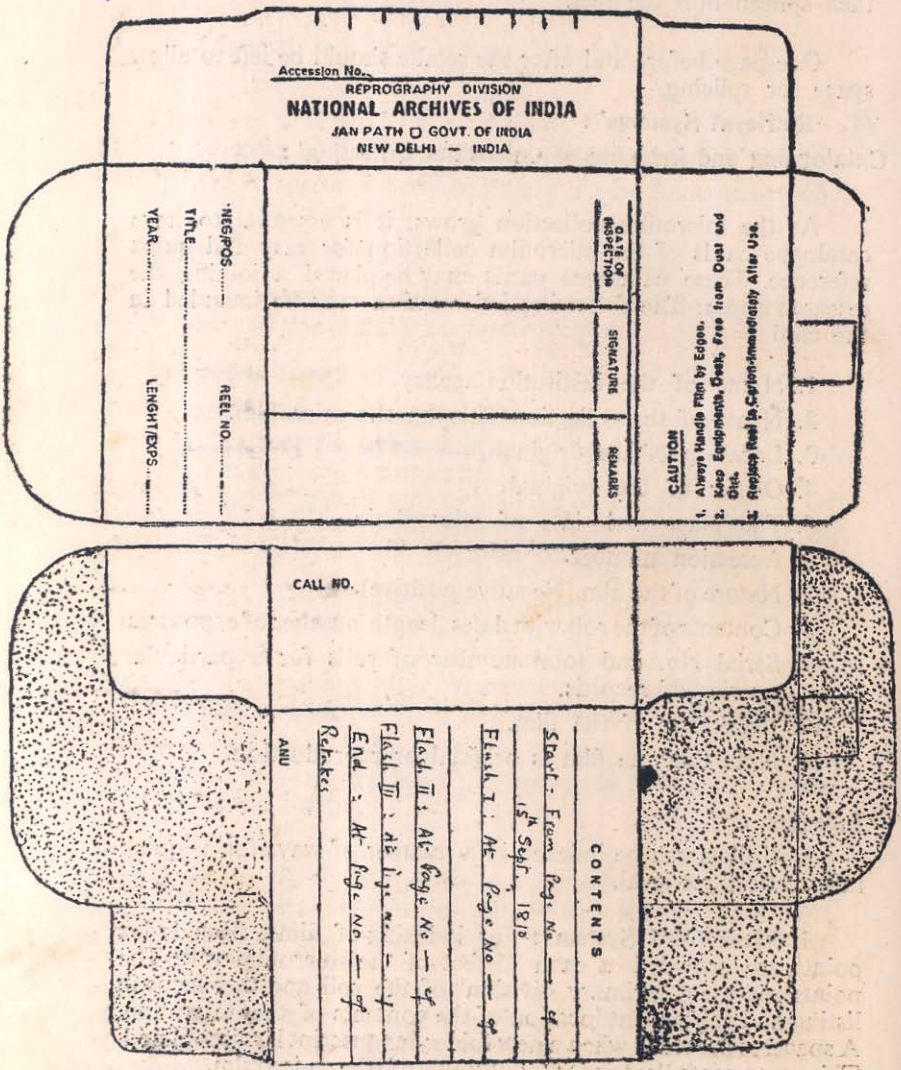


Fig. 39

2. **Odometer** : The general location of frames is indexed to an odometer on the reading machine which measures film length as it is transported.

3. **Image count (blips)** : Film indexing in to-days automated retrieval systems is accomplished by the recording of an image mark (referred to as a "blip") associated with each image along an otherwise clear channel on the edge of the film below the exposed frame with a special camera. With this method frames can be retrieved quickly by using a machine equipped with a push-botton retrieval system that counts the blips electronically. For added indexing flexibility three different sized blips indicating batch, file and page number (known as "multilevel" image marking systems) are used.

4. **Photo-optical coding** : A special camera records numbered codes on microfilm. A special retrieval machine locates the desired number code. This system is inferior to the blip system in that each code requires a whole frame of microfilm and as such it is impractical to index individual frames of information. This method can be used only for general indexing.

Some microform information retrieval system (MIRS).

System	Developed by
1. MICROCITE	National Bureau of Standards, U.S.A.
2. MIRACODE (Microfilm Information Retrieval Access Code)	Eastman Kodak, U.S.A.
3. MINICAD System . . .	Eastman Kodak, U.S.A.
4. CARD (Compact Automatic Retrieval Device).	Fearless Co., U.S.A.
5. WALNUT System . . .	I.B.M., U.S.A.
6. CRIS (Command Retrieval Information System)	Information Retrieval Corpn., U.S.A.
7. FLIP (Film Library Instantaneous Presentation)	Benson-Lehner, U.S.A.
8. FOSDIC (Film Optical Scanning Device for Input to Computers)	National Bureau of Standards, U.S.A.
9. RAPID SELECTOR . . .	Do.

In Computer Assisted Retrieval (CAR) of microform records, documents are stored relatively inexpensively on microfilm while index to these files is stored in the computer, thus allowing quick retrieval. This system is known as SPINDEX (Selective Permutation Indexing). A CAR system can be either an on-line index with off-line retrieval of the text on microform or an on-line index electronically interfaced with an automated microform retrieval system.

V. STORAGE AND PRESERVATION OF MICROFILMS

The life expectancy of microfilm depends upon :

1. The nature of the film base & emulsion,
2. The method of processing, and
3. Storage.

If the film used has inherent stability and processing is done as per manufacturer's recommendations, proper storage will ensure long life to the microfilms.

Storage Conditions :

Photographic film and paper are a more delicate medium than paper. Under unfavourable environmental conditions of storage they are much more susceptible to deterioration than paper. High relative humidity (above 60%) encourages the growth of mould, while low humidity (below 30%) can cause film brittleness, curling and static charge. Heat also accelerates film shrinkage and may produce physical distortion. It is, therefore, essential that photographic records intended to be preserved for a considerable length of time are stored under proper environmental conditions. For this an efficient airconditioning system working round the clock is a must. A temperature of 14 $\pm$ 2°C and relative humidity of 35 $\pm$ 5% provides an ideal storage environment. Since obtaining such lower limits of temperature in tropical climate increases considerably the cost of operation of an air-conditioning plant, a temperature of 20-22°C and relative humidity of 45-50% provides a workable solution.

Studies on image permanence indicate that even if hypo- and silver salts might be removed completely from the image it would still be subject to deterioration when attacked by external gases like ammonia, hydrogen peroxide, hydrogen sulphide or sulphur dioxide. Films should therefore, be provided with adequate leaders to give protection to the image portion of the film roll from external contamination. This leader appears to react with the major portion of entering gases reducing chances of attack on subsequent image bearing film. In addition, the air of the storage area should be filtered to remove dust and should be given an alkaline wash to make it free of acidic gases and

circulated under slight positive pressure to prevent pockets of stagnant air. Sufficient fresh air should be drawn in continuously to satisfy the needs of personnel working in the conditioned area.

Adequate precautions against fire damage should be taken—smoke detector and alarm system may be installed with appropriate type of fire-extinguishers. The fire hazard introduced by openings for air-conditioning ducts can be over-come by the use of automatic fire-control dampers. Sufficient insulation should be provided in the vault to permit satisfactory temperature control at all seasons of the year and to prevent moisture condensation from forming on the walls. Storage facilities therefore, should consider temperature, humidity, air purification, air-conditioning, water and fire protection.

For reasons of safe keeping, the negatives, positives and the duplicates should be kept separately. Safety and nitrate base films are not to be stored together. The master negatives should be stored away from the original records, preferably in another location/city.

If under-ground storage (e.g., basements, tunnels, mines etc.) is used, steps to prevent seepage of water, flooding, splash through ventilators, leaks from roof, fire-sprinkler discharge, back-flow of drainage, system should be taken.

Ventilation :

1. Except when the storage area is air-conditioned, adequate ventilation near the ground and ceiling should be provided. The ventilator and windows should be covered by a weather shade of an incombustible material.

2. All the ventilators and windows should be fitted with metal grids on the outside face of the wall and with non-corroding wire gauze (16 mesh) fitted in an angle frame on the inside face of the wall.

3. Ventilators should not be obstructed by racks provided in the storage area for keeping the microfilm.

Exits :

Each storage area shall have atleast one door opening which shall have two doors connected through a vestibule—the

inner door opening on the inside and the outer door outwards. The former shall be of self-closing type and the outer flush with the ground.

Emergency exit may also be provided.

Microfilm Storage Equipment :

1. **Reels :** Both negative and positive microfilms, in accordance with the accepted practice, are maintained in lengths of not more than 110 feet (33.5 meters) on reels with an internal diameter of not less than 2.5 cm. Longer lengths are unwieldy and may not fit into standard containers. The reels should be made of non-corrosive materials such as non-ferrous metal or stable plastics that are free of peroxides. The use of rubber bands around microfilm reels should be avoided because the rubber may contain residual sulphur, which is harmful. The use of adhesive tape splices, bleached paper, or printed paper such as newspaper, around microfilm reels also has adverse effects and should be avoided.

2. **Reel Containers and Cartons :** The most acceptable containers for storing negative microfilms are corrosion-resistant metal cans, with telescopic lid e.g., cans made of anodized aluminium or of stabilised plastic. Cardboard containers may be used for storage of negative film, only when they are relatively acid-free and non-peroxide producing.

3. **Shelves and Cabinets :** To ensure preservation, both negative and positive microfilms should be stored in fire proof and dust proof cabinets preferably made of steel that have been carefully constructed and treated with non-corrosive, non-staining and non-combustible paint. These cabinets should be designed so as to prevent dirt and dust from the air settling on the film containers and permit free circulation of the air in drawers and compartments. The lowest drawer should be at least ten to fifteen centimeters above the floor.

The cabinets should be stored in an air-conditioned space. But care should be taken at the time of taking out film rolls to non-conditioned areas. The film containers should be opened only after they have acquired equilibrium with the outside atmosphere otherwise condensation of moisture will occur.

Similar precaution has to be taken when the film is brought back for restoration in an air-conditioned area.

A microfilm reel container

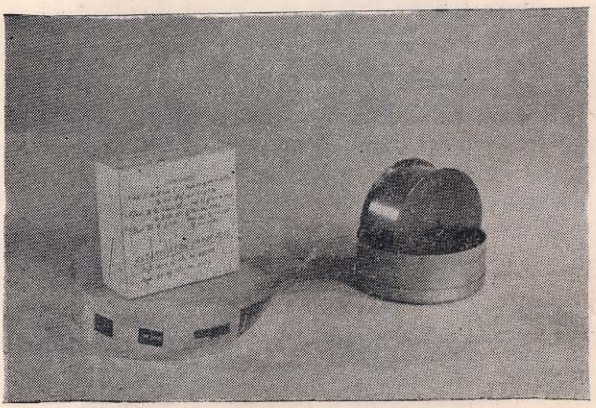


Fig. 40

A microfilm carton

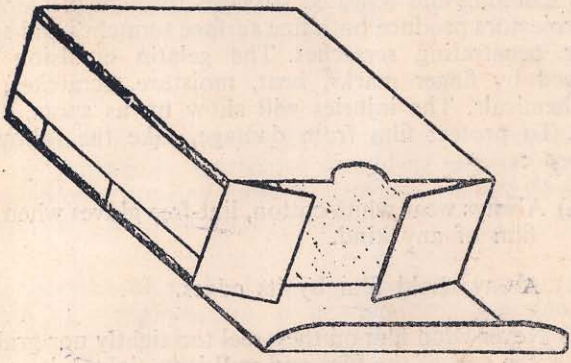


Fig. 41

A microfilm storage cabinet

Fig. 42

Care in Handling :

Keeping the film free of finger marks, dust, scratches and abrasion is of great importance. Uric acid in the natural oils of the skin may eventually etch the surface of the film. Continuous handling and repeated passages through printers, readers and projectors produce both fine surface scratches and sometimes deeper penetrating scratches. The gelatin emulsion is easily damaged by finger marks, heat, moisture, scratches, pressure and chemicals. The injuries will show up as spots, streaks or stains. To protect film from damage, take the following precautions :

(a) Always wear white-cotton, lint-free gloves when handling film of any kind.

(b) Always hold film by its edges.

(c) Never wind film on the reel too tightly nor grab or hold the end of the film and pull it to tighten it on the reel. Wind film on the reel only as tight as the camera, viewer, or other rewind mechanism permits.

(d) Before using viewers, microscopes, densitometers, etc. always clean all parts that will come in contact with the films, and keep them clean during use. Dust is an enemy of film.

(e) After the service copy of the microfilm has been produced, inspected and accepted, use the original camera negative only in emergencies.

(f) Keep chemicals and chemical fumes away from film-storage and film use areas. Never use alcohol to clean film; use film cleaner (photographic).

(g) Wind and store film on plastic instead of metal reels. In humid areas metal tends to rust and the rust penetrates the film emulsion.

(h) Periodically check stored film. This check is most important. Check for fungus, mildew, film stickiness, too tight winding, image etching etc. Perform this check atleast annually and more often in areas of high or very low natural humidity, especially if film is not maintained under controlled temperature and humidity.

Negatives should not be placed closed to radiators nor should they touch a light bulb or anything that might melt the emulsion. While laying a negative down it should be placed only on a clean, smooth surface with its emulsion side facing up. Paper clips should not come in direct contact with the negative or paper print. A piece of clean paper should protect the negative or print from the clip.

Inspection :

Photographic film records should be inspected after every use and any damage to the record should be repaired promptly and reels and cans showing signs of corrosion, should be replaced before they are sent back for storage.

Film stored even under ideal conditions may have acquired some kind of contamination. It is therefore, desirable to set up a regular schedule for inspection. Films should be examined atleast once every year and should be checked for base and image condition etc. For general cleaning recommended film cleaner should be used. Copies should be made of films that

show signs of deterioration, because deterioration once initiated is an irreversible process that may be restrained but not terminated by improving storage conditions.

Films already processed without previous consideration for archival storage should be tested for residual hypo (Appendix II). If the residual hypo exceeds the limits specified, the films should be rewashed, provided that the gelatin in the emulsion has not already been damaged by fungus or moisture and become water soluble. If this has occurred, the film should be first carefully cleaned and then duplicated.

VI. ORGANISATION AND MANAGEMENT

The increasing use of reprographic services in a library or an archives makes it necessary that such services are properly organised and managed, to provide an efficient and economical service. Therefore, while planning and establishing a reprographic service, the following points are to be considered.

Process Selection :

With the very wide range of reprographic systems and equipment available, the proper selection of document copying processes and equipment for any establishment depends upon a number of considerations. In every case the full requirements of the unit have to be examined alongwith the capabilities of the various techniques in order to decide upon the most suitable processes and equipment. Some considerations which would determine the choice are as follows :

'The size' of the originals to be copied is important as this will determine the size of the machine required. When enlargement or reduction of the original size is required this will further restrict the choice of equipment and technique.

'The quality' of the originals is another important consideration. If old faded documents, generally of a poor quality are to be copied a process which gives a good contrast has to be

chosen and when the documents contain colour, illustrations in half tone or continuous tone, entirely different processes may be necessary. The thickness (say, of bound volumes) of the originals will also determine the choice of equipment as some can use only loose sheets.

'Permanence' required of the copy is also a consideration as some processes do not give durable copies while others can give archival permanency.

'The number' of copies usually to be made of the originals is also important, as some processes are economical in short runs and others only when a number of copies are to be made.

Other considerations that will apply are the quickness with which a copy can be produced, the operational skill required, the space required (including whether a dark-room is needed), the initial outlay and last but perhaps the most important in a country like India, the availability of the equipment and raw materials.

The advantages and disadvantages of the various processes for the above considerations are repeated here briefly.

'Silver halide copying' : These produce by far the best quality copies from any type of original but the raw materials is expensive and when more than a few copies of an original are usually required, the process becomes uneconomical. Equipment for reflex copying occupy very little space and are easily operated. The equipment and raw materials are available in India. When storage space is a problem, microfilming, one of the silver halide processes, is the ideal solution.

'Diazo process' : Diazo is the least expensive of the sensitive materials but it has the limitation in not being permanent, and, usually needing a translucent master for producing copies. The process however, can give quick dry direct positive copies and where a number of copies (six or more) are

required, it is the most economical. Equipment and raw materials are easily available in India.

'Thermal process' : This gives dry copies very quickly but they are not of archieval quality. The process can however, be used for making duplicate copies.

'Electrography' : Electrographic techniques seem to provide answer to many of the varied requirements of a reprographic unit, especially supply of readable copies to Research Scholars, etc.

Besides the copying methods described above for one of a few copies, there are available duplicating techniques, stencil duplication, hectographic duplication and offset printing, which find application when a large number of copies are required to be produced.

Organisation :

The basic requirements for a document reproduction services are equipment, premises, plumbing and electric supply installations and services, personnel, supplies of raw materials and facilities for maintenance of equipment. While estimating the basic requirements for the service it is important that not only the immediate requirements are taken into account, but, as far as possible some provision is made for space, additional equipment, etc., for future expansion of the services. When a reprographic service starts functioning the demand for the services quite often increases far above the initial level because of the utility of such services.

The choice of equipment would depend upon the considerations enumerated earlier and once this has been made, the premises for the work have to be planned. The choice of premises that is, the number of rooms, their size and location will depend upon the processes employed and the volume of work. The size of the rooms should be big enough to provide comfortable and hygienic working conditions and their location

should be planned according to the flow of work. If some of the photocopying services are employed, dark-rooms will be necessary and it is imperative that these are properly ventilated.

Installations : Besides electric supply of the appropriate voltage for the operation of equipment, plumbing arrangements for water supply and drainage, may also have to be provided where wet processing is employed. Airconditioning installations are also required to control the humidity and temperature and avoid dust, for the storage of chemicals and raw materials, for the processing of films and their storage, for microfilming and xerographic equipment, etc.

Supplies : A regular supply of materials such as films, photographic paper, and chemicals for silver halide copying, Diazo coated papers, ammonia or chemicals for wet development for diazography, selenium coated plates and toner (developer) powders for xerography, special zinc oxide coated paper for electrofox, and thermofax paper for heat processing, are all required to be kept in stock to ensure an uninterrupted flow of work. The quantity so stored will not only depend upon the output but shelf life of the stored material.

Management : Reprographic services in libraries and information centres are generally run on a non-profit basis but this does not preclude the need for their efficient management. General principles of management that apply to any branch of technology would of course apply in this case as well but the following are some pointers towards better management of a reprographic service.

Planning :

The provision and installation of various reprographic facilities in an organisation will depend upon the orders received for copies from research scholars/institutions as a part of reference service or availability of sufficient records for microfilming as a measure of security and preservation. As a general guide,

installation of an in-house microfilming system can be justified if the backlog is in the region of atleast one lakh exposures and there is a work load of 15,000 document sheets per month.

Reprographic Laboratory :

If a new archives building is being planned it is possible to design a reprographic laboratory that will meet current needs as well as provide for future expansion. If however, the facility is to be located in an older building the selection of suitable areas for the location of the laboratory is important. It should preferably be located on the ground floor or basement areas where it will have firm floors. It is also essential to locate it away from heavy machinery as well as street traffic which might cause vibrations & noise that can seriously interfere with the proper functioning of the photographic equipment. The camera and the enlarger room should have sufficient height to accommodate the equipment selected for microfilming. Provision should be made for adequate ventilation, good plumbing, water supply and drainage facilities, extra heavy power outlets as well as a good number of ordinary electric outlets to meet the requirements of various equipments. The reprographic laboratory can depend upon artificial lighting.

Many problems can be avoided if a reprographic laboratory has a filtered air-conditioning system with temperatures between 21-24°C and a relative humidity between 40-50%.

In planning the lay-out of a reprographic laboratory it is desirable to prepare a list of the equipment to be installed and then develop a scaled lay-out of the necessary equipment and fixtures. Temporary partitions are more suitable as they may need to be removed or their location changed as the laboratory develops. They also do not interfere with the operation of air-conditioning or ventilation systems.

A suggested lay-out of reprographic laboratory keeping in view the principles of work flow is at Appendix I. Minimum requirements in respect of equipment, staff and funds for setting up a reprographic unit for a medium sized record repository are as under :

Equipment :

1. Automatic Plain Paper Copier . Rs. 60,000 to Rs. 1,50,000
2. Microfilm Camera 35 mm planetary
   (a) Stationary model . . Rs. 2·00 to 2·75 lakhs (F.E. Rs. 75,000)

	(b) Portable model . . .	Rs. 1·0 lakhs (F.E. Rs. 30,000)
3.	Film Processing Unit with Inspection Kit.	Rs. 30,000 to Rs. 2,50,000 (F.E. Rs. 60,000) Semi-automatic/automatic
4.	Microfilm Reader	Rs. 10,000 to Rs. 25,000
5.	Microfilm Enlarger . . .	Rs. 10,000 to Rs. 70,000
6.	Microfilm Duplicator . . .	Rs. 30,000 to Rs. 2, 50,000. (F.E. Rs. 60,000) Table Model/Automatic with density control
7.	Microfilm Reader Printer . .	Rs. 2·,50,000 (F.E. Rs. 60,000)

Micrographic equipment is still mostly of foreign manufacture. Equipments of well-known brand imported through their agencies in India are durable and dependable for uniform and good results. However, it is to be ensured that the equipment is delivered with sufficient supplies of spares and consumables.

8. Miscellaneous items :

Besides the above, other accessories like film dryer, water cooler, dark room accessories, inspection tables, rewinders, splicers and film storage cabinets would be needed for which an amount of approx. Rs. 50,000 may be provided.

Raw Materials :

Raw safety, tri-acetate or plyester base microfilms (both negative and positive) for microfilming as well as photographic chemicals and papers etc. are required for preparation of microfilms and for use in plain-paper copier. At an estimated output of about 250-300 rolls of negative and positive microfilms each year and normal operation of a plain-paper copier the recurring cost of raw materials will be approx Rs. 125,000.

The raw films are imported by the firms against their own quota of foreign exchange and are available through m/s India Photographic Co.,M/s Agfa Gevaert Ltd. and M/s Camera Works Pvt. Ltd.

Financial Provision :

A financial provision of approx Rs. 10-13 lakhs (Foreign Exchange Rs. 2-3 lakhs) would therefore, be required for non-

recurring expenditure on equipment and accessories depending upon the choice of equipment etc. with a recurring expenditure of about Rs. 1.25 lakhs on raw microfilms, photographic paper and chemicals etc. Allowance must also be made for the cost of any essential extras required and for fluctuations in currency exchange, and customs duty in case of imported items of equipment.

Space Requirement :

Space is required for microfilm camera, film processing unit, film duplicating, enlarging, film inspection, film storage and plain-paper copier besides office space for technical staff. In addition space is also required for keeping the records awaiting microfilming/xerox, for storing the raw materials and accessories as well as for mixing of chemicals. The size of accommodation required will depend upon the range of equipment, processes and the scale of operations. It is however, possible to lay-down some minimum standards for the space required to house several components.

		sq m
1.	Automatic Plain Paper Copier and Reader Printer.	20
2.	Microfilm camera	25
3.	Film processing room—Dark room with plumbing running water, drainage, sink (6'x2'x1') and exhaust fan	20
4.	Film enlarging dark room with sink, runnng water, safe light etc.	14
5.	Microfilm Readers, Inspection and Splicing Room	42
6.	Film printing and special copying room	15
7.	Office space	40
8.	Raw film and Paper storage	20
9.	Chemicals Store room with a kitchen type sink and running water for mixing chemicals etc.	24
10.	Record Handling Area	45
11.	Miscellaneous	30

Air-conditioning :

For all technical operations as well as for film storage, air-conditioning is strongly recommended . For storing master negative microfilm copies of vital records, a separate location away from the original documents is required. For long term storage of such microfilms round the clock air-conditioning with temperature of about 15°C and relative humidity between 30-40% is essential. The films require proper conditioning before they are taken out or restored after use/inspection.

Personnel : It is essential that a new reprographic facility has proper staffing at every level. If a large installation is planned, the manager of the facility should be appointed early in the planning stages and should then be involved in the overall provision of equipment and staff for the new unit.

The staff required for the Unit may be as follows :

1. Reprographic Officer . . . . . One

   To plan, organise and execute the microfilming programme etc. and supervise the work.

2. Senior Reprographic Asstt. . . . One

   To assist the Reprographic officer in the supervision and distribution of work and purchase of equipment, raw materials etc.

3. Junior Reprographic Asstts. . . . Three

   To operate the various equipments.

4. Photo/Lab. Asstts. . . . . Two

   To assist the Junior Reprographic Asstts. in their respective jobs and preparation of photographic solutions etc.

5. Lab. Attendant . . . . . One

   For cleaning the equipments, dark room and other assistance.

6. Helper . . . . . One

The qualifications and scales of pay for each of the posts recommended may be fixed in accordance with existing equivalent or similar posts in the state concerned. As microfilming is based on photographic principles, the persons employed should have a good knowledge of and experience in photographic work. It is also desirable that the staff selected may receive training in an established Reprographic Service Centre.

National Archives of India provides training facilities in reprography to both sponsored and non-sponsored candidates free of cost, in its School of Archival Studies. The duration of each course is 8 weeks and two courses beginning in April and September, are held in a year.

Inspection and Standardisation :

The quality of the copies produced by the unit must be high and should be comparable with the originals to serve the purpose of security or reference copies so that the scholars could be asked

to dispense with the use of originals. It is therefore, desirable that equipment making the copies as well as the viewing equipment is always kept clean and properly maintained.

Variety in the processes, sizes, packing etc. should be limited so as to make the service economical as well as convenient for the user.

Costing/charges for service :

Even though run on a non-profit basis an account has to be kept of the cost factors as inadequate accounting leads to inefficiency, pilferage and wastage. While working out the rates for the service, the factors considered are direct costs such as cost of raw materials, skilled labour, over-head costs like supervisory costs, rentals, water, electricity, servicing and maintenance of equipment, handling charges, depreciation of equipment and return on investment. However, as the supply of copies is a service to scholars, the rates charged take into account only a part of the cost e.g. the expenses on raw materials and skilled labour are realised.

A schedule of rates for various reprographic services available in the National Archives of India, New Delhi is at Appendix IV.

Copyright Considerations :

In case of government records copyright vests with the Archives holding the records or the creating Ministry/ Department. If unpublished maps form part of the documents, permission may also have to be obtained from Ministry of Home Affairs, Ministry of External Affairs, Ministry of Defence or the Survey of India depending upon the nature of maps, for the supply of copies.

A scholar/institution applying for a copy, has to give an undertaking not to sell, duplicate or transfer photo copies/xerox copies/ transcripts of documents supplied by the National Archives of India, without prior permission of the Director of Archives and also to suitably acknowledge the material, if published (Appendix III) and to supply to National Archives of India one copy of such publications, free of cost. The Reprographic Services of an Archives usually mark the films or reproductions of archival documents with a copyright notice in the form of a stamp which states the reservations on publications.

Copyright for manuscripts vests with the author or his legal heirs and in case of printed books with the author/publisher for a period of 50 years from the beginning of the calend ar year next following the year in which the author dies.

Copyright laws pose certain restrictions on the free use of microfilms whether they are original publications or copies duplicated from conventional documents. In both cases, duplication is governed by Copyright Laws. The British Act of 1956 and the American Counterpart of 1976 specifically allowed "fair copying" i.e. copying of small portions of any document copyrighted. There is now a move towards an International Copyright Law.

In determining whether the use made of a work in any particular case is a fair use, the factors to be considered shall include :

1. the purpose and character of the use.
2. the nature of the copy-righted work.
3. the amount and extent of the portion used in relation to the copy-righted work as a whole.
4. the effect of the use upon the potential market for or value of the copy-righted work.

Legal Status of Microfilms :

The law prescribes for the courts (authorities) to consider. the evidence with the help of microfilm not as a primary and direct evidence but only as secondary, indirect or supplementary evidence.

The value of microfilms and their copies as evidence will depend upon.

(i) The nature of documents i.e. public or private documents.

(ii) Bodies authorised to make microfilm or copies from the microfilms :

a. The organisation which created the original documents.

b. The organisation where the documents are legally kept (Office/department).

c. The organisation authorised by law or by agreement to keep the documents (archives, record centre, notary public etc.)

(iii) The identity of the validating authority.

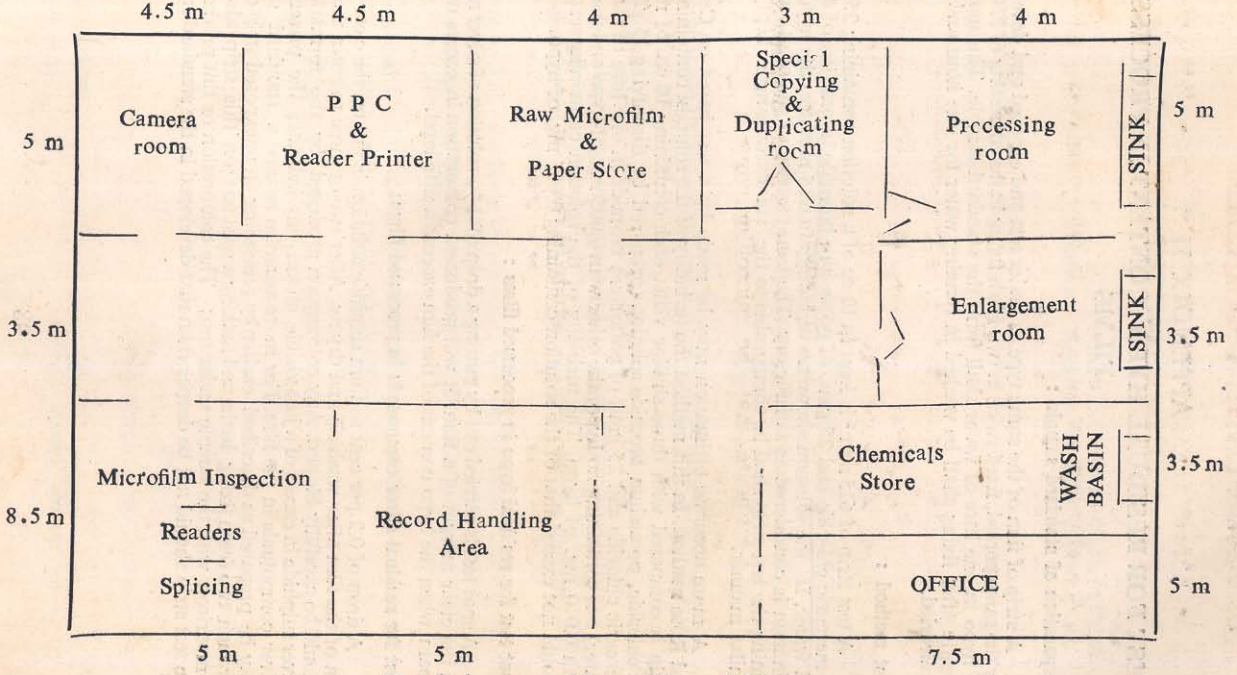
(iv) Independence/integrity of the validating authority.

Legal Requirements for microfilms when used as a substitute for original documents are :

1. Completeness viz all parts of the documents must be shown on the microfilm.
2. Continuity viz the contiguous documents follow one another on the microfilm.
3. Custody and Control of the original documents :
   (a) At the beginning and end of the microfilm there should be indicated the name and address of the organisation which produced the microfilm as well as the one where the original documents are kept.
   (b) data for identification of the original document.
   (c) Certificate that the microfilm copy is true to the original.
4. Method employed to obtain microimages which should
   (i) be legible i.e. comparable to originals.
   (ii) follow standard procedure.
   (iii) ensure proper (a) custody of the originals. (b) system of storage. (c) lists or catalogues.

APPENDIX I

SUGGESTED LAY-OUT OF A REPROGRAPHIC LABORATORY



Total Area = 20 × 17 = 340 Sqm.

APPENDIX II

TEST FOR RESIDUAL HYPO CONTENT IN PROCESSED FILMS

Preparation of standard sample :

A strip of film of the same type as under test and exposed and developed for the same period, fixed twice in two fresh fixing baths consisting of 250 gms of hypo in one litre of water shall form the standard sample. The standard sample after fixing shall be washed in running water for one hour and shall be airdried.

Test method :

A test strip of 625 mm.^{2} is kept in 10 cc of a solution containing 25 gms. of mercuric chloride and 25 gms. of potassium bromide in one litre of distilled water. If the solution shows no turbidity after 15 minutes, the hypo elimination is considered as satisfactory. The transparency of the solution containing the test strip shall be comparable to the standard sample kept in a similar manner.

A more accurate estimation may be made by a test based on Crabtrie and Rose method. In this method the turbidity of the solution containing test strip is compared with three similar vials, each containing 10 cc. of mercuric chloride, potassium bromide solution (prepared by dissolving 25 gms. of mercuric chloride and 25 gms. of potassium bromide in one litre of distilled water) one containing no hypo, the other with 0.005 mg. of hypo and the third with 0.010 mg. of hypo. The turbidity of the solution containing test strip should not exceed that of the solution containing 0.005 mg. of hypo.

Spot test for residual hypo in processed films :

A spot test is carried out by putting a drop of 1% solution of silver nitrate on the clear margin of a film. It will produce a colouration in excess of pale cream when the hypo content of the film exceeds a safe level.

Test for residual silver compounds in processed films:

A drop of 0.2 per cent sodium sulphide solution is put on the clear margin of the film after washing and drying. After two or three minutes the spot should be carefully blotted. Any colouration produced by the formation of silver sulphide in excess of a just visible cream tint indicates the presence of silver compounds in the film. For more accurate results a standard sample may be prepared as described earlier by processing an unexposed strip of film through two fresh fixing baths and making a spot test on this strip also, for comparison with the sample under test. The colouration or tint produced in the test strip should not be deeper than that developed in the standard sample.

APPENDIX III

Reprographic/Transcription Serviec
National Archives of India, NEW DELHI

The Director of Archives,
National Archives of India,
New Delhi

Sir,

Kindly supply me Microfilm (NEG/POS) PHOTO COPIES/XEROX/ TRANSCRIPTS of the material (s) indicated in the enclosed list for my research/publication/University. The material is from the Ministry(s) Department(s) of ——————————————————————. It consists of——————————————to ——————————.

1. I declare that the above material is for my research/Publication/University.

2. I undertake :—

   (i) to pay the charges as per schedule of rates prevailing at the time of completion of work. I understand and accept that the estimated cost, when supplied is only tentative and the rates are also liable to revision without notice.

   (ii) not to sell, duplicate or transfer photo-copies/Xerox Copies/transcripts of documents supplied to me by the National Archives of India, Government of India to any other person without prior permission of Director of Archives.

   (iii) to suitably acknowledge the material, if published and comply with the provisions of copyright, where applicable.

3. I hereby deposit a sum of Rs.——————————————as advance.

Yours faithfully,

(Signature)

(Name in block letters)

Permanent Address
(in Block letters)

Local Address :—

FOR OFFICIAL USE

Advance received vide receipt no.————————dated————————for Rs.————————————————

Service charges have come to Rs.————————————————

Balance received vide Receipt No.————————————dated————————

Amount outstanding, if any————————————————————

Cleared for photo-copying/transcription : Subject to following.

Signature of Archivist
Date :

No. of O.C.s/Volume
————————————————
Received back the documents.

Archivist

APPENDIX IV

REPROGRAPHY SERVICES

National Archives of India

SCHEDULE OF RATES

Effective from 28th May, 1986.

	Charges Rs. P.
1. *Negative Microfilm*	
(a) Rate per exposure	1·60
(b) Minimum charge	30·00
(c) Rebate for 30 metre raw negative 35 mm microfilm of Archival Standard, if supplied	150·00
2. *Positive Microfilm*	
(a) Rate per metre	16 00
(b) Minimum charge	50·00
(c) Rebate for 30 metre raw positive 35 mm microfilm of Archival Standard, if supplied	75·00
3. *Photo copying*	
(a) Rate size 600 sq. cm or part thereof . . .	13·00
(b) Minimum charge	20·00
N.B.—The cost of making the Negative when required will be extra as in (1) above.	
4. *Processing of 35 mm microfilm*	60·00
5. Special copying	As per estimate in each case.
6. Xerox copying	Re. 1/- per copy
7. Cost of 35mm×30 meter microfilm spool & can	Rs. 10

NOTE :—For individual Indian Scholars who desire reprographic services for personal research & study, a rebate of 50% will be allowed on services at Sl. No. 1 to 5 and of 25% on zerox services.

APPENDIX V

LIST AND ADDRESSES OF THE FIRMS DEALING IN REPROGRAPHIC EQUIPMENT

For Microfilm Equipment :

	Manufacturer	Agent in India
1.	Eastman Kodak Co. 343 State Street Rochester, New York-14650	India Photograhic Co. Ltd., 22-A, Janpath, New Delhi-110 001.
2.	Fuji Photo Film Co. Ltd. 26-30, Nishiazabu 2-Chome, Minato-ku Tokyo 106 (Japan).	Camera Works Pvt. Ltd. 502, Rattan Jyoti 18, Rajendra Place New Delhi-110 008.
3.	Veb Carl Zeiss Jena, G.D.R.	C.Z. Instruments Pvt. Ltd. 42-B, Jawala Mansion, Asaf Ali Road, New Delh-110 002.
4.	Hirakawa Kogyo Sha Co., 2-23 Hirakawa Cho Chiyoda-Ju, Tokyo, Japan.	Agfa Gevaert Ltd. 18-A, Shivaji Marg, New Delhi-110 015.
5.	Agfa Gevaert Ltd. Mortsel, Belgium.	Do.
6.	Microfilm Products Division 3 M Company, 3 M Centre St. Paul, Minnesota, U.S.A.	3-M Products Division Associated Printers Madras (Pvt.) Ltd., Anna Salai, Madras-600 002.
7.	Imtec Equipments Ltd. 170 Honeypot Lane Stanmore Middlesex HA7 1LB England.	Hindustan Reprographics Ltd., 801, Deepali House 92, Nehru Place New Delhi-110 019.
8.	Minolta Camera Co. Ltd. 30, 2-Chome, Azuchi-Mochi Higashi-Ku, Osaka 541 Japan.	Methodex Systems Pvt. Ltd., 607, Meghdoot 94, Nehru Place New Delhi-110 019.
9.	Consolidated Micrographics Inc. 27631 La Paz Road, Laguna Niguel, California 92677.	Cinerama Pvt. Ltd., Metro House Mahatma G dhi Road, Bombay-400an 020.
10.	Bell & Howell Microfilm Products Division 6800 Mc Cormick Road Chicago, Illinois 60645-2797.	Advani Oerlikon Ltd. Ador House 6, K. Dubash Marg Bombay-400 023.

11. Zeutschel Gm bH & Co.
D-7400, Tiibingen 5,
West Germany.

12. Canon Inc.
7-1 Nishi-Shinjuku
2-Chome, Shinjuku-Ku
Tokyo 160, Japan.

Adwani Oerlikon Ltd.
Ador House 6 K. Dubhash Marg,
Bombay-400 023.

Batliboi & Co. Ltd.
Instruments Deptt.,
Apeejay House
Dr. V.B. Gandhi Marg,
Bombay-400 023.

Indigenous manufacturers of reprographic equipment—microfilm readers, Xerox machines and accessories.

1. Macneill & Magor Ltd.,
Reprographics Division,
Mackinnon' Mackenzie Building,
Ballard Estate,
Bombay-400 038.

2. Advani Oerlikon Ltd.,
Ador House,
6, K. Dubash Marg,
Bombay-400 023.

3. Audo-Viso Corporation,
E-48, Connaught Place,
New Delhi-110 001.

4. Kores India Ltd.,
(Business Machines & Systems Divn.)
206, Surya Kiran,
19, Kasturba Gandhi Marg,
New Delhi-110 001.

5. Das Reprographics Pvt. Ltd.,
406, Surya Kiran Building,
Kasturba Gandhi Marg,
New Delhi-110 001.

6. Anu Enterprise.
3448-52, Delhi Chamber,
Behind Telephone Exchange Building,
Delhi Gate, New Delhi-110 002.

7. Chowgule Industries,
Allahabad Bank Building,
17, Parliament Street,
New Delhi.

8. India Duplicating Co. Ltd.,
6, Bahadur Shah Zafar Marg,
New Delhi-110 002.

9. Modi Zerox Ltd.,
2nd Floor, Scindia House,
Janpath,
New Delhi-110 001.

10. Logic Systems Pvt. Ltd.,
2, Anarkali Bazar,
Pragati Maidan,
Lal Bahadur Shastri Marg,
New Delhi-110 001.

11. National Instruments Ltd.,
1/1, Raja S.C. Mullick Road,
Calcutta-700 032.

12. National Radio & Electronics Co.
Ltd., (NELCO)
5th Floor, Deen Dayal Upadhya Trust Building,
7E, Rani Jhansi Road,
New Delhi-110 055.

13. India Reprographic Systems,
1st floor, Plaza Cinema Building,
Connaught Circus,
New Delhi-110 001.

For Microfilms & Photographic Paper

1. India Photographic Co. Ltd.
22-A, Janpath,
New Delhi-110001.

2 Agfa Gevaert Ltd.,
18-A, Shivaji Marg,
New Delhi-110 015.

3. Camera Works Pvt. Ltd.,
502, Rattan Jyoti-
18, Rajindra Place,
New Delhi-110 008.

4. Orwo Pvt. Ltd.,
18-B, Asaf Ali Road,
New Delhi-110 002.

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APPENDIX VI

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