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TECHNICAL DEVELOPMENT PROGRAM

JANUARY 1965

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NATIONAL PHOTOGRAPHIC INTERPRETATION CENTER

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TECHNICAL DEVELOPMENT PROGRAM

JANUARY 1965

Prepared by the Plans and Development Staff

NATIONAL PHOTOGRAPHIC INTERPRETATION CENTER

THE NPIC'S TECHNICAL DEVELOPMENT PROGRAM
(JANUARY 1965)

The National Photographic Interpretation Center (NPIC) is responsible for conducting an active program of technical development in equipment and techniques to improve and advance the exploitation of photography in support of the national intelligence effort. The development of new systems, instruments, materials, and devices for photographic exploitation includes a wide range of optical-mechanical and electronic instrumentation as well as the application of automated systems for the extraction of data from photographic [redacted] 25X1 In addition, the Center provides technical advice and support to Agency and government components responsible for the development of new photographic systems for intelligence collection, and coordinates its research and development activity with interested elements of the intelligence community for their own use or further adaption.

The Plans and Development Staff is responsible for technical development to support timely, efficient, and accurate photographic intelligence production. This responsibility has increased in relation to the increased size and significance of the reconnaissance effort. The importance of this relationship was accented in the COMOR paper of 18 April 1963 (and subsequent amendments) covering requirements to 1968.

The ability of the NPIC to carry out its exploitation mission in the future will depend increasingly on the equipment and systems available to handle the new demands. Advanced planning for technical development is imperative to provide the lead-time necessary to make equipment available to the user as it is needed. Planning will be directed as much as possible toward systems' design that will take into consideration the functional relationship of the various components and the contributions that each piece of equipment will make to exploitation.

During the past year, a plateau was reached in the initiation of new research and development activity. This plateau was directly related to budgetary allotments and to the capacity of the Staff to effectively handle the current work load. It does not reflect any reduction in the problems and requirements associated with new and increased inputs from acquisition systems. This situation is not expected to have an immediate impact on the Center's ability to carry out its mission. It may, however, increase the lead-time necessary to develop the equipment required to efficiently exploit inputs from new acquisition systems now in the conceptual stage of development.

As in preceding years, some development projects for photographic exploitation equipment and techniques that had been commenced in prior years were brought to completion and integrated into operational activities. Other projects were modified to conform to changing needs. New programs were initiated to provide the methods and means to cope with the increased volume and high quality of photographic inputs. Included in the new programs were investigations into problems associated with interpretation and analysis of imagery other than conventional black-and-white photography. These activities are described in detail in the following pages.

Continued emphasis on NPIC research and development activity will be required in the years ahead. Sophisticated high-quality material in large volumes is on the horizon. Equipment and techniques must be developed to extract the critical information needed to support national intelligence objectives. Emphasis will continue to be directed toward the on-line photographic measurement and viewing concept. Increased activity will be devoted to development of techniques and equipment to ensure the NPIC's readiness [redacted] Development activity will be continued on contingency programs in which exploitation teams may be required to operate in remote areas.

This report presents a summary of the research and development effort of the Plans and Development Staff in the technical development field. This volume, however, has been altered in content from previous issues. In addition to equipment under development, it now also contains descriptions of equipment in use to allow the reader to visualize the base upon which research and development in the NPIC is carried forward. Generally, each item is covered by a short narrative and a photograph or conceptual drawing. Where possible, the approximate cost of a production unit is given; these figures should be used with care, however, as prices will vary.

This issue updates the last publication, dated January 1964. As additional information becomes significant, this report will again be updated.

For purposes of convenience, equipment and development activities are grouped into 4 sections as follows:

I. Reproduction and Processing
II. Viewing and Interpretation
III. Measurement and Evaluation
IV. Special Techniques, Studies, and Automation

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SECTION I REPRODUCTION AND PROCESSING

A. INTRODUCTION

B. PROCESSING

C. DRYING

D. PRINTING

E. ENLARGING

F. COPYING

A. INTRODUCTION

In the broad area of reproduction and processing, efforts are directed toward the development of equipment and techniques which incorporate the most advanced improvements and features in order to produce all required media for the full exploitation of acquired data with the least possible delay between acquisition and use.

To provide needed improvements in the state-of-the-art in contact printing, flat-bed step-and-repeat printer developments are under way to achieve the maximum possible quality and resolution as well as greater operational versatility. The new concept envisions the possibility of cleanroom operation and will employ programed printing to facilitate single or multiple printing of selected frames for film conservation and for adjacent printing of stereo pairs. Automatic exposure control is included to assure correction for under- or over-exposure in the original, and means are being sought for a successful utilization of automatic dodging. To supplement wet processing, the development of dry-process printing is being advanced with notable success, bringing with it attendant savings in equipment, space, chemicals, manpower, and time. Projection printer programs are in process to improve the modulation transfer function and to increase negative coverage and print size. A high-resolution chip printer development is under way to provide high-resoltuion cut-sheet transparencies of targets from aerial roll film.

To the present time, virtually all roll-film processing machines have employed designs in which the film is transported by friction in a serpentine mode over a series of motor-driven rollers or belts. This method has necessitated the physical contact of both the emulsion and base of the film against a multitude of surfaces as it passed through the various solutions and the dryer. A new concept of film processing now under investigation will provide a state-of-the-art advance in that the film will be fully processed through all solutions and drying in a perfectly parallel path by air-bearing transport with no film surface contact; solution transfer or leakage from one tank to another is prevented by differential air pressure between solution modules. Also going forward is a reversal processor program which will improve the quality of duplicate negatives for positive reproduction and reduce the production time.

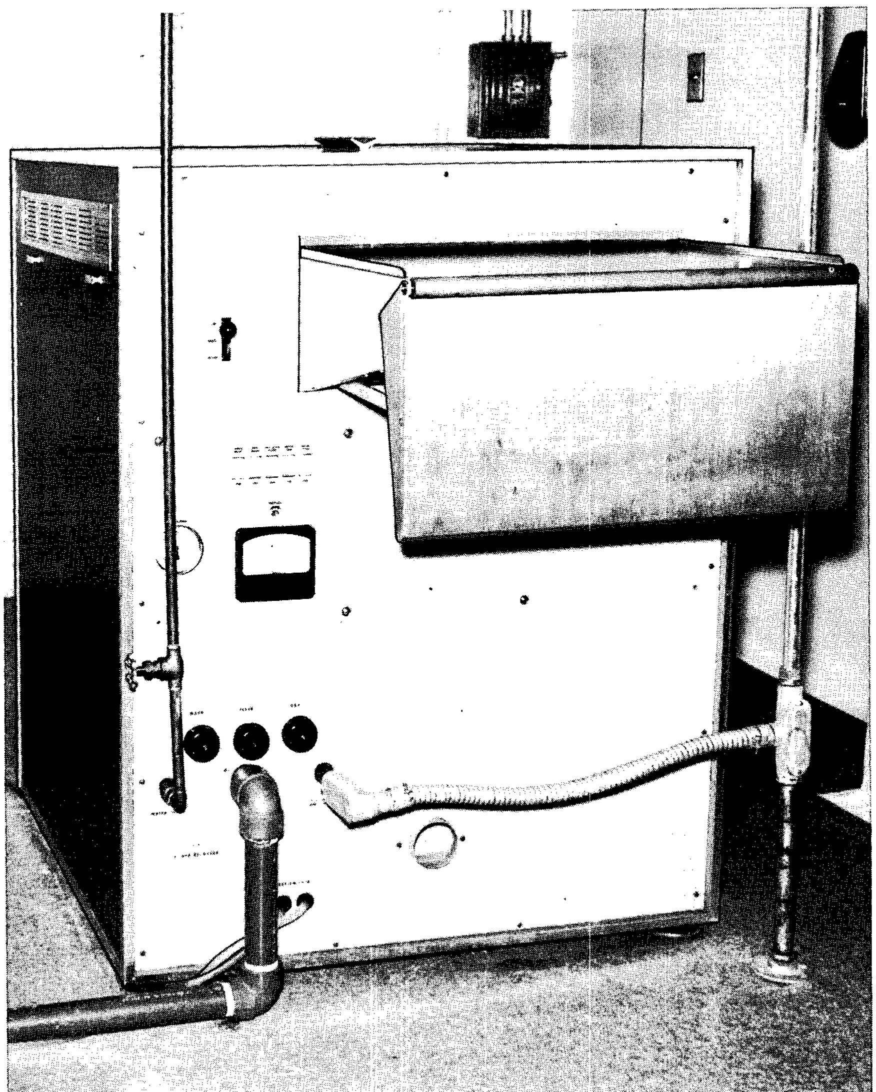
A chip processor program is under way to automate the processing of film chips as they are printed on the chip printer. An automated large-print processor is under development for the automatic processing of briefing prints.

[redacted]

B. PROCESSING

1. [redacted] PROCESSOR

This machine (Figure 1) processes [redacted] sheet film in sizes ranging from 5 by 7 inches to 24 inches wide by any length. It is a self-contained unit having built-in temperature control, solution replenishment, and recirculation of solutions. Film is transported through the several solutions and the dryer by a series of rollers, the processing speed ranging up to 4.4 feet per minute. The machine is 40 inches wide, 50 inches deep, 50 inches high, and weighs approximately 1,000 pounds. It costs about [redacted]

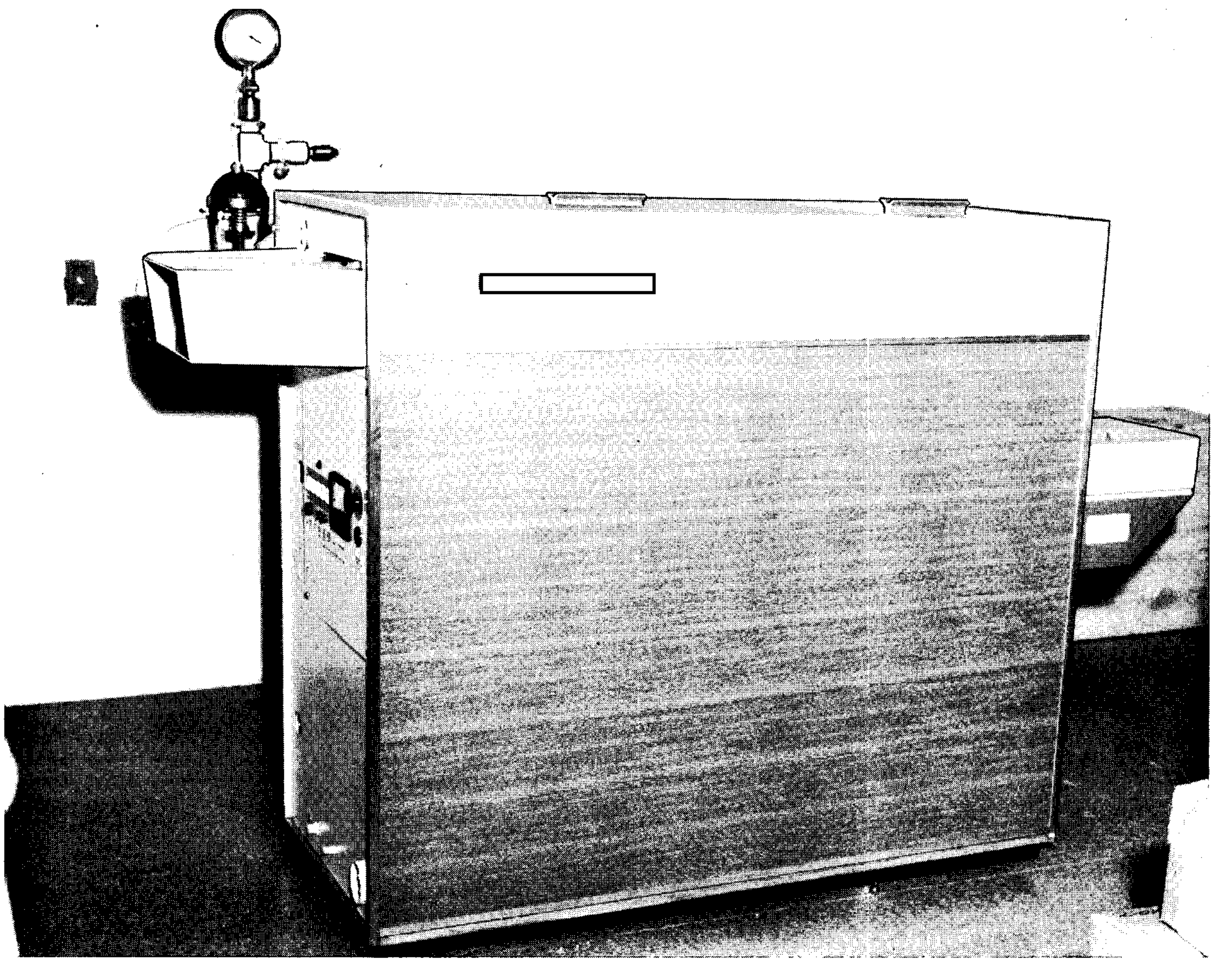


NPIC J-8904 (3/65)

[redacted]

2. [redacted] FILM PROCESSOR

The [redacted] Film Processor (Figure 2) accommodates sheet films ranging in size from 4 by 5 inches to 11 by 14 inches; by the use of feed and take-up roller attachments, it will accept roll films up to 9.5 inches wide. The equipment makes use of a series of rollers to guide and transport the film through the several processing baths and the self-contained dryer. Processing speed ranges up to 25 feet per minute. Temperature control, solution replenishment, and recirculation of solutions is built into the machine, which is approximately 57 inches long, 24 inches wide, 51 inches high, and 1,200 pounds in weight. The cost of a production model is [redacted]



NPIC J-8905 (3/65)

[redacted]

X1 [redacted]

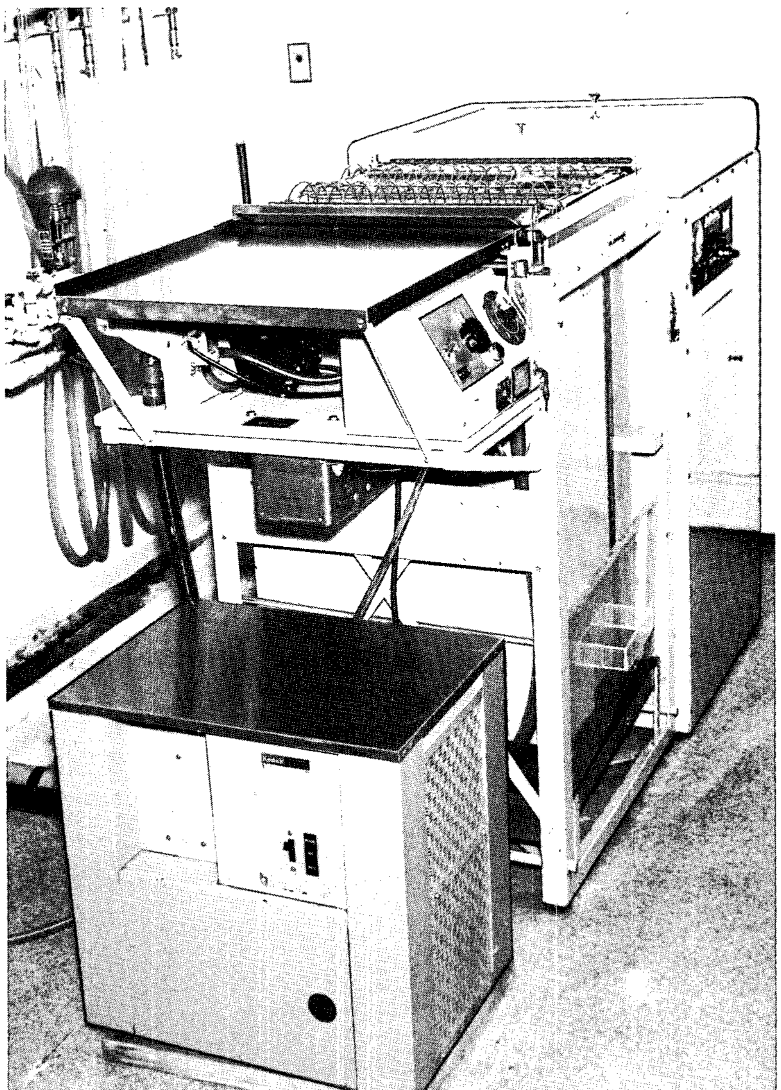
[redacted] 25X

X1

3. [redacted] FILM PROCESSOR

This lithographic film processor (Figure 3) has power-driven rollers and web belts that carry the lithographic films through the various solutions and the dryer. It will accept either cut sheet or rolls in any size up to 31 inches in width and all graphic film thickness including the .002 inch. The film transport speed can be varied between 2.8 and 4.5 feet per minute, and the processing time between 2.5 and 1.5 minutes. Including the "tandem" dryer, the equipment is 79.75 inches wide, 44.75 inches deep, 54.50 inches high, and weighs 1,610 pounds. It costs [redacted]

25X



X1 [redacted]

X1 [redacted]

[redacted]

25X

[redacted] 25X

4. [redacted] ROLLER-TRANSPORT REVERSAL PROCESSOR (12 INCH)

The roller-transport negative and reversal processor (12 inch) will handle up to 12-inch widths of either roll film or cut sheets (Figure 4). The self-threading machine will have its own dryer and will allow ready conversion from negative to reversal processing by change of chemicals and adjustments. Output rates expected for negative processing are from 8 to 15 feet per minute; for reversal processing from 5 to 10 feet per minute. The weight of the machine without solutions will be about 7,000 pounds. It is estimated that delivery will be made by [redacted] in May 1965. 25X

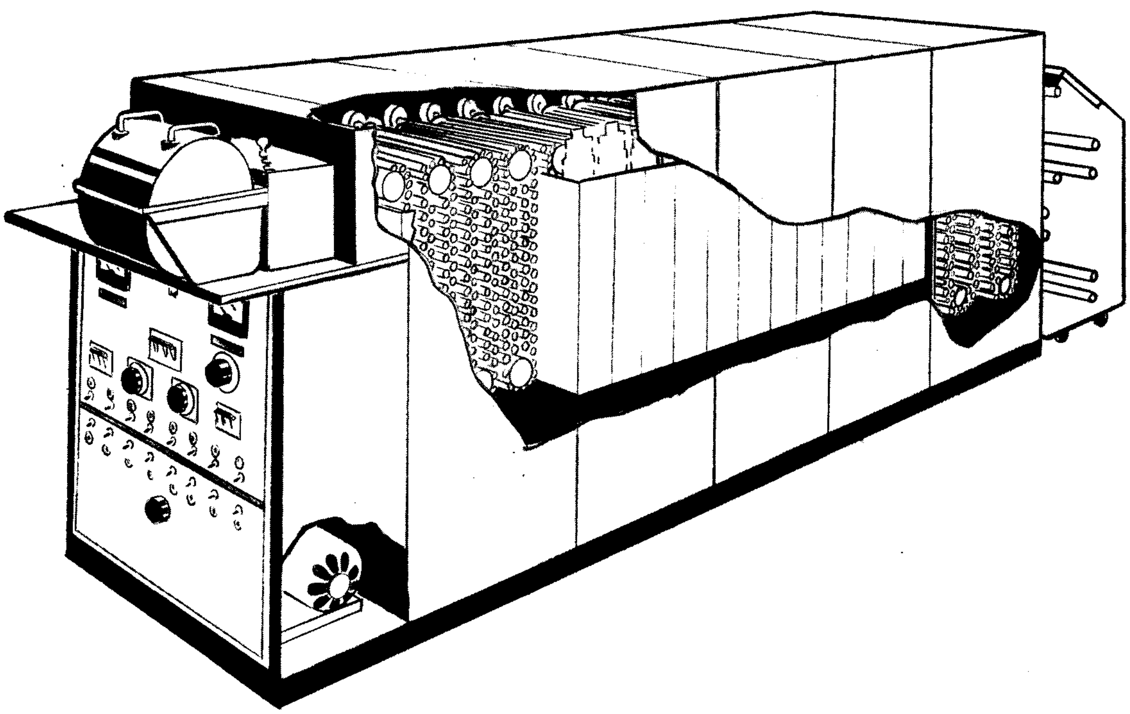


FIGURE 4. [redacted] ROLLER-TRANSPORT REVERSAL PROCESSOR (12 INCH).

NPIC J-8907 (3/65)

X1

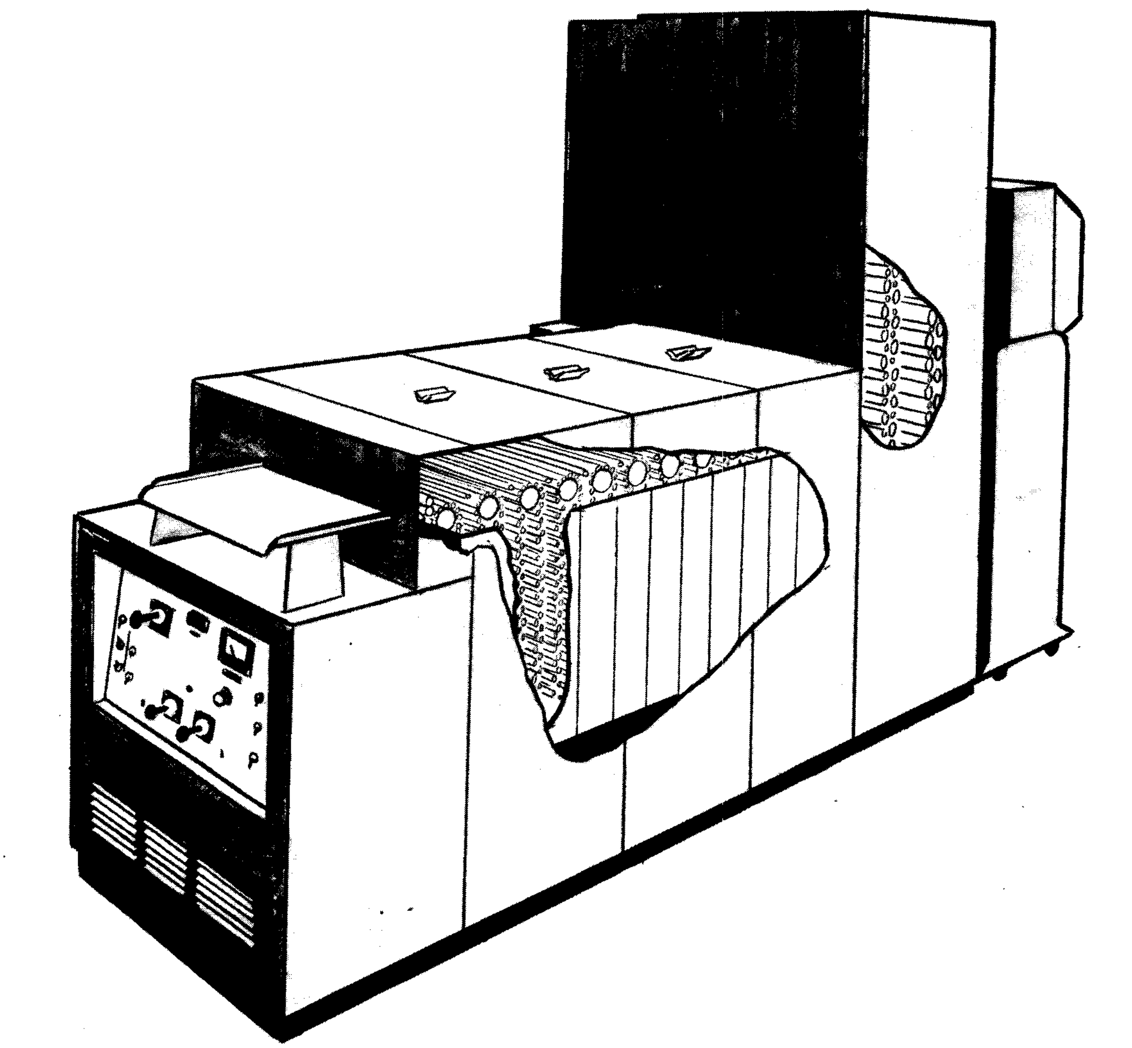
[redacted]

25X

 [redacted]

5. [redacted] ROLLER-TRANSPORT PROCESSOR (24 INCH)

This roller-transport film and paper processor (Figure 5), which will handle up to a 24-inch sheet of cut film or waterproof paper, will be self-threading and will include its own dryer. The processing time from dry to dry for negative materials will be 14 minutes; for print materials, 7 minutes. The weight of the machine without solutions will be about 7,000 pounds, and it is estimated that delivery will be made by [redacted] in May 1965.



NPIC J-8908 (3/65)

FIGURE 5. [redacted] ROLLER-TRANSPORT PROCESSOR (24 INCH).

6. [redacted] FILM-CHIP PROCESSOR

The film-chip processor (Figure 6) is being designed to process the 4- by 5-inch cut-sheet film chips produced by a chip printer which is also currently under development. The film chips will be processed without any physical contact of the film emulsion or base at a rate of 10 chips per minute. In operation, the processor will be wedded to the printer in such a manner as to enable the chips to be passed automatically from the printer to the processor with no interim handling. Delivery of a production model is expected in April 1965 at an estimated cost of [redacted]

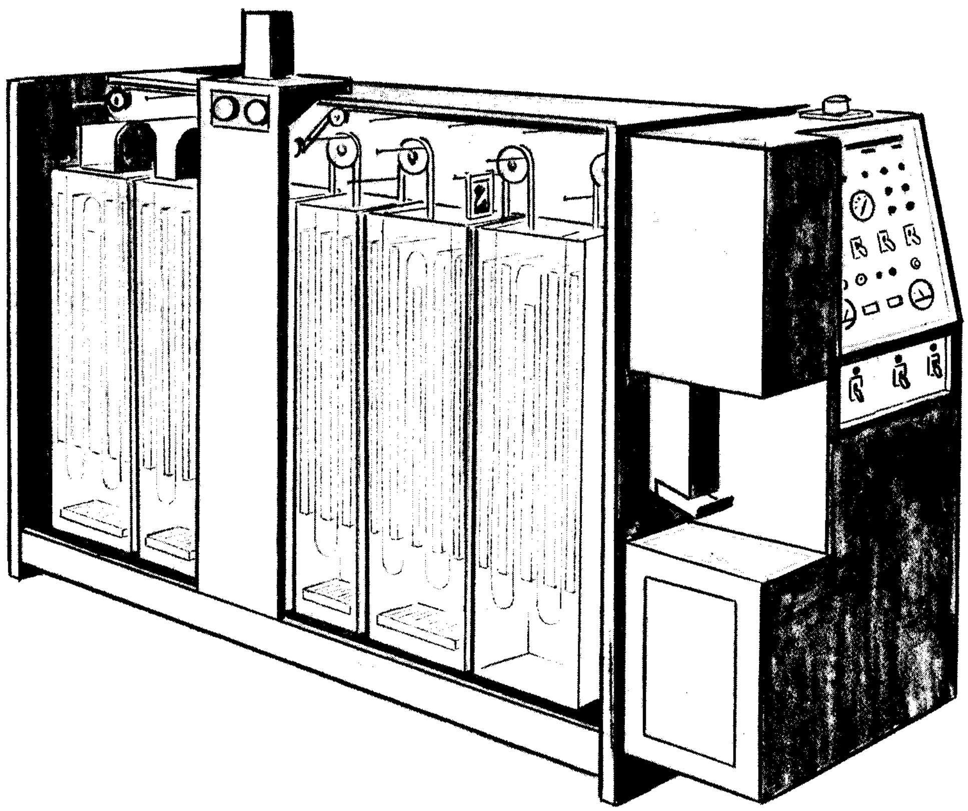


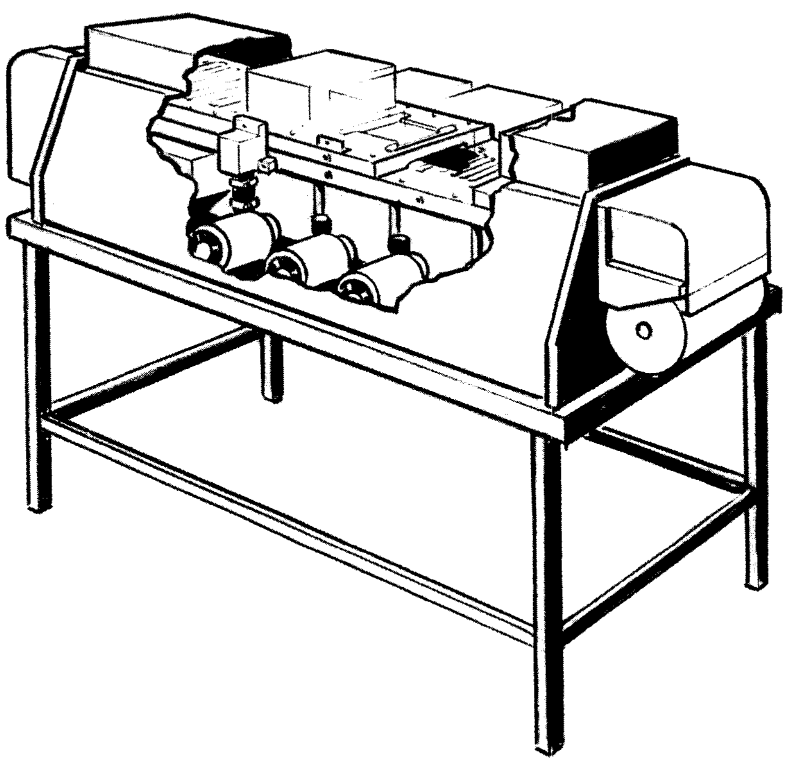
FIGURE 6. [redacted] FILM-CHIP PROCESSOR.

NPIC J-8909 (3/65)

7. [redacted] SEPRATRON AIR-BEARING FILM PROCESSOR

This proposed development (Figure 7) is a continuous processor that will fully process, wash, and dry 70mm- to 9.5-inch-wide aerial roll film with no physical contact of the film base or emulsion. The film will follow a perfectly parallel path through the developer, fixer, stabilizer, washer, and dryer modules by air transport. The film passes through the walls of successive tanks on air bearings. Solution transfer or leakage from one tank to another is prevented by differential air pressure between the tanks, greater than the head pressure in the solution tanks.

The feasibility of this concept for processing 70mm-wide film has been fully demonstrated. Processing at a rate of 4 feet per minute has been accomplished in a processor 3 feet long and 15 inches high. In the proposed processor, the length will not exceed 6 feet and the processing rate will be 10 feet per minute. The prototype model is due to be delivered by August 1966, and the estimated cost of a production model will be [redacted]



NPIC J-8910 (3/65)

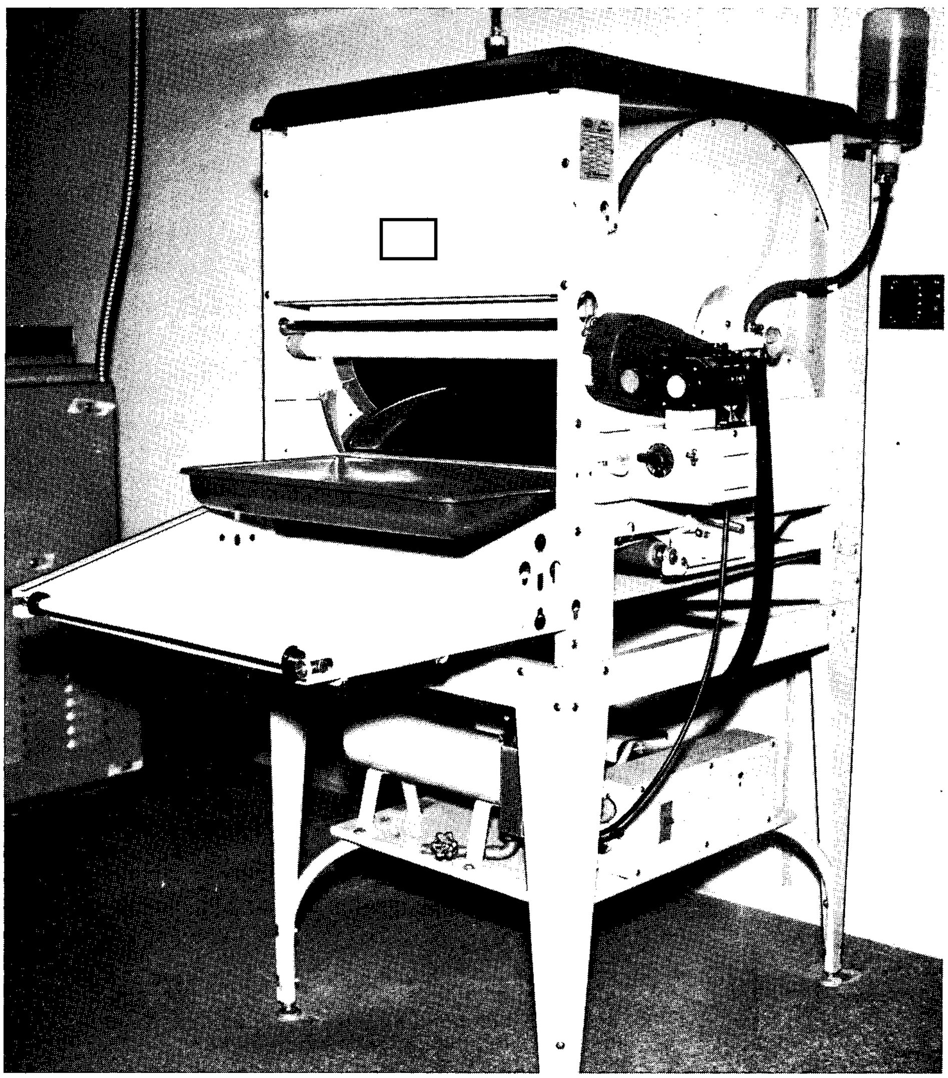
FIGURE 7. [redacted] SEPRATRON AIR-BEARING FILM PROCESSOR.

[redacted]

C. DRYING

1. [redacted] PAPER DRYER (DRUM)

This machine (Figure 8) is an electrically heated paper-print dryer for glossy prints up to 24 inches in width. The prints are carried around a stainless steel drum by a web belt which also serves as an apron for accepting the wet prints and discharging the dry ones. Temperature uniformity in the drum is maintained by internal circulating water. The speed of the rotating drum can be controlled to meet the time requirements of the material being dried. The machine is approximately 3 feet wide, 3 feet deep, 6 feet high, weighs about 200 pounds, and costs $[redacted]

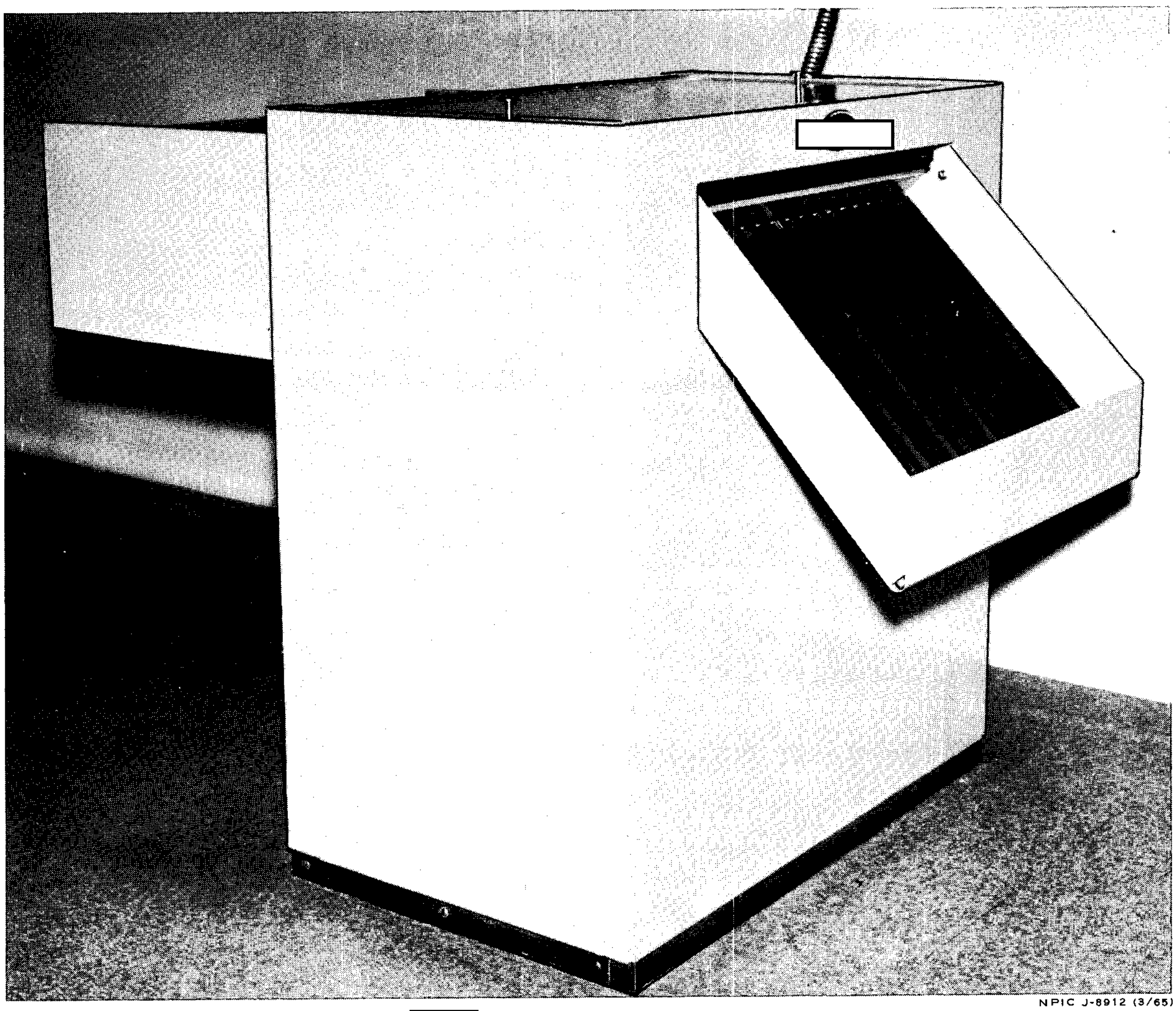


NPIC J-8911 (3/65)

FIGURE 8. [redacted] PAPER DRYER (DRUM).

2. [redacted] ROLLER-TRANSPORTED CUT-FILM DRYER

This dryer (Figure 9) will accommodate either black-and-white (continuous tone) or lithographic (halftone) cut film in widths ranging from 5 to 24 inches and in lengths up to 36 inches. It is a heated-air (90 to 150 degrees F), impingement-type dryer in which the negatives are carried through by a series of driven rollers. Drying time is as short as 1 minute but can also be increased for the heavier-type emulsions. The film transport speed ranges from 6 to 30 inches per minute. The minimum thickness of material able to be handled without a leader is .005 inches for acetate and .004 inches for polyester. The machine is 37 inches wide, 44 inches deep, 43.25 inches high, weighs 470 pounds, and costs $[redacted]



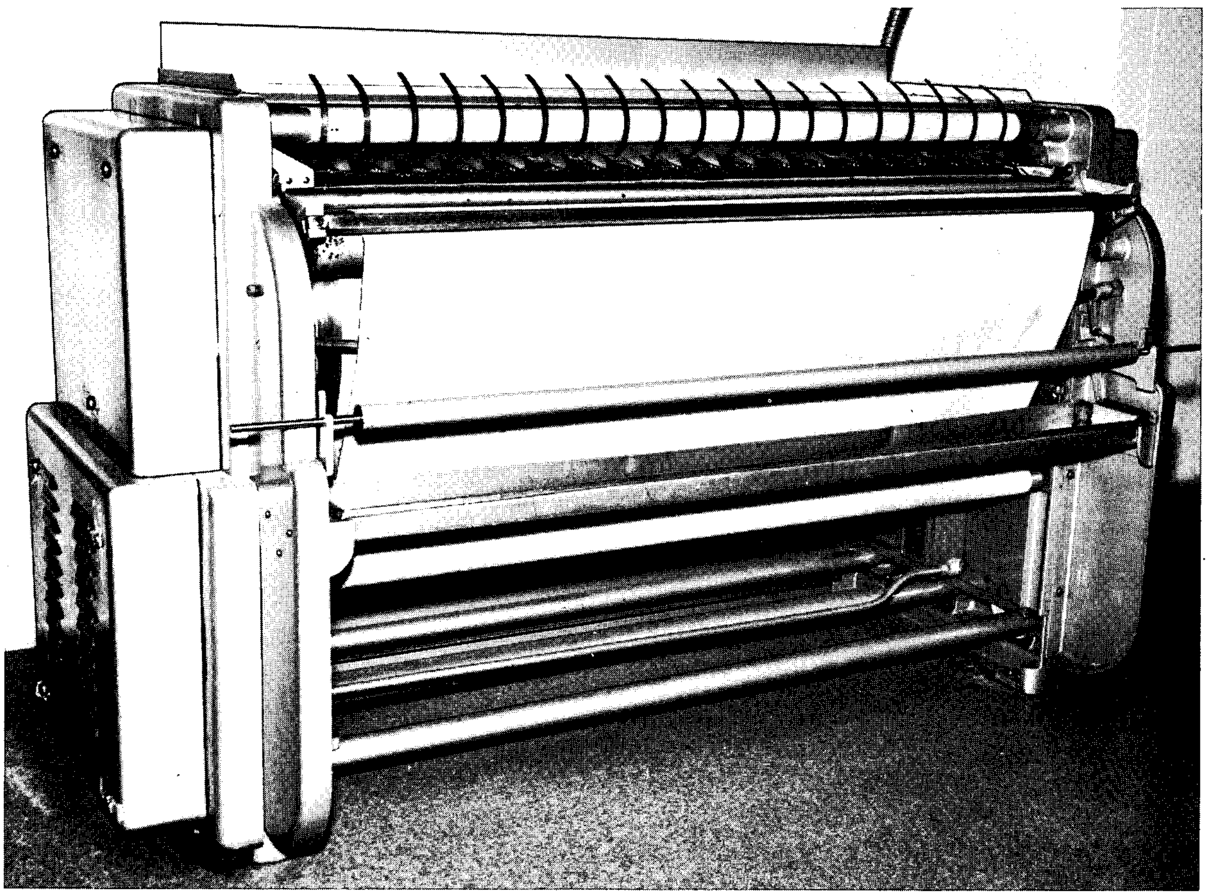
NPIC J-8912 (3/65)

FIGURE 9. [redacted] ROLLER-TRANSPORTED CUT-FILM DRYER.

[redacted]

3. [redacted] LARGE-PRINT DRYER

The large-print dryer (Figure 10) is an electrically heated machine for mat drying of single- or double-weight prints up to 54 inches in width. The prints are carried around the thermostatically controlled drum on a canvas belt at a drying rate of approximately 7 linear feet per minute. The machine is 81 inches wide, 35 inches deep, 49 inches high, weighs an estimated 900 pounds, and costs [redacted]



NPIC J-8913 (3/65)

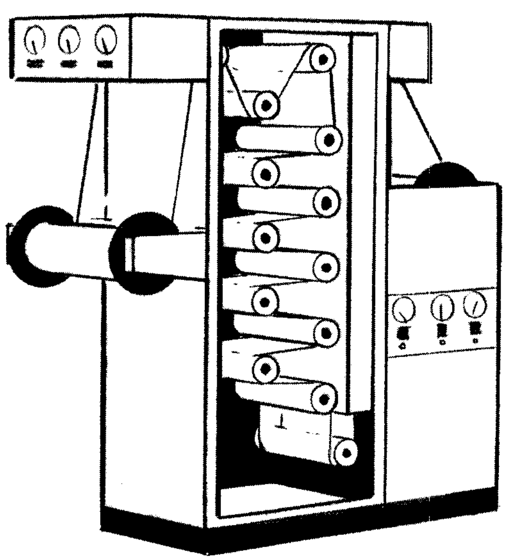
FIGURE 10. [redacted] LARGE-PRINT DRYER.

4. [redacted] ABD/4 FILM DRYER

A new roll film dryer (Figure 11) now under development by [redacted] can be attached to the HTA/2 or HTA/3 Film Processors, or it can be used separately with other equipment. Designated type ABD/4 (Air-Bearing Drive), it employs the air-bearing principle to transport the film through the drying cabinet on a cushion of air warmed slightly above ambient temperatures. The dryer will consume approximately 25 amperes at 230 volts and achieve proper drying and conditioning of the roll film to ambient relative humidity at approximately 30 feet per minute. It occupies only one-fifth of the space of the former equipment.

Principal advantages are: 1) elimination of direct contact with film surfaces, 2) simplification by eliminating many moving parts, 3) reduction of required maintenance, and 4) improvement of transport method. The transport method impinges large volumes of air against the film surfaces, resulting in an accelerated drying rate in a smaller compartment.

At the present time, only 1 prototype has been completed; the estimated cost of a production model will be $[redacted]



NPIC J-8914 (3/65)

FIGURE 11. [redacted] ABD/4 FILM DRYER.

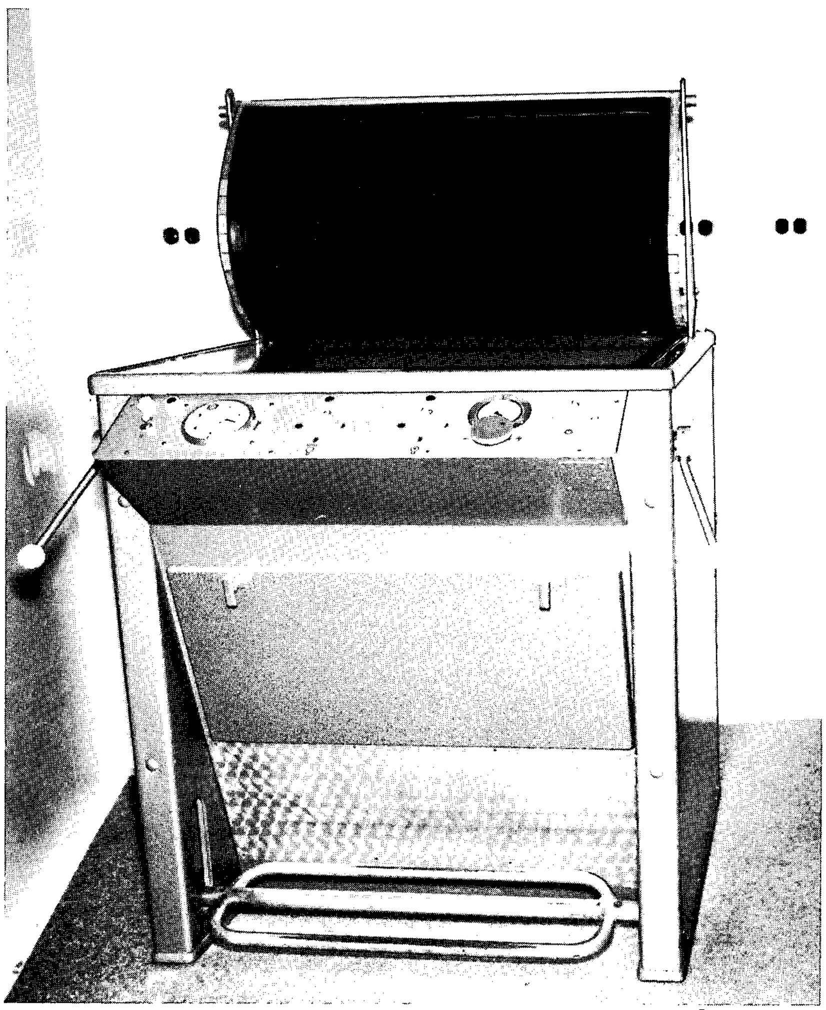
[redacted]

[redacted]

D. PRINTING

1. [redacted] CONTACT PRINTER (20 BY 24 INCH)

This is a vacuum-type printer (Figure 12) in which the negative and print stock are held in intimate contact by vacuum: a rubber blanket is brought into position over the negative-paper sandwich and the air evacuated between the blanket and the printer cover-glass. The printer contains 2 light sources, one with tungsten-opal lamps, the other with a "point" light. Exposure is accomplished by means of an electrical shutter actuated by a timer, and filters are provided in a rotating filter disc. No provision is made to handle roll negatives. The machine is 32 inches wide, 34 inches deep, 38 inches high, weighs an estimated 200 pounds, and costs about [redacted]



NPIC J-8915 (3/65)

FIGURE 12. [redacted] CONTACT PRINTER (20 BY 24 INCH).

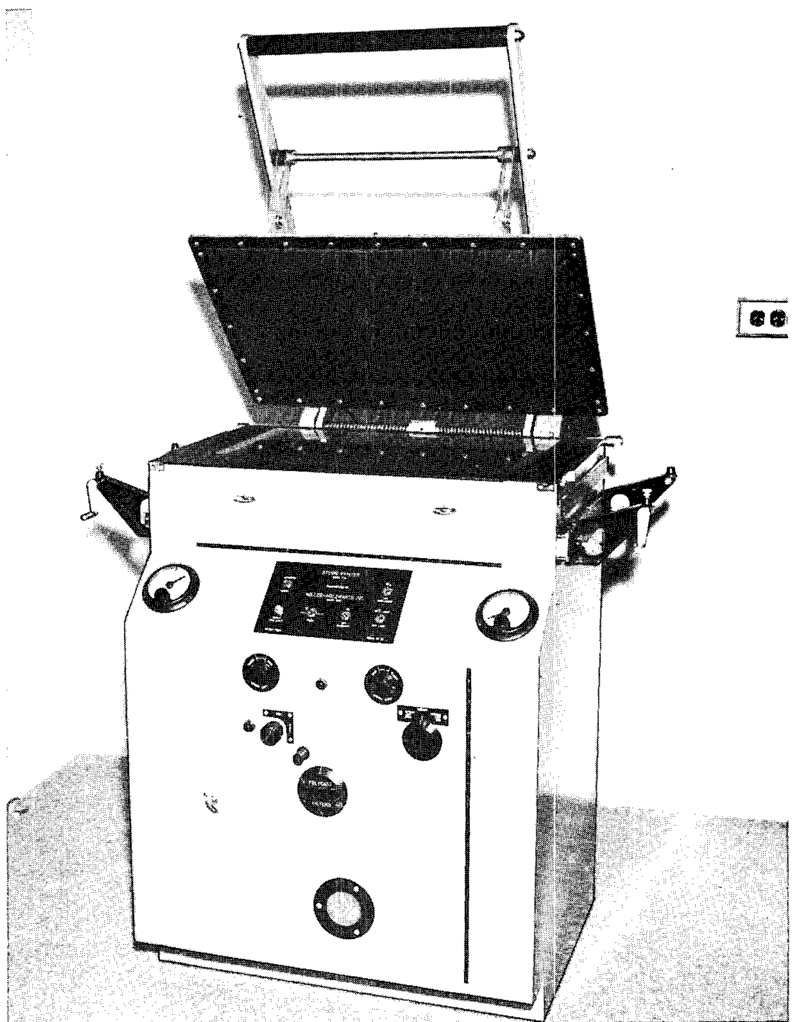
[redacted]

[redacted]

25X1

2. [redacted] CONTACT PRINTER (HIGH RESOLUTION)

This high-resolution contact printer (Figure 13) is a step-and-repeat instrument handling either sheet film up to 11 by 19 inches, or roll film in any width up to 9.5 inches and any length up to a maximum of 500 feet. Critical contact is obtained by means of an air bag, and the light may be either specular or diffused, depending on whether or not a diffusing glass is used. Area dodging is accomplished by manual manipulation of the controls, and variable contrast papers may be used by inserting contrast filters. The printer has a resolution capability of 228 lines per mm, and the wavelength of the unfiltered light is suitable for color printing. It is 30 inches wide, 28 inches deep, 43.5 inches high, weighs 185 pounds, and costs about [redacted]



NPIC J-8916 (3/65)

FIGURE 13. [redacted] CONTACT PRINTER (HIGH RESOLUTION).

25X1

25X1

25X1

[redacted]

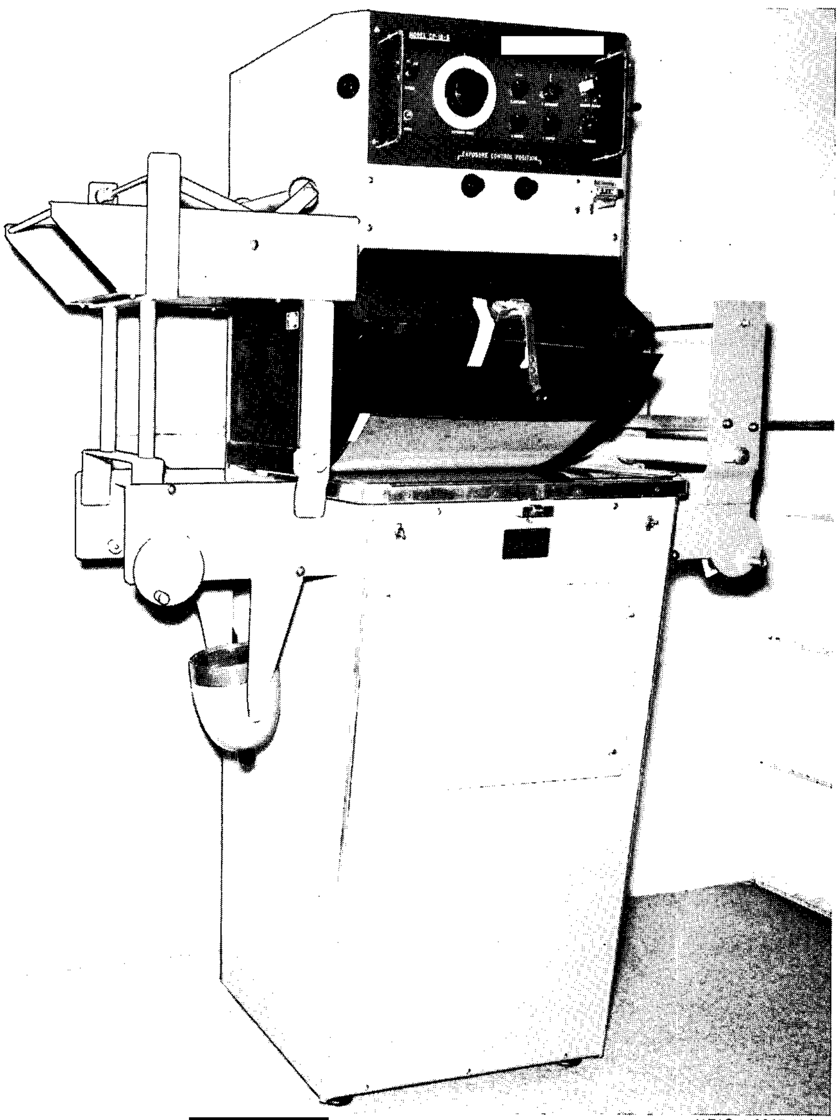
X1

3. [redacted] CONTACT PRINTER (AUTOMATIC DODGING)

This is a 12- by 20-inch format step-and-repeat printer (Figure 14) in which the printing light is a flying-spot scanner similar to that in normal television. After passing through the negative, the scanning light is sensed by a phototube and, by means of a feedback circuit, its intensity is altered to match the local density of the negatives. Transport of both negative and printing paper is manual, and the printer will accept either cut or roll negatives. The machine is 40 inches wide, 25 inches deep, 60 inches high, weighs 450 pounds, and costs $[redacted]

25X1

25X1



NPIC J-8917 (3/65)

X1

FIGURE 14. [redacted] CONTACT PRINTER (AUTOMATIC DODGING).

25X1

[redacted]

[redacted]

4. [redacted] CONTINUOUS-STRIP CONTACT PRINTER (AUTOMATIC DODGING)

This printer (Figure 15) accepts roll film up to 9.375 inches in width and up to 400 feet in length, both the negative and the print stock being transported by motor drive at speeds which can be varied from 6 to 60 feet per minute. The printing light is a flying-spot scanner which scans in a straight line across the width of the film. After passing through the negative, the scanning light is sensed by a phototube and, by means of a feedback circuit, its intensity is altered in ratio to the density of the negative, thus providing local dodging of the image. The machine is capable of resolutions up to 140 lines per mm at high contrast. It is 40 inches wide, 25 inches deep, 68 inches high, weighs 450 pounds, and costs [redacted]

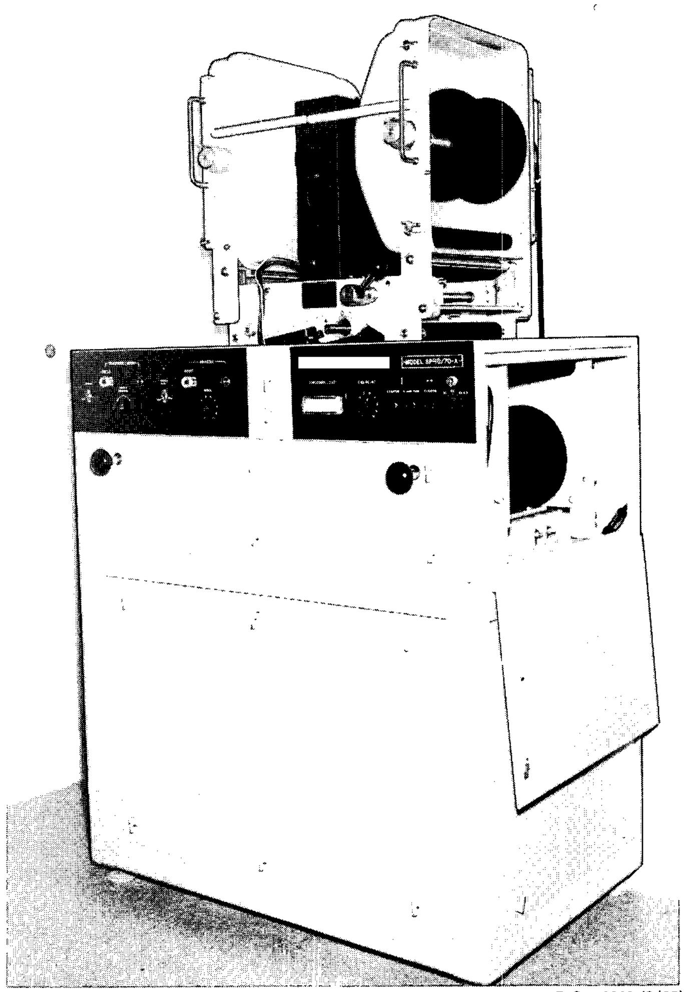


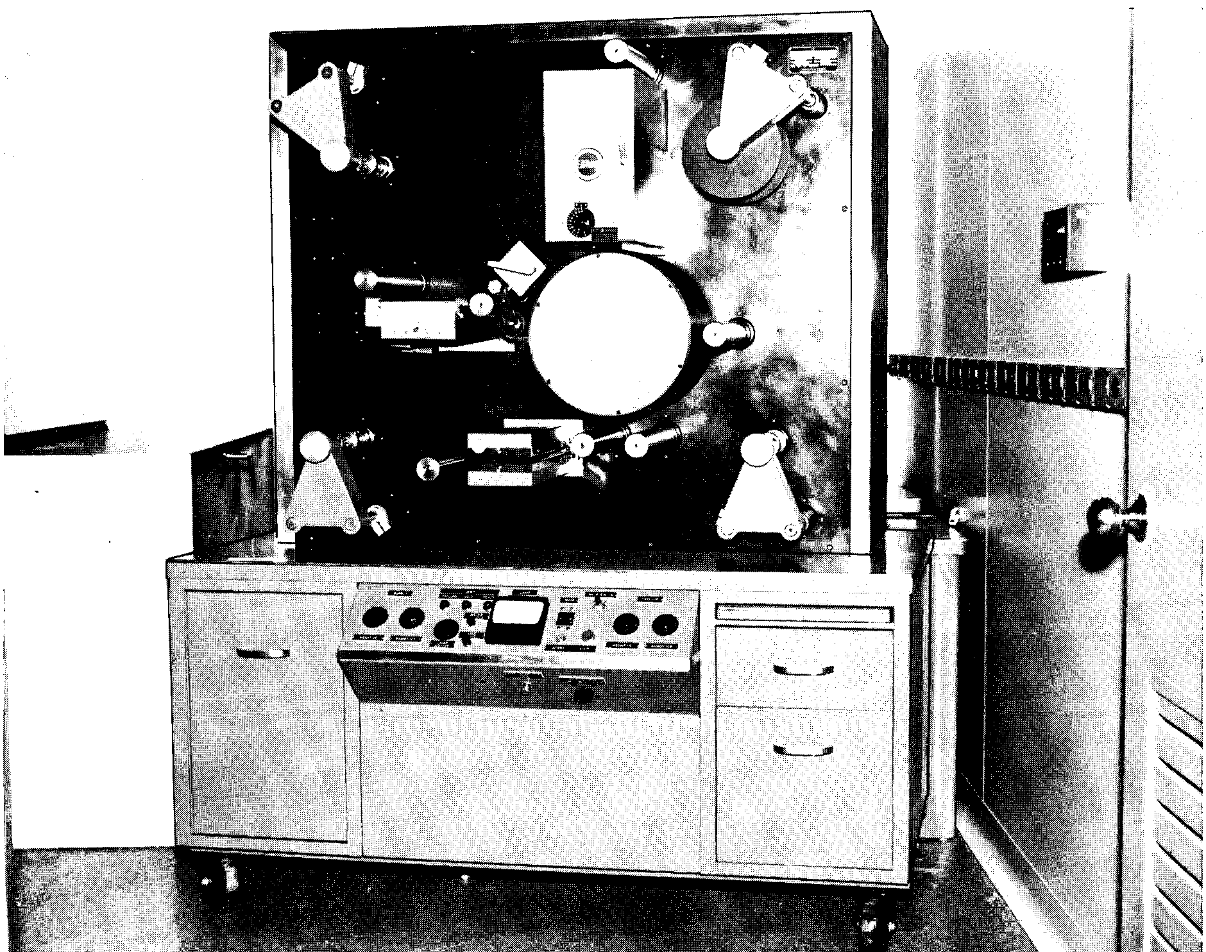
FIGURE 15. [redacted] CONTINUOUS-STRIP CONTACT PRINTER (AUTOMATIC DODGING).

[redacted]

[redacted]

5. [redacted] CONTINUOUS-STRIP PRINTER (NIAGARA)

This printer (Figure 16) is used for the continuous contact printing or duplicating of films ranging from 70mm to 9.5 inches in width, at a speed of 82.5 feet per minute. Exposure from the ultraviolet mercury light is attenuated by means of a neutral-density wedge introduced into the light path at 22 positions ranging in density values from 0 to 1.10. The maximum resolution capability of the printer is 397 lines per mm at 1,000:1 contrast. The machine is 60 inches wide, 34 inches deep, 70 inches high, and weighs 1,100 pounds.

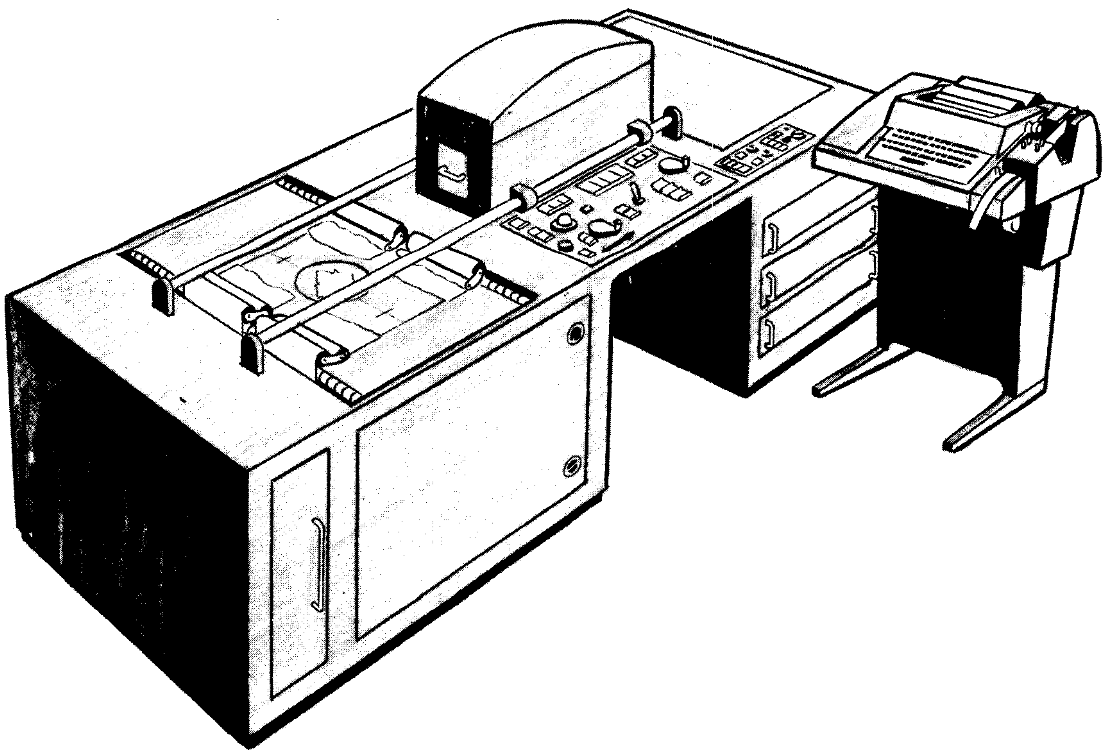


NPIC J-8919 (3/65)

FIGURE 16. [redacted] CONTINUOUS-STRIP PRINTER (NIAGARA).

6. [redacted] CONTACT CHIP PRINTER

This contact chip printer (Figure 17) is now under development and will be capable of producing high-resolution photographic images on 4- by 5-inch cut film. Three image sizes will be provided -- 55 by 95mm, 80 by 95mm, and 105 by 95mm -- offering the analyst an image size commensurate with scale and ground coverage insofar as can be accommodated. A human/machine-readable accession or reference number consisting of usable information as well as fiducial marks and security classification will be simultaneously printed on the output film chip. Input materials will be 70mm- to 5-inch-wide original negatives in single or dual roll, or single rolls up to 9.5 inches wide. The printer will be paper-tape driven with manual override for all functions.



NPIC J-8920 (3/65)

FIGURE 17. [redacted] CONTACT CHIP PRINTER.

[redacted]
25X1
[redacted]
25X1

7. [redacted] HIGH-RESOLUTION STEP-AND-REPEAT CONTACT PRINTER

This high-resolution step-and-repeat contact printer (Figure 18), currently under development, will eliminate the known deficiencies of existing standard printers, incorporate additional capabilities, and generally extend the state-of-the-art in printing techniques and equipment. It will be a high-precision, automatically operated, step-and-repeat contact roll-film printer capable of producing exposures of the highest quality, resolution, and acutance from roll film ranging in width from 70mm to 9.5 inches and in any selected frame length from 2.25 to 30 inches at a printing rate of 10 frames per minute (equivalent to a printing speed of 25 feet per minute). The unit will be an electrically driven, daylight-operating floor model with cleanroom interior atmosphere. It will have automatic exposure control and, possibly, automatic dodging. Provision will be made for programed selective printing, multiple printing of selected frames, and adjacent printing of stereo pairs. The prototype will be delivered in June 1966. The estimated cost of a production model is [redacted] 25X1

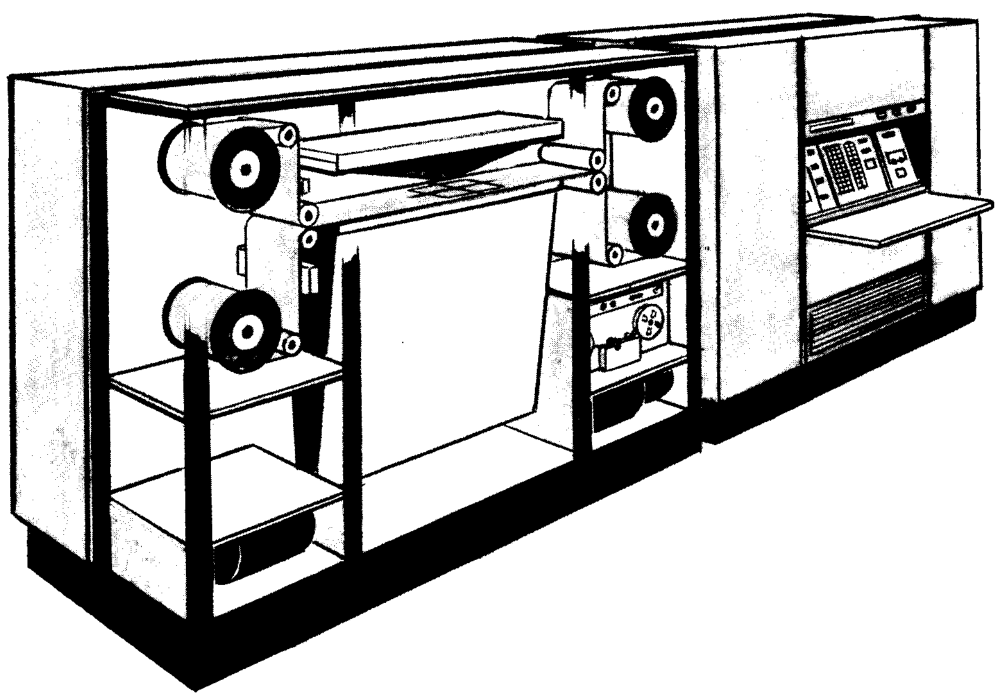


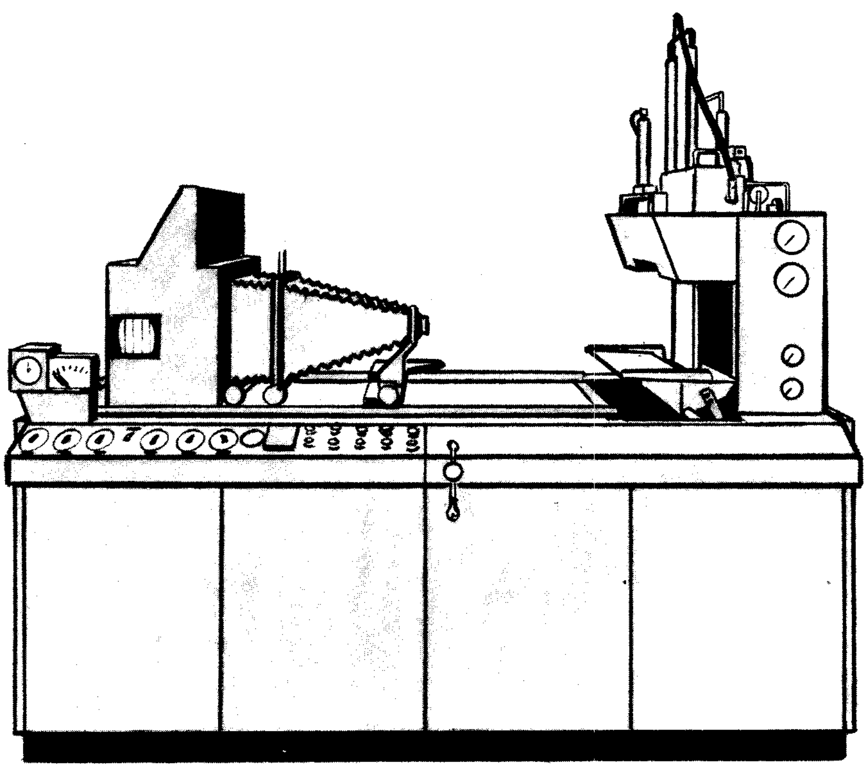
FIGURE 18. [redacted] HIGH-RESOLUTION STEP-AND-REPEAT CONTACT PRINTER. NPIC J-8921 (3/65)

[redacted]
25X1

8. [redacted] ELECTROCOLOR PRINTER-PROCESSOR (MODEL ECP-4)

The Electrocolor printer-processor (Figure 19) is an automated machine process in which full-color photographic prints of high quality are exposed, processed, dried, and delivered in less than 4 minutes. The machine is presently being leased for evaluation of its capabilities and applications.

In the processor, color photographic prints of variable magnification are prepared from masked or unmasked color negatives by electroplating 3 separate dyes (cyan, magenta, and yellow) in sequence upon a white light-sensitive surface. The printer accommodates color negatives ranging from 2.25 inches square to 4 by 5 inches, and produces prints 8.5 by 11 inches. The system provides either true-color prints or prints of distorted color for special purposes. In addition, when a single "black" dye is used, good-quality black-and-white prints can be produced from black-and-white negatives. The equipment is capable of a cycling rate of 1 print every 5 minutes. The estimated cost of a production model is [redacted]



NPIC J-8922 (3/65)

FIGURE 19. [redacted] ELECTROCOLOR PRINTER-PROCESSOR (MODEL ECP-4).

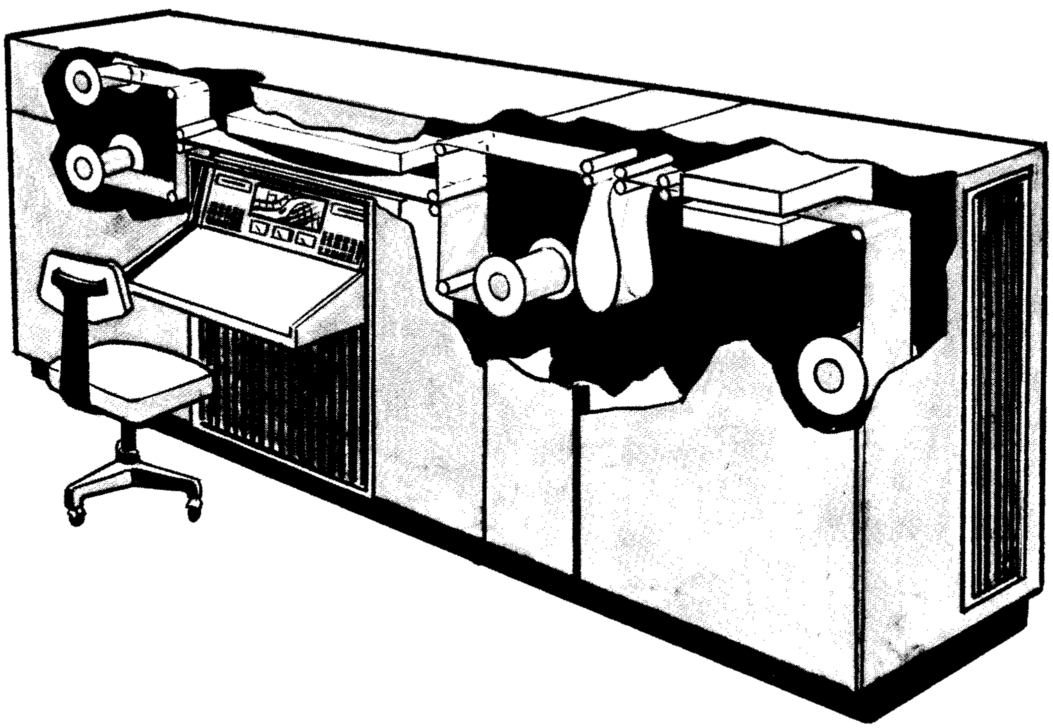
[redacted]

[redacted] 25X1

9. [redacted] DRY-PROCESS PRINTER-PROCESSOR

This proposed development, as illustrated in Figure 20, represents a simplified prototype dry-process step-and-repeat contact printer-processor for printing, processing, and delivering completely finished positive reproductions from aerial negatives at a rate of ten 30-inch prints per minute. The printer accomplishes both exposure and heat development within the same unit.

This printer-processor will be a companion item to the dry-photo material currently being developed under the "Dry-Photo Process Study" (q.v.) in which the film will remain completely dry and require no wet processing. In the dry-photo process, this printer-processor will perform in 1 machine all the functions which in the conventional wet silver system require separate operations for printing, developing, fixing, washing, and drying. The engineering model is due at NPIC in February 1966. The estimated cost of a production model is [redacted]



NPIC J-8923 (3/65)

FIGURE 20. [redacted] DRY-PROCESS PRINTER-PROCESSOR.

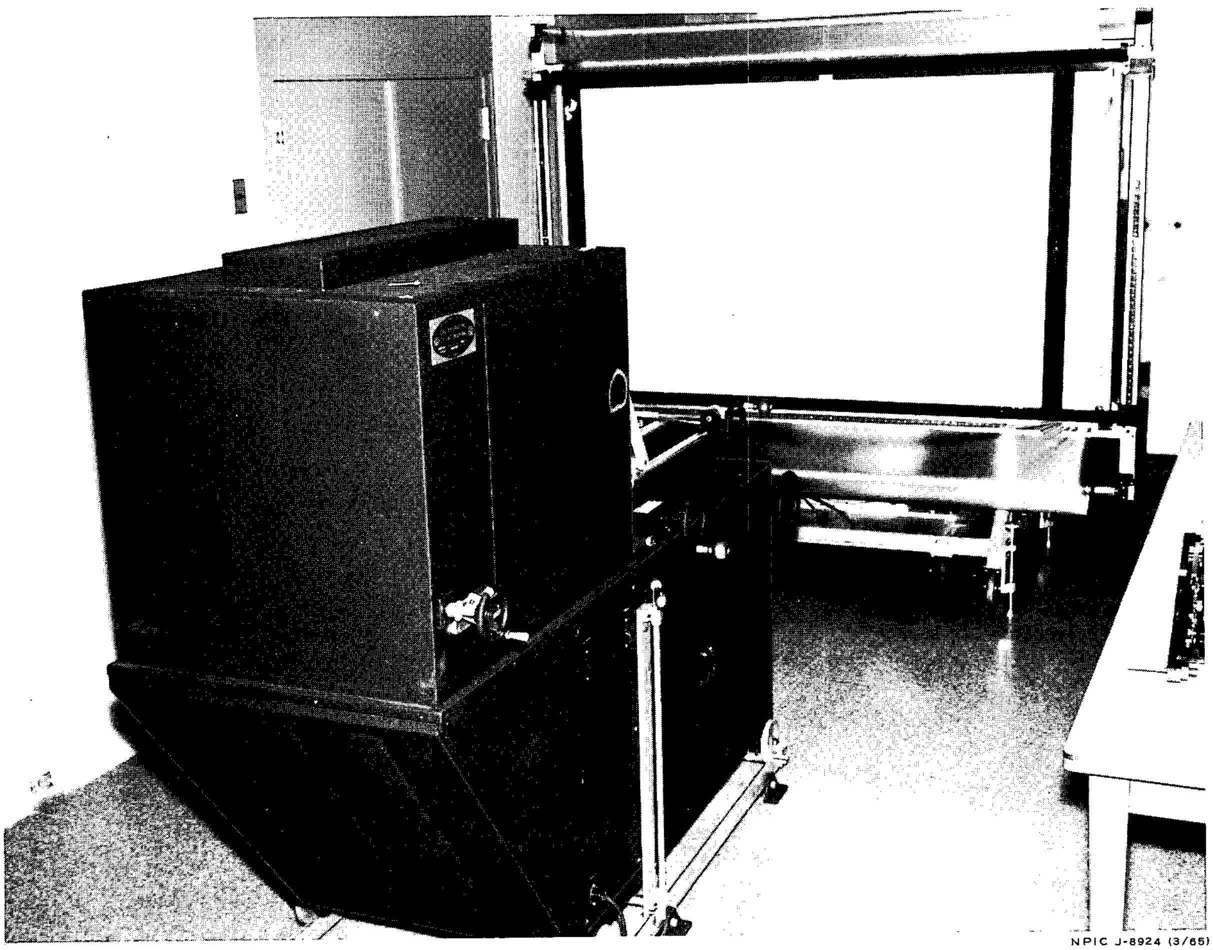
[redacted]

E. ENLARGING

1. [redacted] HORIZONTAL ENLARGER (8 BY 10 INCH)

X1

With appropriate lenses, this instrument (Figure 21) is suitable for enlargements up to 5x but requires long exposure times at maximum magnification. The lens, which has rising and falling front and transverse adjustments, can be racked through 18 inches, while the total bellows extension is about 2 feet. The 8- by 10-inch cut-film negative holder can be rotated through 360 degrees. The 9.5-inch aerial roll-film holder, which accommodates up to 300 feet of film, cannot be rotated. The entire camera unit (less easel) is mounted on a 12-foot track, with the maximum movement being 8 feet. Exposure is accomplished by the lens-capping method without use of a shutter. There is no easel provided with this instrument nor any rack for mounting one. The instrument is 6.75 feet long (without track), 2.9 feet wide, 5.75 feet high (including track), and weighs an estimated 1,000 pounds.

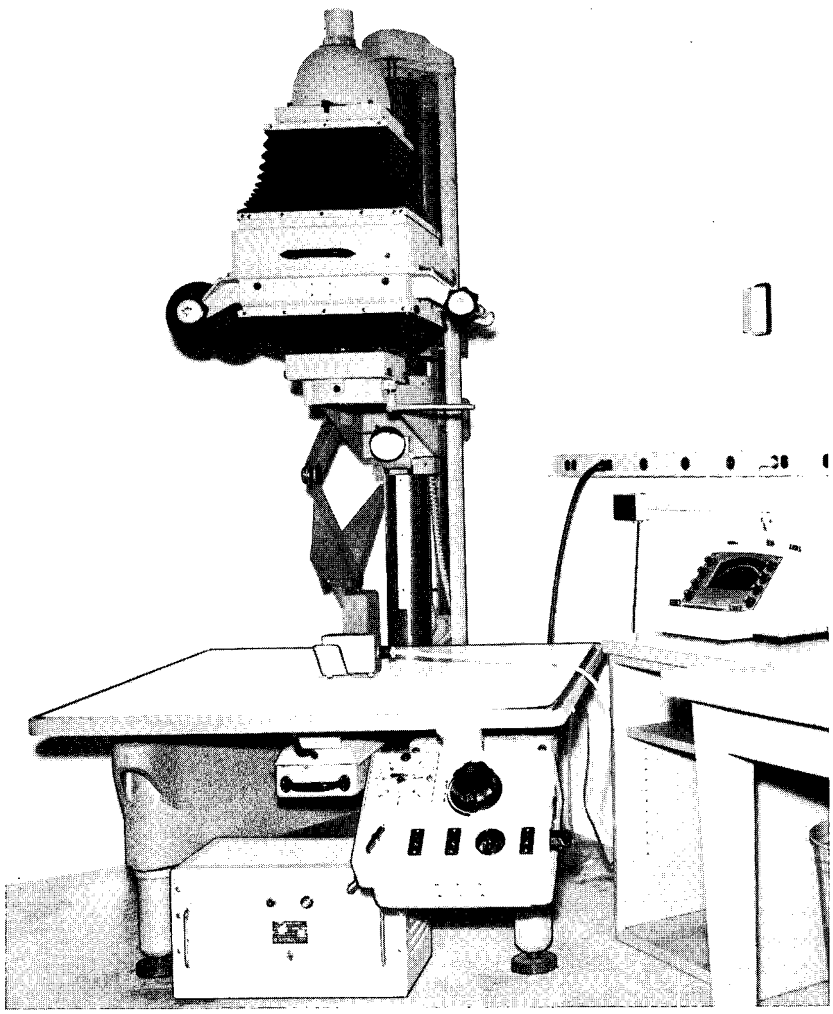


NPIC J-8924 (3/65)

X1 *FIGURE 21. [redacted] HORIZONTAL ENLARGER (8 BY 10 INCH).*

2. [redacted] VG-1 AUTOFOCUSING ENLARGER (.75X TO 7X)

The [redacted] VG-1 Enlarger (Figure 22) will accommodate glass plates or cut film up to 9.5 by 9.5 inches, and roll film up to 9.5 inches in width and 500 feet in length. The light source is a diffused mercury-vapor lamp and the enlarging lens is corrected to the narrow bandwidth or wavelength of this light (350 to 700 $m\mu$). The Reprogon lens has a focal length of 150mm, a speed of f/5.6, and a maximum angular field of 74 degrees. Its capability ranges from 100 lines per mm on-axis to about 60 lines per mm at 37 degrees off-axis. Exposure time is controlled by a built-in meter and is accomplished by means of a between-the-lens shutter. The maximum paper, or easel, size is 41 by 41 inches. The machine is 41 inches wide, 77 inches deep, 9.25 feet high at 7x, and weighs 1,160 pounds. It costs [redacted]

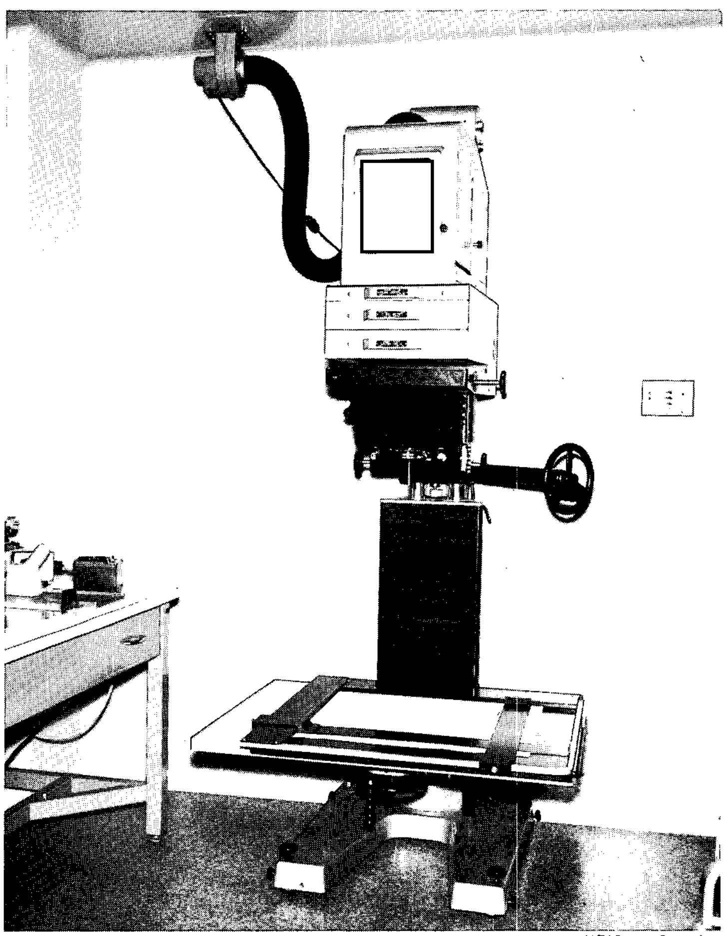


NPIC J-8925 (3/65)

FIGURE 22. [redacted] G-1 AUTOFOCUSING ENLARGER (.75X TO 7X).

3. [redacted] ENLARGING PRINTER (35MM TO 8 BY 10 INCHES)

This enlarging printer (Figure 23) can be used either vertically, with a 28- by 39.5-inch adjustable easel, or horizontally, projecting onto the wall of a room. The enlarger head can be tilted up to 90 degrees and the lens stage can be swung to either right or left to match the tilt of the negative. The easel, or baseboard, can be ball-and-socket mounted to provide movement in any direction to correct for distortions. Lenses from 50mm to 360 mm are available, depending on the size of the negative used and the degree of magnification desired, and 2 different lamp houses are also available, one with a frosted tungsten lamp and the other with a cold cathode grid. Condensers and filters are designed with drawer mounts and are readily interchangeable. A roll-film carrier, available as an accessory, handles film up to 9.5 inches in width and up to 500 feet in length. The machine is 39.5 inches wide (at the easel), 35 inches deep, and 9 feet 2 inches high (at maximum magnification). It weighs 352 pounds and costs [redacted] 25X1

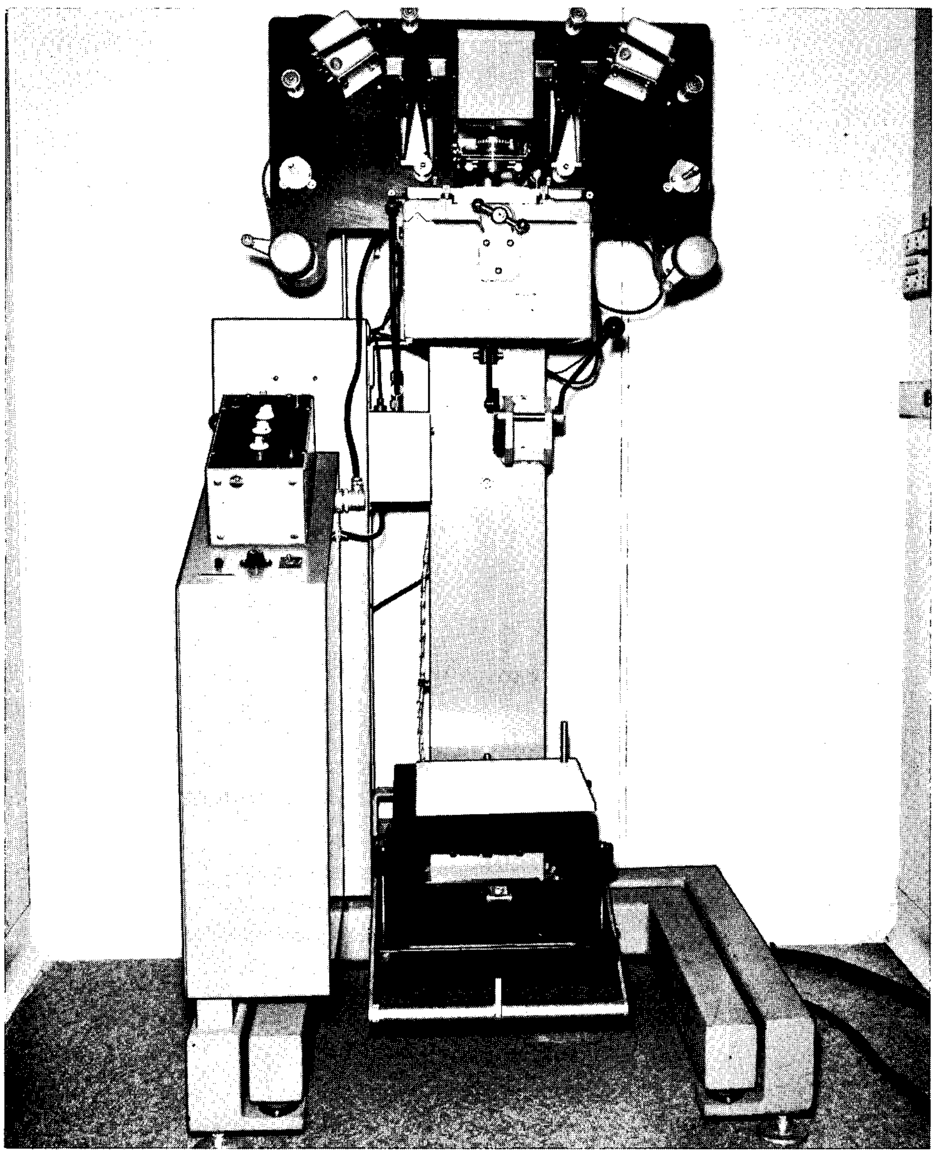


NPIC J-8926 (3/65)

FIGURE 23. [redacted] ENLARGING PRINTER (35MM TO 8 BY 10 INCHES). 25X1

4. [redacted] PRECISION ENLARGER (20X)

This high-resolution enlarger (Figure 24) with a fixed magnification of 20x is designed for 70mm roll film and enlarges a .45-inch-square area up to 9 by 9 inches. The enlarger uses specular illumination and matching optics. The negative being enlarged is held in a liquid immersion gate, the refractive index of the liquid matching that of the film base. On-axis resolution capability is about 500 lines per mm. The instrument is 32 inches wide, 36 inches deep, 70 inches high, weighs 725 pounds, and costs about [redacted]

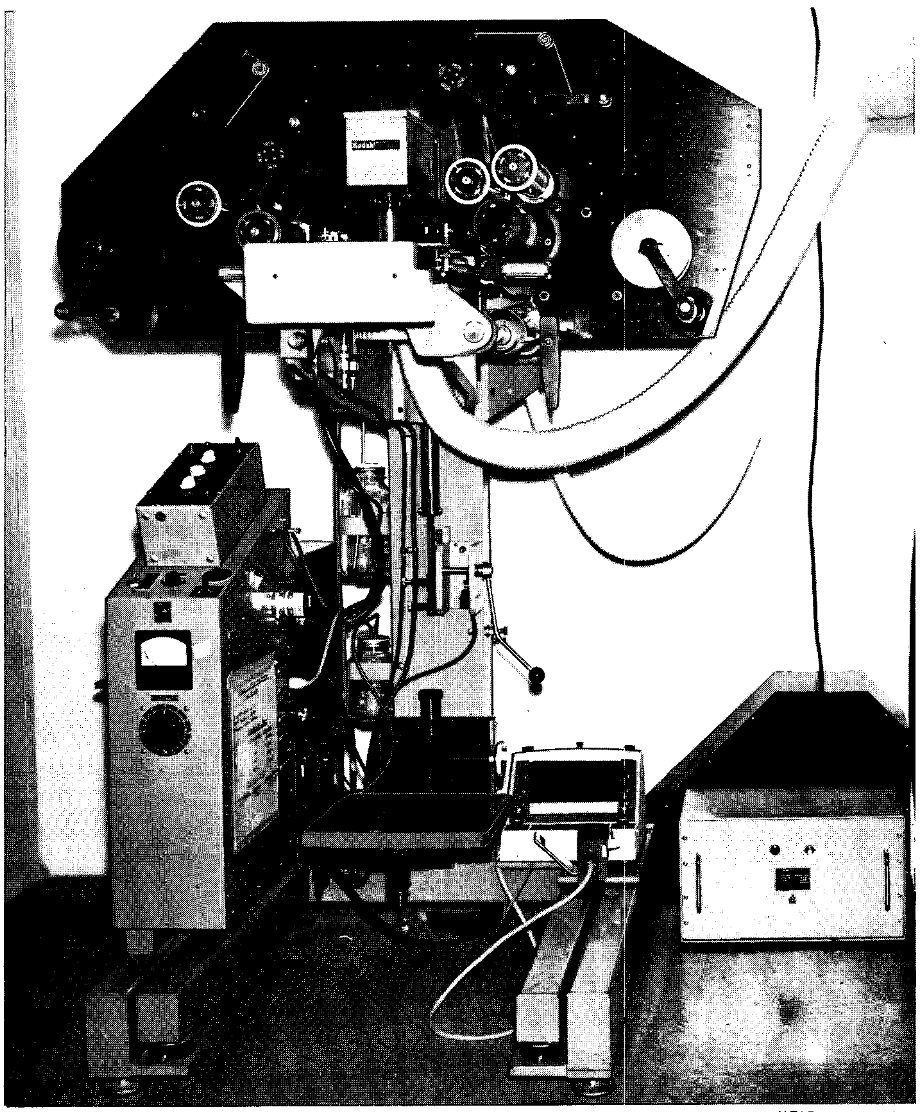


NPIC J-8927 (3/65)

FIGURE 24. [redacted] PRECISION ENLARGER (20X).

5. [redacted] PRECISION ENLARGER (10X-20X-40X)

This high-resolution enlarger (Figure 25) is similar to the [redacted] 20x Precision Enlarger except that negatives of 70mm, 5, 6.6, 8, and 9.5 inches are accommodated and are transported by motor drive. Magnifications of 10x, 20x, and 40x are obtainable by means of separate lenses. The on-axis resolutions obtained by this enlarger are: for the 10x, 350 lines per mm; for the 20x, 550 lines per mm; and for the 40x, 575 lines per mm. The dimensions and weight of this enlarger are only slightly greater than those of the 20x enlarger. The cost of this model is [redacted]



NPIC J-8928 (3/65)

FIGURE 25. [redacted] PRECISION ENLARGER (10X-20X-40X).

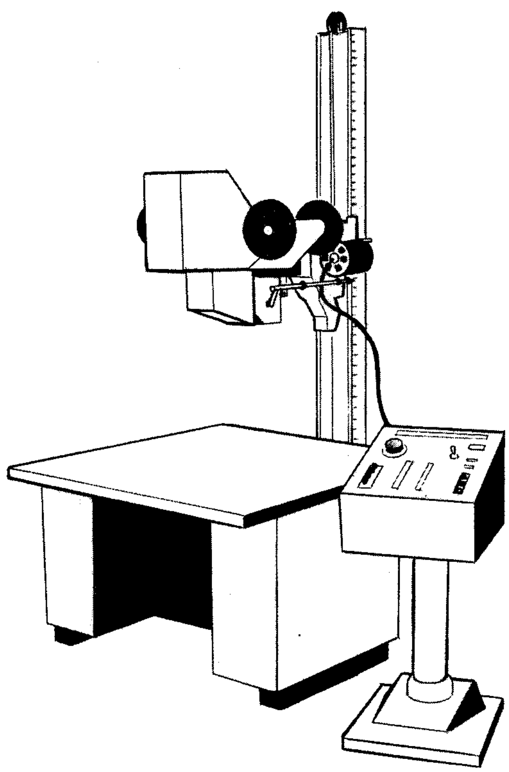
25X1
[redacted] 25X1

6. [redacted] PRECISION ENLARGER (3X TO 12X)

This new enlarger (Figure 26) has been developed to accommodate a range of requirements not fulfilled by either of the enlargers now in use, the [redacted] 10x-20x-40x Enlarger or the [redacted] VG-1 Enlarger. Each of these instruments is a precision device but is limited in magnification range. In addition, the [redacted] unit has a very small (9 by 9 inches) easel, and the VG-1 has no Y movement of the film carriage to facilitate on-axis enlargement.

The new enlarger has a continuously variable ratio from 3x to 12x with an electrically operated autofocus unit and a 40-inch-square vacuum easel. The film carriage will accommodate 500-foot rolls of film from 70mm to 9.5 inches in width. Movement of the film in both X and Y directions allows on-axis projection of a 70mm-square area from any chosen film size. Separately collimated light sources are provided for either black-and-white or color materials.

As originally developed, this instrument was a prototype rather than a true production model and after more than a year of use and evaluation, certain modifications enabling more efficient operation have been decided on. The modified version is expected to be operational in April 1965, and the cost of a production model will be about [redacted] 25X1



NPIC J-8929 (3/65)

FIGURE 26. [redacted] PRECISION ENLARGER (3X TO 12X).

7. [redacted] BRIEFING PRINT ENLARGER (10X TO 60X)

This briefing print enlarger (Figure 27), which is now under development, will enlarge a 2.25-inch-square area up to a size of 20 by 24 inches on film negatives ranging from 70mm to 9.5 inches. The enlarger will be of horizontal design, will be suitable for small-scale black-and-white or color negatives, and will have a range of magnification from 10x to 60x accomplished by a family of 3 separate lenses. It is estimated that delivery will be made in June 1966.

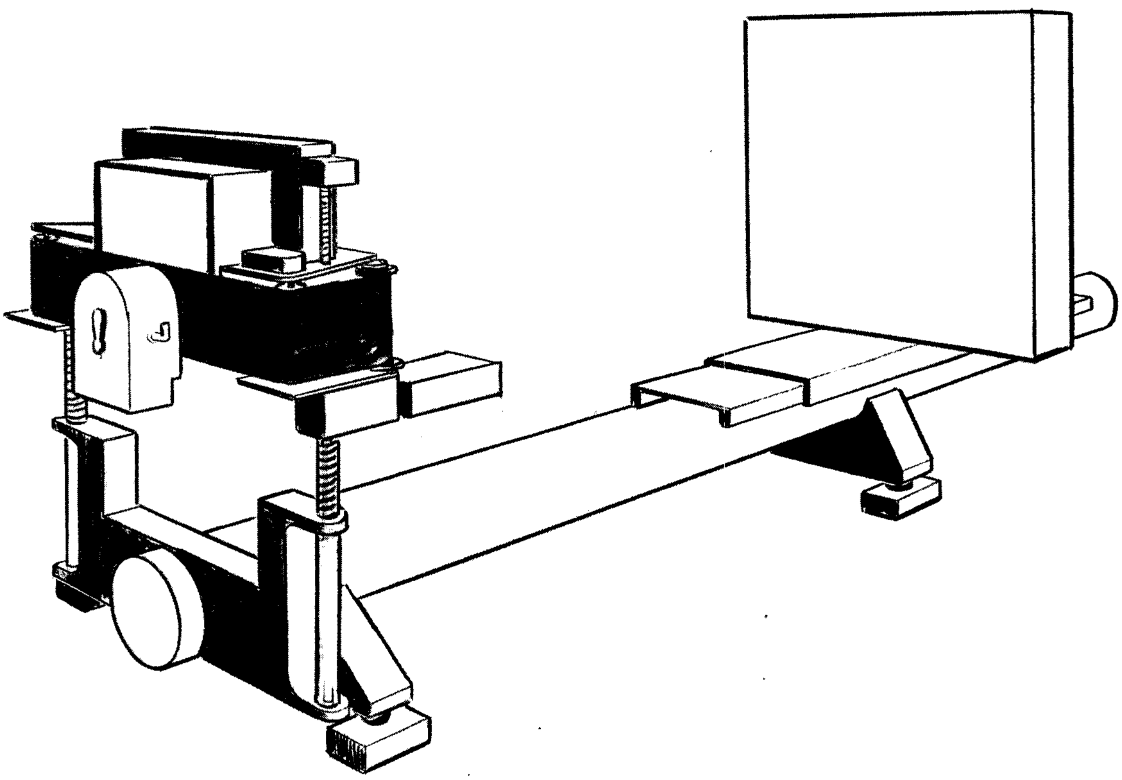


FIGURE 27. [redacted] BRIEFING PRINT ENLARGER (10X TO 60X). NPIC J-8930 (3/65)

[redacted]

[redacted]

8. [redacted] FLUID-GATE ENLARGER (3X TO 15X)

Briefing prints are currently being made on the [redacted] VG-1 Enlarger and the [redacted] 10x-20x-40x Enlarger. The VG-1 Enlarger is limited to a relatively low resolution because the film negative is held between glass platens and all dirt and scratches appearing on the negative are greatly magnified on the prints. Images near the edge of a 9-inch film cannot be faithfully enlarged because there is no means provided to bring the area to the on-axis position of the lens. In the case of the 10x-20x-40x enlarger, the problems of dirt and scratches on the on-axis position of the film are overcome; however, this enlarger is limited to 3 exact magnifications, namely 10x, 20x, and 40x. This leaves "holes" in the range of enlargements that can be produced. With the continuing increase of information per unit of the negative area enlargement, it must be possible to bring the information to within the resolution capability of the human eye.

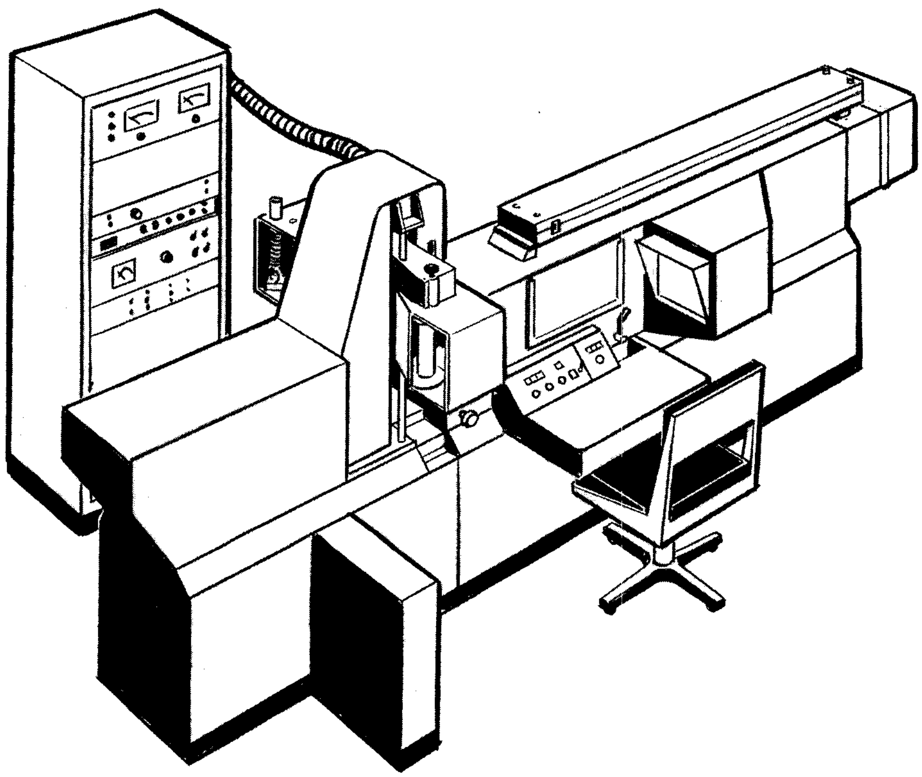
The 3x to 15x Fluid-Gate Enlarger is designed to meet this requirement. Although the area to be enlarged will be limited to 70mm by 70mm, the entire width of the negative will be immersed in the liquid gate. This immersion of 9-inch film has already been accomplished experimentally on film projection equipment, but it has not yet been proven practical for enlargers. The 3x to 15x enlarger will accommodate all aerial films in the range from 70mm- to 9.5-inch widths in either black-and-white or color, and in film lengths up to 500 feet. The fluid gate will remove dirt and scratches and also prevent the generation of Newton rings, which is also a problem with glass platens. The easel, which will accommodate enlargements up to 40 by 40 inches, will be of the vertical-vacuum type.

In appearance and basic configuration, this enlarger is quite similar to the 10x to 60x Briefing Print Enlarger previously described (Figure 27). Delivery of a prototype model is estimated for June 1966.

[redacted]

9. [redacted] COHERENT-LIGHT ENLARGER

The coherent-light enlarger currently under development (Figure 28) will make use of a helium-neon laser light source and will produce 9- by 9-inch prints of selected 70mm square-format negative areas from aerial roll films. The prime objective of this development is an optical system capable of producing 4x imagery with a modulation transfer function that is flat out to 200 cycles per mm. The basic purpose of this instrument is to provide work prints for the photo interpreter containing a maximum amount of intelligence enlarged from original low-contrast imagery recorded at frequencies as high as 200 cycles per mm. By reduction of the spatial frequency to one-fourth without loss of information in the transfer process, the photo interpreter will be able to read out the image completely with conventional viewing instruments. An engineering model of this enlarger is currently under evaluation. A production model will cost an estimated [redacted]



NPIC J-8931 (3/65)

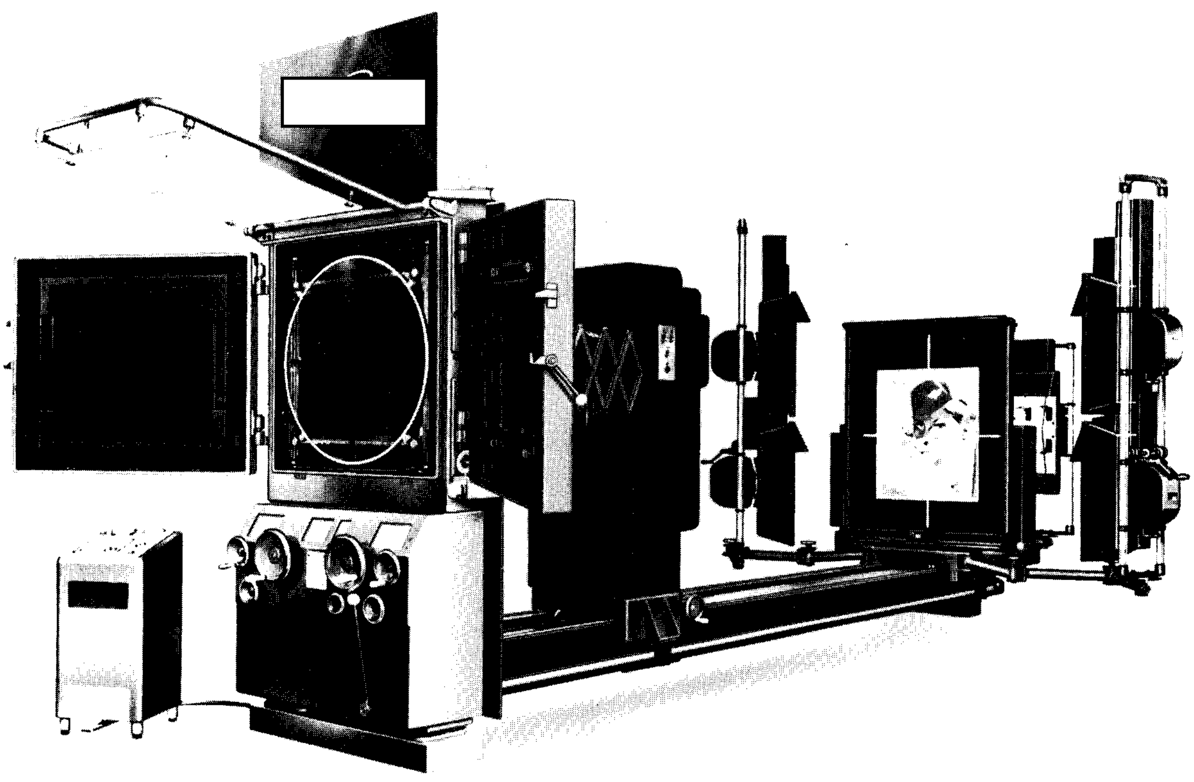
FIGURE 28. [redacted] COHERENT-LIGHT ENLARGER.

[redacted]

F. COPYING

1. [redacted] HORIZONTAL COPY-CAMERA (32 INCH)

This is a darkroom-type camera for half-tone, line, and continuous-tone negatives or transparencies, color separations, and masking (Figure 29). The lens stage and easel are mounted and travel on a heavy channel at floor level; the four 1,000-watt xenon enclosed-arc lamps are mounted to, and travel with, the easel base. Vacuum is provided for holding the film in the camera back, and exposure is controlled by means of an electrical behind-the-lens shutter. The equipment is designed for through-the-wall-type installation with the camera back and controls in a darkroom. Capable of reproductions ranging from 7x for enlarging to 10x for reducing, the equipment is 19.5 feet long, 4.75 feet wide, 7 feet high, and is estimated to weigh about 1 ton altogether. It costs [redacted]

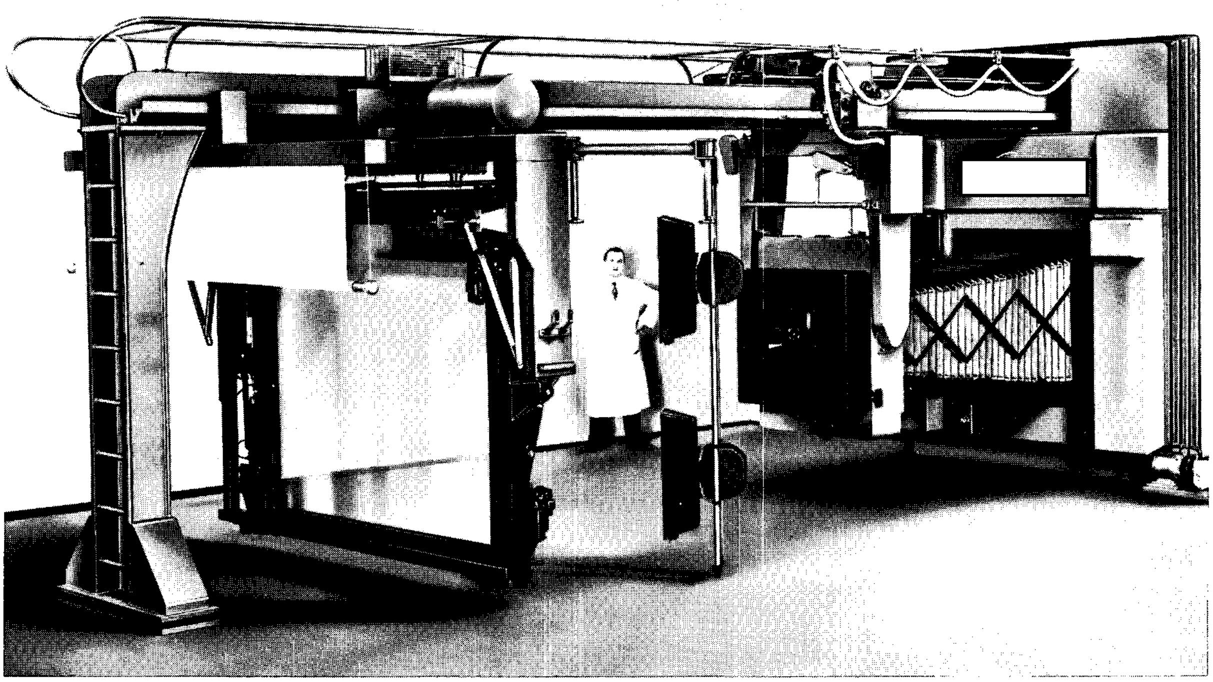


NPIC J-8932 (3/65)

FIGURE 29. [redacted] HORIZONTAL COPY-CAMERA (32 INCH).

2. [redacted] AUTOFOCUSING COPY-CAMERA (40 BY 40 INCH)

This is a large, horizontal, precision, overhead, darkroom-type camera (Figure 30) for halftone, line, or continuous-tone reproductions from either reflection or transparent copies (color reproductions may also be made). The overhead rails that carry the movable copyboard and lens stage are supported by columns at the ends. The camera is designed for through-the-wall installation in which the film holder and controls are in the darkroom. Complete freedom of movement is provided for the copyboard and lens mount to allow for rectification and correction of distortion. A double-reversing mirror system is also provided for inverting the negative image when necessary; vacuum is available for holding both the film and the copy material. Four 1,000-watt xenon enclosed-arc lamps are included for illumination of the copy material. The range of reproduction is 1x to 5x for enlargements and 1x to 12x for reductions. Exposure is controlled by an electrically operated behind-the-lens shutter. The machine is 26.5 feet long, 10 feet wide, 10.5 feet high, and the weight of the entire unit amounts to several tons.



NPIC J-8933 (3/65)

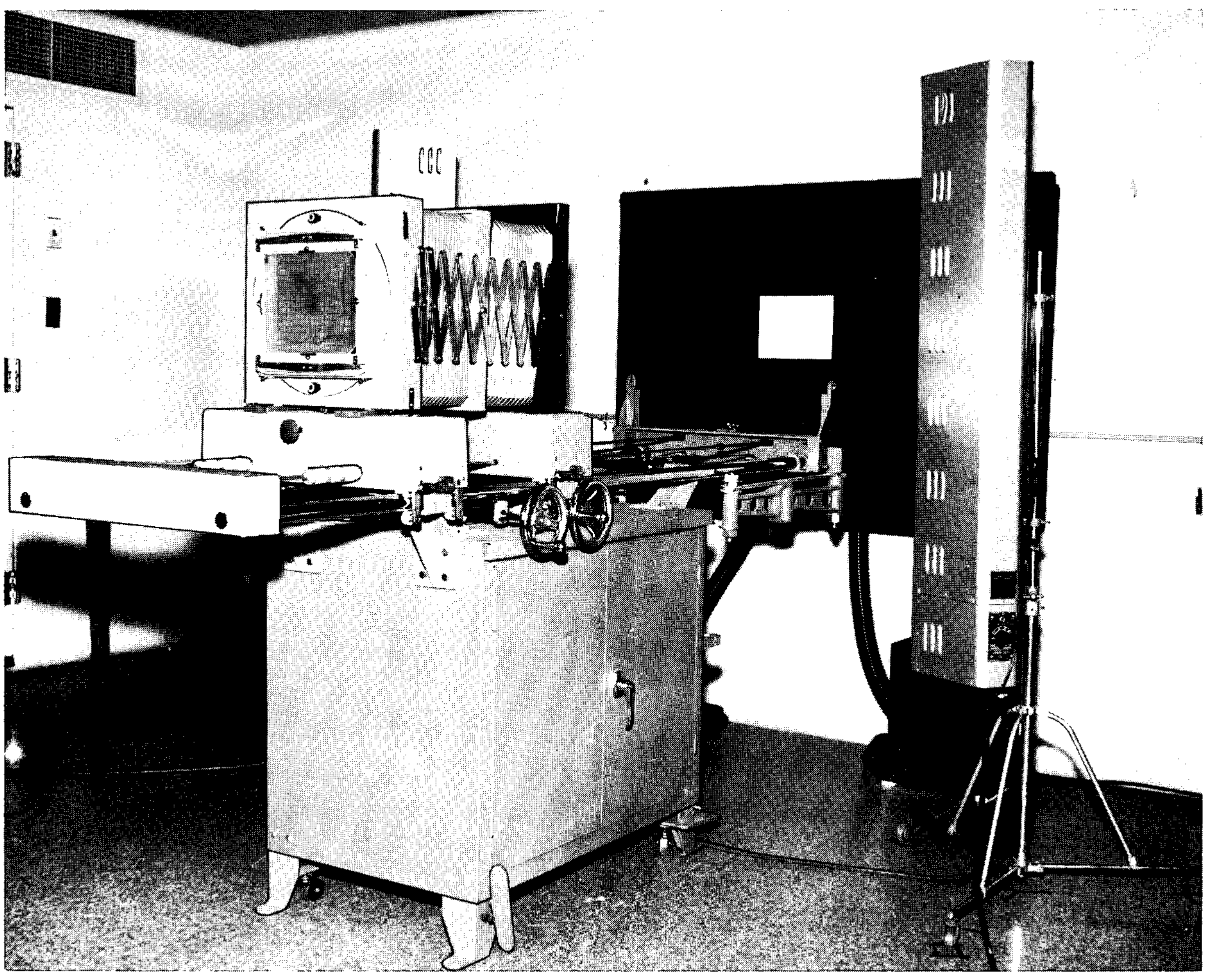
FIGURE 30. [redacted] AUTOFOCUSING COPY-CAMERA (40 BY 40 INCH).

25X [redacted]
25X

3. [redacted] COPY-CAMERA (11 BY 14 INCH)

This copy-camera (Figure 31) may be used in either the vertical or horizontal mode, and 4- by 5-inch film is accommodated by means of a reducing back, the maximum enlargement/reduction obtainable being 4 times the linear dimension of the area being copied. The easel is fixed to the front of the camera bed and the camera moves on the bed by means of 2 carriages, one supporting the lens, the other the camera back. The lens is a Series XII Anastigmat copying type having a focal length of 12 inches and a maximum aperture of f/6.3 with a 15- to 60-inch focus range between the lens and the copy object. The shutter is a between-the-lens type with speeds ranging between 1.5 and .02 seconds, flash synchronization being provided for both Class M and Class X bulbs at all speeds. The lamps required to illuminate the copy material are not included. The machine is approximately 87 inches long, 29 inches wide, 62 inches high, and weighs 147 pounds. It costs [redacted]

25X



NPIC J-8934 (3/65)

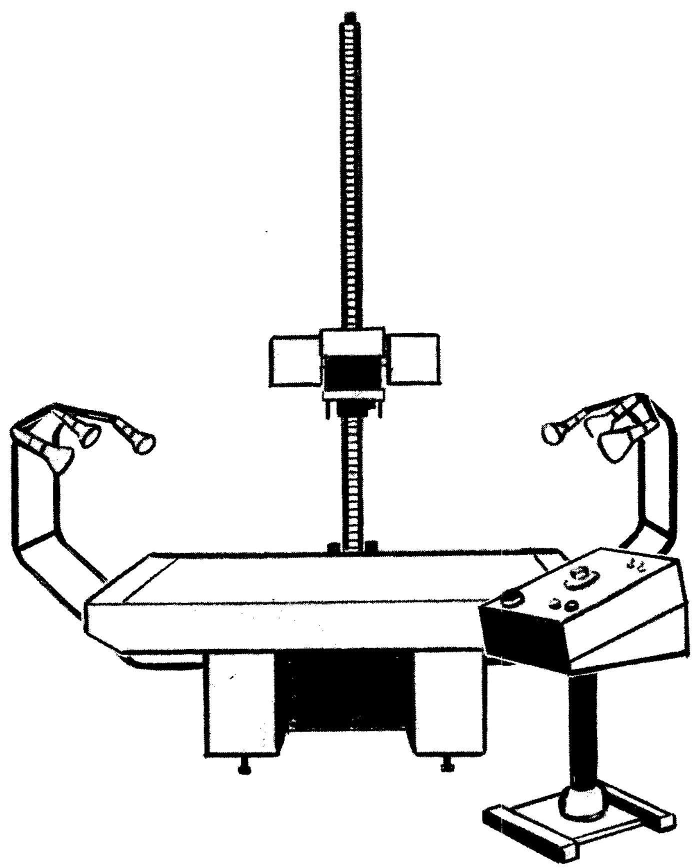
FIGURE 31. [redacted] COPY-CAMERA (11 BY 14 INCH).

25X

X1

4. [redacted] COPY-CAMERA

This machine (Figure 32) uses non-perforated 70mm film in 100-foot darkroom-loading spool-type magazines. A cut-off knife is built into the magazine to permit instant removal of a single exposure from any part of the 100-foot roll. The 60- by 40-inch easel is equipped with vacuum and has a built-in diffused backlight light source for exposing any transparent subject matter. The reflection illumination consists of 6 reflector-type floodlamps, the intensity of which can be controlled from a console. Exposure with speeds ranging from 0.1 to 11 seconds is accomplished by an electrically operated shutter that is controlled by an electronic timer. The reduction ratio ranges from 8x to 30x and automatic focus is provided throughout the entire range. The reduction ratio is set by means of a motor drive on a geared center post; the maximum height is 9.5 feet. The cost of the machine is [redacted] 25X



NPIC J-8935 (3/65)

X1 *FIGURE 32.* [redacted] *COPY-CAMERA.*

5. FIXED-FOCUS COPY-CAMERA

This camera, under development, has a fixed-focus 10x enlargement capability on Polaroid film. This development will enable the operator to produce an instantaneous enlargement of the area of interest on an image. The camera has been designed for use by inexperienced operators, the only adjustment being that of length of exposure, which depends on the type of Polaroid film being used. This camera is simply placed over the imagery that is on a light table and the film is exposed by opening the shutter. An enlargement is immediately available. The camera can be used in a normally lighted room.

SECTION II VIEWING AND INTERPRETATION

Part 1. Basic Interpretation Tools

A. INTRODUCTION

B. MAGNIFIERS

C. MICROSCOPES

D. LIGHT TABLES

E. PROJECTORS

F. MISCELLANEOUS MEASURING TOOLS

G. MISCELLANEOUS TOOLS

A. INTRODUCTION

The image quality of photography received at the NPIC has continued to improve during the past year, and a consequent upgrading of our viewing capability remains a steady need. To meet this requirement, many already existing basic tools have been improved and, beyond this, entirely new items and concepts are being developed or evaluated.

Foremost among the new developments are variable-ratio anamorphic eyepieces for the [redacted] Zoom 70 Stereoscope. In addition, the optical industry is being canvassed to search out the optimum capability of microscopes in resolution, field of view, eye relief, and exit pupil.

At present, the highest quality stereo instrument in use is the [redacted] microstereoscope. It is anticipated that for several years to come this instrument will furnish the photo interpreter with an adequate capability for extracting photo information. However, this instrument also provides a performance standard in preparing design objectives for future viewing equipment.

To provide a means for deriving relative dimensions from photography, in addition to the "Real-Time Photo Measurement System," (q.v.) several items are now available to the photo interpreter, including a fixed 2-power macroscope, a projected-scale micrometer, and a more accurate stage-micrometer.

These and other basic interpretation tools, both projected and in-house, are described and illustrated in the first part of this section.

[redacted]

[redacted]

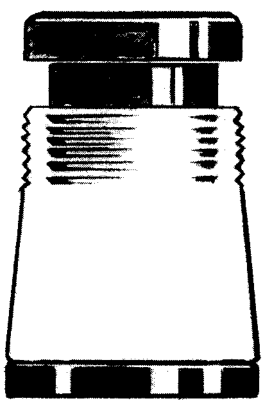
B. MAGNIFIERS

1. [redacted] 7X TUBE-MAGNIFIER

The most used item of photo-interpretive equipment is the 7x tube-magnifier (Figure 33) costing [redacted] However, this instrument is inadequate for the interpretation of very small-scale imagery. The use of a higher power simple magnifier presents its own problems, for as the power increases the field of view decreases. Furthermore, the working distance of the magnifier decreases to the point where the instrument cannot be used comfortably. The present limit for a reasonably comfortable magnifier is approximately 12x. Therefore, there are currently under development 2 prototype advanced-concept magnifiers.

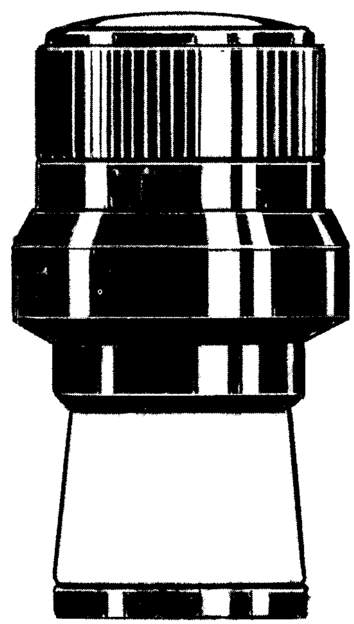
2. [redacted] 8X TO 18X ZOOM TUBE-MAGNIFIER

One of these (Figure 34), a prototype zoom tube-magnifier, is designed to provide the photo interpreter with a light-weight, compact tube-magnifier which incorporates continuous zoom magnification from 8x through 18x with a working distance of 15mm and an overall height of 86mm. The production model of this instrument is due in August 1965 at an estimated cost of [redacted]



NPIC J-8936 (3/65)

[redacted]



NPIC J-8937 (3/65)

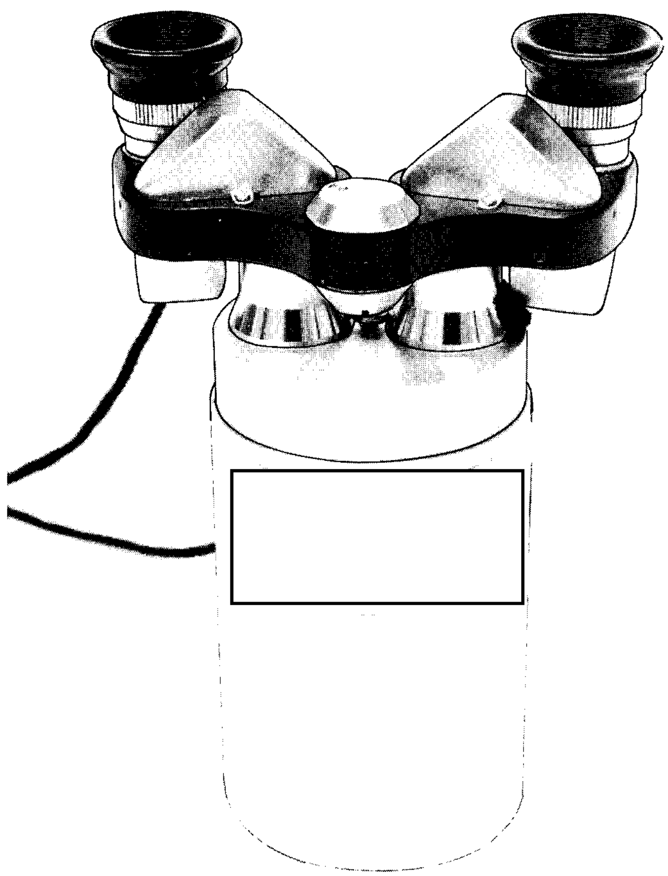
[redacted]

[redacted]

3. [redacted] BINOCULAR TUBE-MAGNIFIER

The second instrument is a binocular tube-magnifier (Figure 35) which is designed to provide the advantages of binocular viewing in a small hand-held instrument that can be used in much the same manner and for many of the same purposes as the present photo interpreters tube-magnifier; experience with microscopes, comparators, and other direct-viewing equipment has shown that binocular viewing is both more comfortable and more effective than monocular viewing.

The binocular tube-magnifier will be of a reasonable weight and size, with a transparent and stable base mounting. Although both mechanically and optically simple, it will offer excellent image quality. The salient features will include a conversion whereby a single instrument can be quickly modified to produce either 10x or 20x magnification; a field of view of 15.5mm at 10x, and 8mm at 20x; and an interpupillary distance adjustment between 56mm and 76mm with individual focusing adjustments for both eyes. The first production model is due in June 1965 at an estimated cost of $[redacted]



NPIC J-6938 (3/65)

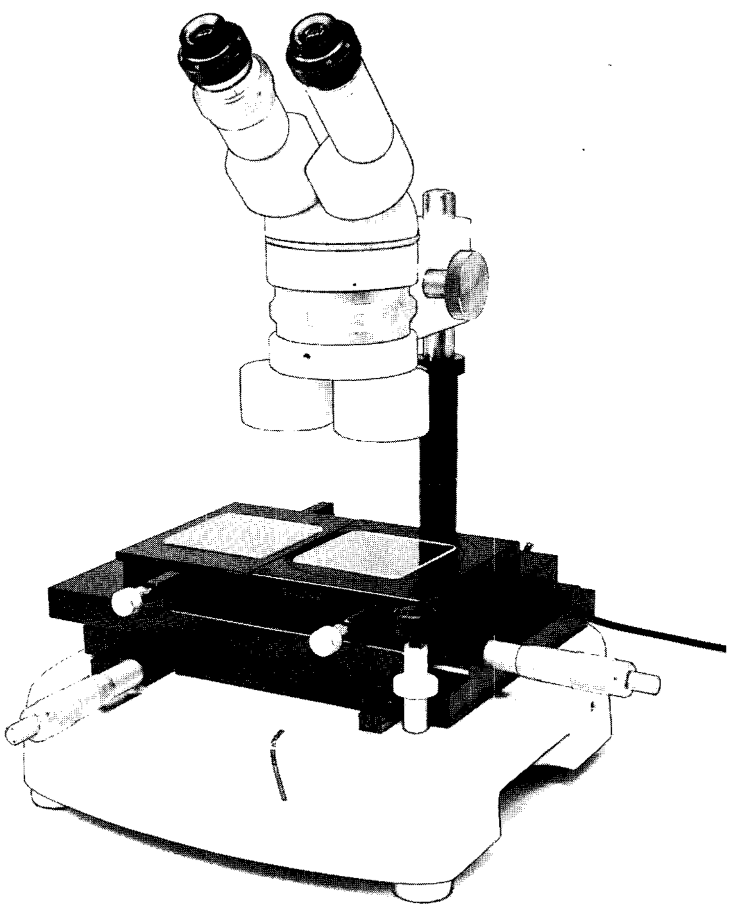
FIGURE 35. [redacted] BINOCULAR TUBE-MAGNIFIER.

[redacted]

C. MICROSCOPES

1. [redacted] M-5 MICROSTEREOSCOPE

The [redacted] M-5 Microstereoscope (Figure 36) permits stereoscopic examination of either transparencies or prints at magnifications of 6x, 12x, 25x, or 50x. The working distance between objectives and stage-plate remains constant after initial focusing no matter which magnification power is used. There is no need for changing of eyepieces or objectives, this being eliminated by the intermediate optical system provided for each single magnification which operates in conjunction with the common objective component. By substituting the single calibrated eyepiece and using the vernier-screw-controlled stage-plates, accurate measurement to within .01mm of both X and Y coordinates can be effected. The same calibrated eyepiece also permits angular measurement through a full 360 degrees. Rheostat-controlled variable-intensity illumination is provided for each film stage. The cost of the instrument is [redacted]



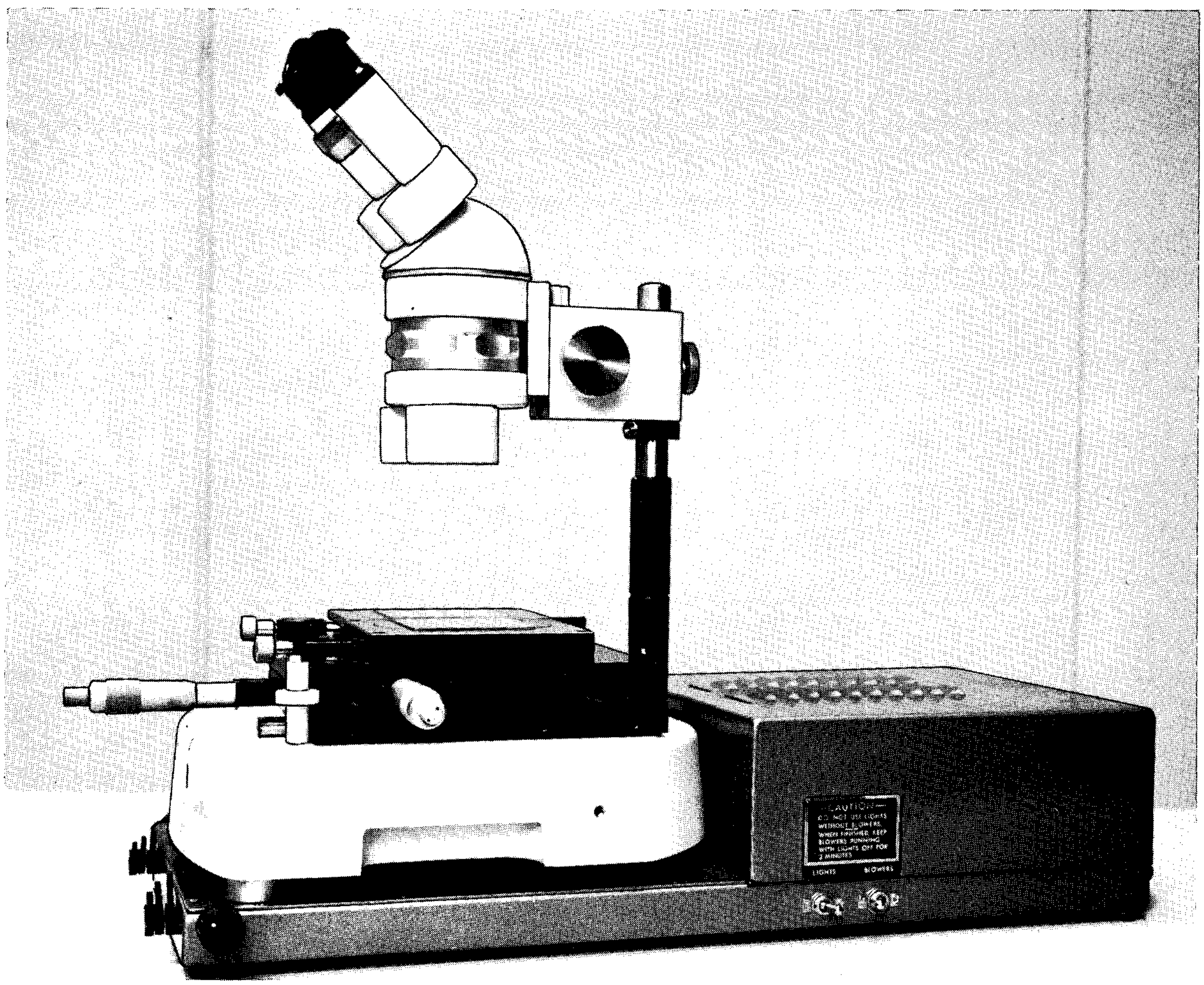
NPIC J-8939 (3/65)

FIGURE 36. [redacted] M-5 MICROSTEREOSCOPE.

[redacted]

2. EXPERIMENTAL LIGHT FOR [redacted] MICROSTEREOSCOPE

An experimental light source (Figure 37) has been designed and fabricated in-house for use with the [redacted] M-5 Microstereoscope. It makes use of projection systems taken from 2 Accura 35mm slide projectors. The projection lamps are enclosed to a fan-cooled enclosure located to the rear of the microstereoscope. Light is projected into the 2 apertures originally provided for the light source and is reflected to the stereoscope by the same mirrors used with the original light source. Light intensity is varied separately for each half of the stereoscope by the use of density filters that are rotated into the light path, a total of 8 variations being available.



NPIC J-6940 (3/65)

FIGURE 37. EXPERIMENTAL LIGHT FOR [redacted] MICROSTEROSCOPE.

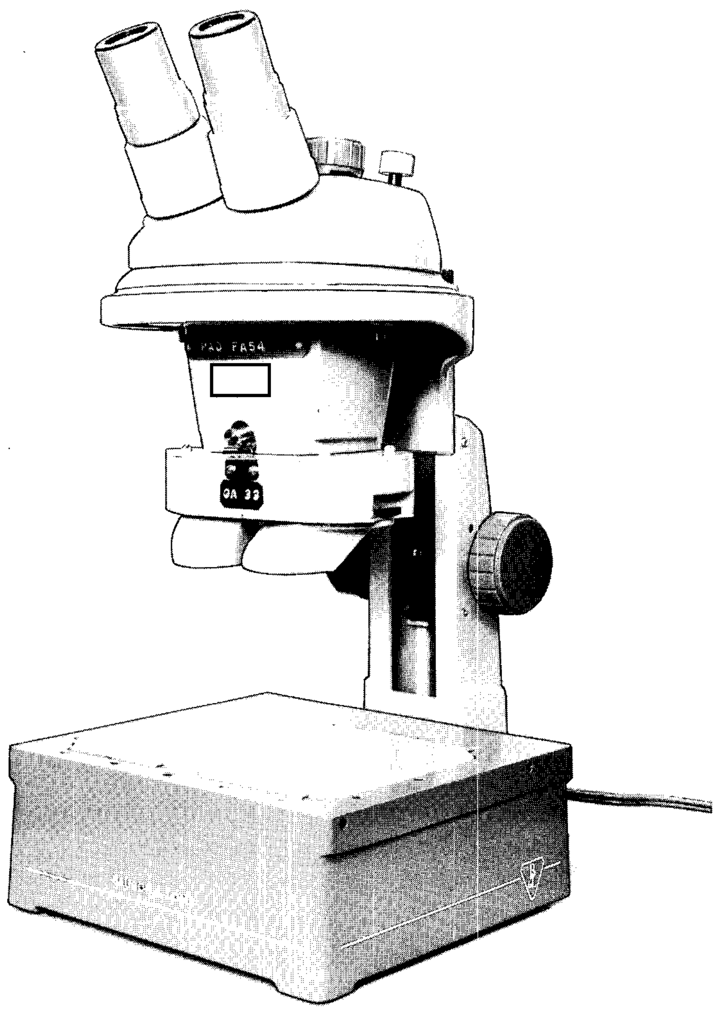
X1

[redacted]

X1

3. [redacted] STEREOMICROSCOPE (MODEL II)

The Model II (Figure 38), a revised version of the original Zoom 70 stereomicroscope, incorporates numerous improvements and new features. Its versatility has been extended by providing additional zoom controls that can either vary the magnification in both halves of the optical system simultaneously or be disengaged for individual magnification control when photographs of different scales are viewed. In addition, by detaching the rhomboid arm assembly and replacing it with an adapter plate and a supplemental 2x objective lens, the instrument becomes a zoom microscope. It can then be used for binocular viewing of photographic images with continuously variable magnification from 3.5x to 120x. It costs [redacted]



NPIC J-8941 (3/65)

FIGURE 38 [redacted] STEREOMICROSCOPE (MODEL II).

[redacted]

4. [redacted] DYNAZOOM MICROSTEREOSCOPE

This instrument (Figure 39), also known as the High-Power Stereoviewer, has been developed by [redacted] to provide the capability of viewing, in stereo, conjugate pairs of high-resolution images under high magnification. It incorporates 2 [redacted] Dynazoom laboratory microscopes and offers continuously variable magnification from approximately 8x to 200x by combinations of 6x and 10x eyepieces and 1.3x to 10x objectives. Film is acceptable in randomly precut chips, each chip being held flat between a glass stage-plate and a metal pressure-plate. Image rotation by optical means is provided in each optical path, precluding the necessity for precise placement of the film chips on the glass stage.

A total of 54 of these instruments has been ordered by the intelligence community and the preproduction model is scheduled to be completed in April 1965. After approval is given on this model, the balance will be delivered at the rate of 2 per week starting 4 weeks later, at an estimated cost of $[redacted]

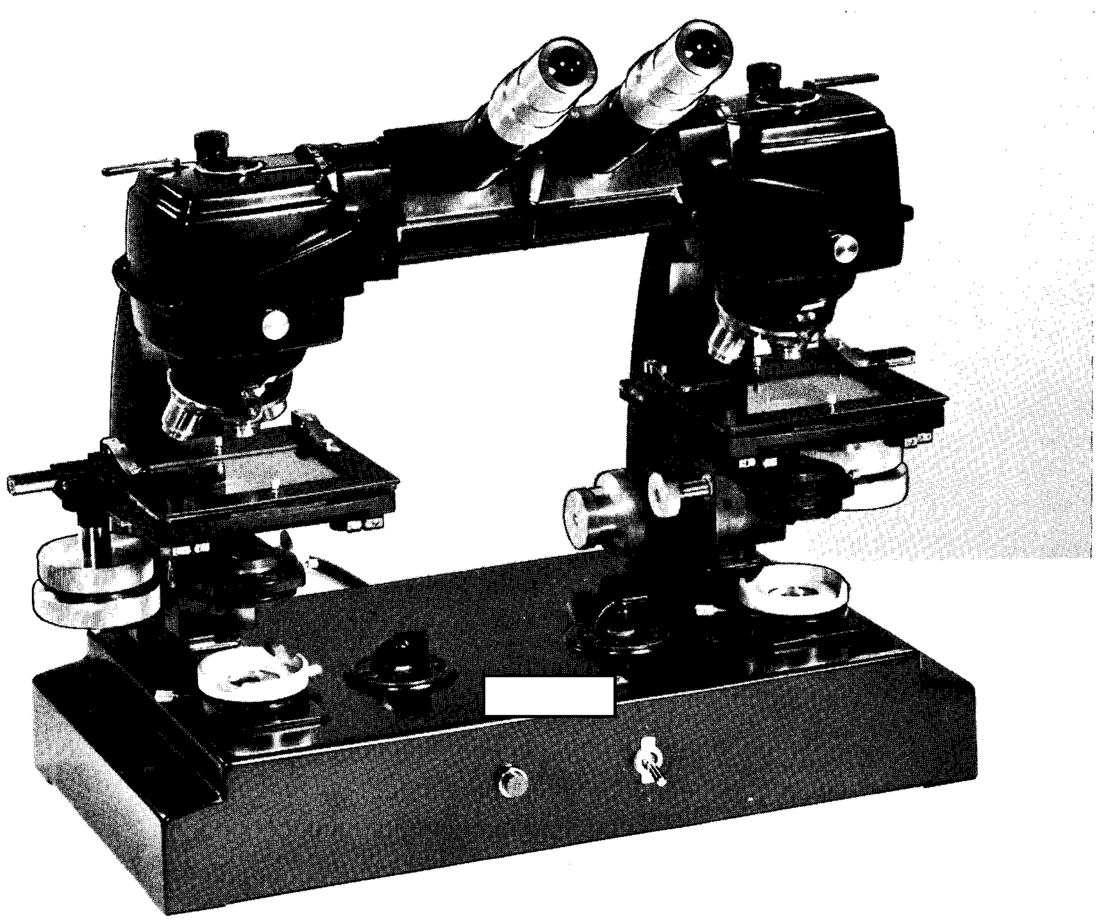


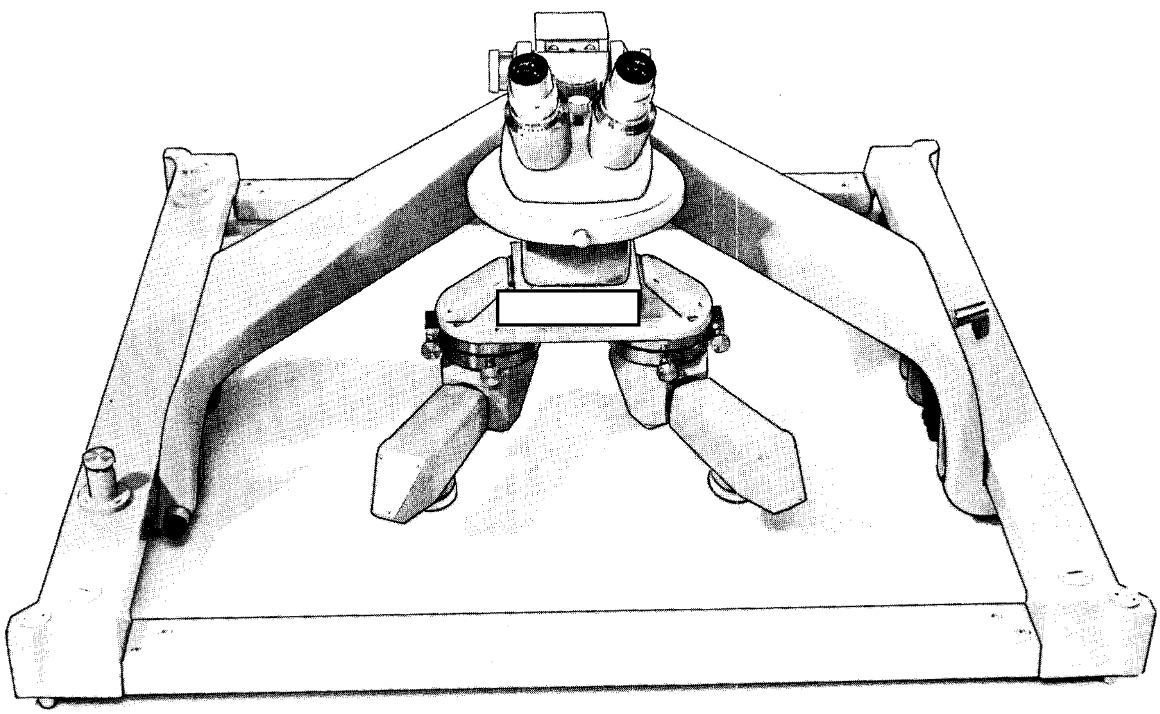
FIGURE 39. [redacted] DYNAZOOM MICROSTEROSCOPE. NPIC J-8942 (3/65)

[redacted]

[redacted]

5. INTERCHANGEABLE RHOMBOID STEREOSCOPE

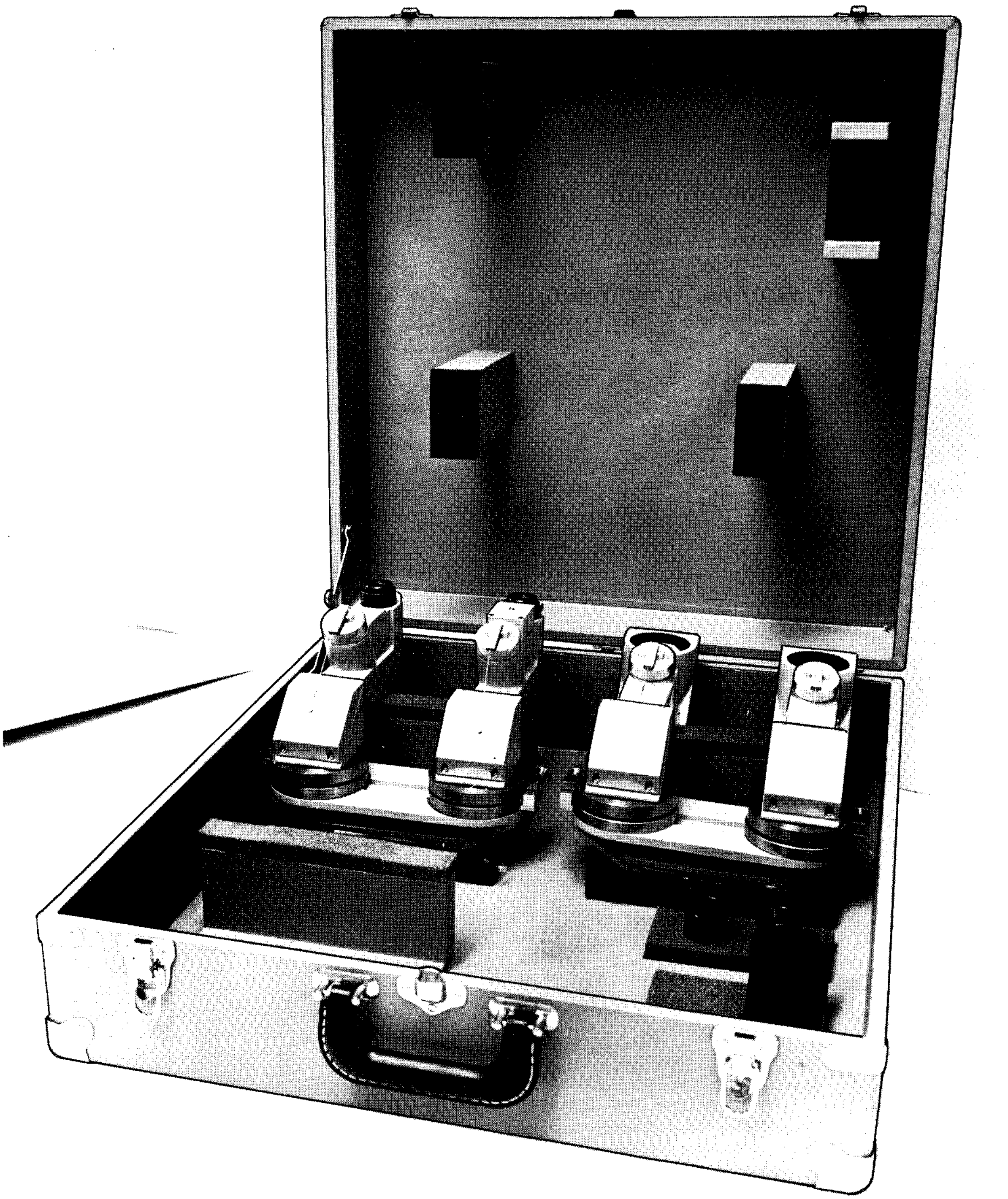
This is a high-power, high-resolution microstereoscope designed and built by [redacted] for the Naval Reconnaissance Technical and Support Center; the second prototype (Figure 40) has been acquired by the NPIC for evaluation. The instrument provides magnifications from 3x through 120x and resolutions up to 600 lines per mm. Magnification is of the zoom type and is continuously variable in 3 stages by utilizing 3 separate clip-on rhomboid relay systems (Figure 41). Independent zoom magnification and optical image rotation are incorporated into both right and left optical paths. This stereoscope is unusual in that the extremely long rhomboid arms provide a maximum spread of 469mm and therefore permit stereoscopic viewing of roll film in all conventional widths. The production model, equipped with 3 separate rhomboid sets for different magnification ranges, will cost an estimated [redacted] and is due by October 1965.



NPIC J-8943 (3/65)

FIGURE 40. INTERCHANGEABLE RHOMBOID STEROSCOPE.

[redacted]



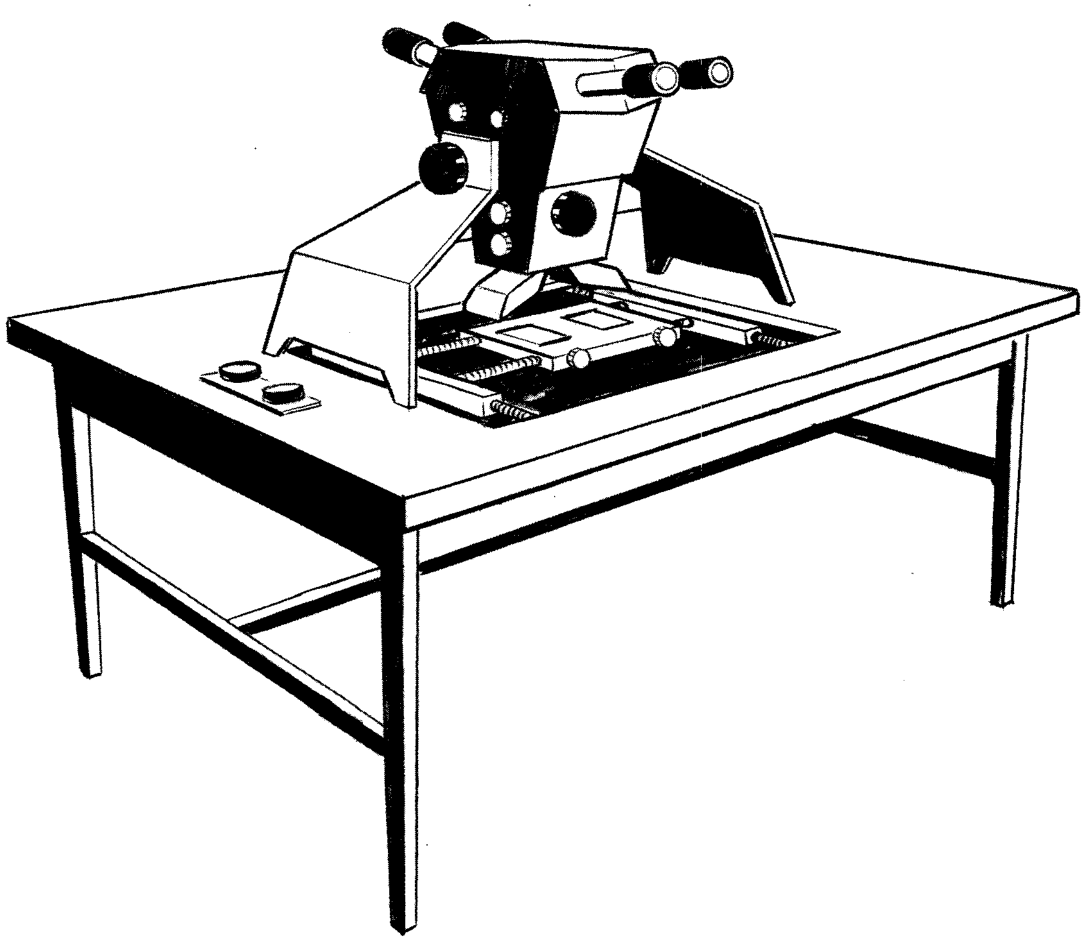
NPIC J-6944 (3/65)

FIGURE 41. RELAY SYSTEMS FOR INTERCHANGEABLE RHOMBOID STEREOSCOPE.

25X1

6. [redacted] DUAL-VIEWING MICROSTEREOSCOPE

The dual-viewing microstereoscope (Figure 42) is a sophisticated, high-resolution device permitting 2 analysts to view simultaneously, in stereo, the same stereo pair at a common magnification and orientation. To be used for training in briefing and for actual interpretation where more than 1 analyst is involved, the instrument will provide 10x through 75x zoom magnification and 375 lines per mm maximum resolution through a 7:1 zoom element.



NPIC J-8945 (3/65)

25X1 *FIGURE 42. [redacted] DUAL-VIEWING MICROSTEROSCOPE.*

7. [redacted] STEREOMICROSCOPE

The [redacted] Stereomicroscope (Figure 43) provides a 4:1 zoom range (.75x to 3x) with good continuity of focus throughout. The use of 10x and 20x eyepieces (with or without a 1.5x auxiliary objective lens) provides a total range of 7x through 90x magnification. The instrument costs $475 and is superior optically and mechanically to the standard [redacted] [redacted] Zoom 70; however, it cannot be used for viewing stereo pairs and a stereo version is currently under consideration.

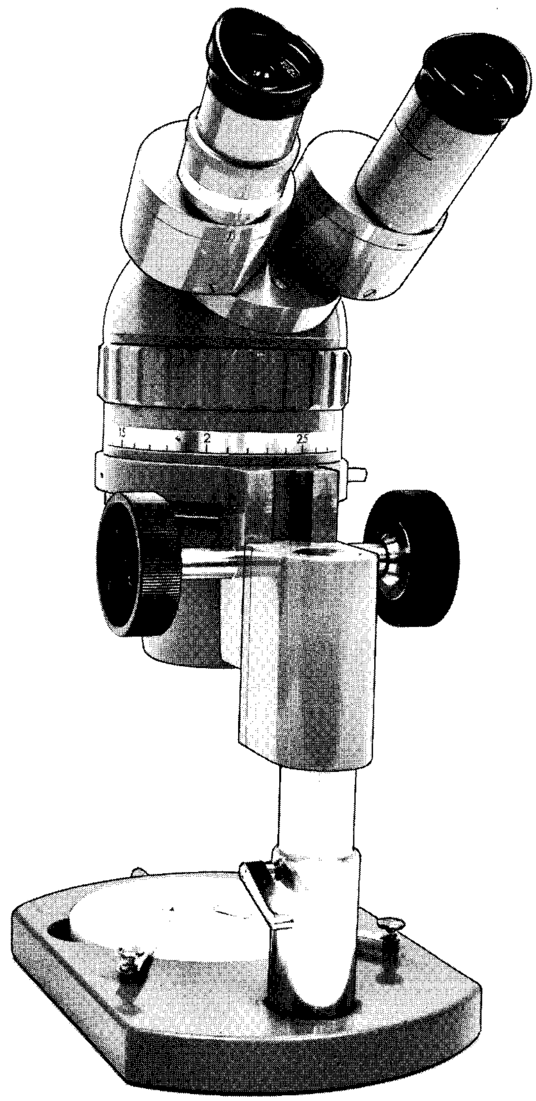
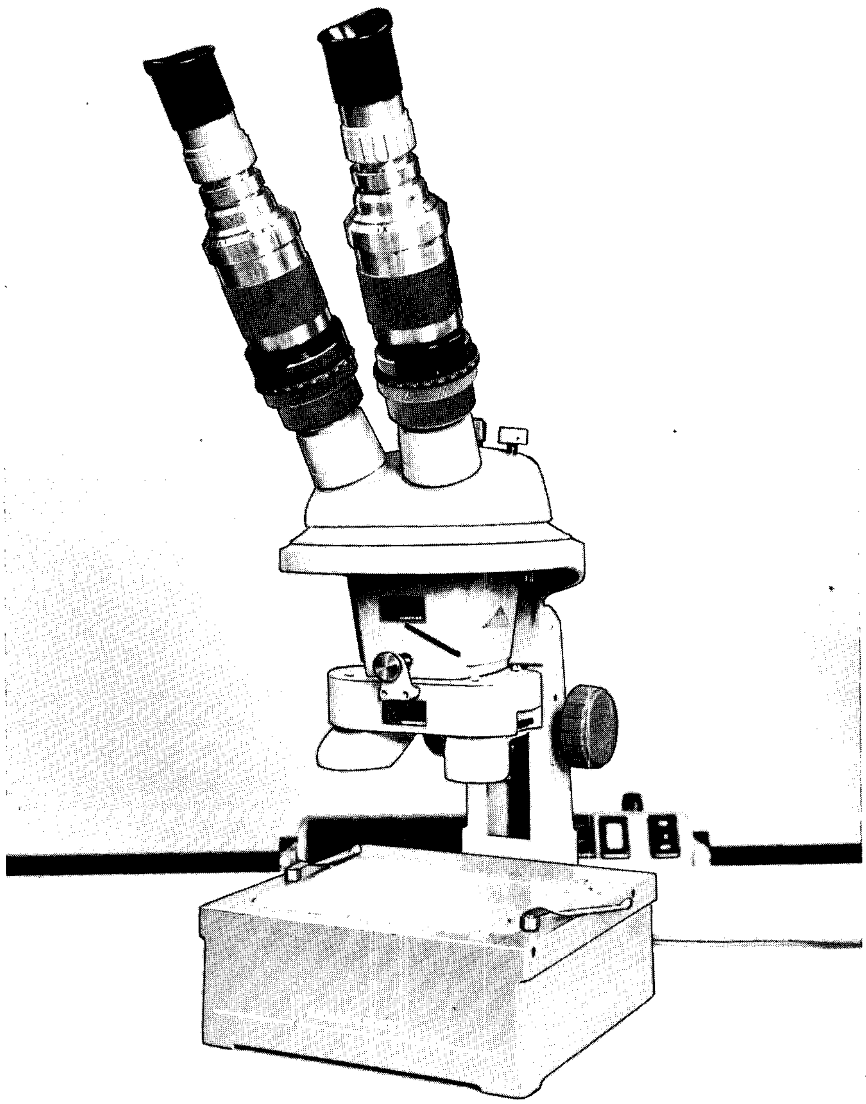


FIGURE 43. [redacted] STEREOMICROSCOPE. NPIC J-8946 (3/65)

[redacted]

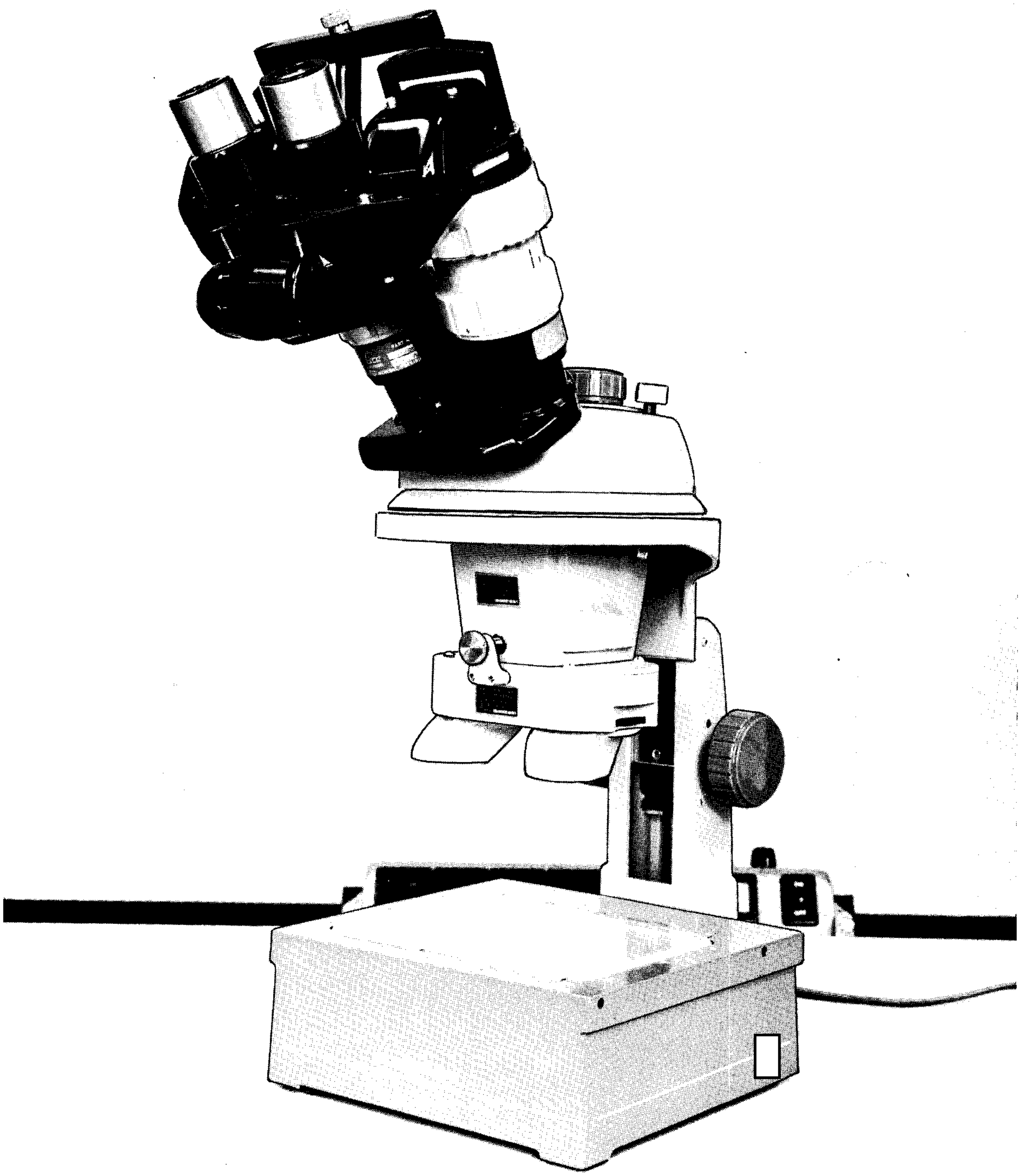
8. VARIABLE RATIO ANAMORPHIC EYEPIECE (PROTOTYPE)

These are eyepieces which can be used with a [redacted] Zoom 70 Microstereoscope to enable the operator to enlarge the image along 1 axis with the other axis being held to the fixed microscopic magnification. These eyepieces will enable the operator to "stretch" the image up to 3x in 1 axis, thereby providing the interpreter with a capability to visually rectify images. The prototypes have been developed by [redacted] (Figure 44) and by [redacted] (Figure 45). Production models are due in May 1965 at a cost of $[redacted]



NPIC J-8947 (3/65)

FIGURE 44. VARIABLE RATIO ANAMORPHIC EYEPIECE [redacted] PROTOTYPE).



NPIC J-8948 (3/65)

FIGURE 45. VARIABLE RATIO ANAMORPHIC EYEPIECE [redacted] PROTOTYPE).

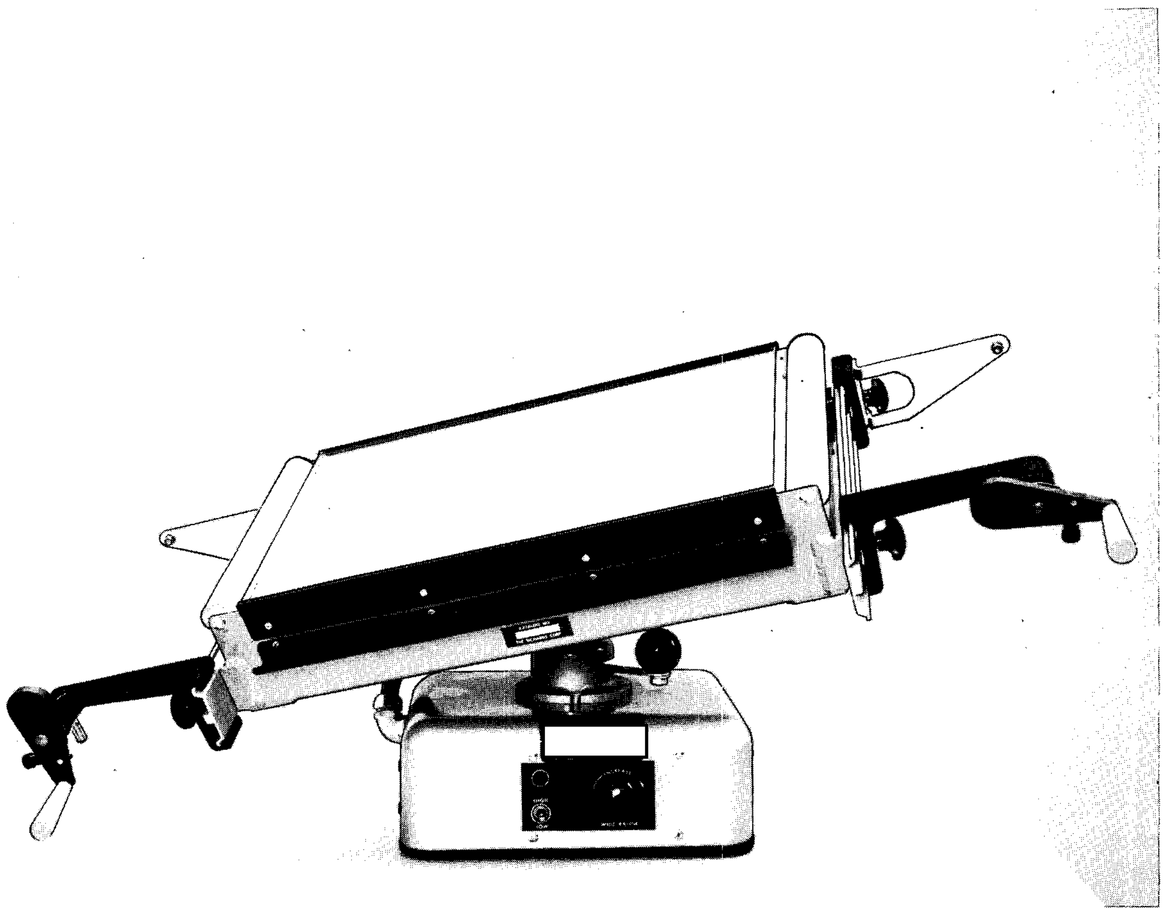
[redacted]

[redacted]

D. LIGHT TABLES

1. [redacted] LIGHT TABLE (MODEL GFL 918)

The [redacted] GFL 918 Light Table (Figure 46) has an 11- by 18-inch viewing surface mounted on a universal ball-and-socket base with adjustable tension, allowing over 45 degrees of tilt in any direction. All Richards light tables are available with a cold-light grid having an infinitely variable intensity control from 900 foot lamberts intensity, complete diffusion being accomplished through a specially coated grid and a translucent plastic top. A plate-glass top for a rigid working surface is also available. The table can handle film from 70mm to 9.5 inches in width and up to 500 feet in length with welded polyester transport belts and single-reel brackets; with segmented nylon rollers and dual reel brackets, it has the additional capacity of handling two 70mm, or one 70mm and one 5-inch, film roll up to 500 feet in length. All reel brackets have adjustable nylon drags, positive-latching spindle retractors, and full ball-bearing spindles. The unit is 32 inches wide, 12 inches deep, 11 inches high, weighs 55 pounds, and costs [redacted]



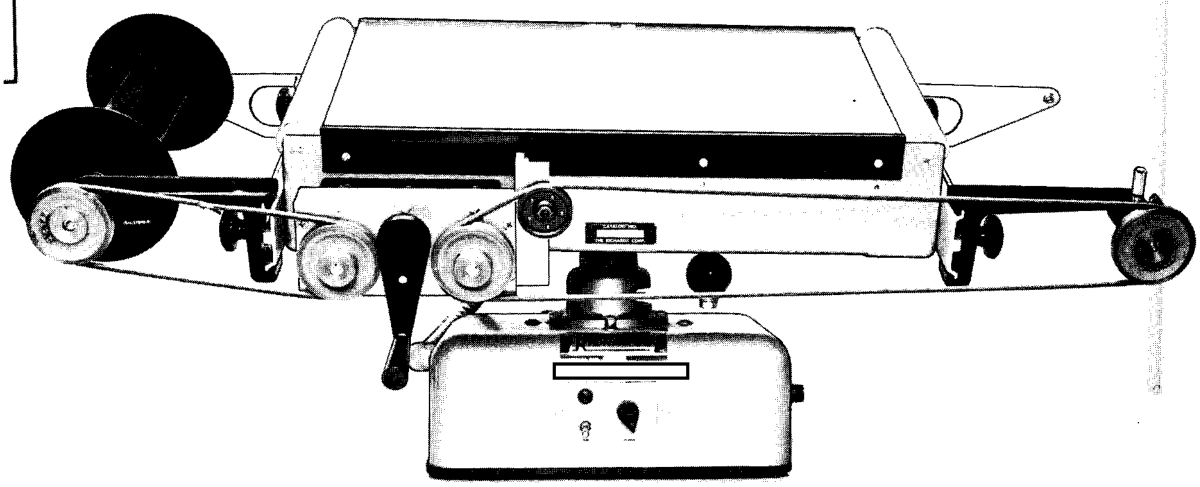
NPIC J-8949 (3/65)

FIGURE 46. [redacted] LIGHT TABLE (MODEL GFL 918).

[redacted]

2. SINGLE-CRANK DRIVE FOR 918 LIGHT TABLE

A single-crank drive for the [redacted] GFL 918 Light Table (Figure 47) has been designed and fabricated in-house. Intended for use when the table is in a tilted position, the device is mounted near the bottom of the table and allows an operator to wind film onto either film spool by simply turning the crank in the proper direction. The production model is due in May 1965 at a cost of [redacted]



NPIC J-8950 (3/65)

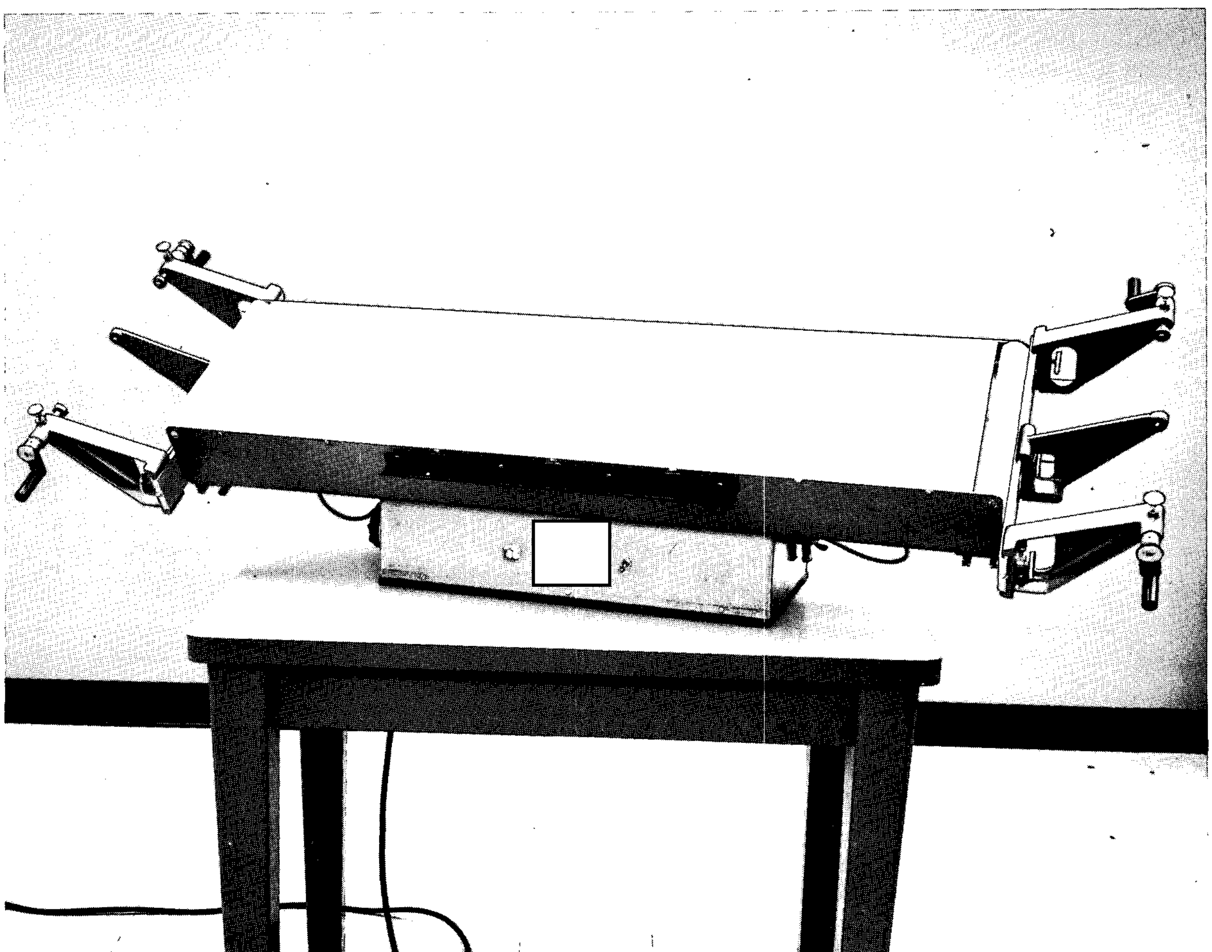
FIGURE 47. SINGLE-CRANK DRIVE FOR 918 LIGHT TABLE.

[redacted]

[redacted]

3. [redacted] LIGHT TABLE (MODEL GFL 940)

This table (Figure 48) provides an 11- by 40-inch viewing surface, tiltable up to 45 degrees forward, with a [redacted] cold-light grid, controls, and reel brackets. An engraved grid system can be provided on the plastic table top, to order. Optionally available on this and other models is an ultrasonically spliced polyester transport belt on ball-bearing rollers. This table is available either with standard light source, cold-light argon-mercury grid having at least 900 foot lambert intensity at 70 degrees F, or with encapsulated light source, cold-light argon-mercury grid embedded in clear elastomer matrix having at least 900 foot lambert intensity at 70 degrees F. The table is 54 inches wide, 12 inches deep, 11 inches high, weighs 70 pounds, and costs [redacted]



NPIC J-8951 (3/65)

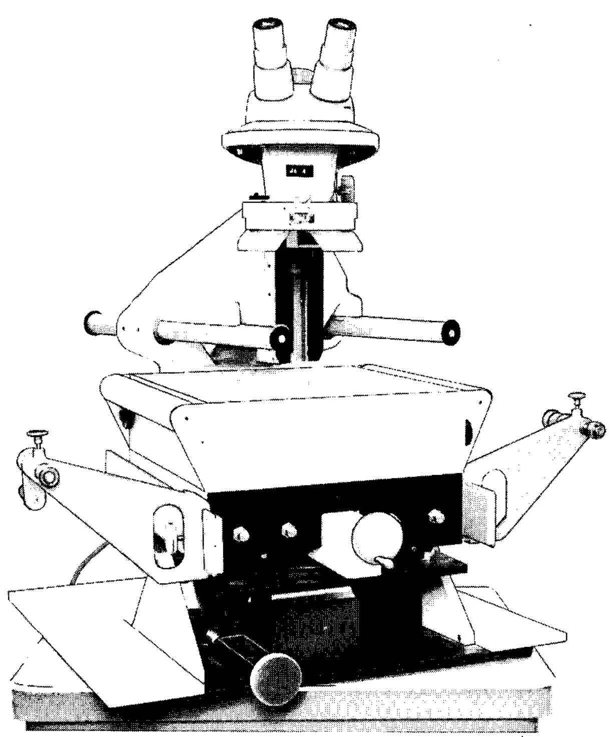
FIGURE 48. [redacted] LIGHT TABLE (MODEL GFL 940).

[redacted]

4. [redacted] LIGHT TABLE (MODEL 45)

The [redacted] Model 45 Light Table (Figure 49) is a unique, custom-made viewing table. Designed for the convenience of the operator, the instrument has many capabilities which have never been utilized together in a single film-viewing device. With a [redacted] zoom microscope mounted in the bracket provided, the operator may study an area on any portion of the 9.5- by 11.5-inch illuminated surface under magnification up to 60x.

For the convenience of the operator, the table has been designed to rotate up to 90 degrees on either side of center and tilt 35 degrees to the front. The microscope may be traversed 5.5 inches forward or back along slides, and the slide mount itself may be rotated. The actual viewing table may be traversed from side to side more than 1.5 inches from center. Versatility was also considered during the planning and, consequently, the instrument is capable of handling either two 70mm rolls of film side by side, or 1 of any other width of film up to 9.5 inches. To cut down on eye strain while working over the viewing table, sliding opaque masks may be moved from the front and rear. The illumination, consisting of 4 sets of 3 fluorescent lamps each, may also be varied by independent switches to the sets. To provide even lighting, an opalescent plastic diffuser is mounted beneath the .25-inch plate-glass surface. This illumination, together with the multi-motion frame and microscope mount, comprises a relatively compact unit weighing roughly 75 pounds and taking up an area less than half a normal desk top.

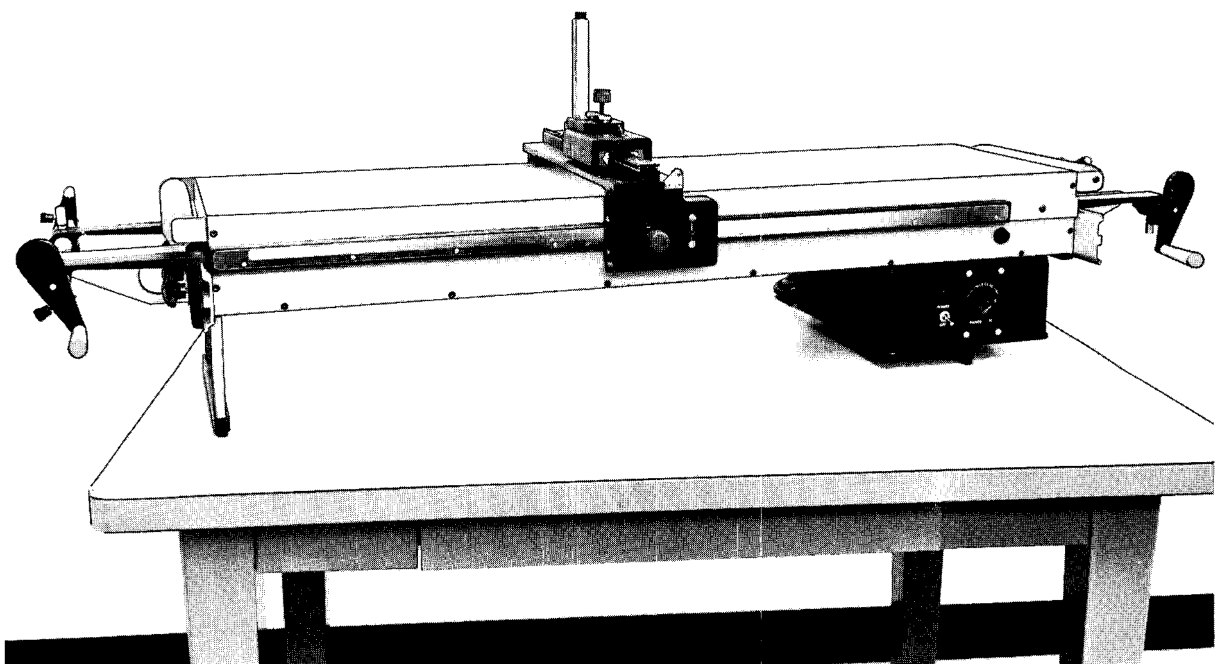


NPIC J-8952 (3/65)

FIGURE 49. [redacted] LIGHT TABLE (MODEL 45).

5. [redacted] LIGHT TABLE (MODEL GFL 940MC)

This table (Figure 50) provides an 11- by 40-inch viewing area with a cold-light grid having infinitely variable control with a 5:1 ratio (20:1 ratio optional) from 900 foot lamberts. [redacted]-type T-2-5 reel brackets with multiple nylon rollers provide for the viewing of dual 70mm or 5-inch film widths on standard 7.625 inch reels (500 feet) or single films from 70mm to 9.5 inches in width. Brackets have adjustable nylon brakes permitting any desired film tension over the viewing area and positive cam latches for the retractable spindles. The microscope carriage covers a 10- by 28-inch area with full recirculating ball-bearing suspension, adjustable drag brakes, and limit stops. In addition, a quick and simplified optical measurement of X and Y coordinates can be provided. Other optional equipment available includes an encapsulated light source, reel brackets to accommodate 1,000-foot spools, and a vacuum hold-down top. The table is 40.5 inches wide, 17 inches deep, 14 inches high, weighs 80 pounds, and costs [redacted]



NPIC J-8953 (3/65)

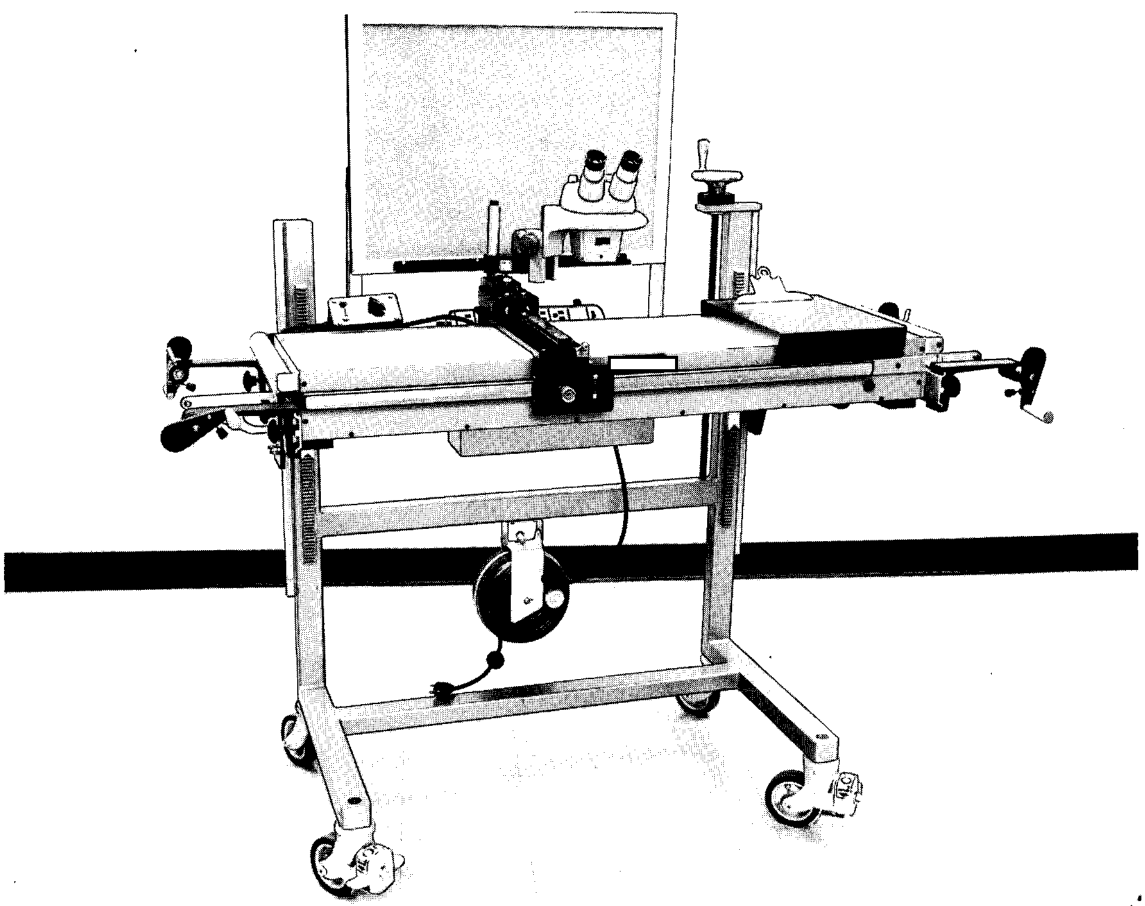
FIGURE 50. [redacted] LIGHT TABLE (MODEL GFL 940MC).

[redacted]

[redacted] 25X1

6. [redacted] LIGHT TABLE (MODEL GFL 940MCE)

This unit (Figure 51), a combination of the Model GFL 940MC Light Table and the new Model TE-2140 Elevating Table, allows the photo interpreter to be seated in a comfortable position without strain while viewing the full range of film sizes this table can handle. All the features of the Model GFL 940MC Light Table have been retained, including variable-intensity cold-light source, recirculating ball-bearing microscope carriage, and a choice of T-series reel brackets. Operating controls are mounted in a detached control box which can be located wherever desired on the table. These units are available with a choice of accessories, such as power-plug strip, retractable 20-foot powercord fused for 7 amperes, heavy-duty coiled powercord fused for 15 amperes, drawers, or backboard. In addition, the unit can readily be equipped with the [redacted] Optical Measuring System for rapid film measurement. The unit is 40.5 inches wide, 24 inches deep, 48 inches high, weighs 270 pounds, and costs about $[redacted]



NPIC J-8954 (3/65)

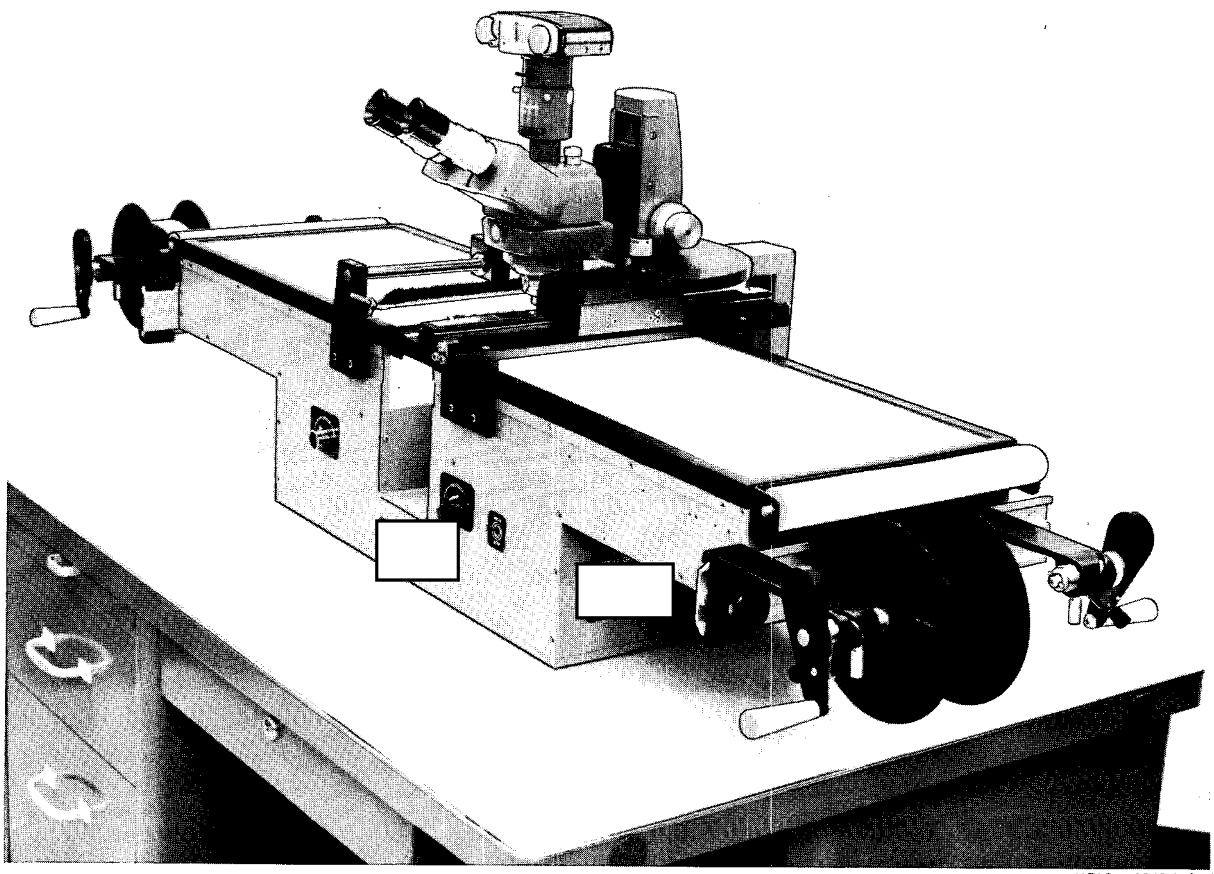
FIGURE 51. [redacted] LIGHT TABLE (MODEL GFL 940MCE).

[redacted]

[redacted]

7. LIGHT TABLE MOUNTED WITH [redacted] MICROSCOPE

This unit (Figure 52), developed primarily for use in film evaluation, consists of an old-style [redacted] GFL 940 Light Table especially adapted to mount a stock [redacted] Microscope with associated photo-micrographic equipment. The split light table has an integral-tracking high-intensity light source.



NPIC J-8955 (3/65)

FIGURE 52. LIGHT TABLE MOUNTED WITH [redacted] MICROSCOPE.

8. ADVANCED-CONCEPT LIGHT TABLES

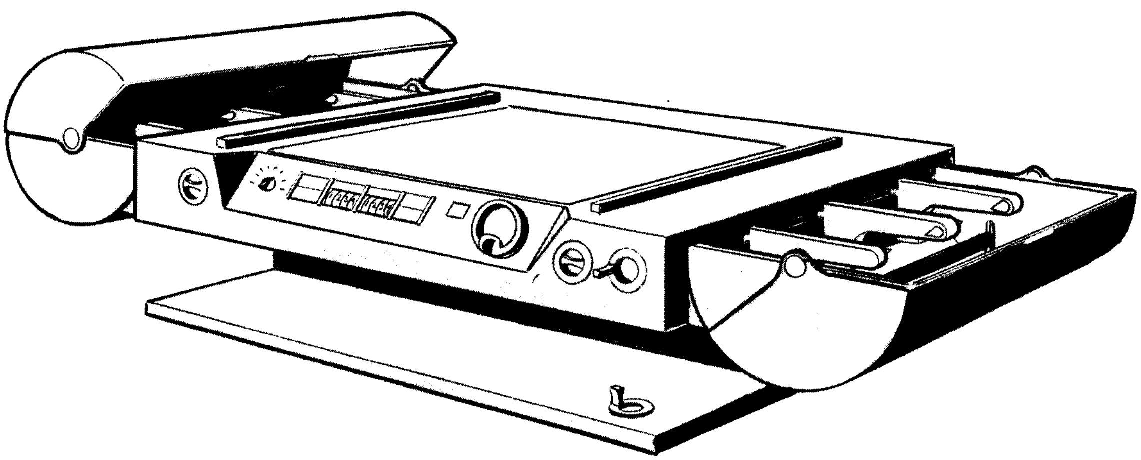
In a parallel effort by 2 manufacturers, similar groups of 3 prototype advanced-concept light tables are currently under development. These 3 prototype models are:

a. An 11- by 18-inch format tilt-top unit (Figure 53)

b. An 11- by 40-inch format non-tilting unit with translating microscope carriage (Figure 54)

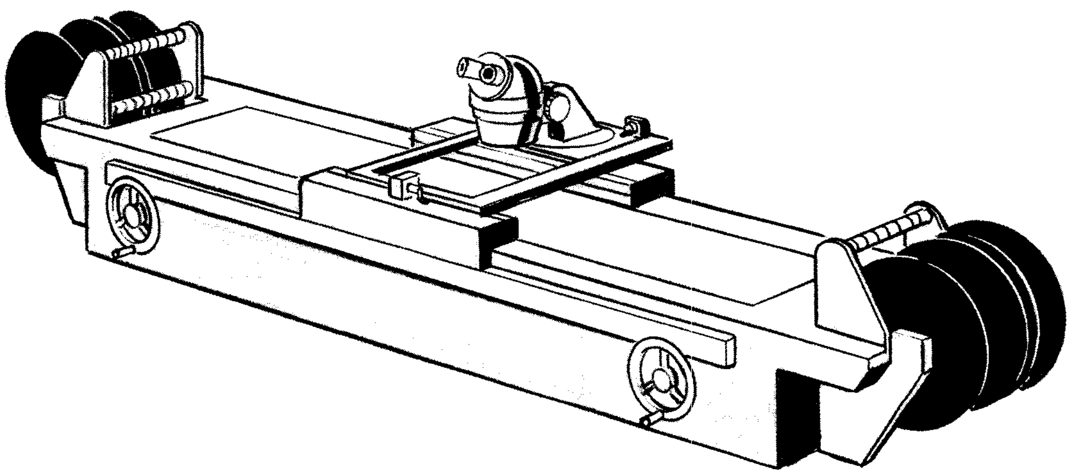
c. An 11- by 40-inch format non-tilting unit with translating microscope carriage and an integral high-intensity tracking light source (not illustrated)

Overall, this effort will result in sophisticated but reliable prototype light tables designed with due regard for human engineering and providing better illumination, better film drives, and more comfortable viewing conditions for the operator.



NPIC J-8956 (3/65)

FIGURE 53. 11- BY 18-INCH FORMAT TILT-TOP LIGHT TABLE.



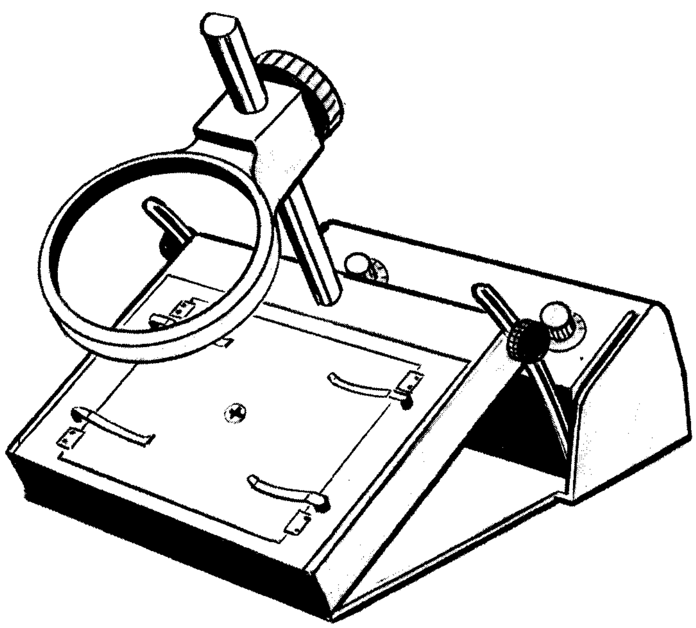
NPIC J-8957 (3/65)

FIGURE 54. 11- BY 40-INCH FORMAT LIGHT TABLE WITH TRANSLATING MICROSCOPE CARRIAGE.

[redacted]

9. [redacted] TWIN-LIGHT-SOURCE STEREOSCOPIC LIGHT TABLE

This table (Figure 55) will have a large illuminated stereoscopic viewing surface that can be tilted to positions convenient for the user, and is divided into 2 separately controlled viewing areas. Each light source will be continuously variable from 100 to 2,000 foot lamberts, and its operation will be independent of the other. The size of each light source will be 5 by 6 inches and the overall size of the table will be 16 by 17 inches. The light table will accommodate the [redacted] Model II Zoom 70 Stereomicroscope or the [redacted] M-5 Microstereoscope. If viewing in the monoscopic mode, the light baffle between the 2 light sources can be removed and an even distribution of light is produced over the entire 6- by 10-inch viewing area. The production model is due in July 1965, and will cost an estimated $[redacted]

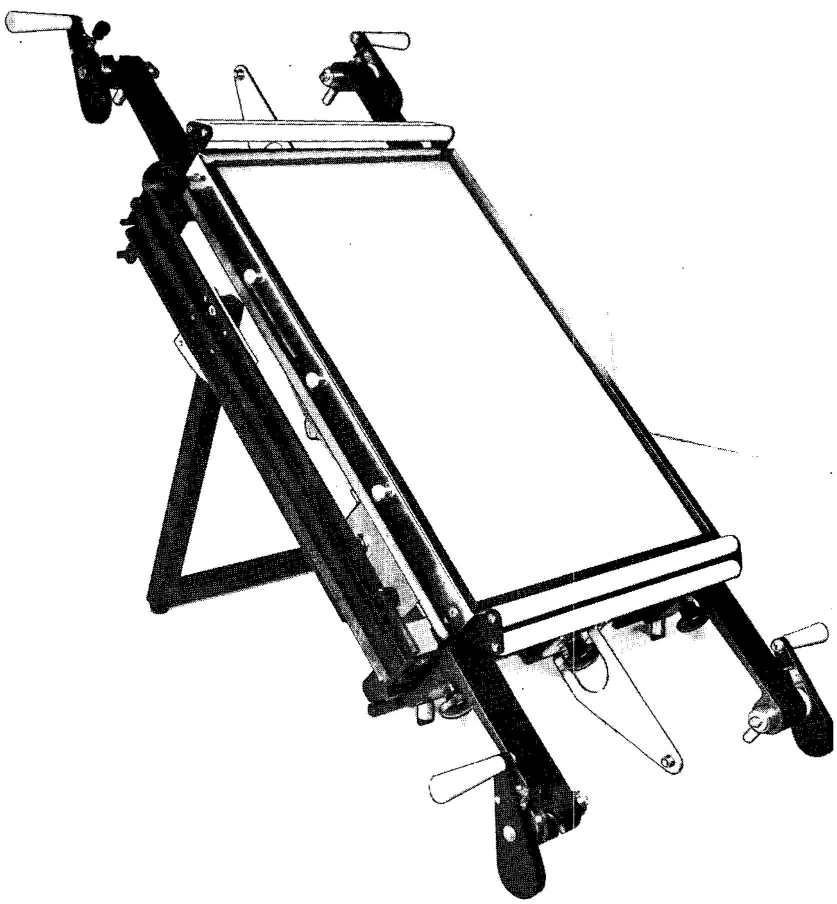


NPIC J-8958 (3/65)

FIGURE 55. [redacted] TWIN-LIGHT-SOURCE STEROSCOPIC LIGHT TABLE.

10. LIGHT TABLE FOR PI FLY-AWAY KIT

This light table (Figure 56), designed for field use, is a rugged, light-weight unit which is completely functional and yet easily packed for shipment. The table is so constructed that the reel brackets and film rollers can be removed, allowing the table to be reduced to a 19.5- by 14.5-inch size. This small, compact size will allow the table to be packed in the present waterproof shipping containers. The brightness of the viewing surface is continuously variable from 100 to 1,200 foot lamberts without flicker. The table is so constructed that it may be used in 2 modes of operation: 30 and 45 degrees. Production models are due by April 1965 at an estimated cost of $[redacted]



NPIC J-8959 (3/65)

FIGURE 56. LIGHT TABLE FOR PI FLY-AWAY KIT.

[redacted] 25X
25X

E. PROJECTORS

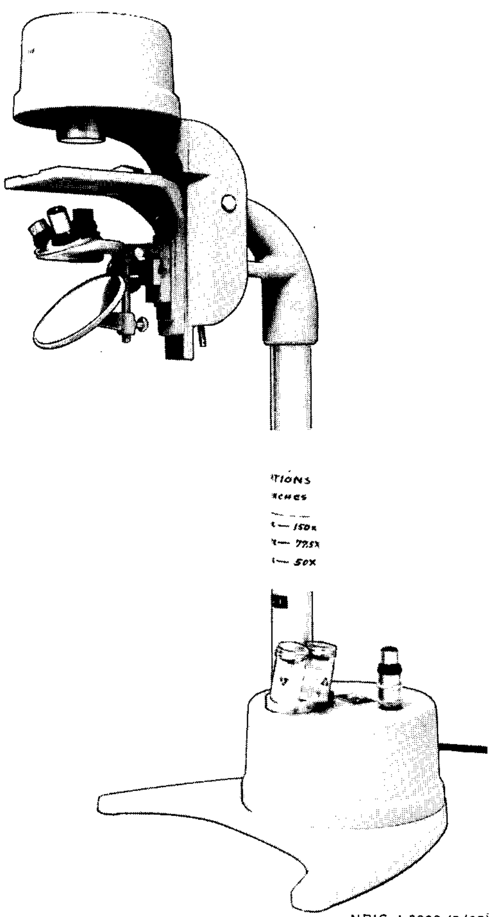
1. [redacted] TRI-SIMPLEX PROJECTOR

X1

Objectives on the Tri-Simplex Projector are of microscopic quality and are balcotted to reduce internal flare which so frequently causes image deterioration. The internal condensing system is the [redacted] 2-lens design, engineered for maximum efficiency and provided with functional heat-absorbing glass. An external swing-in/out supplementary condenser provides ample light intensity for the high-power 43x objective. In addition, there is a 12x objective as standard equipment, and 2.7x and 5x achromatic objectives as optionals at extra cost. The 4-inch-square stage is recessed to compensate for cover-glass thickness. A 3.5-inch-diameter mirror with a clamp and supporting post serves to project images onto a vertical surface.

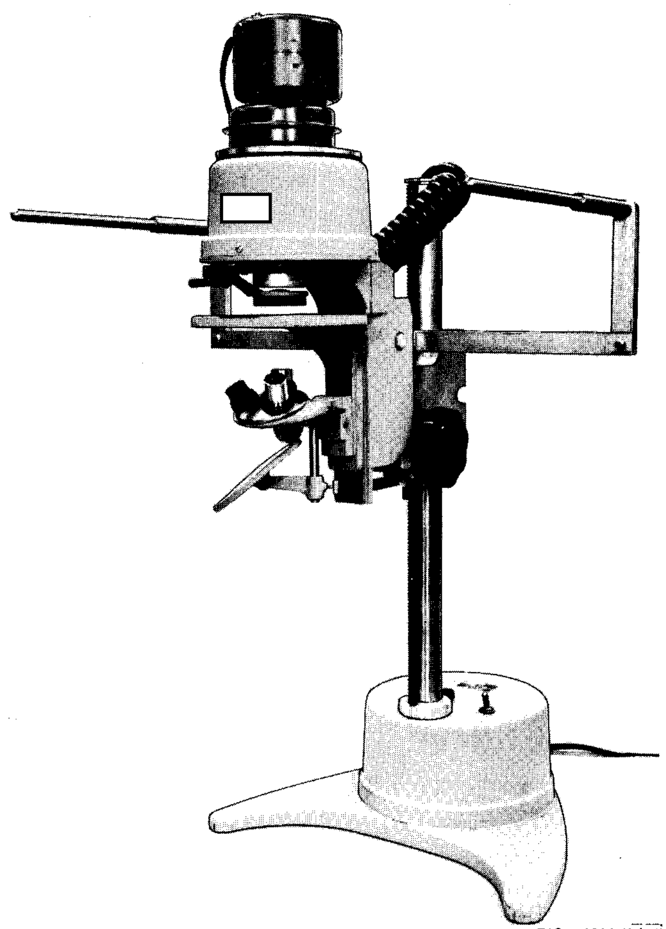
X1

The original model of this instrument (Figure 57), which costs $174, has now been generally superseded by a US-Navy-developed modification (Figure 58), which costs [redacted] 25X



NPIC J-8960 (3/65)

FIGURE 57. [redacted] TRI-SIMPLEX PROJECTOR, ORIGINAL MODEL.



25X

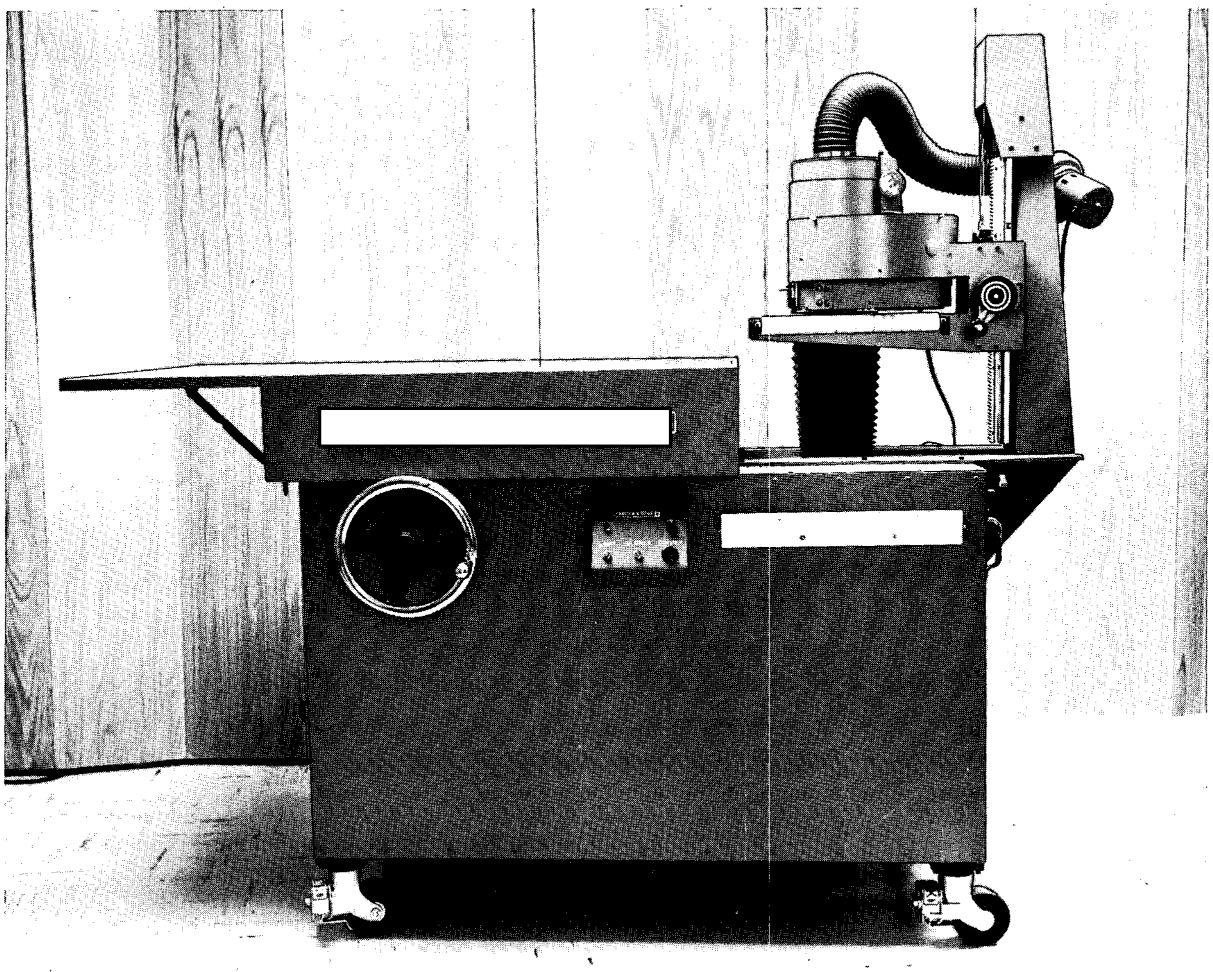
NPIC J-8961 (3/65)

FIGURE 58. [redacted] TRI-SIMPLEX PROJECTOR, MODIFICATION. 25X

X

2. [redacted] VARIABLE-MAGNIFICATION TRACING PROJECTOR

This prototype tracing projector (Figure 59), developed for the NPIC by [redacted] provides a ready means of projecting contact-size film positives at magnifications ranging from 2x to 16x for the purpose of preparing line drawings. The image is rear-projected onto tracing material placed over a 24- by 24-inch horizontal, glass work-surface. Either film chips or roll film from 70mm to 9.5 inches in width can be used on the instrument, which costs approximately [redacted]



NPIC J-8962 (3/65)

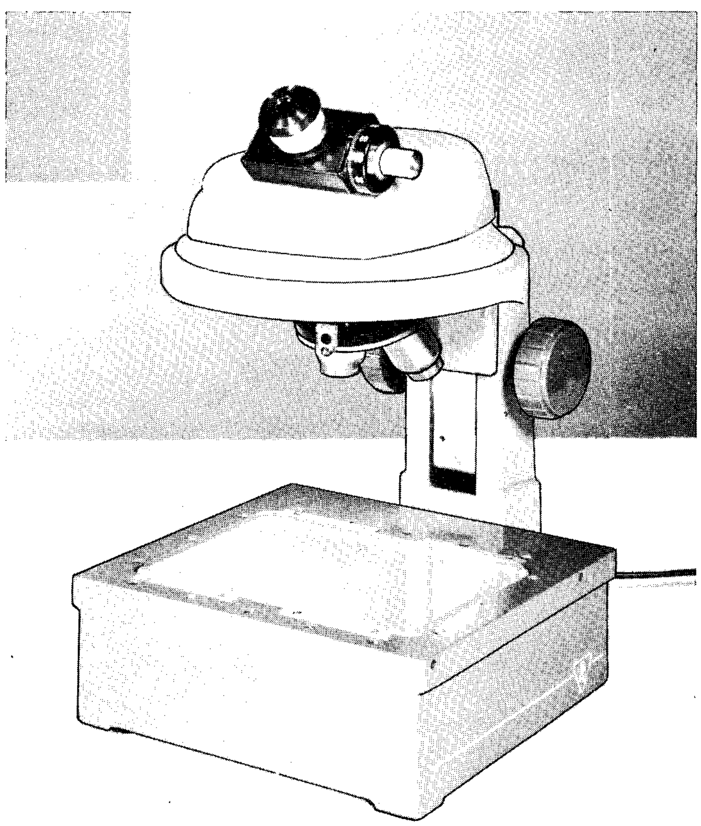
FIGURE 59. [redacted] VARIABLE-MAGNIFICATION TRACING PROJECTOR.

F. MISCELLANEOUS MEASURING TOOLS

Two recently developted measuring tools are now shelf items with the manufacturer: the [redacted] Dual-Power Measuring Macroscope, and the Model I Projected-Scale Micrometer. An advanced version projected-scale micrometer, the Model II, is currently under contract.

1. [redacted] DUAL-POWER MEASURING MACROSCOPE

This device (Figure 60) provides more facility, twice the resolution, and 10 times the accuracy of the zoom macroscope, which was previously the best simple measuring tool for small images. The filar eyepiece measuring device with 20.5x and 41x magnification can be mounted in any ring stand that would normally accept a [redacted] power pod. Its cost is $[redacted]



NPIC J-8963 (3/65)

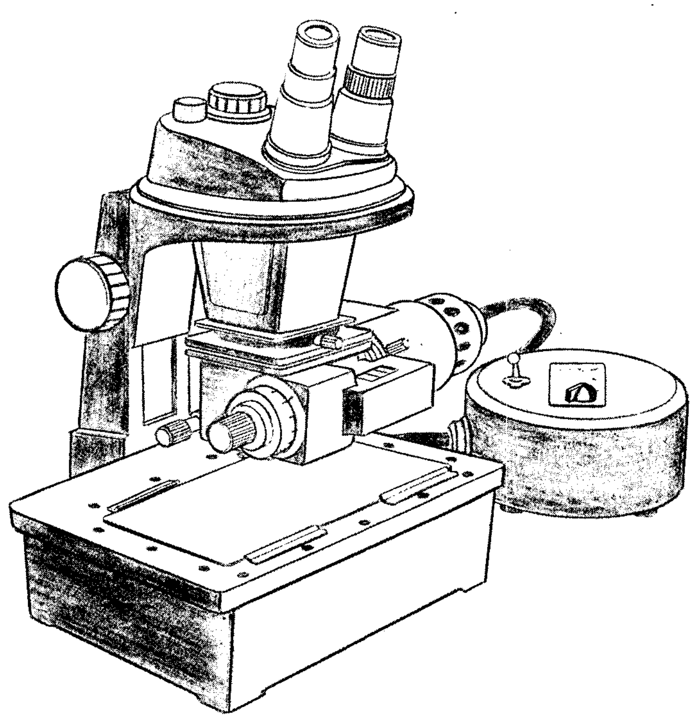
FIGURE 60. [redacted] *DUAL-POWER MEASURING MACROSCOPE.*

2. [redacted] PROJECTED-SCALE MICROMETER (MODEL I)

This already developed shelf item (not illustrated) is a projection-type measuring device which clips to the base of the Model II Zoom 70 Stereomicroscope. It permits binocular viewing of a .00001-foot scale superimposed on the photographic image through the Zoom 70's full range of magnification. Its cost is $500.

3. [redacted] PROJECTED-SCALE MICROMETER (MODEL II)

This instrument (Figure 61) incorporates many improvements over the Model I production version, including: a luminous-line reticle instead of a scale projected into the plane of the photograph, the reticle being moved across the field of view by a micrometer screw; a combination digital counter/micrometer drum that will record the measurement. In addition, the unit will be more compact and the micrometer drum will remain in a fixed position when the line azimuth is rotated. The production model is due in November 1965 and will cost [redacted]



NPIC J-8964 (3/65)

FIGURE 61. [redacted] PROJECTED-SCALE MICROMETER (MODEL II).

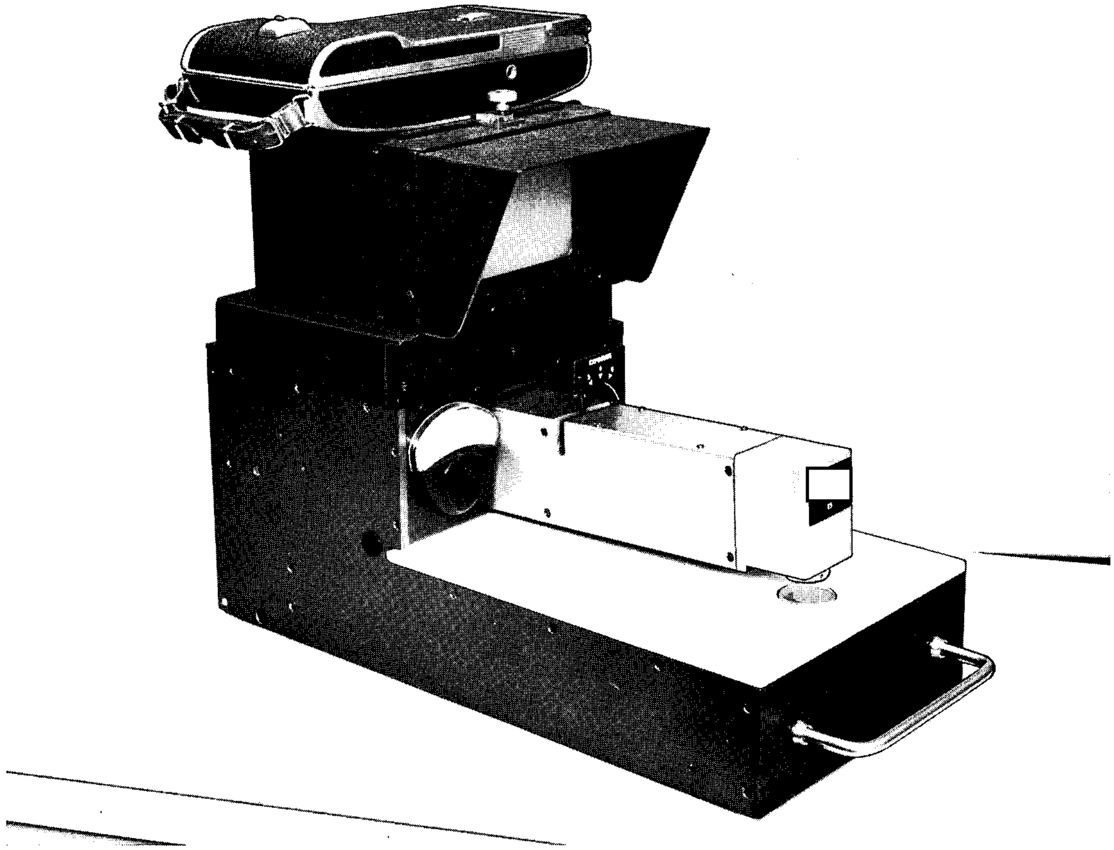
[redacted]

[redacted]

G. MISCELLANEOUS TOOLS

1. [redacted] PHOTOMICROGRAPHIC ENLARGER

The [redacted] Photomicrographic Enlarger (Figure 62) is designed to meet the need of photo interpreters and photogrammetrists who must frequently make photomicrographs yet cannot afford more than a minimum of time, effort, and preparation. The enlarger provides magnified permanent photographic records of small areas of film and is intended for table-top use in ambient light. It incorporates all the necessary elements for high-quality photomicrography, including condenser unit, microscope objective, ocular, viewing screen, and Polaroid film back. Exposure and fine-focus adjustments are provided for occasional trim-up or use with a filter. A choice of 3 magnifications (15x, 33x, or 64x) is offered by substituting objective heads. The first production models are due in June 1965 at an estimated cost of $[redacted]



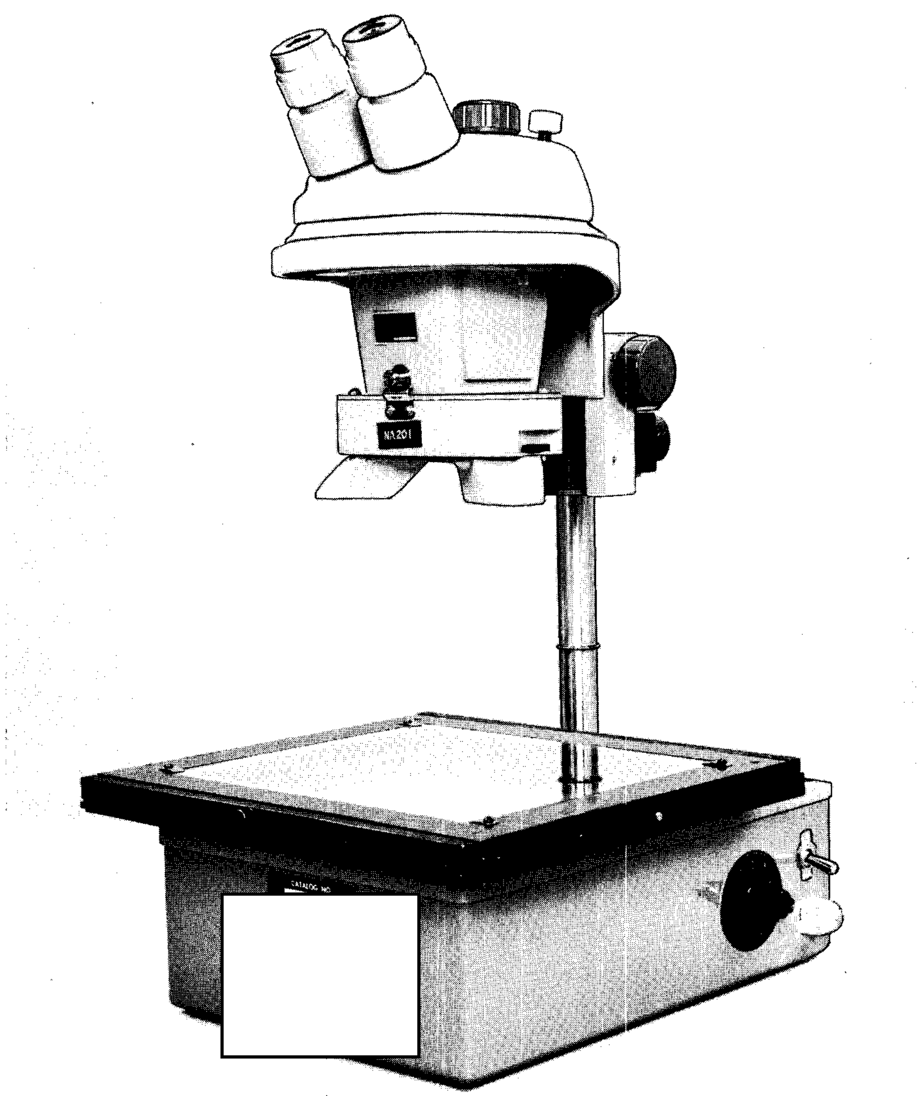
NPIC J-8965 (3/65)

FIGURE 62. [redacted] PHOTOMICROGRAPHIC ENLARGER.

[redacted]

2. X-Y TRANSLATING STAGE

An X-Y translating stage, designed and fabricated in-house, consists of a movable stage that is easily mounted on a light base to permit film scanning in the X-Y directions. The stage was designed primarily for the [redacted] Zoom 70 Stereoscopes that have the pod support arm set back from the rear edge of the light base. However, it is versatile and can be used with other stereoscopes having similar light bases, as illustrated (Figure 63).



NPIC J-8966 (3/65)

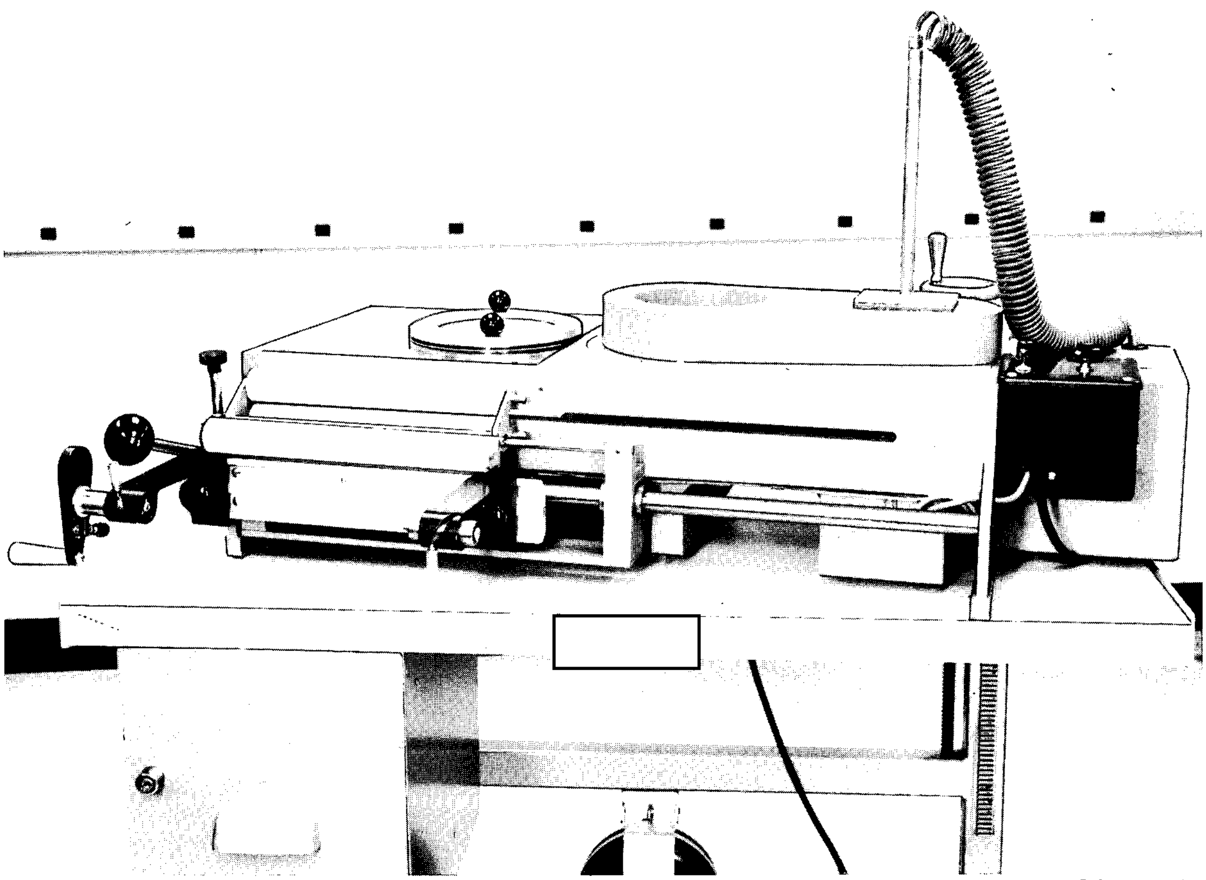
FIGURE 63. X-Y TRANSLATING STAGE.

 25X

[redacted] 25X

3. [redacted] CHIP CUTTER

This chip cutter (Figure 64), designed by the [redacted] cuts rectangular chips from film frames on roll film. Although it presently produces 70mm by 100mm chips, it could easily be redesigned to cut other sizes. The instrument operates in a horizontal position and consists of a die-cutter assembly, 2 light tables with film rewinds, and a vacuum chip-removal device. Its cost is $[redacted]. 25X



NPIC J-8967 (3/65) 25X

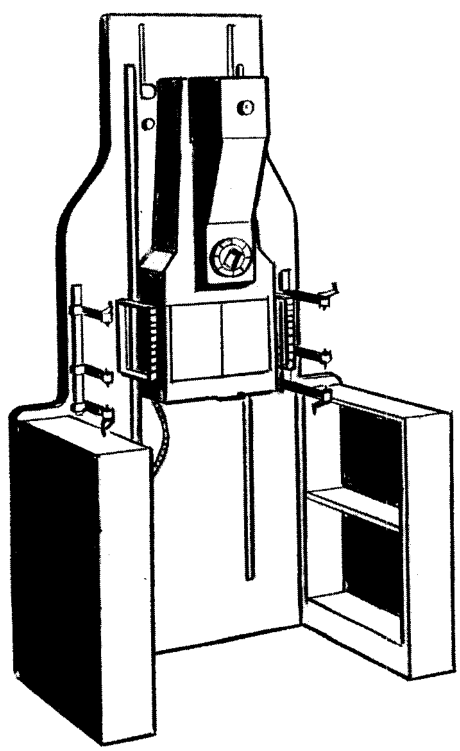
FIGURE 64. [redacted] CHIP CUTTER. 25X

 25X

4. CHIP CUTTER

This chip cutter (Figure 65), being designed and fabricated in-house, will cut rectangular chips from film frames on roll film. Although the prototype will produce 70mm by 100mm chips, the size can be revised on any subsequent models.

The instrument will consist essentially of an integrated die-cutter assembly and a light table with film rewinds, both mounted in a vertical position that enables the operator to view and cut the film while in a seated position. A 360-degree rotation will be provided in the die-cutter assembly to permit selective azimuth orientation for the base lines of the chips.



NPIC J-8968 (3/65)

FIGURE 65. CHIP CUTTER.

[redacted]

5. [redacted] SLITTER

A slitter for trimming 35mm headliner paper or film has been designed and fabricated in-house (Figure 66). It consists of a series of steel roller cutters, each designed to trim simultaneously from 1 to 3 lines of a specific size of type. Production models are due by May 1965 and will cost $[redacted]

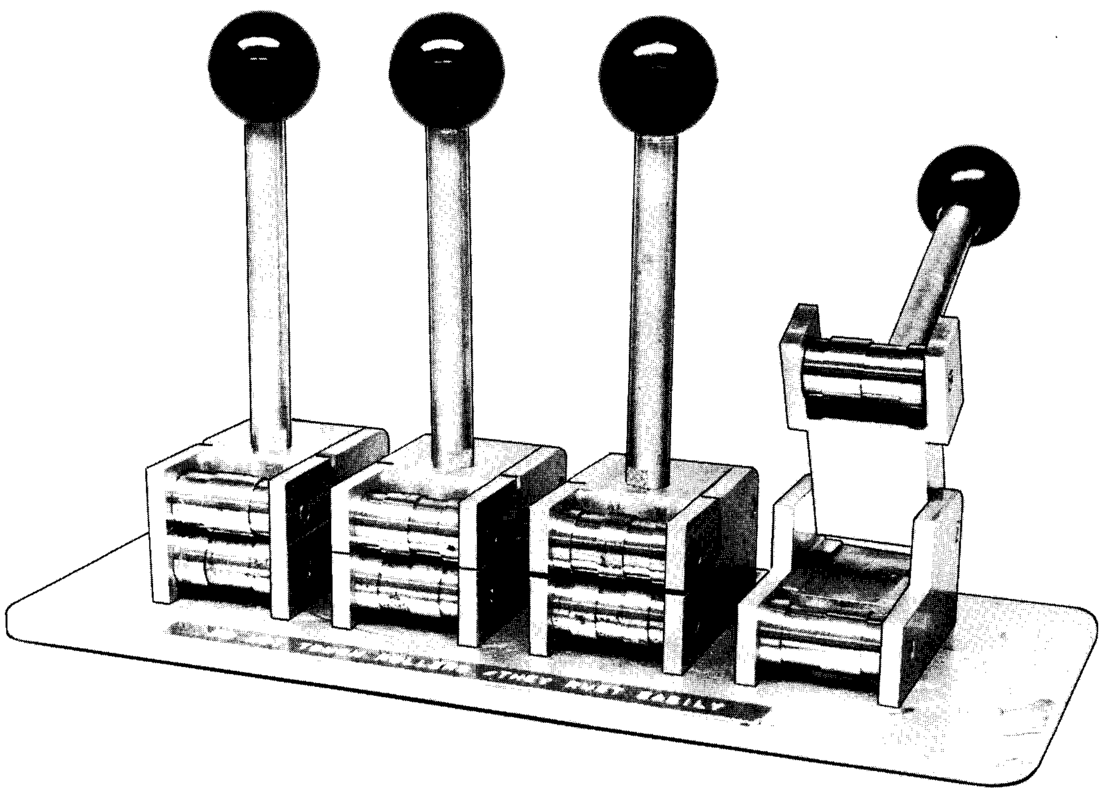


FIGURE 66. [redacted] SLITTER.

NPIC J-8969 (3/65)

SECTION II VIEWING AND INTERPRETATION

Part 2. Complex Interpretation Equipment

A. INTRODUCTION

B. VIEWERS

C. READERS

D. STEREO VIEWERS

A. INTRODUCTION

For the past several years, the quantity of film produced by the various collection systems has necessitated the use of a team concept in photo interpretation, especially in the initial readout phase. This team concept has, in turn, established the need for a variety of group-viewing instruments which the NPIC has been able to satisfy only through the development of increasingly complex rear-projection viewers and through the emerging concept of "Real-Time Photo Measurement" (q.v.) in which viewer-reader combinations permit photo interpreters to perform their own immediate measurements by using this equipment on-line with a computer.

In addition, beyond these general viewing and measuring problems, there is a rapidly growing field of specialized requirements that calls for equipment capable of handling stereo viewing, panoramic stereo viewing, and precisely manipulated viewing, all demanding higher quality, greater magnification, and a wider range of detection capabilities.

To furnish the tools for all these varied objectives, the development approach within the NPIC has been equally varied and, hopefully, all-encompassing. For example, viewer components are being fully explored through independent yet mutually supporting investigations into light sources, film handling systems, lens systems, and screen materials. At the same time, entirely new concepts are being explored, such as aspheric lens systems and virtual image viewing.

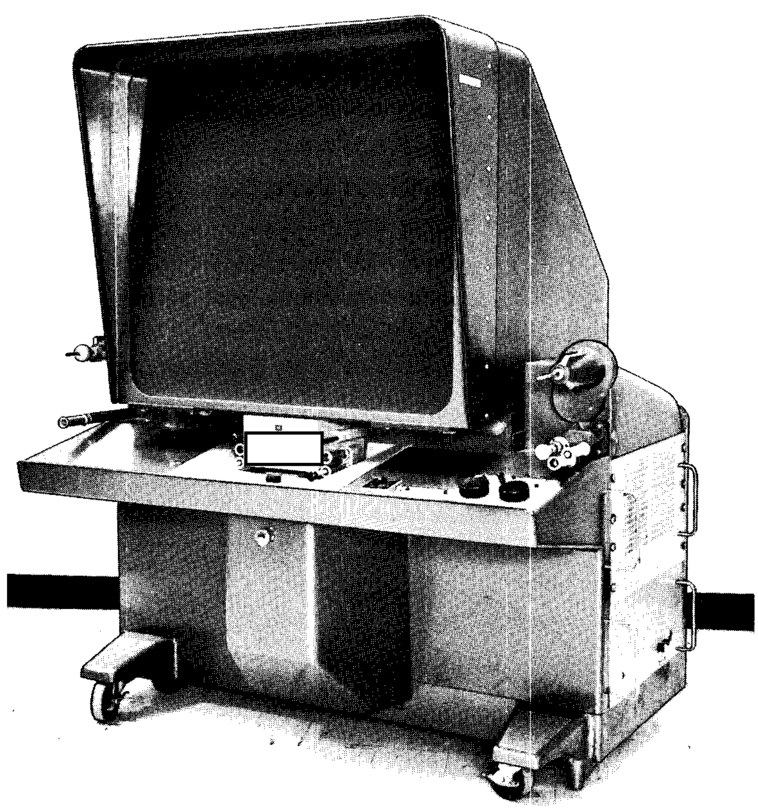
Prototype rear-projection film readers are being built by both the [redacted] 25X1 25X1 in a development program designed to give the photo interpreter a measuring capability while scanning roll film. Both of the new readers will operate directly on-line with the UNIVAC 490 computer, and will have the capability of measuring over a format width of up to 9.5 inches and a length in excess of 4 feet with a least-count of 10 microns in either axis.

Thus, the design and development of a growing family of complex interpretation equipment continues to be an important part of the NPIC exploitation program, as exemplified by the various viewers and readers which are described and illustrated in the second part of this section.

B. VIEWERS

1. [redacted] FILM VIEWER (MODEL 550-M)

This unit (Figure 67) provides rapid scanning and viewing of images on 35mm and 70mm perforated or non-perforated film on reels of up to 1,000-foot capacity. Film transport speed ranges from 0.1 to 3 inches per second in "flomotion" forward or reverse. When the stop switch is actuated, the film is immediately stopped and a solenoid-operated glass platen automatically closed for optimum focus. Upon release, the platen opens and the film continues to advance at the preselected speed. A 2-lens indexing turret is provided, allowing the operator to electrically select either 10x or 20x magnification. The lenses are parfocal and the operator has an additional manual fine-focus control. Each lens has its own optical rotating prism which can be turned 360 degrees. The light source is a 500-watt Sylvania Tru-focus projection lamp. The unit costs [redacted]



NPIC J-8970 (3/65)

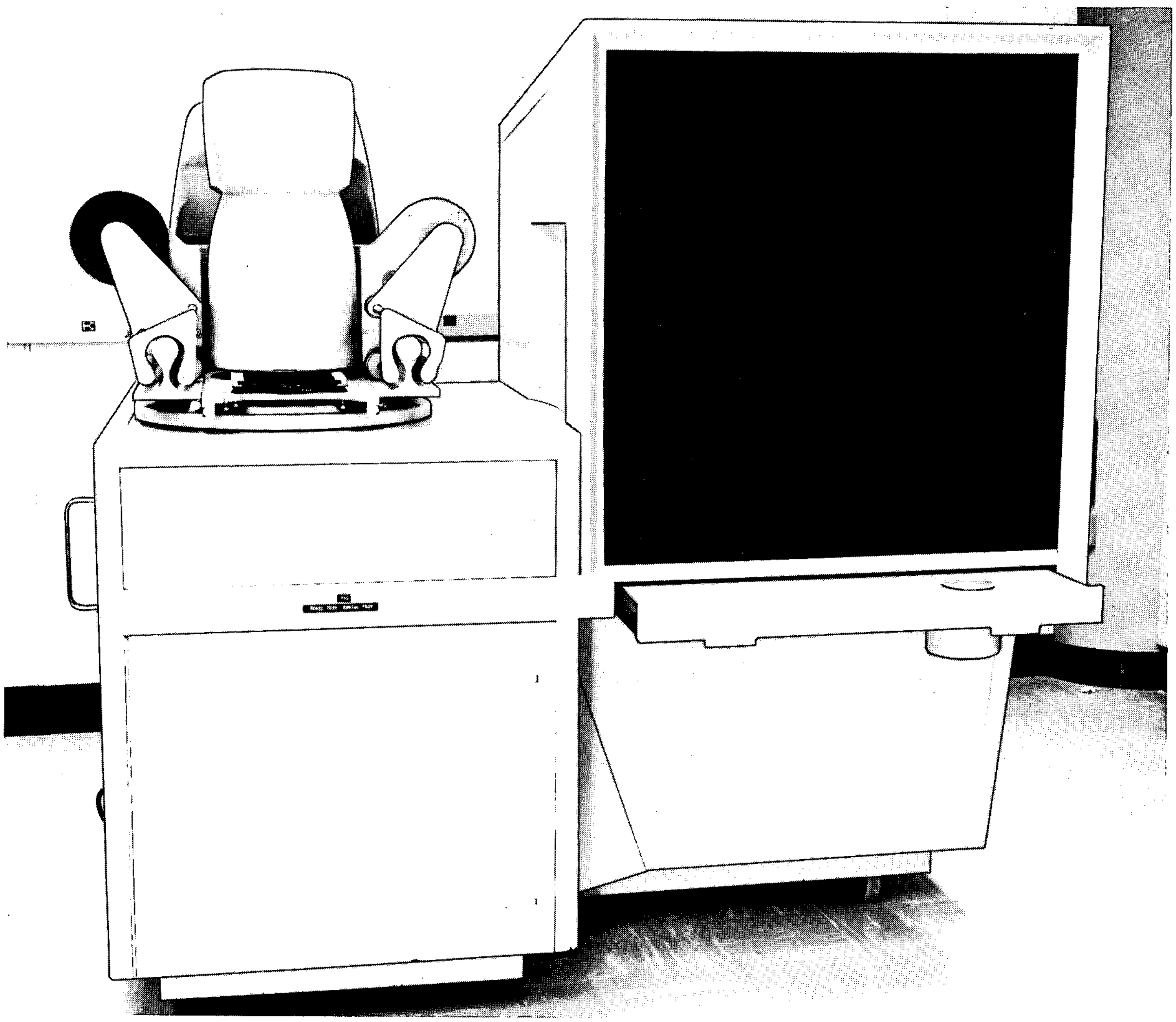
FIGURE 67. [redacted] FILM VIEWER (MODEL 550-M).

[redacted]

[redacted]

2. [redacted] FILM VIEWER, SERIES 700

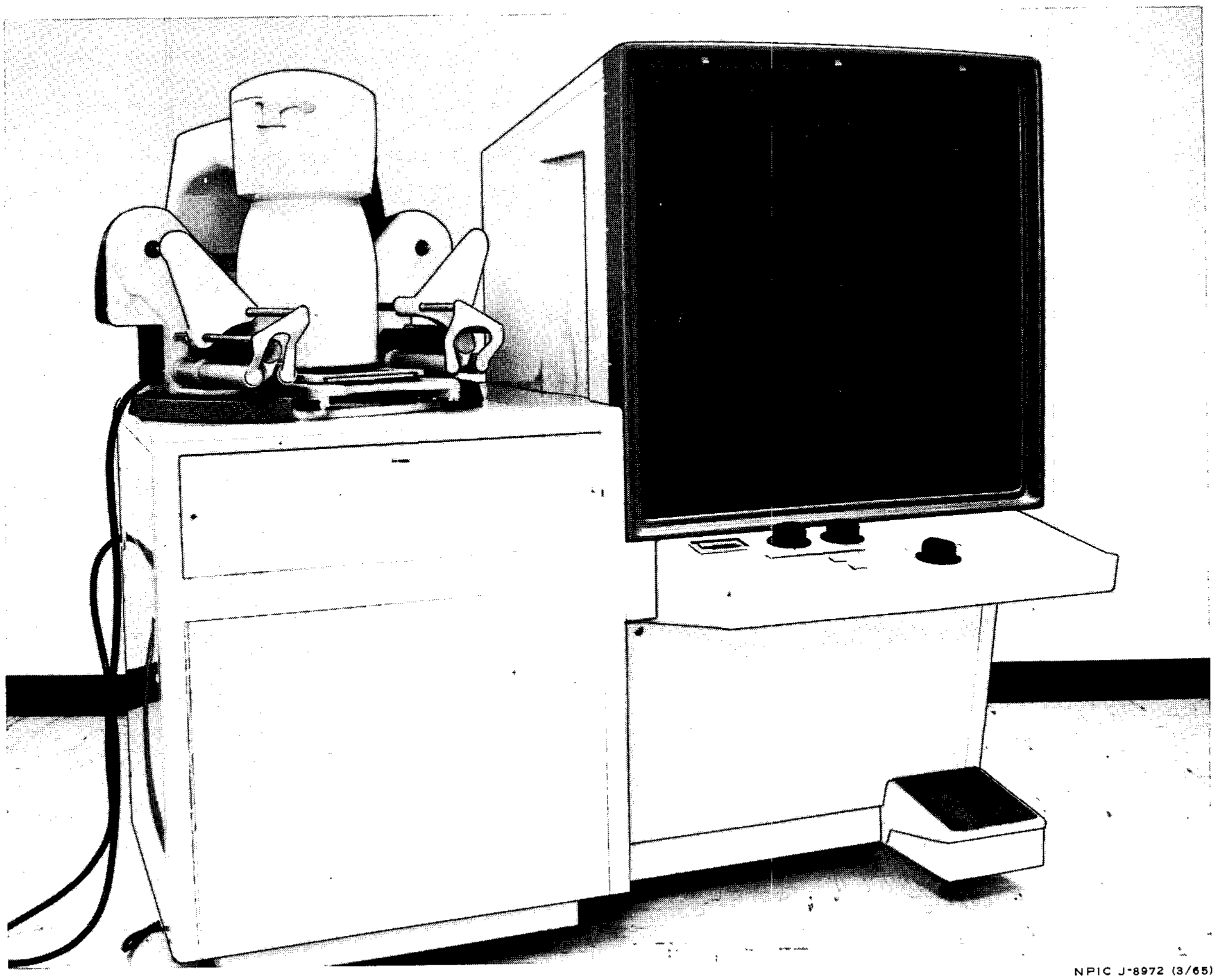
The 700-Series viewers retain many of the qualities of the Model 550-M [redacted] Viewer; they have many additional advantages, however, including the ability to accommodate 70mm to 9.5-inch-wide film and permit viewing and reading of images at 5x, 15x, and 30x magnifications. Two models in this series are illustrated, the 705-V (Figure 68) and the 706-M/V (Figure 69). An improved version, the 707-V, is currently being developed and is discussed separately. The costs of the 705-V and 706-M/V are about the same, approximately [redacted]



NPIC J-8971 (3/65)

FIGURE 68. [redacted] FILM VIEWER, SERIES 700, MODEL 705-V.

[redacted]



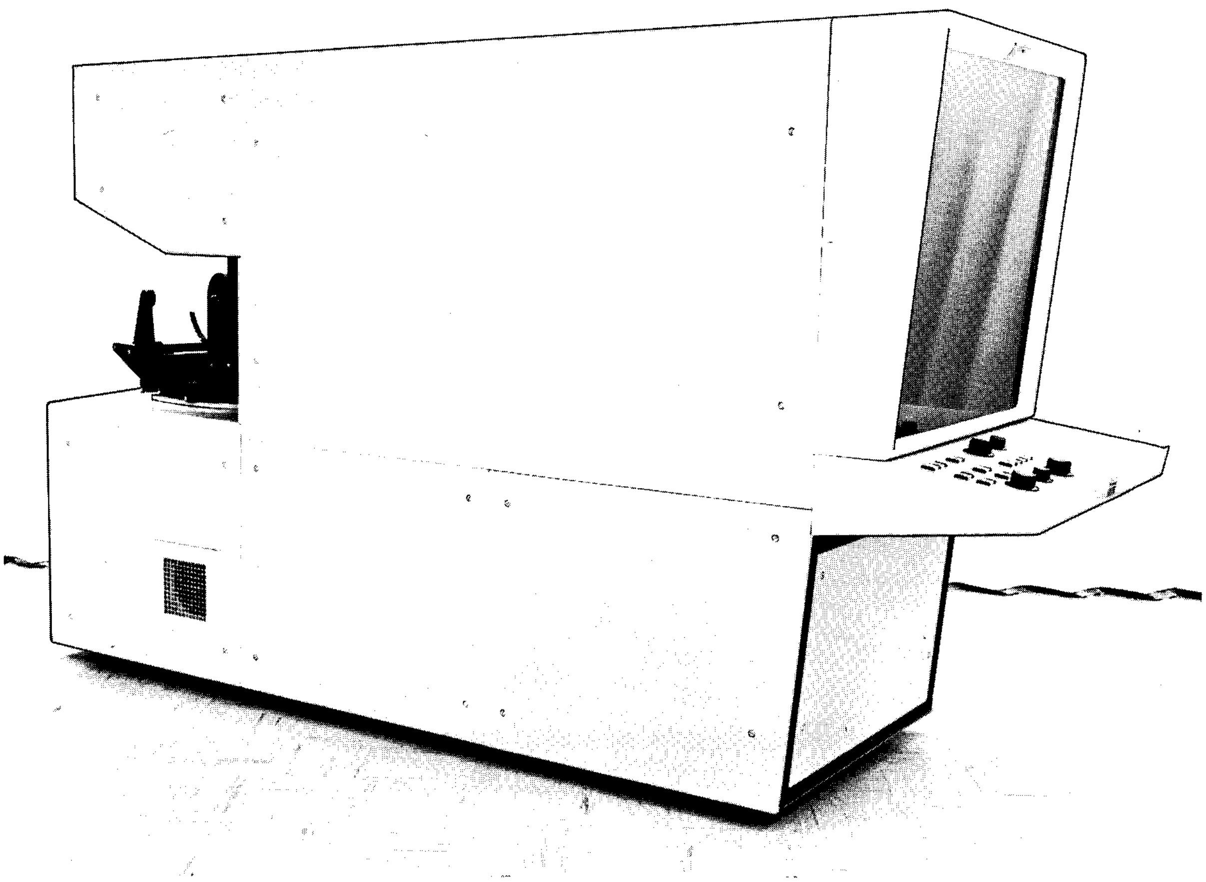
NPIC J-8972 (3/65)

FIGURE 69. [redacted] FILM VIEWER, SERIES 700, MODEL 706-M/V.

X1

3. [redacted] FILM VIEWER (MODEL 707-V)

The Center is currently developing the Model 707-V rear-projection film viewer (Figure 70), which has improved performance characteristics over the Model 706-M/V, the last in the [redacted] 700-Series viewers. The new model is of the single-image reflecting-mirror type and has a completely redesigned film transport, condenser system, and lens-shift mechanism. As with the older models in the 700 Series, this one will also have fixed magnifications of 6x, 12x, and 30x with a maximum projection aperture of 5 inches and a film accommodation width of up to 9.5 inches. In addition, the on-axis illumination may exceed 200 foot lamberts at all magnifications, and the resolution will be no less than 6 lines per power. Sufficient flexibility has been included within the new design parameters to allow future modifications for the further upgrading of this viewer. The production model is due by January 1966 and will cost about [redacted]

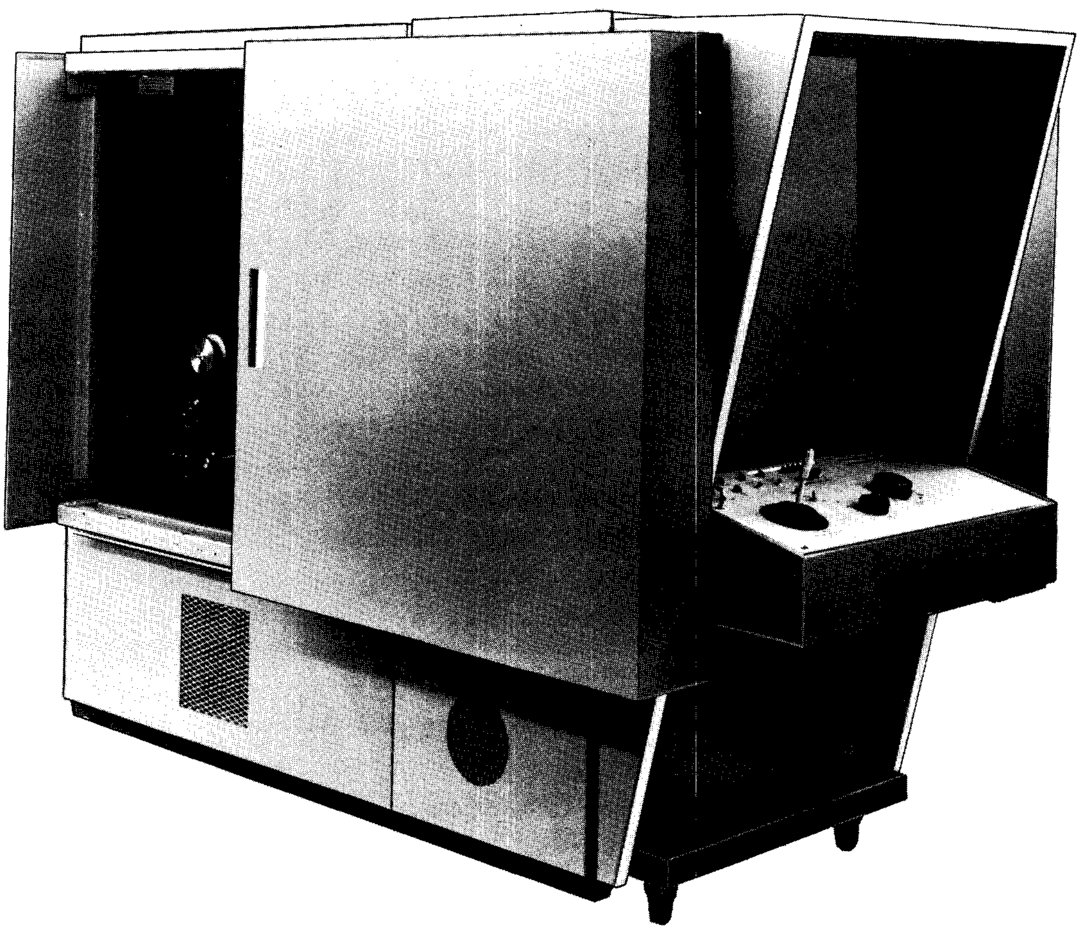


NPIC J-8973 (3/65)

FIGURE 70. [redacted] FILM VIEWER (MODEL 707-V).

4. [redacted] VARISCAN FILM VIEWER

In an effort parallel to the current development program involving the [redacted] 707-V, the NPIC has purchased for evaluation purposes a Variscan Rear-Projection Film Viewer (Figure 71) from the [redacted] Variscan is of the same single-image reflecting-mirror design as the [redacted] 707-V, but it is smaller because of the use of wide-angle projection lenses and it has an interchangeable condenser-element system. The major feature of the Variscan is its ability to project a 9.5- by 9.5-inch frame at 3x. Additional fixed magnifications are at 6x, 12x, and 30x. Also incorporated into the Variscan is a new film-spool holding system which permits use of virtually any film width between 35mm and 9.5 inches without modification or adapters. A production model is due by August 1965 at an estimated cost of [redacted]



NPIC J-8974 (3/65)

FIGURE 71. [redacted] VARISCAN FILM VIEWER.

5. REAR-PROJECTION CHIP VIEWER

Design parameters are being formulated on a prototype chip scanner-and-selection unit (Figure 72) for the Center's 4- by 5-inch photo interpretation chip. This development is based on the premise that a considerable number of chips from previous missions will have to be correlated with current material, and that a rear-projection viewer utilizing 35mm slide-projection techniques would be of great assistance to the photo interpreter in this initial selection and evaluation process. The proposed viewer would have either single or multiple magnification of sufficient resolution for screening purposes and would accept a cassette of previous-coverage chips to enable fast and easy review by the analyst. Such an intrument would also be valuable for group viewing, small briefings, and collateral referencing.

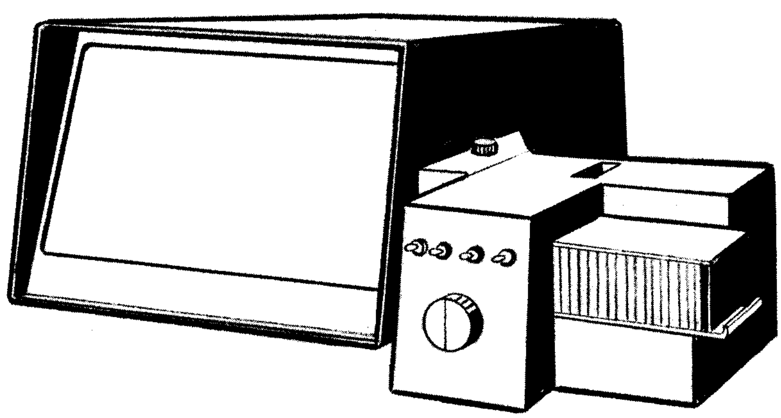


FIGURE 72. REAR-PROJECTION CHIP VIEWER.

NPIC J-8975 (3/65)

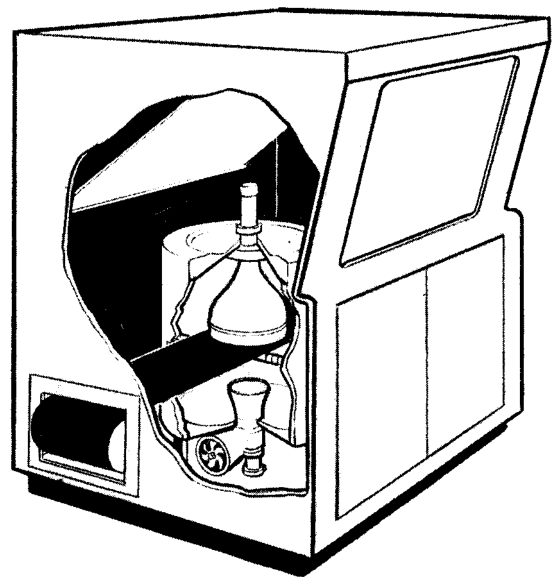
6. MODULATED-LIGHT FILM VIEWERS

Feasibility studies and subsequent development are planned for a new viewer-illumination concept. This concept of modulated-light (dodged) film viewing is a direct result of studies of the psychological and physiological reactions of photo interpreters, and of observations of the actual methods employed by photo interpreters while viewing with present equipment. In current practice, the photo interpreter is generally restricted in the observation of roll-film transparencies to the use of conventional fluorescent-illuminated devices that have no facility for localized attenuation or modulation of illumination over large or small areas. As a result, it is usually considered futile to search for detail in the dense regions of a transparency since the brilliant illumination of the unmasked light box causes the eye to close (stop down), thereby further increasing the apparent opacity of the transparency. The same visual difficulty is also caused by flare in the clear areas between frames. Naturally, if all extraneous illumination could be removed from the light box, existing detail in the dense areas of the transparency would be more readily observed. But even when the light box is correctly masked, similar difficulties continue to arise when seeking detail in the dense areas of a predominately thin transparency because the bright light transmitted by the thin regions still appears to the eye as flare. Thus, it would be advantageous not only to be able to confine all illumination to the precise area under investigation, but to be able to do so without the necessity of making special masks.

As a means of correcting these evident deficiencies in the film viewing and analysis equipment presently available to the photo interpreter, 2 versions of a modulated-light viewer are proposed: the Modulated-Light Rear-Projection Film Viewer (Figure 73) and the Modulated-Light Direct Film Viewer (Figure 74). An engineering model of the rear-projection version is due in December 1966, and of the direct-viewing version in April 1966.

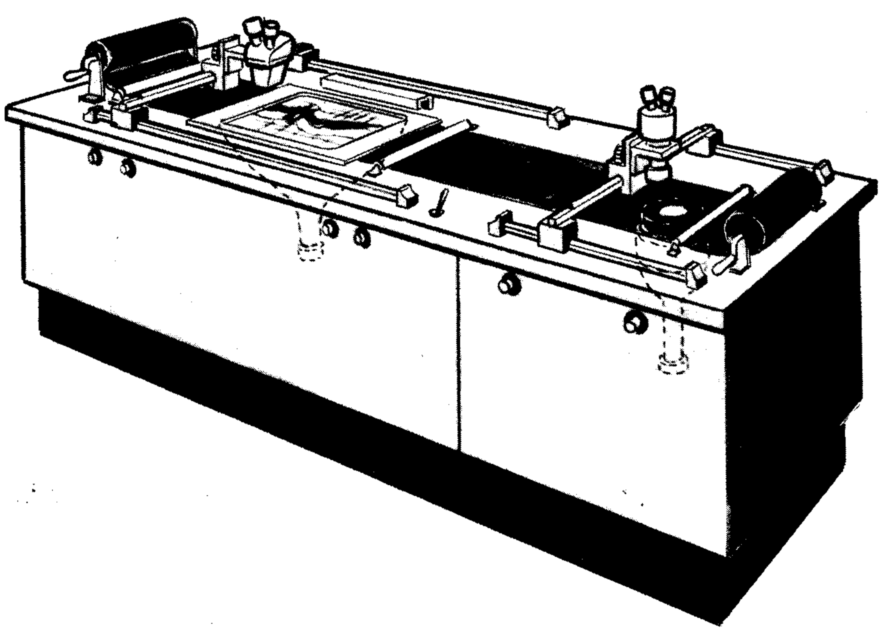
These proposed units, both employing the new viewing concept which utilizes a kinescope light source, will have an almost infinite capability for image masking and automatic modulation of transparency illumination in all size areas from the smallest to the largest. These devices are expected to provide dodged visual presentations of transparencies similar to the well known effect produced by the [redacted] Printer on hard-copy prints. 25X1

25
25



NPIC J-8976 (3/65)

FIGURE 73. MODULATED-LIGHT REAR-PROJECTION FILM VIEWER.



NPIC J-8977 (3/65)

FIGURE 74. MODULATED-LIGHT DIRECT FILM VIEWER.

25X

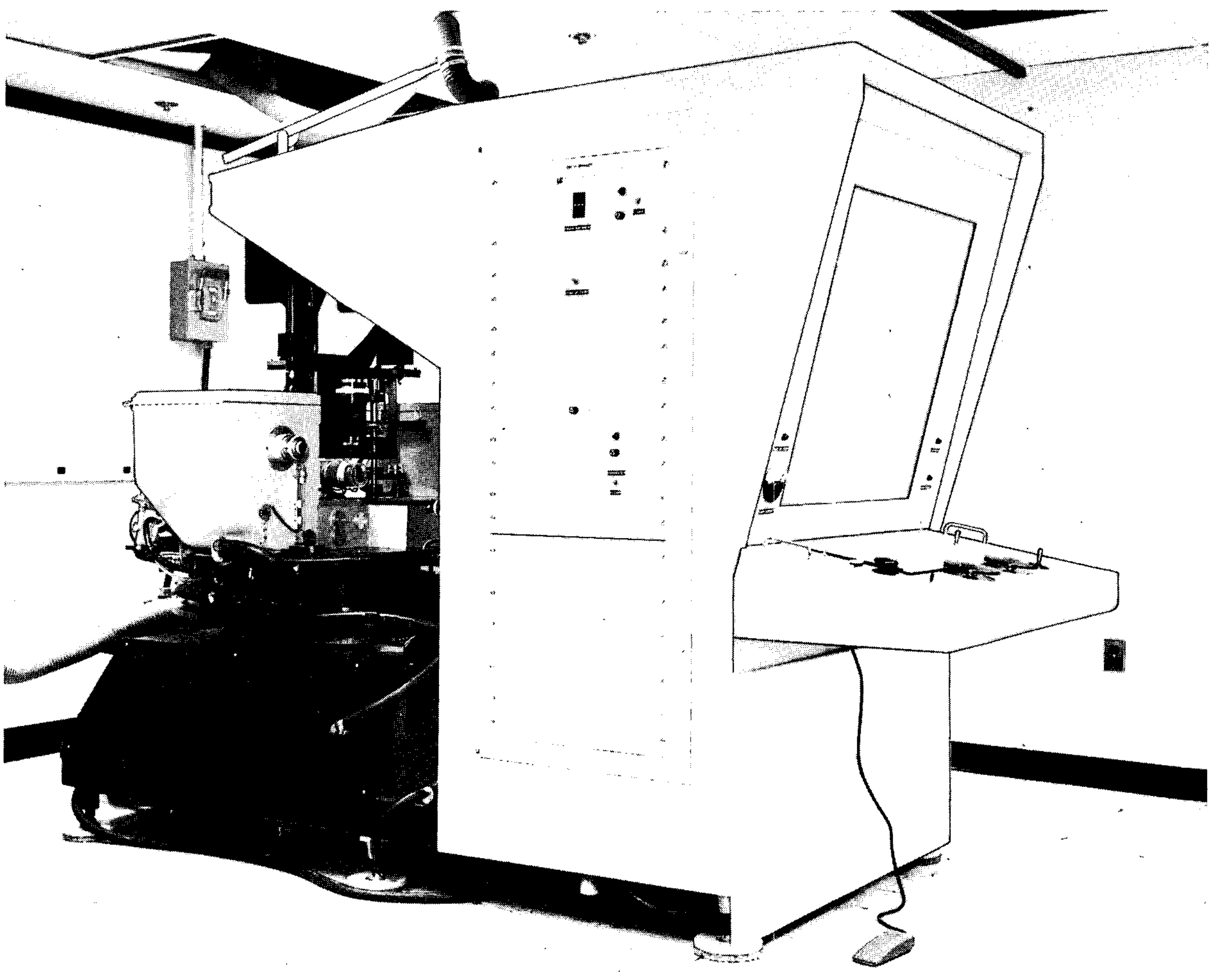
[redacted]

[redacted]

C. READERS

1. [redacted] VARIABLE-WIDTH FILM READER

The [redacted] Variable-Width Film Reader (Figure 75) contains several advancements in rear-projection viewing. It will handle film widths up to 9.5 inches, and utilizes a liquid film-gate cooling system. This latter feature is necessary to give adequate cooling when using the 5,000-watt xenon short-arc light source in the illumination system. Four optical magnification ranges are available at the operator's option: 6x, 12x, 24x, and 48x. Indications are that intensities in excess of 300 foot lamberts will be achieved at 48x with proportionately higher levels at lower magnifications. This instrument has been delivered to the NPIC and is presently being evaluated. The production model is due in June 1965, at an estimated cost of [redacted]



NPIC J-8978 (3/65)

FIGURE 75. [redacted] VARIABLE-WIDTH FILM READER.

[redacted]

2. [redacted] FILM READER (MODEL 707-R)

The [redacted] development in this field, the Model 707-R (Figure 76), consists of a modified version of their Model 707-V Film Viewer that has similar optical viewing characteristics but will be coupled with the computer and teletype units. Its cost is $[redacted]

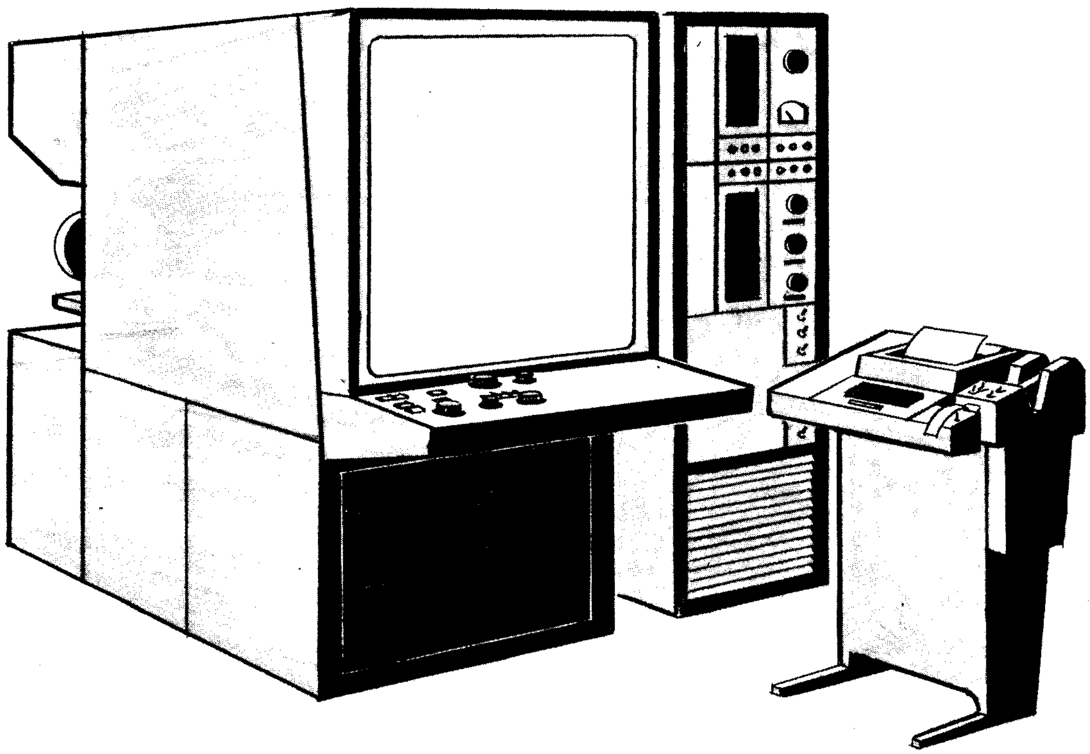


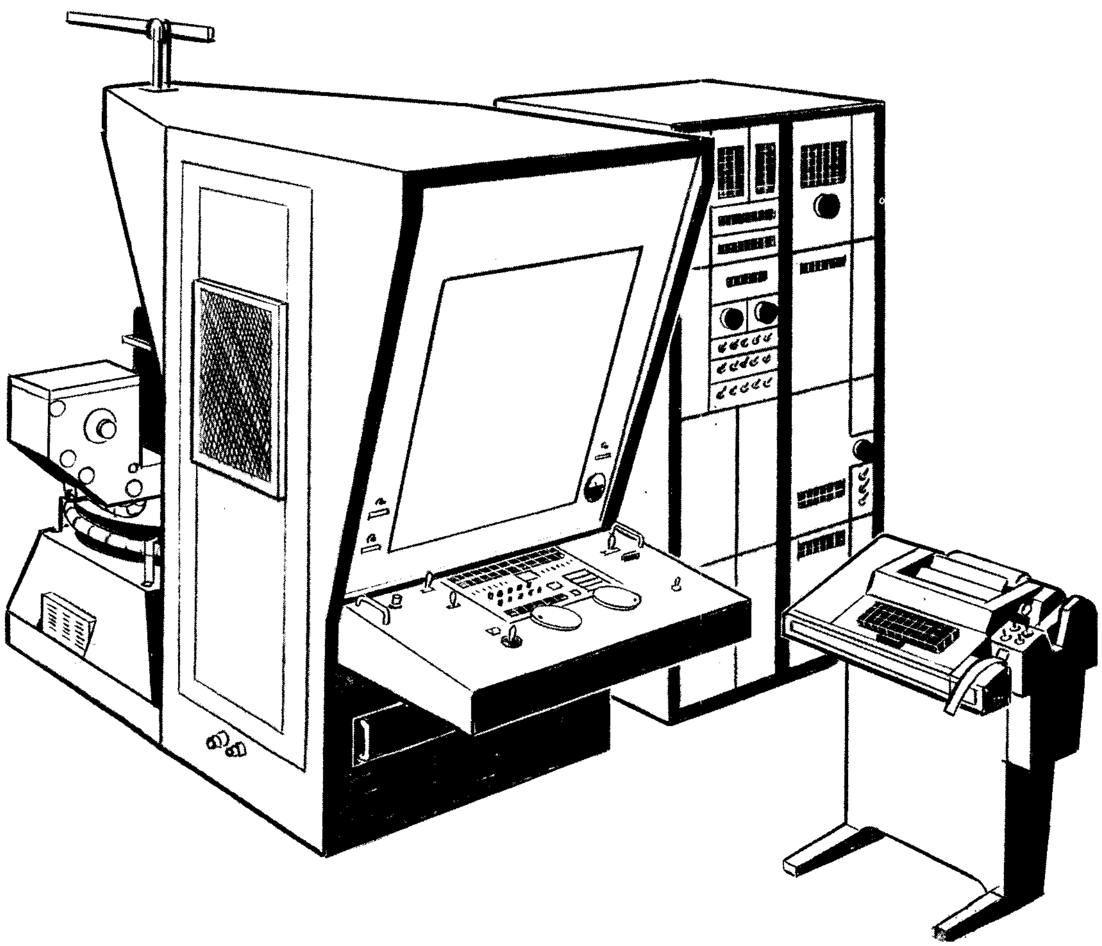
FIGURE 76. [redacted] FILM READER (MODEL 707-R).

NPIC J-8979 (3/65)

3. FILM READER WITH COMPUTER

In addition to the readers being developed for on-line operation with the NPIC UNIVAC 490, the Center is planning to contract for a reader (Figure 77) with characteristics similar to the [redacted] readers but with a small, self-contained computer system capable of performing any single-frame photogrammetric solution with little or no external computer support.

Contract details and expected delivery date are not available at this time.



NPIC J-8980 (3/65)

FIGURE 77. FILM READER WITH COMPUTER.

D. STEREO VIEWERS

1. [redacted] VERSATILE HIGH-PERFORMANCE STEREO VIEWER

X1

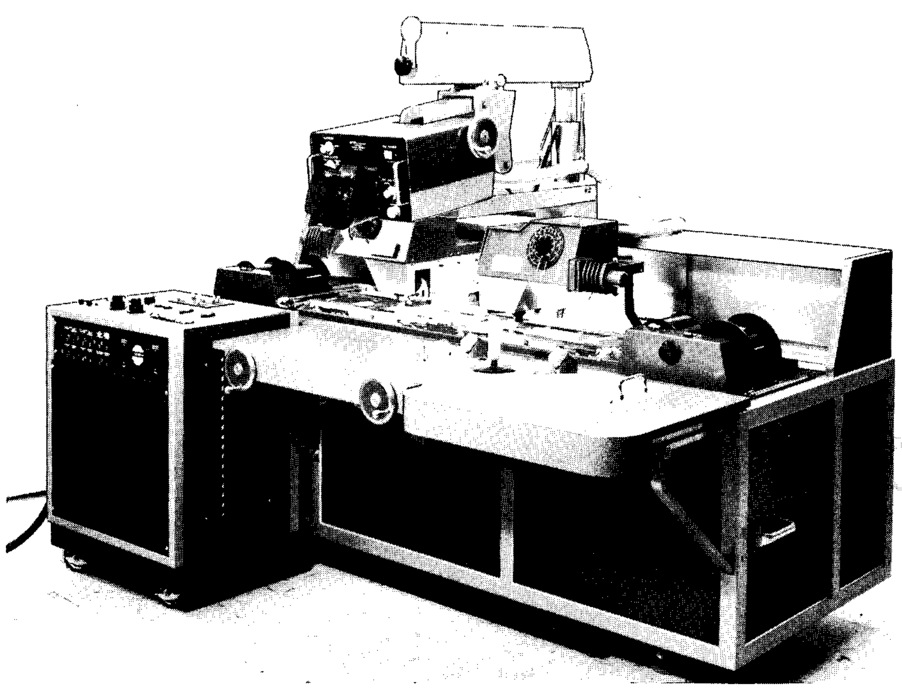
The basic characteristics of the versatile high-performance stereo viewer were established by the Model 387 stereo viewer developed under contract to the Bureau of Naval Weapons. The current development by [redacted] Inc., was sponsored by the NPIC to expand the versatility and increase the performance of the instrument.

X1

This new viewer (Figure 78) measures about 7 by 4 by 4 feet and has a cast frame, permitting conversion to a 5-micron stereo comparator. The zoom magnification range is from 1.5x to 135x in 4 steps. The field of view is approximately 36 degrees, an increase of 3 times over the earlier model, with 600 lines per mm resolution.

The versatility of the optical system is indicated by independent magnification, 360-degree rotation, independent image reversion, crossover of the stereo channels, and binocular monoscopic viewing. Scanning is controlled through a single joystick, but the direction and proportion of the scan is correlated to both the magnification and the rotation setting of the corresponding optical train. Film is handled manually, with a capacity for 1 or 2 rolls between 70mm and 9.5 inches in width and in lengths up to 500 feet. The loop-forming mechanism has been expanded to handle 19 feet of film between sequential stereo pairs. The film is held flat by vacuum while being viewed.

The first production model is due by July 1966, and will cost an estimated [redacted] 25X1



NPIC J-8981 (3/65)

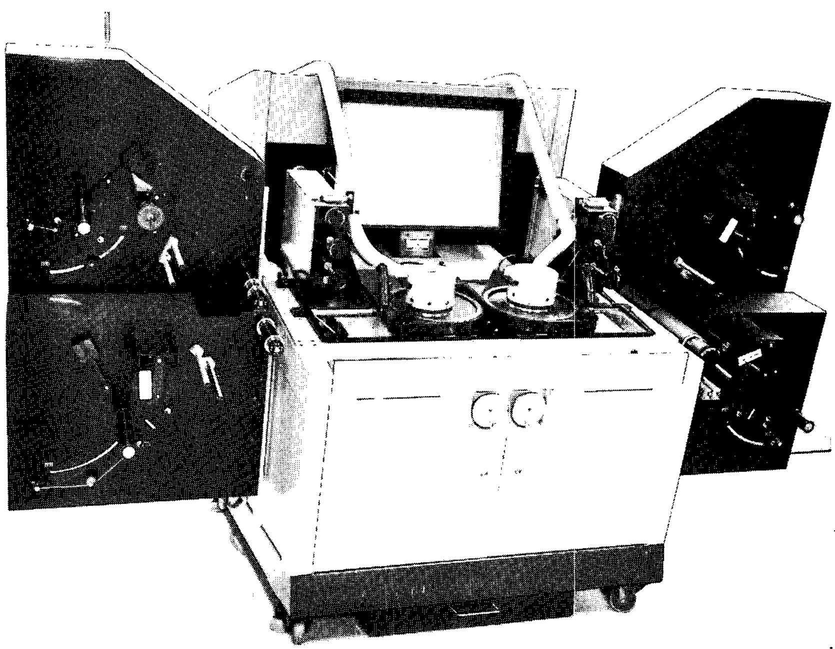
X1

FIGURE 78. [redacted] ERSATILE HIGH-PERFORMANCE STEREO VIEWER.

2. [redacted] STEREO PROJECTION VIEWER

Although the individual advantages of stereoscopic and rear-projection viewing have been well established, the possible benefits of combining the 2 are not as well defined. One of the reasons for this lack of definition is the unavoidable complexity of a device which would provide stereo scanning of roll film and yet require but a minimum of operator intervention to maintain a fusible stereo image. However, exploratory development of a device to provide some of the basic answers has been completed, and installation of the prototype viewer (Figure 79) was made at the NPIC in September 1964. The primary purpose of this prototype is to provide a test bed upon which various projection techniques and positional control systems can be evaluated in the process of analyzing the significance of rear-projection stereo viewing.

The prototype stereo projection viewer will handle one or two 500-foot rolls of film 70mm to 9.5 inches wide; thus, stereo images on the same or different rolls may be viewed. Film transport and scanning are motorized. For accomplishing registration of conjugate images, 3 degrees of freedom, X, Y, and θ, are provided, but no adjustments for differences in scale or distortion are included. Stereoscopic viewing is achieved by the polarizing technique, and 3 magnification settings are provided: 7.5x, 15x, and 30x. Equivalent magnification at the normal 37.5-inch viewing distance is 2x, 4x, and 8x, and these are subject to doubling by halving the viewing distance if the operator desires. A special design feature is an air-bearing gate which cleans the film and maintains the focus while operating in the scanning mode.



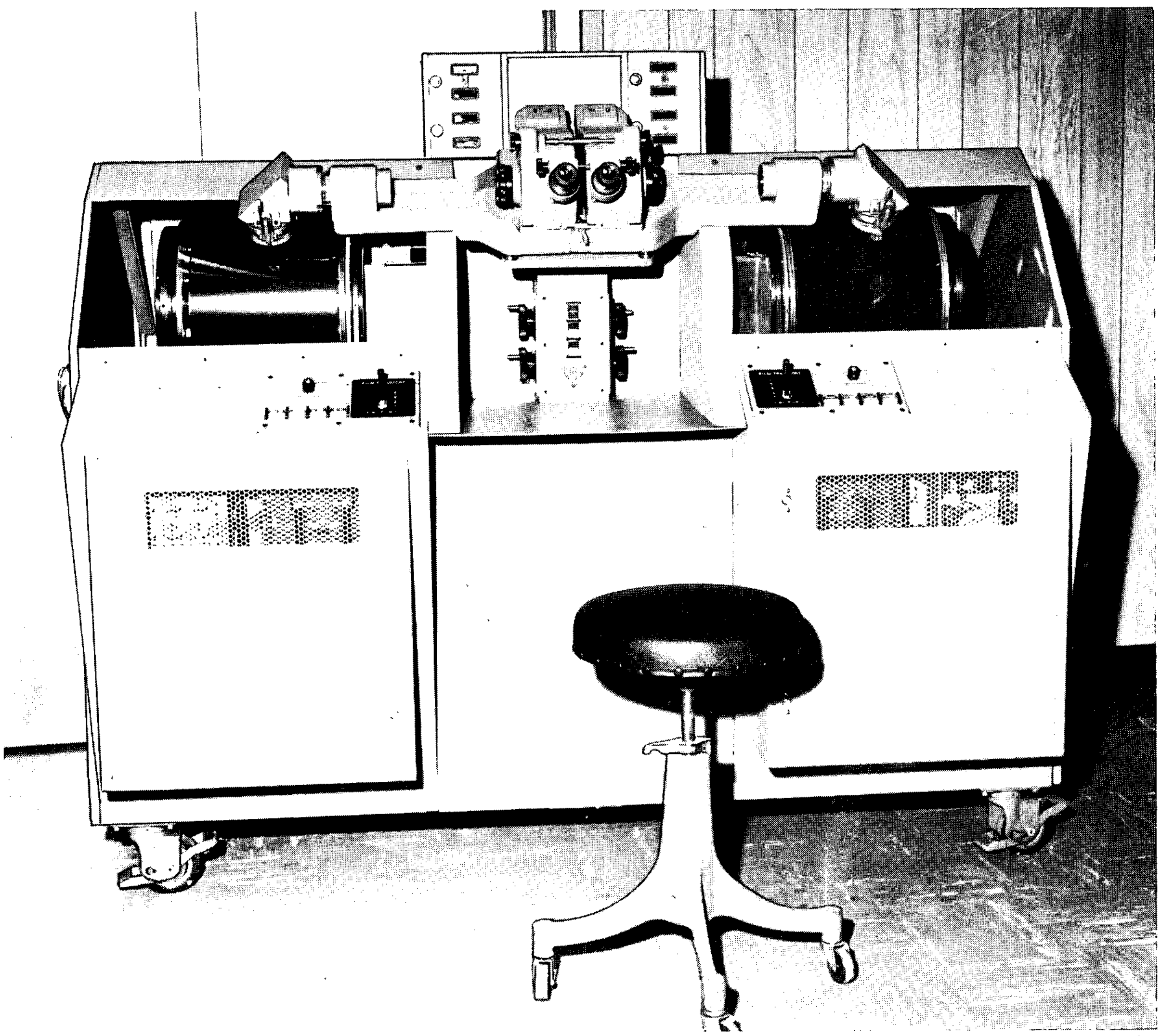
NPIC J-8982 (3/65)

FIGURE 79. [redacted] STEREO PROJECTION VIEWER.

25X
[redacted] 25X

3. [redacted] PANORAMIC STEREO VIEWER

The panoramic stereo viewer (Figure 80) will provide a means for viewing stereo images on 2 rolls of conventional, convergent, and panoramic stereo roll film regardless of scale, format, orientation, or obliquity. It will accept film in widths ranging from 70mm to 9.5 inches, and in reels up to 10.5 inches in diameter. Two motorized film drives can be operated independently or can be synchronized. A variable-magnification binocular optical system provides magnifications from 3x to 48x. Each half of the optical system can be adjusted separately, or the 2 sides can be coupled for synchronized changes. Each optical path contains an element allowing an independent, 360-degree image rotation.



NPIC J-8983 (3/65)

FIGURE 80. [redacted] PANORAMIC STEREO VIEWER.

SECTION III MEASUREMENT AND EVALUATION

A. INTRODUCTION

B. MEASURING

C. EVALUATING

D. PLOTTING

E. MISCELLANEOUS

25
25

A. INTRODUCTION

Within the last few years, photographic systems have been constantly improving and from all indications will continue to improve, putting greater and greater demands on mensuration equipment. To meet this demand the NPIC is constantly working toward improving the comparators required by the photogrammetrist and photo interpreter. As the resolution and acutance of the photographic input improve, higher quality viewing systems (optics) are required as well as improved measurement techniques. The NPIC is currently investigating designs for comparators with viewing systems having magnifying power in excess of 100x and sub-micron least-count measurement systems.

An additional aspect of advanced comparator requirements is the tremendous variation of photographic input formats. One approach to handling large formats is the chip comparator designed for high-precision measurement of a limited format. Another approach is the large-format comparator with high-precision local accuracy but reduced accuracy standards over the full stage travel.

The value of stereo viewing is of ever-increasing significance, even on an instrument with 2-axis measuring systems, and several developments in this area are included among the following illustrations.

Also of increased importance with improved equipment is a film evaluation program. The NPIC is actively developing higher quality film inspection tables, film analyzers, and microdensitometers, as well as image-quality evaluation study programs. It is anticipated that in the near future some of the current evaluation developments such as microdensitometry will be applied to mensuration techniques and equipment.

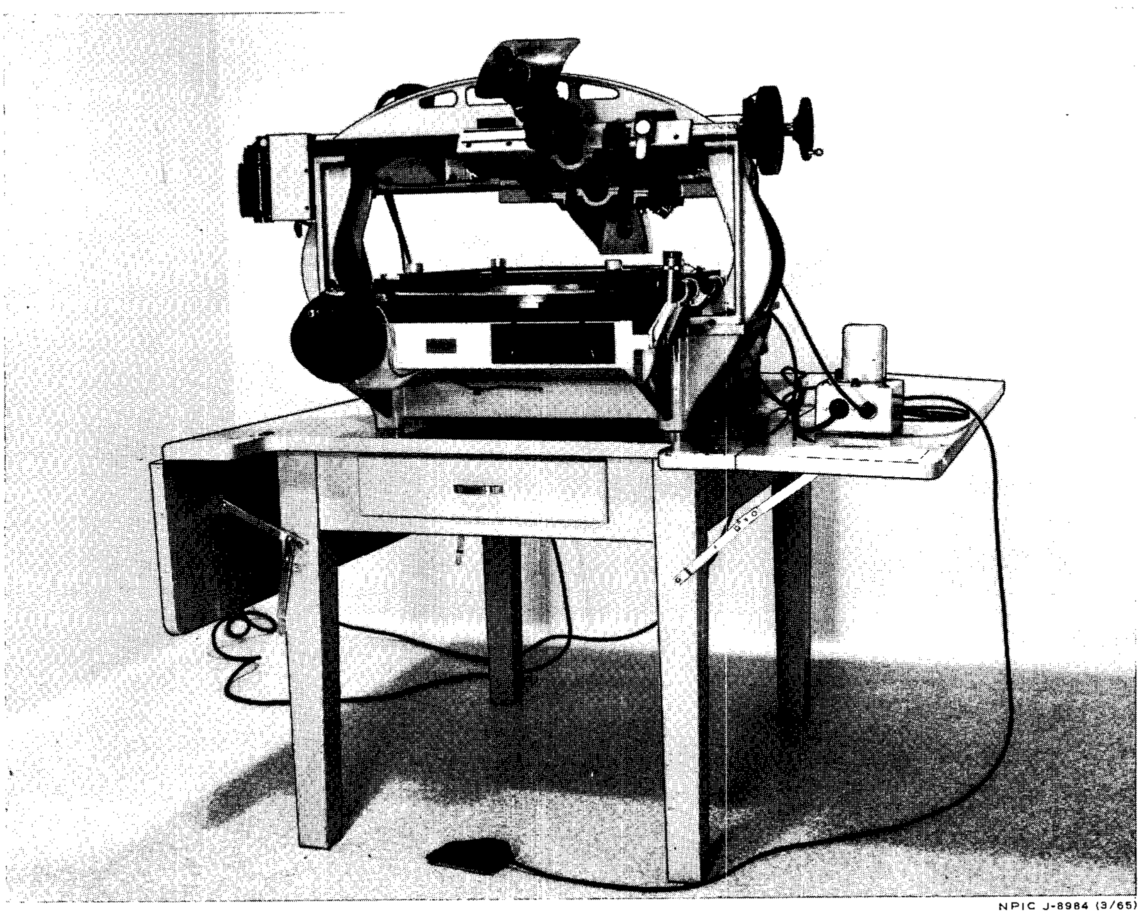
25

B. MEASURING

1. [redacted] COMPARATOR (TYPE 621)

This is a large, 2-coordinate comparator (Figure 81) with 500mm travel in the Y axis, 360mm in the X axis, and accommodation for roll film up to 9.5 inches in width and 250 feet in length. Coordinates read direct to 1 micron by means of illuminated dial systems located at the ends of the screws. Both screws are motor-driven for ease of travel between widely separated points. The microscope has internal focusing and a continuously variable power range from 12x to 28x. Instant selection of any one of 4 reticle patterns is available. The rotating stage has full 360-degree range and its position may be read optically to 20 seconds. The cost of the machine is [redacted]

A modification is currently under contract to apply a binocular optical system and a new light source. This will provide a zoom system capable of resolving 400 line pairs per mm at the film plane with a magnification range of 20x through 80x.

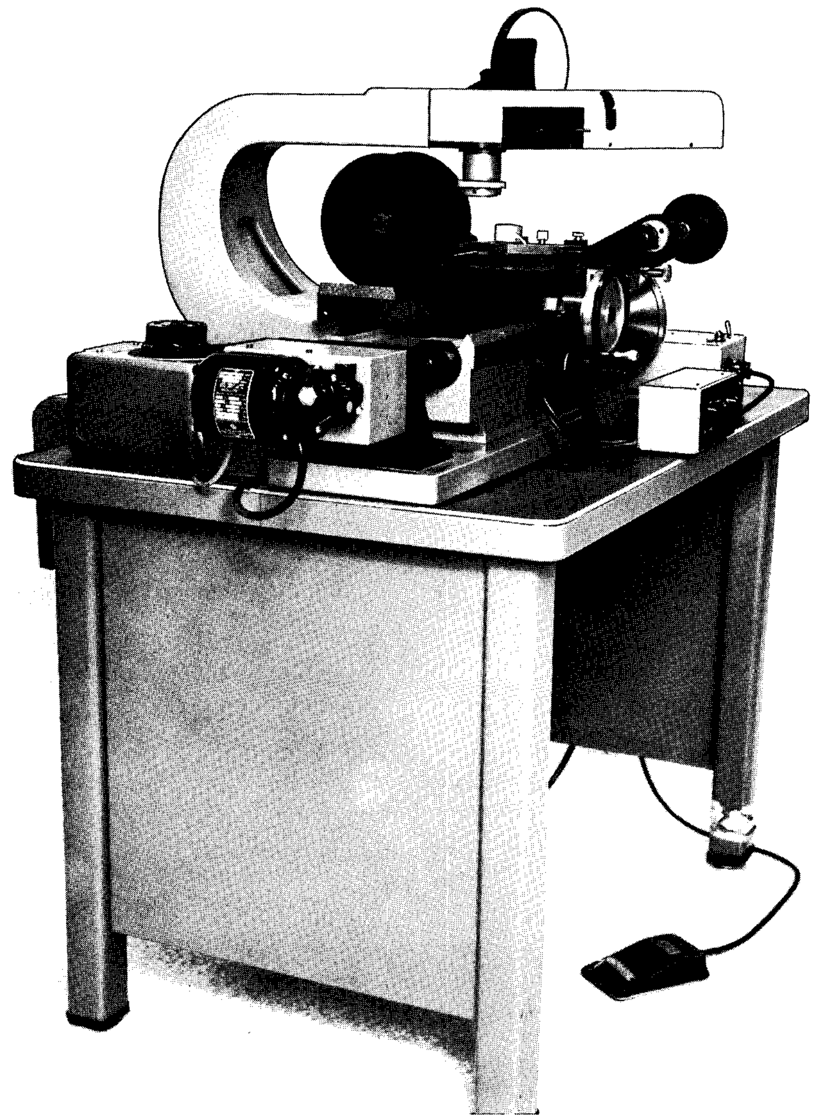


NPIC J-8984 (3/65)

FIGURE 81. [redacted] COMPARATOR (TYPE 621).

2. [redacted] COMPARATOR (TYPE 829C)

This type of comparator (Figure 82) is designed for horizon data reduction work. Readings are direct to 5 microns in the 2 coordinate axes. Measurements can be made over an area 100mm by 150mm on plates or films up to 4.5 by 7 inches; plates 2 by 10 inches can be accommodated easily. A front surface projection system gives superior resolution and quality. Direct-viewing quality is provided without the confining positions of direct-viewing systems. The cost of this type is about [redacted] 25X1



NPIC J-8985 (3/65)

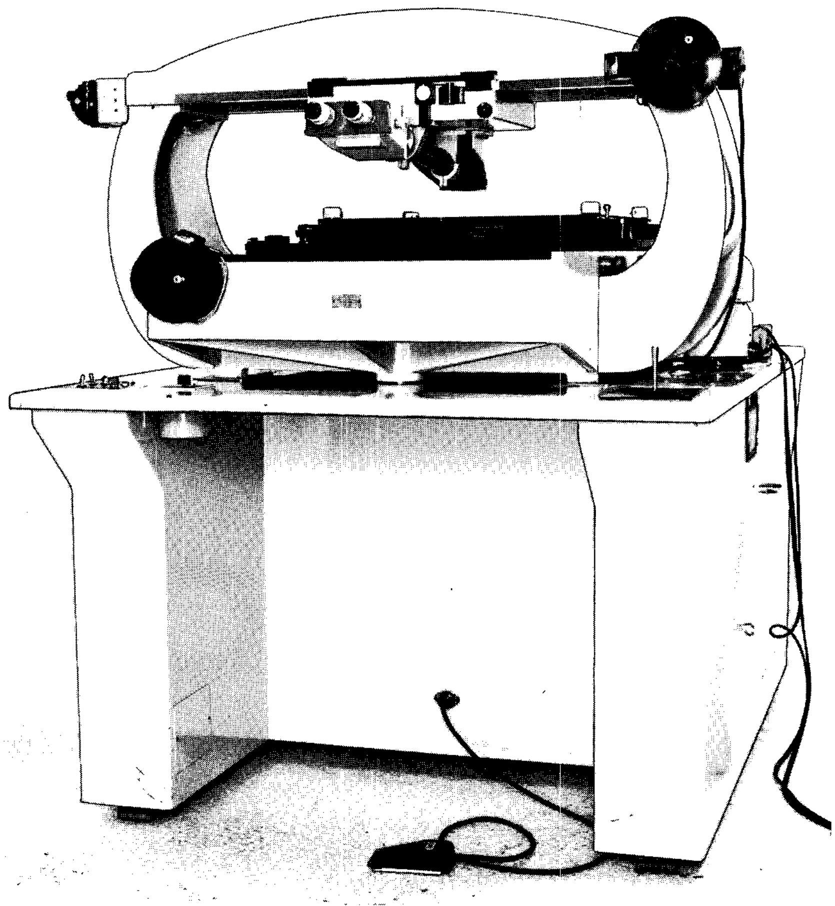
FIGURE 82. [redacted] OMPARATOR (TYPE 829C). 25X1

[redacted]

[redacted]

3. [redacted] COMPARATOR (TYPE 880A)

This modified [redacted] Type 880 2-coordinate comparator was installed in the NPIC in March 1964 (Figure 83). It accepts film formats of 70mm, 5, 6.6, 8, and 9.5 inches. Measurement is accomplished on both axes by precision ground and lapped lead screws. Readout is available on a coded disc directly readable by the operator, or from a position resolver which provides paper tape and typewriter print-out when connected through a digital accumulator. Viewing is accomplished by a binocular optical system which furnishes a continuously variable magnification of 17.5x to 35x with 5x eyepieces, or 35x to 70x when 10x wide-field eyepieces are used. Field of view is 2.6mm to 5.2mm with a crosshair constantly visible in the optical path. Modifications consist of the binocular optical system, provision for handling various film sizes, a selsyn-drive system for the secondary axis, a selsyn-drive high-intensity light source, and provision for accepting a projection viewing screen. It costs [redacted]



NPIC J-8986 (3/65)

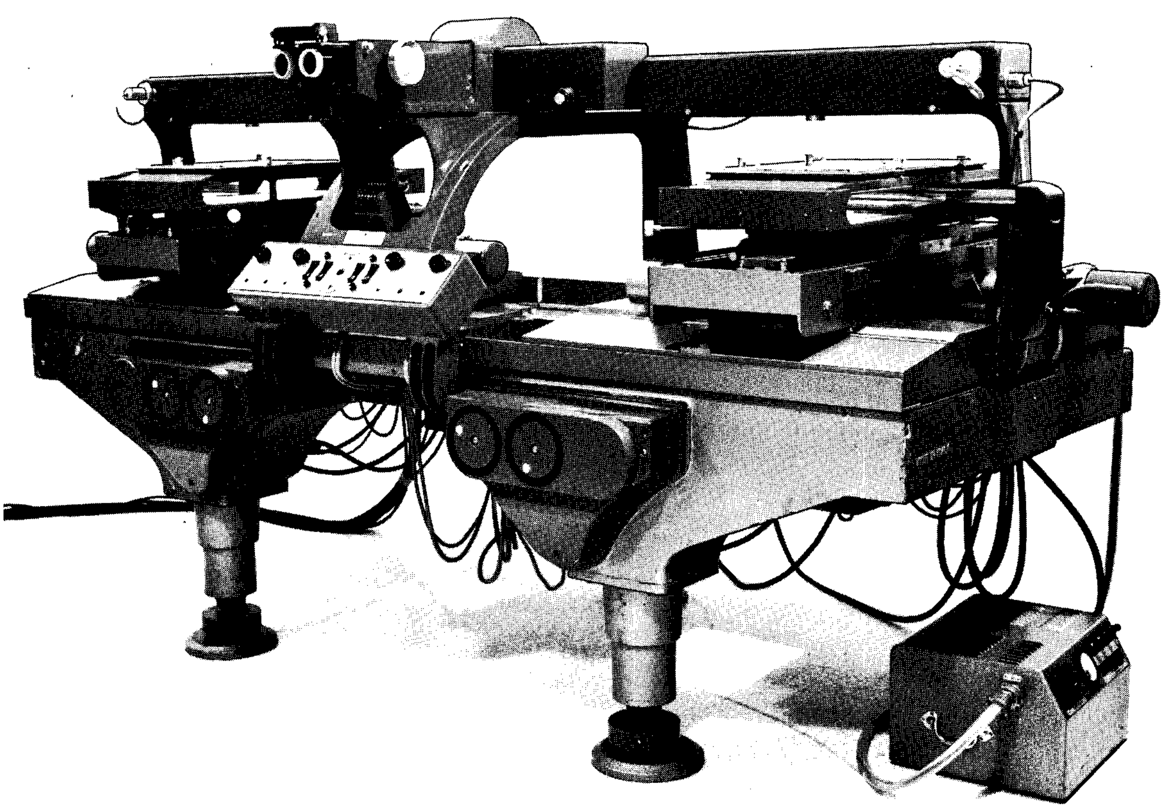
FIGURE 83. [redacted] COMPARATOR (TYPE 880A).

[redacted]

[redacted]

4. [redacted] STEREO COMPARATOR RIC/1

The [redacted] Stereo Comparator RIC/1 (Figure 84) handles formats up to 9.5 by 18 inches in either cut film or glass plates. The magnification range is from 4.5x to 18x, and the measurement system is the Ferranti Moire fringe with a 2-micron least-count. The instrument is designed primarily for control extension work but has a limited application in the intelligence field utilizing medium-scale high-resolution photography. It costs about [redacted]



NPIC J-8987 (3/65)

FIGURE 84. [redacted] STEREO COMPARATOR RIC/1.

5. [redacted] DUAL-SCREEN MEASURING PROJECTOR

The [redacted] Dual-Screen Measuring Projector (Figure 85) is a high-precision film comparator now operational at the NPIC. It has the capacity to measure format areas up to 9.5 by 29 inches. The Ferranti Moire fringe system has been modified to give the measuring sensors a least-count of 1 micron, and air bearings have replaced the conventional lapped method of stage transport. The unique vacuum clamping and film transport device accommodates films in rolls from 35mm to 9.5 inches wide. This instrument has been connected directly on-line with the UNIVAC 490 computer for data reduction.

Two screens are used simultaneously: the larger, 40 by 40 inches, is for scanning; the smaller, 12 by 17 inches, is for mensuration purposes. The larger screen has a fixed magnification of 8x; the smaller offers 8x, 16x, or 30x magnifications, with the area of high magnification indicated on the low-magnification image. A crosshair is projected on the small screen as a fixed reference point. A 2,500-watt water-cooled mercury-vapor arc lamp provides illumination for the crosshair projection and for the image on both screens.

NPIC J-8988 (3/65)

FIGURE 85. [redacted] DUAL-SCREEN MEASURING PROJECTOR.

6. [redacted] VERSATILE STEREOSCOPIC POINT TRANSFER DEVICE

A contract has been awarded to [redacted] to develop the versatile stereoscope point transfer device, and delivery is expected in May 1965. The production model is due in August 1966 and will cost an estimated [redacted]

The device will consist of a versatile roll-film scanning stereo viewer fitted with a precision point-marking system (Figure 86). The viewing system will handle 1 or 2 rolls of film with widths between 70mm and 9.5 inches. Independent magnification of each eye-train will range from 1.5x to 135x. Maximum resolution is expected to be 625 lines per mm. Highly versatile optical and mechanical systems will be incorporated. A laser point-marking system will make minute round marks about 20 microns in diameter at the selected image point. A more prominent flagging mark and number will be readily visible in the comparator to act as a point of reference for position measurement. This may be accomplished manually by the operator or automatically by a system within the comparator. In this way, greater quantities of meaningful data may be extracted more efficiently from a wide variety of photographic sources. To further increase the versatility of this unit, a 2.5-micron measurement readout has been incorporated to provide a stereocomparator capability.

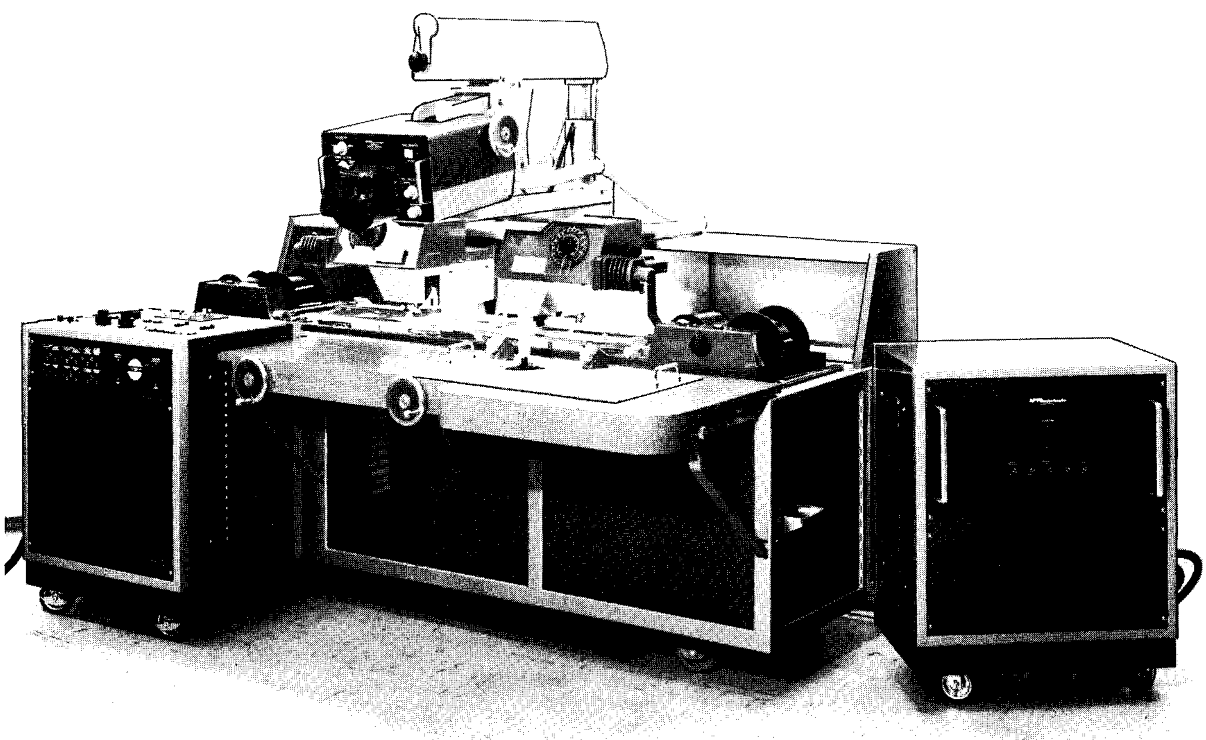


FIGURE 86. [redacted] VERSATILE STEREOSCOPIC POINT TRANSFER DEVICE. NPIC J-8989 (3/65)

X1

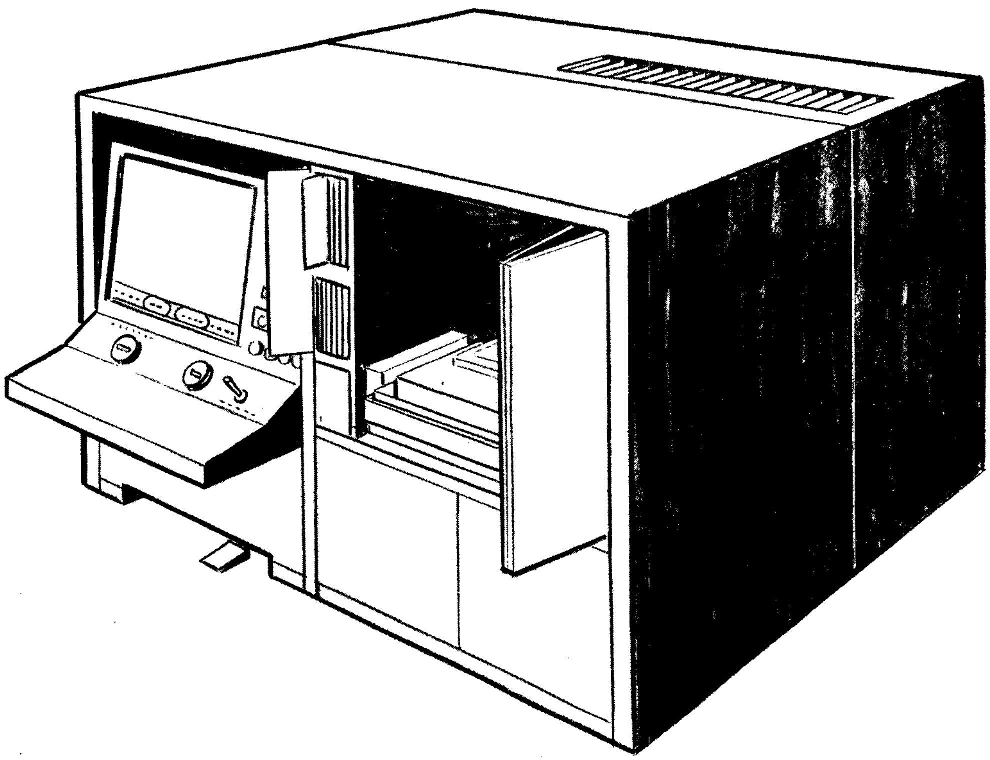
[redacted]

25

7. STELLAR COMPARATOR

The stellar comparator (Figure 87) is a precision, rear-projection measuring instrument capable of plus-or-minus 1 micron accuracy over a format 10 inches square. It can handle film up to 9.5 inches wide and has a magnification range from 20x to 40x. Centering on the stellar image can be accomplished either manually by the use of handwheels or automatically by the use of a joystick coupled with an autocentering device.

Although called a stellar comparator, it is actually a dual-purpose instrument since both stellar coordinates and distances on terrestrial photography can be determined.



NPIC J-8990 (3/65)

FIGURE 87. STELLAR COMPARATOR.

X1

8. [redacted] STEREO CHIP COMPARATOR

This prototype stereo chip comparator (Figure 88) was installed at the NPIC in July 1964. It is designed with 5- by 5-inch stages which accept the proposed NPIC 4- by 5-inch film chip oriented in either direction. This instrument simultaneously measures the X and Y coordinates of any point on the film plane with respect to a chosen reference. The system is capable of resolving to .13 micron least-count. Linear measurements are obtained through the output of an X- and Y-axis interferometer, utilizing the wavelength of an Hg 198 lamp (5461A°). The comparator is designed to operate on-line with the UNIVAC 490 system. The prototype has been evaluated and production models are under contract at a cost of [redacted] each.

NPIC J-8991 (3/65)

FIGURE 88. [redacted] STEREO CHIP COMPARATOR.

9. AP/3 STEREO COMPARATOR

The AP/3 stereo comparator is a higher capability version of the AP/2 stereo comparator designed and built by [redacted] The major improvements that the AP/3 has over the AP/2 are higher magnification (100x), higher resolution, higher local measurement accuracy, anamorphic eyepieces, ground-distance readout button, and an increased ground-photography capability. Its cost is [redacted]

10. HIGH-PRECISION STEREO COMPARATOR

In the near future, the NPIC plans to develop an advanced state-of-the-art stereo comparator having the following major design features: 1) ability to accommodate any type of photography in both cut and roll form up to 9.5 inches in width, 2) continuously variable viewing magnifications ranging from 10x to 200x with a minimum resolution of 6 lines per power, 3) a stage size 10 by 20 inches, 4) mensuration characteristics of .25 micron least-count and plus-or-minus-5-micron total-system accuracy, 5) a measurement readout system directly on-line to the UNIVAC 490 computer or IBM punchcards, at the operator's option.

C. EVALUATING

1. [redacted] INSPECTION AND VIEWING TABLE

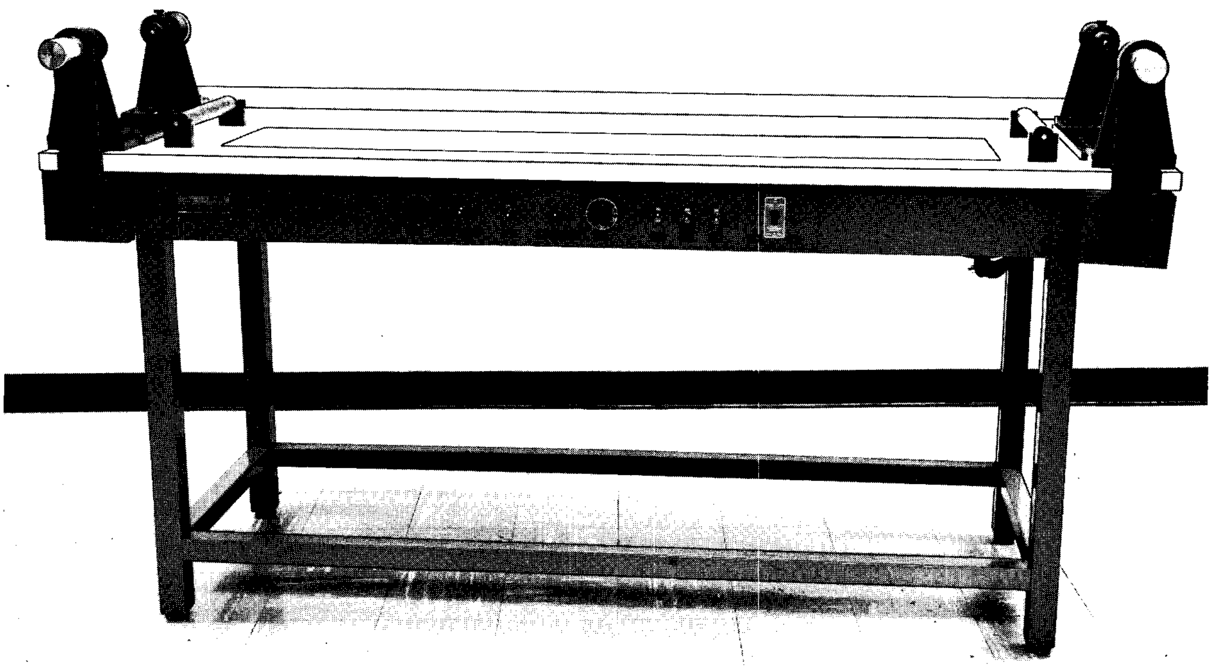
The [redacted] Inspection and Viewing Table (Figure 89) has a 32- by 10-inch viewing surface and is designed for use in inspecting large quantities of film up to 9.5 inches in width. The table has a film tension adjustment and a variable-speed, reversible, motorized spool-drive.

NPIC J-8992 (3/65)

FIGURE 89. [redacted] INSPECTION AND VIEWING TABLE.

2. [redacted] 55-INCH VIEWING TABLE

The [redacted] 55-inch Viewing Table (Figure 90) is a motorized light table designed for the inspection and viewing of large volumes of film. The 55- by 10-inch surface of the light table allows viewing of more than 1 frame of photography at a time. Film speed is variable, and photography ranging in width from 70mm to 9.5 inches can be accommodated. The table costs [redacted]



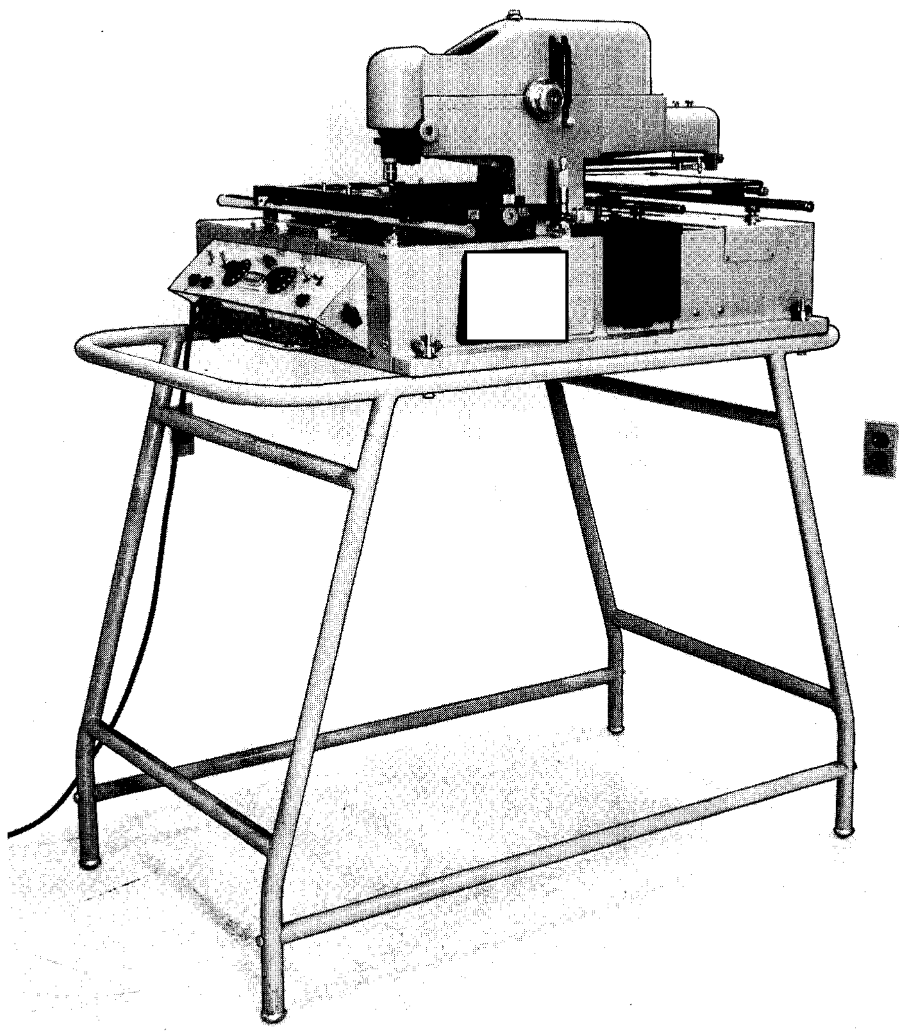
NPIC J-8993 (3/65)

FIGURE 90. [redacted] 55-INCH VIEWING TABLE.

[redacted]

3. [redacted] MICRODENSITOMETER

The [redacted] Microdensitometer (Figure 91), a low-cost double-beam instrument capable of measuring specular-type densities, is used primarily for edge traces and special microdensitometer studies. Various slit and circular effective apertures are available, ranging down to 1 micron in diameter. The instrument is capable of measuring densities up to approximately 4, and the output is a continuous trace of deflection (density) versus distance. The distance scale of the trace can be expanded from a ratio of 1:1 to 1:1,000. It costs $[redacted]



NPIC J-8994 (3/65)

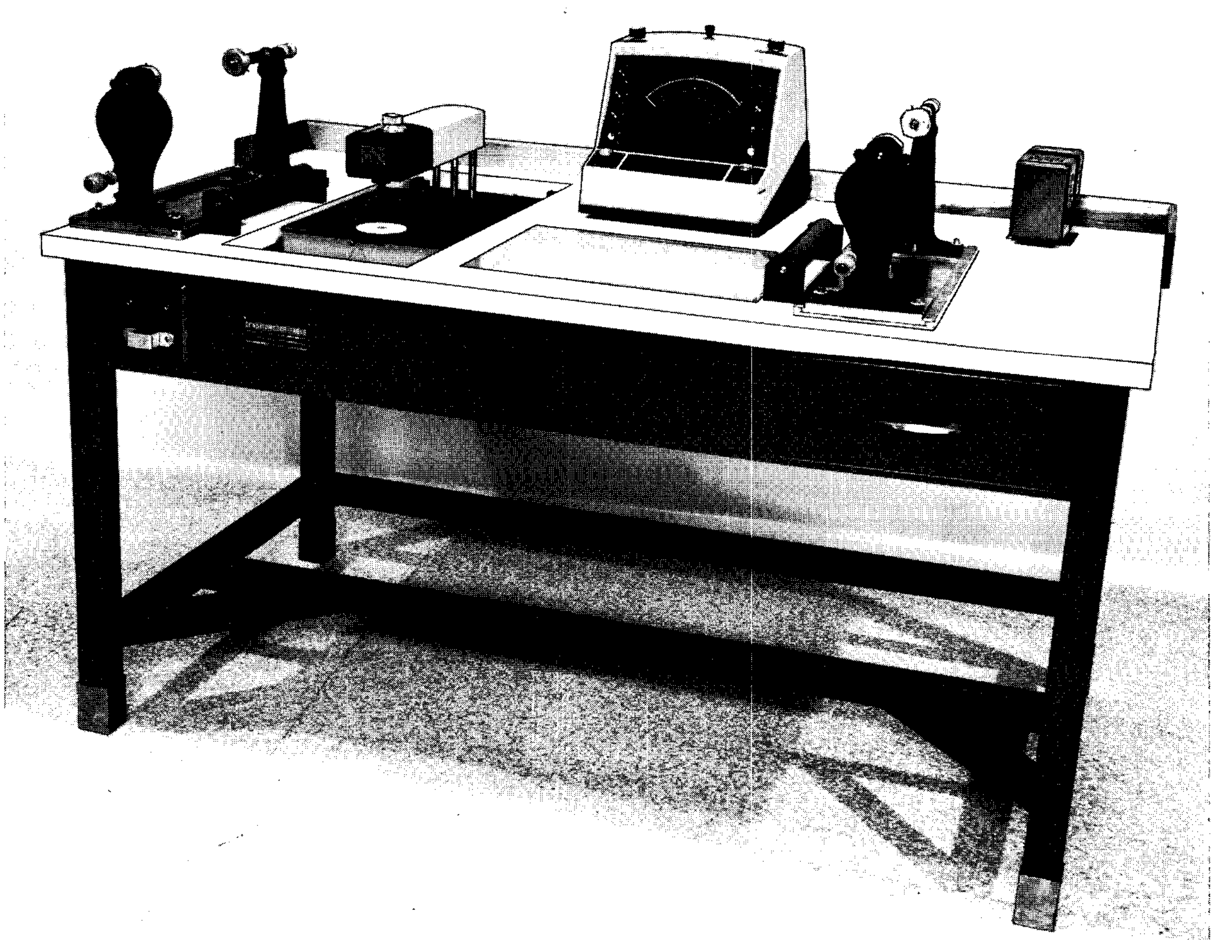
FIGURE 91. [redacted] MICRODENSITOMETER.

[redacted]

[redacted]

4. [redacted] DENSITOMETER

The [redacted] Densitometer (Figure 92) is a standard shelf item used for the measurement of American Diffuse Densities on film. It may be equipped with a variety of aperture shapes and sizes, ranging down to a minimum diameter of 0.5mm. The reading head will accommodate film up to 9.5 inches in width, and the use of various accompanying filters allows measurement of color film. With additional auxiliary units (not shown) the densitometer may be used on an enlarger easel to read the average transmitted light in a projection printer or as an exposure control instrument to read reflection densities in copying. In the present illustration, the [redacted] unit is mounted on an [redacted] densitometer table. The cost of the densitometer is [redacted]



NPIC J-8995 (3/65)

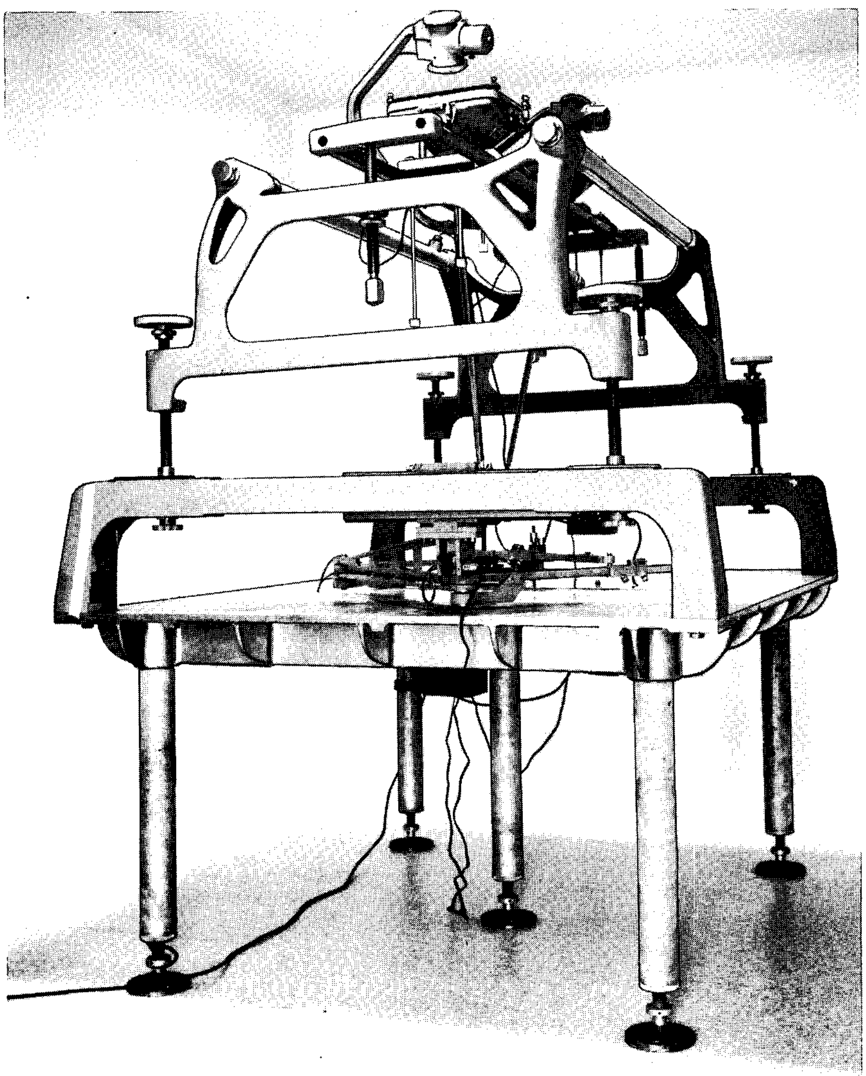
FIGURE 92. [redacted] DENSITOMETER.

[redacted]

D. PLOTTING

1. [redacted] PLOTTER

The [redacted] Plotter (Figure 93) is a projection-type plotting instrument which produces a stereoscopic image by projecting a pair of overlapping photographs. Its primary use occurs in the preparation of maps for which it can delineate both planimetric features and contours. Although primarily designed to utilize 6- or 8.25-inch focal length aerial photography, it can be adapted for limited use with other photography.



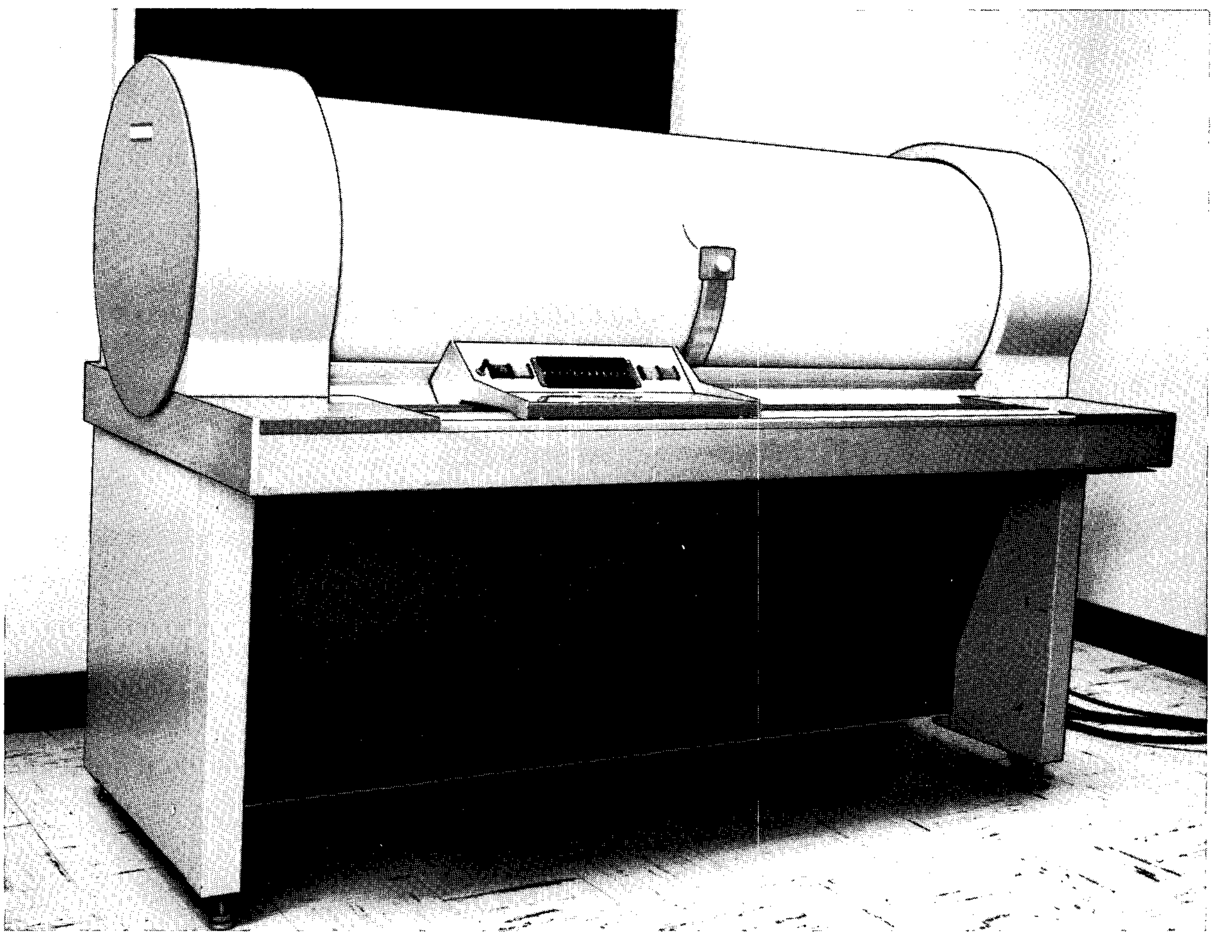
NPIC J-8996 (3/65)

FIGURE 93. [redacted] PLOTTER. 25X1

[redacted]

2. [redacted] LARGE AREA RECORD READER (MODEL D-2)

The Large Area Record Reader (LARR), manufactured by the [redacted] is a semiautomatic precision coordinate reader designed for reading and automatically recording X-Y measurements from records up to 48 by 48 inches in size (Figure 94). It may also be used as a manual point plotter for the precise positioning of points. The coordinates are automatically displayed in a Position Indicating General Measuring Instrument (PIGMI II). The read-plot head mounts a microscope or crosshair and can be moved anywhere along the length of the drum. X-axis measurements are made by moving the read-plot head, Y-axis measurements by rotating the drum with the mounted record. Both motions are controlled by 2 independently operated rollers immediately in front of the operator. Precision steel bands attached to both drum and reading-head drive precision measuring drums geared to optisyn shaft encoders. Counters in the PIGMI II convert the emitted pulses into digital coordinates at 1,000 counts per inch. The cost of the combined LARR-PIGMI unit is [redacted]



NPIC J-8997 (3/65)

FIGURE 94. [redacted] LARGE AREA RECORD READER (MODEL D-2).

[redacted]

3. [redacted] PLOTTER (MODEL H)

This [redacted] Plotter (Figure 95) accepts coordinate input data in digital form and plots a point or symbol at the corresponding location on a 28- by 30-inch plotting table area. The input data may be inserted manually from a keyboard, or it can be read automatically from punched paper tape. Other modes of operation include an incremental stepping of the X axis so that only Y values need be entered, and an analog voltage input for direct plotting from certain [redacted] record readers. In operation, the plotting head follows the intersection of 2 chrome-plated bars which move perpendicularly to each other. Scaling of the plot is variable and permits optimizing of the plot size and exact matching to graph paper which is held in position by a vacuum clamp system to prevent accidental displacement during plotting. The cost of this plotter is about [redacted]

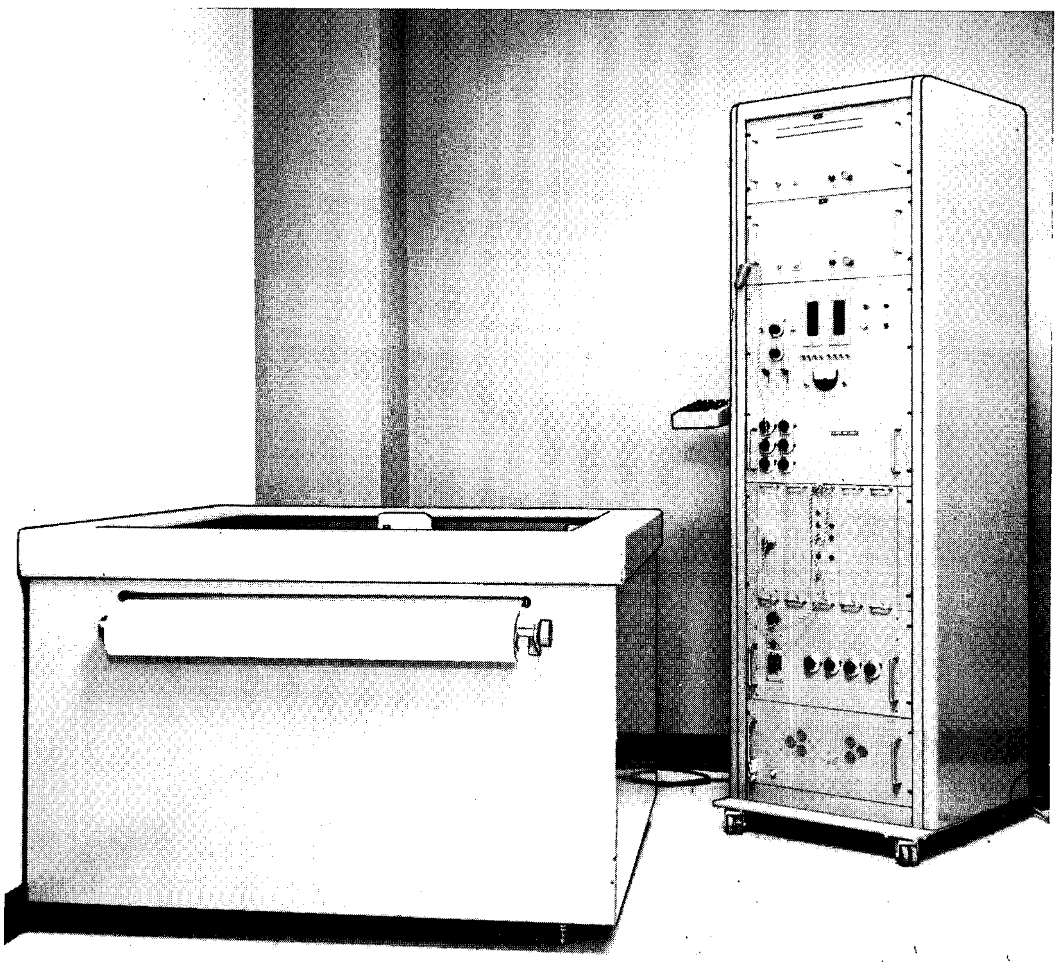


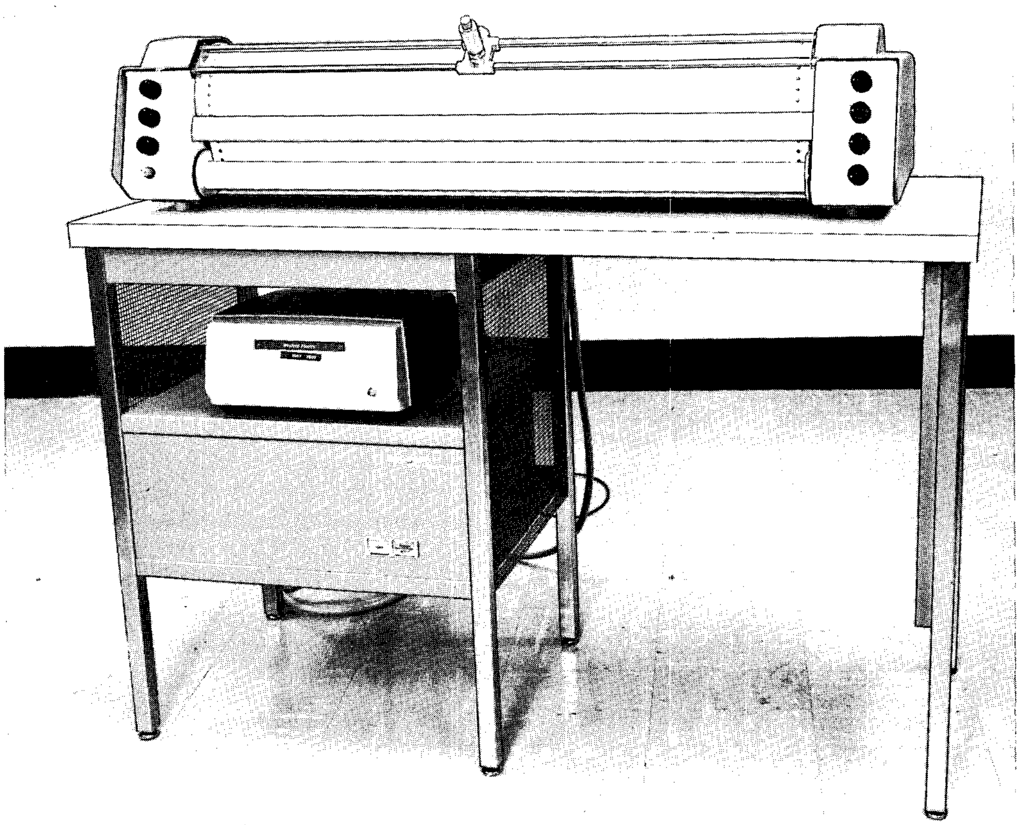
FIGURE 95. [redacted] PLOTTER (MODEL H).

NPIC J-8998 (3/65)

4. [redacted] PLOTTER AND RECEIVER (MODEL 563)

This remote-station plotter (Figure 96), now delivered to the NPIC, is capable of plotting data up to 29.5 inches wide and 120 feet long. Since the plotter accepts data from a Dataphone, it can be used at any computer outlet in the building. Manufactured by [redacted] the plotter is used in conjunction with film readers and chip comparators in the "Real-Time Photo Measurement System" (q.v.).

The [redacted] Plotter is a high-speed 2-axis plotter designed for plotting 1 variable against another. The actual plot is produced by the movement of a pen over the surface of a chart paper, the X axis by rotary motion of the chart drum and the Y axis by lateral movement of the pen carriage. Z-axis motion is provided for by a pen solenoid which permits the pen to be lifted or lowered to the plotting surface in response to electrical input signals. A bidirectional rotary step motor on both the X- and Y-axis drives causes the drum or pen carriage to move .01 inch in either a positive or negative direction at a rate of 200 steps per second. The plotter is about 39 inches wide, 15 inches deep, and 10 inches high. It weighs 53 pounds and costs [redacted]



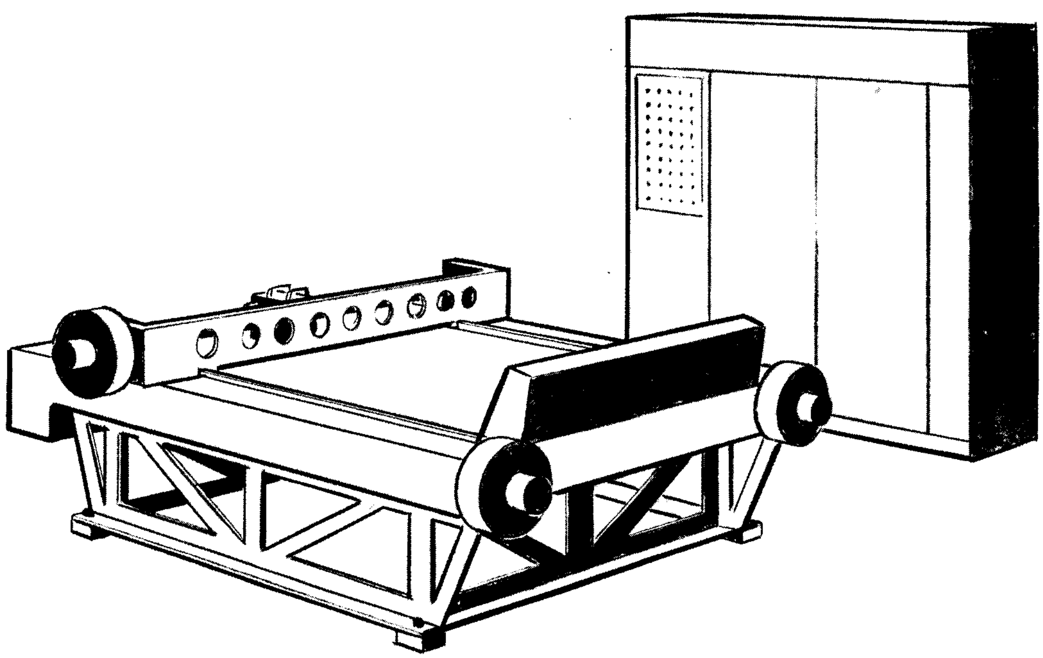
NPIC J-8999 (3/65)

FIGURE 96. [redacted] PLOTTER AND RECEIVER (MODEL 563).

[redacted]

5. PRECISION COORDINATOGRAPH [redacted]

The high-speed precision coordinatograph (Figure 97) is presently being evaluated at the NPIC. Containing a 60- by 60-inch plotting surface which is big enough to produce overlays for the largest maps generally available, the instrument will handle general-purpose plotting requirements, particularly coverage plots based on ephemeris information. It will be used on-line with the UNIVAC 490 and all functions will be under computer control, including vacuum hold-down and paper advance, so that a minimum amount of operator attention will be required. The system logic is digital and no analog techniques are used. The production model is due by March 1966, and will cost about [redacted]



NPIC J-9000 (3/65)

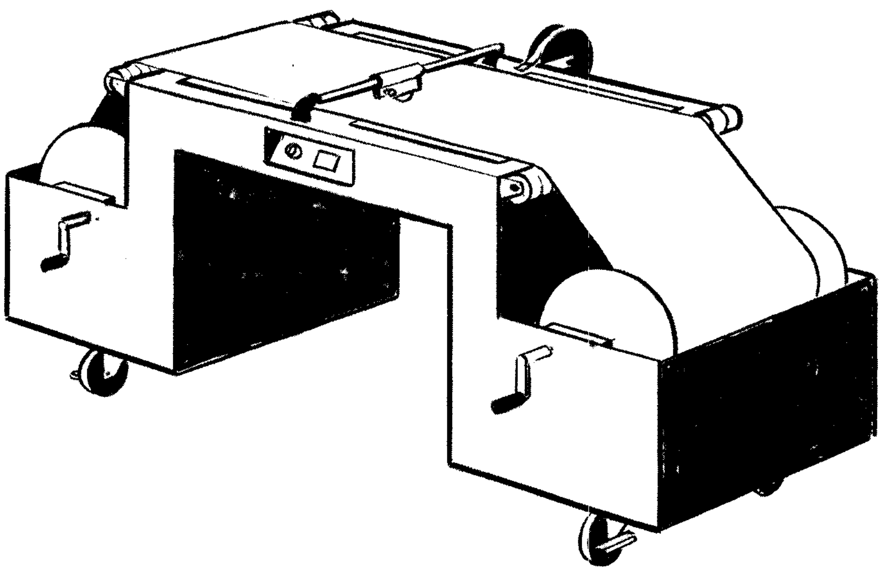
FIGURE 97. PRECISION COORDINATOGRAPH [redacted]

[redacted]

E. MISCELLANEOUS

1. [redacted] FILM EDITING TABLE

This [redacted] film editing table (Figure 98), specially designed with an attachment for handling large-diameter film spools and a device for cutting the film, provides a capability for cutting any film base in roll form and of joining the film with a temporary splice. Used in the editing and breakdown of 9.5-inch negative photography as received from the processing laboratory, this table will facilitate the preparation of manageable-size film spools and the removal prior to reproduction of those portions of a mission which are completely useless. The operator will be able to view the film on either side of the film cutter. Production models are due in September 1965, at an estimated cost of [redacted]



NPIC J-9001 (3/65)

FIGURE 98. [redacted]ILM EDITING TABLE.

2. EVALUATION AND CALIBRATION STANDARDIZATION FOR THE MICRODENSITOMETER

This completed National Bureau of Standards (NBS) contract ran concurrently with the Microdensitometer Capability and Data Interpretation Study, so that one supplemented the other. At present there is no accepted standardized calibration technique. Since density measurement varies with procedure and instrument, calibrations are neither reproducible nor generally reliable. It is felt that this approach may eventually lead to a standardization of microdensitometer calibration. The calibration procedure can lead to a standard acceptable to the American Standards Association and become invaluable as a tool for comparison of intensive microdensitometer studies and evaluations now carried on by numerous government and commercial agencies. An approved standard for calibration would eliminate erroneous interpretations and duplication of effort in a number of research programs. Distribution of the final report is in progress.

3. MICRODENSITOMETER CAPABILITY AND DATA INTERPRETATION STUDY

For the NPIC to realize the capability to provide more comprehensive, accurate, and timely data on systems evaluation, it is essential that the personnel engaged in microdensitometry have a study available for instruction and reference. This study has been completed and the final report, in 3 parts, has been distributed.

Part I of the study includes, but is not limited to: practical applications of slit and spot sizes; spectral and diffuse density relationships; relative sensitivity as applied to scan apertures, emulsion depth, light sources, and film types; and discussions on related scanning capabilities of interrelated visual displays and recording instrumentation.

Part II of the study presents a survey of microdensitometers currently available on the commercial market to enable evaluation of capabilities versus the user's requirements.

Part III covers advanced microdensitometer concepts, including color microdensitometry.

SECTION IV SPECIAL TECHNIQUES, STUDIES, AND AUTOMATION

A. INTRODUCTION

B. SPECIAL TECHNIQUES

C. DEVELOPMENTAL STUDIES

D. AUTOMATION

E. MISCELLANEOUS

A. INTRODUCTION

The primary purpose of this category of the development effort is to segregate those projects on which significant investigatory aspects remain to be accomplished before implementation is indicated. In a sense, this category can be regarded as the logical initial phase of a development project, during which a given requirement or advanced concept is examined for its broadest implications and to determine the feasibility, potential impact, and consequent level at which it should be pursued.

Also included in this category are basic studies such as those required to define the nature of an image and the response of the human visual system to that image. These studies are intended to assist in the definition of parameters to be utilized in compiling objectives for more specific developments such as light-modulation viewers or high-performance reproduction materials.

The need for this subdivision of the development effort has been recognized from the beginning, but it is only within the last few years that the functional importance of treating it as a separate aspect has been realized. As technological advances continue to multiply--increasing the quantity, quality, and diversification of the acquisition materials, and providing new knowledge and devices pertinent to exploitation processes--it is anticipated that this portion of the program will attain a status of prime importance and that the yield from such considerations of requirements and concepts will be many times that of the original inputs.

25X1

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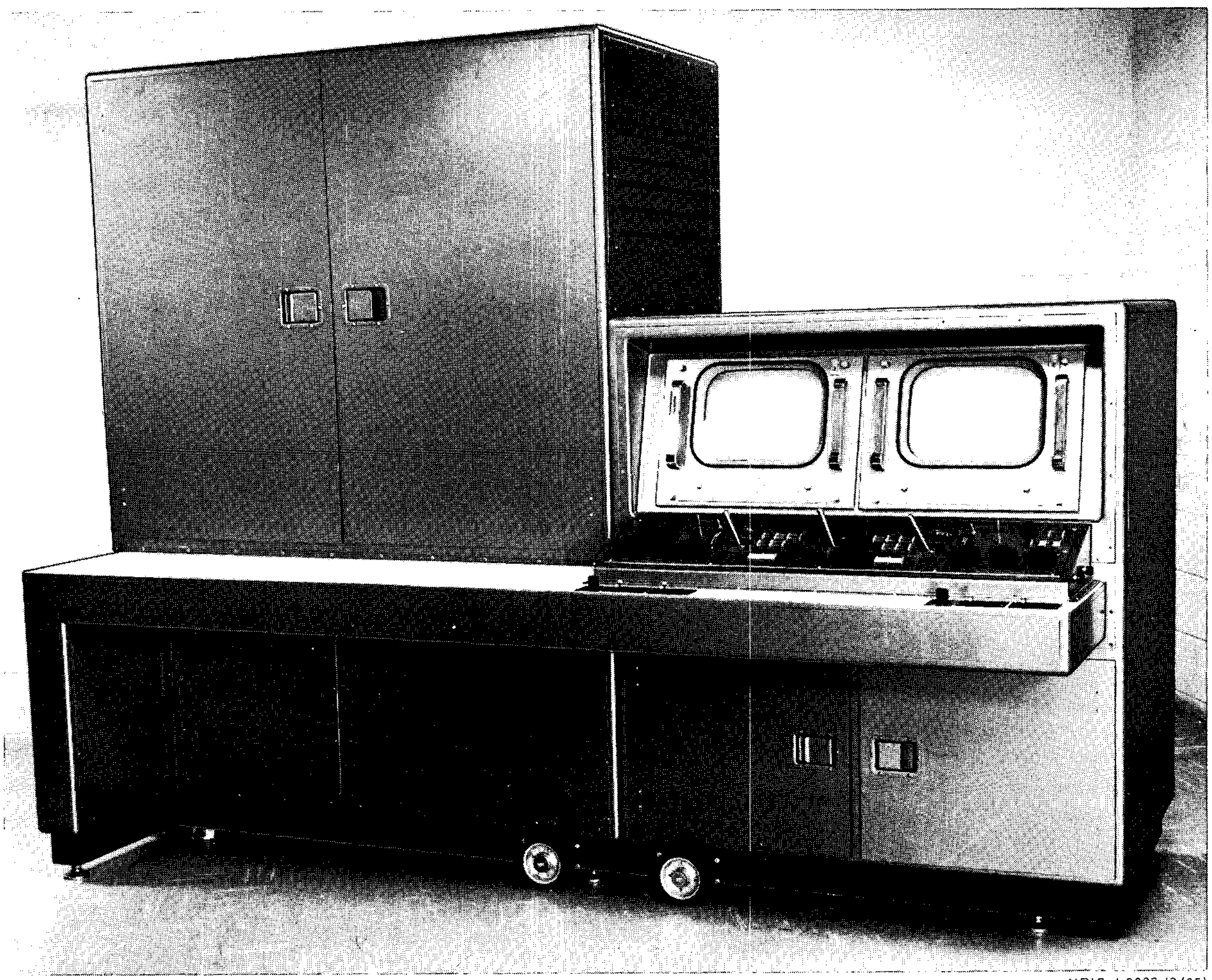
Approved For Release 2004/12/01 : CIA-RDP78T04759A002600010016-2

[redacted]

4. [redacted] CHANGE DETECTOR

The [redacted] Change Detector (Figure 99) is an instrument which automatically registers, compares, and displays photographic data from 2 views of a common area taken at different times, presenting visually the changes that have taken place between the times the 2 photographs were made. An experimental, or preproduction, model of the instrument with a resolution limitation of 50 line pairs per mm has been delivered and is undergoing shake-down adjustment and alignment preparatory to operational evaluation. The cost of the detector is [redacted]



NPIC J-9002 (3/65)

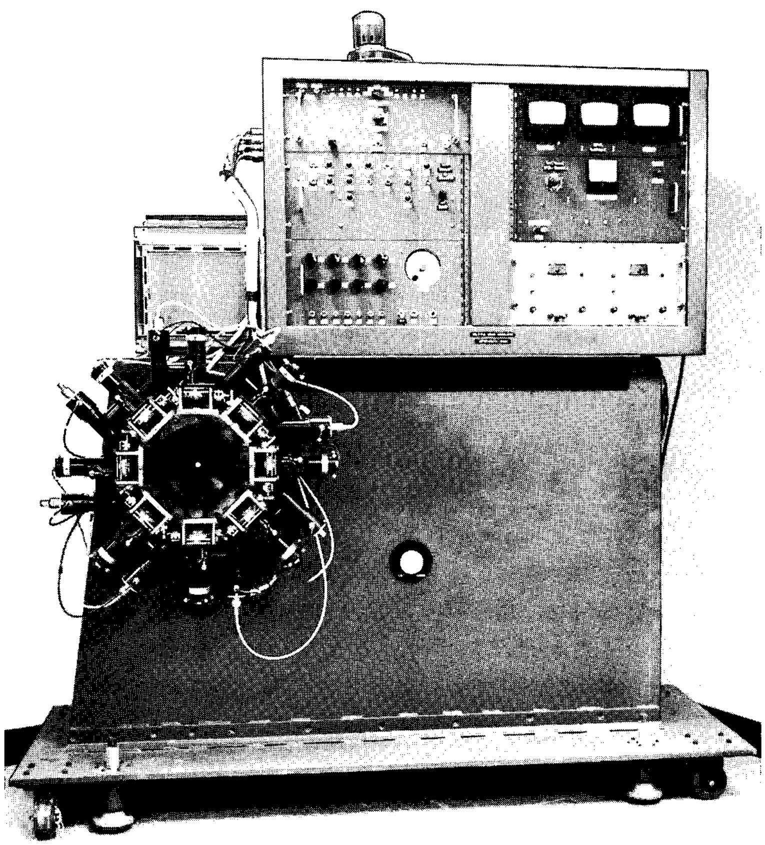
FIGURE 99. [redacted] CHANGE DETECTOR.

5. MULTIPLE IMAGE CORRELATOR (MARK I)

The Mark I Multiple Image Correlator (Figure 100) is designed to register with precision as many as 8 photographic images containing approximately the same photographic imagery or geometry and to print these images simultaneously into a single photographic record enlarged approximately 25 diameters. It has both manual and electronic registration. The latter is necessary to achieve a degree of precision registration to within the limits of the grain structure of the individual negatives. The filling-in effect of the random patterns contained in the several negatives to be integrated results in rather spectacular improvement in the final product.

The Mark I has been delivered and is now undergoing a series of tests. Other NPIC studies are being made to determine additional instrument capabilities. The parameters for the input materials and operational techniques and procedures are also being established.

An image selector, or "cookie cutter," has been fabricated as an adjunct to the Mark I to prepare negative formats in a circle 1 inch in diameter. The input materials will come from several sources, including motion-picture photography, small-format hand-held cameras, and multiple-lens systems.



NPIC J-9003 (3/65)

FIGURE 100. MULTIPLE IMAGE CORRELATOR (MARK I).

6. ASPHERIC LENSES

[redacted] will investigate the design of aspheric lenses and the methods of producing the aspheric surfaces of such lenses. The design will be applied to projection lenses for rear-projection viewers, allowing a maximum of light transmission, minimizing aberrations and distortions, and improving the resolution over the entire format of the area being viewed.

The project also includes research into those improvements in performance that could be obtained by using projection lenses designed for use with highly monochromatic light, and the preparation of a lens evaluation manual.

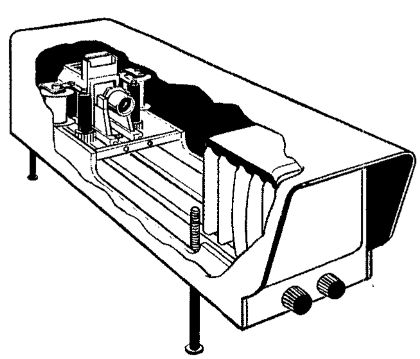
7. LINEAR PHASOLVER

The system concept for a linear phasolver has been successfully demonstrated and this highly reliable measuring technique, superior to any we now have, will be made available for incorporation into future comparators.

Almost all large-format comparators now in use rely on either a precision lead screw with shaft rotation encoders or the Ferranti Moire fringe techniques. The phasolver is a precision device which accurately converts minute increments of mechanical motion into large electrical phase shift information. This information can be easily processed and digitized by electronic equipment for a highly accurate readout.

8. VIRTUAL (DIRECT) IMAGE VIEWER

The virtual image viewer (Figure 101) is capable of presenting the eye directly with ultra-high-resolution aerial images which can be viewed simultaneously with both eyes at magnifications of 5x (60 lines per mm) or 50x (200 lines per mm) in a 3.5- by 3.5-inch pupil field. Because this viewer is not limited in resolution by a diffusing screen and because it can deliver the image directly to the human eye, its performance is comparable in quality to advanced microscope viewing.



NPIC J-9004 (3/65)

FIGURE 101. VIRTUAL (DIRECT) IMAGE VIEWER.

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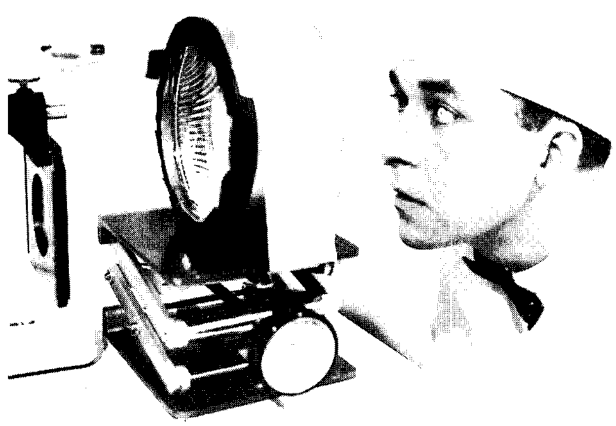
25

To achieve such a high transfer of information, the viewer makes use of a unique optical approach involving diffraction gratings (Figures 102, 103). The grating makes possible a field of 169 pupils, thereby providing the eye with 169 contiguous positions for viewing within a compact area. The success of the viewer depended on the quality of these gratings, and the Exploratory Development Laboratory is responsible for having discovered a technique which makes such quality realizable.

NPIC J-9005 (3/65)

FIGURE 102. FIELD OF EXIT PUPILS AVAILABLE IN EXPERIMENTAL VERSION OF VIRTUAL IMAGE VIEWER.

The use of a crossed-phase grating in the system forms 169 useful pupils over the field where visual resolution has been observed to be in excess of 228 lines per mm at high object contrast.



The optical system producing this pupil is working at approximately 30x -- high magnification reduces the pupil size proportionately.

NPIC J-9006 (3/65)

FIGURE 103. SINGLE EXIT PUPIL TYPICAL OF DIRECT IMAGE VIEWING DEVICES.

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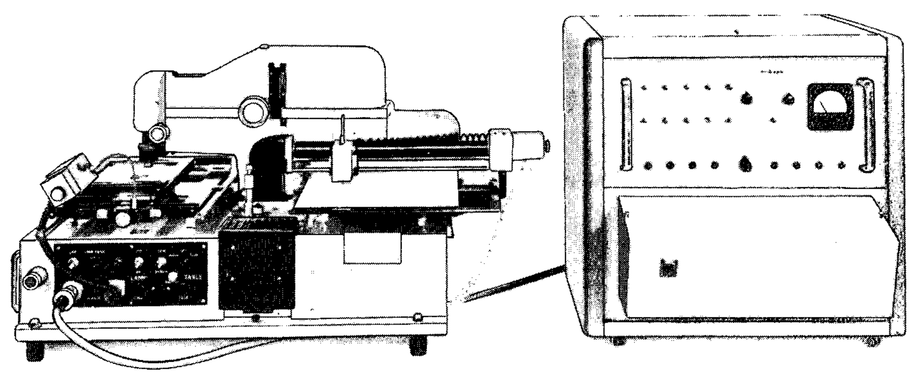
9. ISODENSITRACER AND ISODENSITY MAPPING TECHNIQUES

Because the human eye sees an "edge" only where the ratio of the photographic densities of adjacent areas is large, it is usually difficult for a photo interpreter to see any detail in over- or under-exposed regions of a picture. Thus, in the shadow of a building, for example, if the film has been exposed for the brightness of the surrounding scene as a whole, the eye sees only a featureless area of black, even though the image of objects lying in the shadow has been faithfully recorded by very slight differences in photographic density.

It is possible, however, to make these objects visible by accentuating the minute density-difference patterns until their contrast is great enough to be perceived. In the past, this accentuation of contrast has been done by purely photographic methods: portions of a picture have been copied onto high-gamma, contrasty film which, with careful control of exposure and processing, transforms a small difference in density into a large difference. The drawbacks of this method, however, are so severe that it is seldom applied in practice and, even then, its results are often open to question.

A recent development in microdensitometer technology, the so-called Isodensitracer (Figure 104), now promises to provide a versatile tool to aid the photo interpretation of very low contrast images. Additionally, the Isodensitracer is able to perform certain tasks of density analysis that will greatly improve optical testing of screens and illumination systems of rear-projection viewers.



NPIC J-9007 (3/65)

FIGURE 104. ISODENSITRACER.

The Isodensitracer is a modification of the [redacted] scanning microdensitometer: the specimen is scanned by a beam of light while a recording pen moves over a blank sheet of paper printing a series of lines, dots, and blanks representing the density of that part of the specimen being scanned. The final record is easily interpretable as a set of density contours.

Applied to optical equipment problems, the Isodensitracer furnishes an attractively simple method of evaluating the evenness of illumination on viewer screens. The illuminated screen is photographed, the film is developed under standard conditions, and an isodensity map of the negative is made on the Isodensitracer. Each of these maps can be interpreted in terms of known optical qualities to yield an understanding of the deficiencies or the strong points of each viewer and screen. Other optical tests on lenses, films, filters, and other components are possible using isodensity mapping.

In photo interpretation, isodensity analysis will be valuable when intelligence must be extracted from photographs taken under unfavorable light conditions: low sun angle or overcast skies, for example; or when the illumination range of the scene exceeds the response range of the film, as in the shadows of buildings or trees, or with light-colored objects against a snowy background. Some types of infrared, such as the lower resolution imagery acquired at very high altitudes, is diffuse and has low contrast. Particularly with scanning infrared systems, the Isodensitracer gives an opportunity to smooth the scan-lines, to carry out local rectification of scan-smear, and to detect images hidden by the optical noise of the system.

Looking farther into the future, the Isodensitracer itself can be used to provide the input to a relatively simple photomechanical recording mechanism that would reconstruct the original image with an altered contrast structure or even with a pattern of color replacing the original pattern of density. The color image, ranging from "warm" red through "cool" violet, is especially promising for infrared interpretation. With black-and-white material, the possibilities of contrast manipulation of the image itself, bypassing the isodensity map, were outlined earlier. The Exploratory Development Laboratory is presently working on a prototype of such a mechanism.

C. DEVELOPMENTAL STUDIES

1. FILM PROCESSING RESEARCH PROGRAM

Continuous photographic processing machines have been designed and engineered for many years according to standard procedures. In all cases, the film was transported by friction over a series of motor-driven rollers or belts. This method of drive necessitated physical contact of both the emulsion and base of the film against a multitude of surfaces as it passed through the various solutions and the dryer.

Repeated contact with the surfaces of driven rollers has frequently caused damage to images on soft emulsion surfaces. The torque of the drive rollers has produced a longitudinal image distortion of inconsistent magnitude for which corrective computation is difficult. Until recently, these processing defects were of little or no importance. However, now that photographic exploitation has been developed to an exact science involving identification and measurement of extremely minute targets, it has become imperative that means be sought to minimize film surface damage and image distortion.

A basically new processor known as the

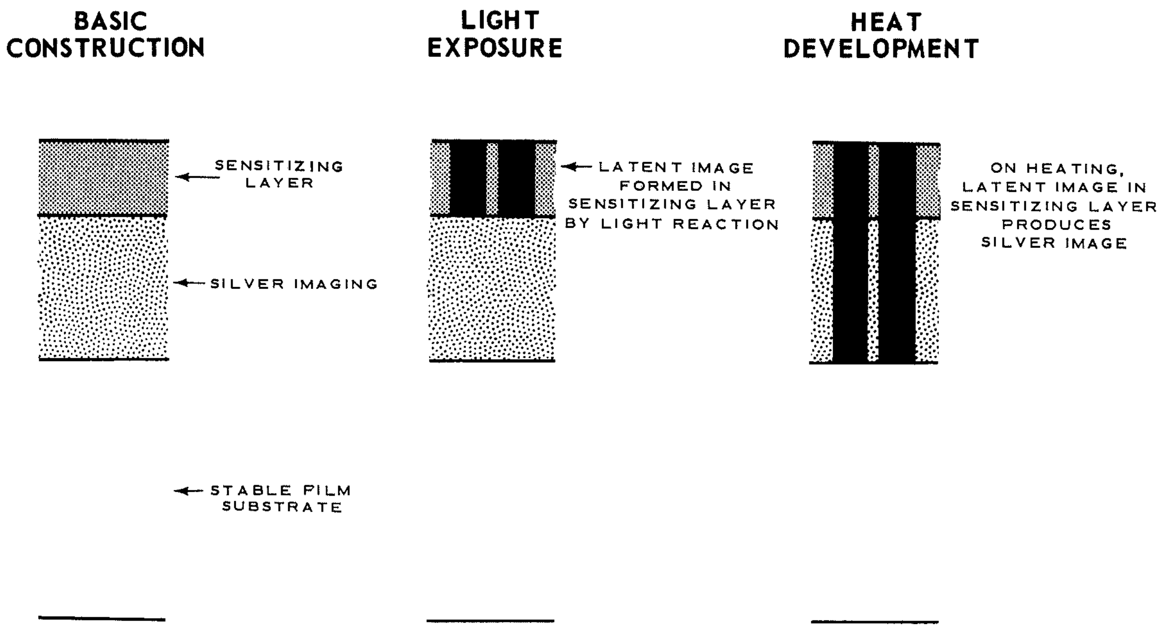
HTA/5 was built in prototype in an effort to eliminate objectionable characteristics in existing equipment. It used an entirely new concept of liquid- and air-bearing transport based on patents originated in Canada. The system employs no moving parts or rollers in the processing and drying stages but transports the film on a cushion of liquid and air with no hard-surface contact. Tests of the HTA/5 have proved the concept to be sound. In addition to the elimination of surface damage and dimensional distortion, the concept simplifies the equipment by elimination of many rollers, bearings, racks, and other operating parts. Required maintenance is reduced. Chemical development is accelerated by the increased agitation inherent in the system.

Despite the significant potential advantages of the liquid/air-bearing concept, tests of the first prototype clearly showed that many untried features of the design needed improvement. However, so little was known about the fundamentals of the concept that suitable research had to precede any major change in design. This research effort would have to be carried on by competent research personnel in an ideal environment properly supported by all necessary facilities with major emphasis placed on reliability, reduction of power requirements, reduction of size, controllable development, color development, reduction of components, reduction of plumbing, and efficiency of air bearings and other components.

Such a research program is now under way in a competent commercial establishment suitably outfitted to provide empirical answers, derived by scientific methods rather than by trial and error, to the many unknowns relating to photographic processing. The present HTA/5 processor will be used as a research vehicle. A portable, government-furnished clean-room enclosure has been provided to simulate realistic and variable operational environments and to assure proper security control of work performed.

2. DRY-PHOTO PROCESS STUDY

The prime objective of the Dry-Photo Process Study is to produce a photographic reproduction material that equals or exceeds the capabilities of the conventional silver processes without their known shortcomings of wet processing, slow readout, and limited resolution. The Dry-Photo Process (Figure 105) would be almost grainless and completely dry, permitting near real-time readout. The media is projection speed, exhibits extreme resolution, and has a very low spread function. In addition, it has a wide range of gamma control and a density range in excess of what is required. Development is accomplished by application of heat. This process shows exceptional potential and promises to exceed conventional silver halide materials in virtually all respects.



NPIC J-9008 (3/65)

FIGURE 105. DRY-PHOTO PROCESS.

3. REAR-PROJECTION SCREEN DEVELOPMENT STUDY

Currently under contract is a feasibility study to develop a high-resolution rear-projection screen system. The basic concept of this program is to provide a transparent luminescent screen composed of organic phosphors and to excite it by ultraviolet or near-ultraviolet illumination. Such a concept also calls for the development of new projection lenses corrected for the 3650A° and 4047A° excitation emitted by the mercury-arc lamp involved. Some of the apparent advantages of this system are: non-directional character, high-resolution capability, and image contrast independence from ambient room light.

The program for the development of a "breadboard" projection system is presently coming to a successful completion and it is anticipated that a follow-on study-and-evaluation contract will be awarded.

4. ELECTRONIC MICROSCOPE/MICRODENSITOMETER STUDY

Optical microdensitometers are approaching a sensitivity limit based on: a) flare light in the optical path, b) diffraction of the light as it passes over the edge of the scanning aperture, and c) the dark current of the photomultiplier tube. Therefore, design objectives are being written for a study of the feasibility of scanning the film with an electron beam in a vacuum. A phosphor-type substance would be coated onto the film to convert the electron beam into light. A photomultiplier tube, as an integral part of the device, would convert the light transmitted by the film into an electrical signal for recording purposes.

5. OTHER RESEARCH STUDIES

Reversal Processing of High-Resolution Films. This study will investigate and develop a reversal process for high-resolution original negatives, duplicate positives, and duplicate negatives. The process is intended to accomplish reversal with a minimum loss of resolution.

Definitive Study of Contact Printers. This study undertakes a comprehensive evaluation of existing contact printers, i.e., flat bed, step-and-repeat, and drum platen (continuous types), in order to determine the printer and/or technique which will provide maximum fidelity of duplication.

Microdensitometric Data on Image Edges. This program will collect and study microdensitometric data from mission materials in an attempt to determine the effect of film emulsions, processing, and printing on the characteristics of image edges. It will also attempt to determine the true location of image edges for mensuration purposes.

Color Photography Systems Capability Study. This study will investigate color photography as a possible future intelligence medium. The investigation should also cover the capability of present and possible future acquisition systems, in an attempt to predict future requirements to support the exploitation and data reduction of the collected color photographic intelligence material.

Color Reproduction Systems Review. In view of the recent importance attached to color photography by the intelligence community, this review will investigate and determine the most suitable means to reproduce and utilize multiple copies of color material. It would also determine the most suitable reproduction systems and types of equipment to be used in all phases of the reproduction cycle. Further, it will attempt to define how color photography can best be utilized by the photo interpreter.

Exposure of Photographic Material with Lasers. The purpose of this study is to determine the manner and degree of the interaction of present and predictable future photographic films with coherent radiation from laser sources in red and near-red infrared spectrum ranges.

Optimization of the Lasers. This study will explore the production of .53-micron (blue-green) laser radiation by harmonic doubling in KDP and ADP crystals.

D. AUTOMATION

1. INTRODUCTION

Frequency of coverage, large volumes of material, and short response time require an increase in the speed and efficiency of the exploitation process. Time, quality, and quantity are all crucial factors. The NPIC's ability to carry out its exploitation mission will depend increasingly on the equipment and systems standing ready to handle requirements.

Some of the areas in which automation can perhaps make a contribution to the speed and efficiency of the photo interpreter and to technical intelligence exploitation are these (Figure 106): a) reduce the amount of film handling required of photo interpreters, b) make rapid, rough measurements or accurate measurements to a fraction of a micron, c) communicate quickly with in-house support elements, d) produce enlargments, chips, and prints quickly, e) store and retrieve collateral data and imagery, f) detect targets rapidly and determine coordinates, g) rapidly determine target changes since last coverage.

[redacted]

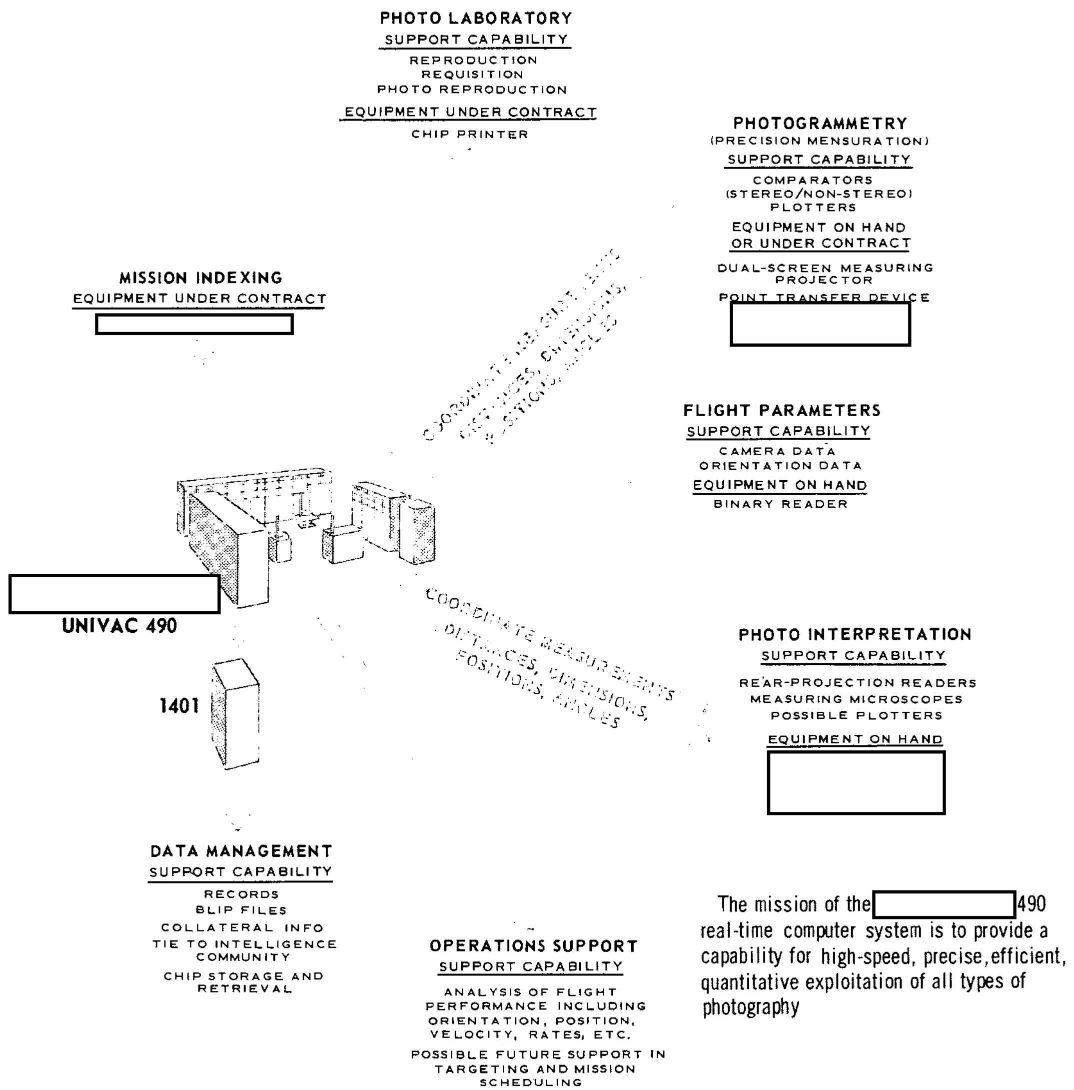


FIGURE 106. UNIVAC 490 REAL-TIME COMPUTER SYSTEM.

Early in 1963, the UNIVAC 490 was installed in the NPIC. The 490 is a high-capacity scientific electronic computer, chosen largely because of its on-line capability. The 490 will be the heart of the NPIC photographic measuring system. Several pieces of on-line equipment have already been installed, and other equipment will follow. (See, for example, the "Real-Time Photo Measurement System.")

The philosophy in emphasizing the on-line concept is this: it will be increasingly costly to make decisions on development and purchase of isolated pieces of equipment, so planing must be directed as much as possible toward system designs that will take into consideration the functional relationship of the various pieces of equipment.

Film readers are under development to give the interpreter a mensuration capability and a communications facility on-line with the computer.

A comprehensive program is under way to search out and evaluate all the automatic image detection and recognition systems now being proposed, developed, or produced. The scanning process can be accelerated by an automatic scanning device that will recognize and indicate possible targets. (A more detailed evaluation of this subject is found under "Automatic Image Recognition Systems.")

A second step toward speeding up the rapid-scanning process will be the addition of the change detector, which is now under test and evaluation at NPIC. The detector will automatically recognize changes in a target since the last coverage: 2 transparencies showing the same area at different times are superimposed and, through proper registration, illumination, and photographic manipulation, the images are combined to make their differences readily apparent.

A feasibility study is now under way on a technique for optical change detection.

2. AUTOMATIC IMAGE RECOGNITION SYSTEMS

The intelligence community generally recognizes that automation of all interpretation procedures and tasks is impossible and probably undesirable. A more realistic first goal may be to develop automatic or semiautomatic equipment or procedures that the interpreter can use to assist him in his most time-consuming and redundant tasks. For example, a machine may be able to count identical or similar objects such as railroad cars more efficiently than a man could. Perhaps a machine could re-scan previous coverage for earlier traces of an item newly discovered on more recent photography. In the past, manual re-scanning for this purpose cost many valuable man hours.

One basic deficiency common to all the several concepts of automatic target recognition that have been developed to date is simply that the computer lacks the ability to generalize. The human interpreter can learn the basic characteristics of a target, and then interpolate and extrapolate. The computer identifies only those specific characteristics it has been taught. The computer cannot identify an unlearned variation of the target. Yet, to teach it all the image variations caused by scale, orientation, contrast, shadow, resolution, partial obscuration, etc., would require a computer with tremendous storage capacity.

A number of the variations, such as scale, distortion, tone, and orientation of the target, might be eliminated by a system to pre-process or pre-normalize the imagery. This would, of course, reduce the large capacity required of the computer.

A current research project is now investigating the potential of this approach. This project, being performed by Scope, Inc., will develop a high-resolution optical scanner to pre-normalize image content and to filter the resultant video signals in such a fashion that they can be "learned" by an existing adaptive recognition device, the Conflex I.

Another approach to semiautomatic image recognition is to use a hologram (of a target) as an optical spatial filter to recognize other examples of that same target. This technique has demonstrated great potential in recognizing words on a page of print, and a project is now being initiated to investigate the possibilities of adapting this technique to recognizing a target in an aerial scene.

3. REAL-TIME PHOTO MEASUREMENT SYSTEM

Of the various applications for the [redacted] UNIVAC 490 computer, one of the most significant is the Real-Time Photo Measurement System for conventional and--eventually--special sensor material. Development is proceeding on remote station equipment for instantaneous response to assist the photo interpreter in his scanning and detailed analysis operations.

Pre-Readout Operations. The receipt of orbital ephemeris and vehicle altitude information and system time data will allow computer personnel to establish a preliminary frame-by-frame set of photo parameters and a mission coverage plot by the time the film arrives at the NPIC.

The necessary communications facilities are now in operation to transmit the ephemeris information. A high-speed precision plotter, the [redacted] has recently been delivered for evaluation. A timely binary readout input is still required at the processing facility to handle information transmitted by cable; no contract action has yet been taken on this item.

Scanning Operations. Most development efforts to date have been concentrated on equipment to support the scanning operation. Now under development to supplement or perhaps even replace present film viewers are 2 film readers, the [redacted] Film Reader and the [redacted] Film Reader (qq.v.). These instruments will give the photo interpreter a measurement capability commensurate with the scanning operation, and will provide a communications capability to be utilized in other phases of the system. The [redacted] Plotter and Receiver (q.v.), a prototype remote-station plotter that provides a response for a rectified plot from the reader, has been contracted for, delivered, and is now operational.

Detailed Analysis Operation. One of the most practical and efficient uses of real-time measurements is in detailed analysis. For this work, the photo analyst almost always uses a cut piece of film (chip) instead of the roll. The volume of such chips now in use precludes a fully automatic chip-handling system, but current plans are to investigate semiautomatic techniques for future use while continuing to use manual techniques. However, the proposed chip format includes a machine-readable code. (Current chip use and a proposed chip format are discussed elsewhere in this publication.)

Four pieces of new equipment are either now available or are proposed to aid in detailed analysis. The first, a stereo chip comparator (q.v.), was delivered in March 1964 and is now operational. The second is the prototype remote-station plotter mentioned under Scanning Operations, which has also been delivered and checked out. A contact chip printer (q.v.) is currently under contract to produce the chip proposed elsewhere in this publication. This chip printer is designed to automatically produce the required mensuration information. Contractual action is still needed on a screening viewer (see "Rear-Projection Chip Viewer" entry) which would not only assist the photo interpreter in selecting a chip from the storage system but would also be valuable for group viewing or small briefings.

Miscellaneous Operations. In addition to the major operations discussed above, the [redacted] 25 Dual-Screen Measuring Projector (q.v.) has been placed on-line and a [redacted] 880 Comparator (q.v.) is being modified for on-line operation. These precision comparators permit rapid response to precise measurement requirements. Due for delivery shortly is the [redacted] Inc., Versatile Stereoscopic Point Transfer Device (q.v.) which will also operate on-line. 25

4. USE OF CHIPS AND A PROPOSED CHIP FORMAT

Roll film is extremely practical in operations that require the scanning of large areas, but chips are more useful in a detailed study. At the NPIC, chips were first cut from film positives for mounting as stereograms in 1957. There was considerable experimentation at first to find a size adequate to cover a majority of targets yet still usable with the simplest stereo-viewing instruments. A governing factor was interpupillary distance. The size finally adopted was 2.5 by 3.5 inches for each stereo pair, with the shorter side serving as the base. The 2 chips that make up the stereogram are mounted adjacently in the open center of a 5- by 8-inch acetate-base form. The area surrounding the mounted stereo pair provides space for data, such as subject, mission, camera, frame, control number, date, city, country, geographic coordinates, scale, WAC number, and accession number. It should be noted that target photo images vary from the very small (1mm or less) to sizes covering 12 or more 9- by 18-inch frames. However, the 2.5- by 3.5-inch chip covered a large percent of the targets.

A stereogram is generally framed to center an item of interest and not to cover the entire target. Some targets can be covered in a single stereogram, others require several, and a few installations require dozens. If the 2.5- by 3.5-inch size is not adequate, the stereogram is cut slightly larger or the film is cut to make a foldout. These cases are rare, however, and foldouts are made only to maintain continuity The chip printer under contract will eliminate the foldout completely, since it will easily produce overlapping or larger format chips.

The mounted stereogram, measuring 5 by 8 inches in its holder, is manually filed in a visible index cabinet designed for this use. These cabinets accommodate 1,350 stereograms, which can all be readily retrieved.

With the advent of more advanced photography, most photo interpreters altered their method of cutting stereograms. Instead of mounting the cutouts in a fixed position as was done with earlier photography, the photo interpreter cut out the area of interest from the two 70mm film rolls and inserted each copy in a separate plastic envelope, 70mm by 6 inches. Necessary information was typed on a small square of adhesive-backed paper and attached to the narrow end of the film, which had been cut longer than necessary to allow space for the square. The pair was filed in the same size cabinet used for permanently bound pairs.

Chips become especially useful when several missions and several rolls of film are involved in comparisons. They are also well suited for briefings, since they can be carried and handled easily. This ease of handling is important, as a matter of fact, in all facets of detailed analysis, e.g., retrieval of targets. In addition, several persons or units may retain duplicate chips and have the same photo information on hand, while leaving the master roll free for others interested in its targets or general content.

Precise measurements remain a problem in the use of chips. For the most accurate and reliable measurements, image coordinates must be related to the principal point of the frame or identified with other points. Under the present and proposed systems of chip cutting, there is no provision for recording displacements from the principal point in the original and thus relating it to the chip. Any measurements taken on cut chips as they are now being used are subject to the photo interpreter's ability to relate the measurements to a scale factor or some other approximate value and to properly hand-reduce the data. In view of this, the UNIVAC 490 system was set up to relieve the photo interpreter of data reduction responsibilities and free him for analysis.

A study made of the collateral information required for a chip system in relation to image sizes found that certain common factors would fulfill the requirements of both a computer measurement system and a retrieval system. This unvarying information could be incorporated into the exposure process. It should be duplicated in codes readable both by humans (alpha-numeric) and by machines. A gummed-paper label containing variable information could be attached to the chip in the space provided.

The proposed image size is 55mm by 95mm, with optional image sizes of 85mm by 95mm and 105mm by 95mm available if needed. The 85mm by 95mm size is considered the largest practical image area usable without special-purpose viewing devices. In the future, it will be possible to make precision enlargements of selected targets with the same format. The total size of the chip will be 100mm by 127mm (standard 4- by 5-inch cut film). Two chips will make a stereogram measuring approximately 5 by 8 inches, or the same size as the mounted stereograms now in use.

The overall size tentatively agreed on by the Interservice Coordinating and Integrating Group (ISCIG) for the Department of Defense (DOD) photo chip is 70mm by 100mm. In the image area of the NPIC's chip, the 95mm dimension has an additional 2.5mm border on each end, resulting in an overall length of 100mm. Therefore, 1 dimension of the Center's chip, including the border, is actually the same as 1 dimension of the tentative DOD chip. Consequently, it will be possible to butt-splice a data block on the DOD chip and generate a 4- by 5-inch chip for entry in our system.

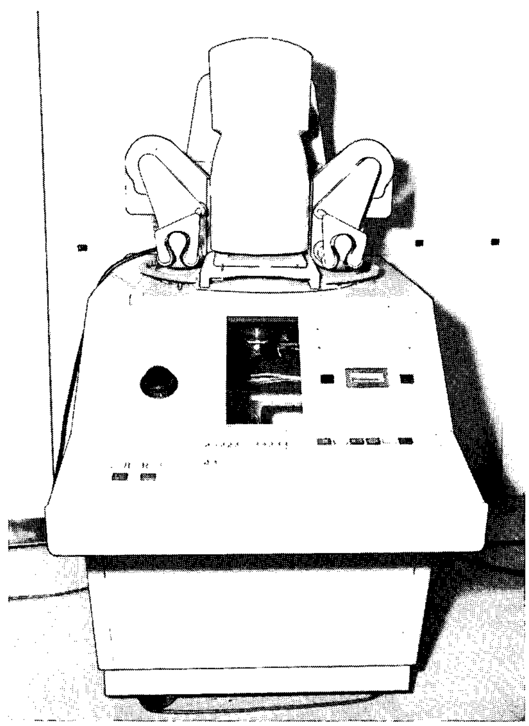
5. CHIP DATA-BLOCK READERS

The NPIC is planning to build an automatic data-block reader for the coded information to be included on the film chip produced by the chip printer (q.v.). Currently, however, action on this item is pending finalization of the exact code to be produced by the chip printer. Once the code design is established, the reader will be produced to be used with chip handling equipment, such as the comparator, and any storage and retrieval system that may be developed.

In addition, action is anticipated shortly in the development of a data-block reader for various airborne systems which do not follow the DOD Military Standard 782-A System because of unique requirements; no further information on this reader is presently available.

6. AUTOMATIC DATA-BLOCK READER

The Automatic Data-Block Reader (Figure 107) is used to read and record, in a form suitable for input to a computer, the binary time-word imaged on each frame of photography. The time-word, which permits calculation of when the frame was exposed to the nearest millisecond, is contained in a 29-bit binary data block and is useless until translated into decimal time. The data reader consists of a variable motor-driven film transport, optics which magnify the data block 3x, a reading head with 31 photo cells, a transistorized amplification stage, a variable light source, and associated electronics which provide the output for the IBM card punch.



NPIC J-9010 (3/65)

FIGURE 107. AUTOMATIC DATA-BLOCK READER.

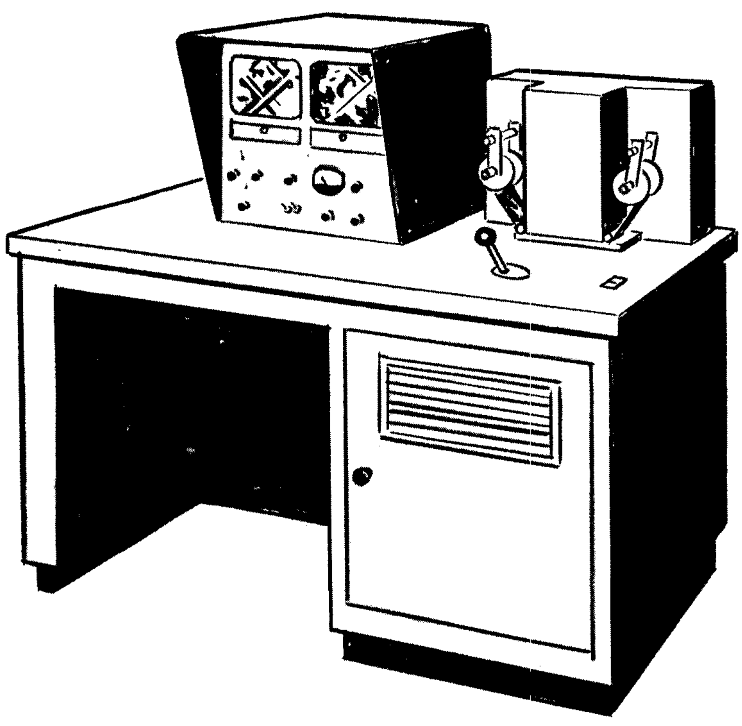
25X1 [redacted]

[redacted] 25X1

E. MISCELLANEOUS

1. CLOSED CIRCUIT TELEVISION

The Plans and Development Staff is considering the use of closed circuit television (CCTV) in the NPIC in terms of security, image quality, alternate approaches, and time savings. While CCTV would probably provide a flexible means of transmitting visual information within the NPIC, the hazard of compromising emanations poses a security problem. Once this difficulty is overcome, CCTV could make a valuable contribution toward rapid communication with in-house support elements. Sufficient equipment must be borrowed or rented for testing before any action is initiated toward installation of a CCTV system. An example of a CCTV viewer is shown in Figure 108.



NPIC J-9011 (3/65)

FIGURE 108. CLOSED CIRCUIT TELEVISION VIEWER.

[redacted] 25X1

[redacted] 25
[redacted] 25

2. IMAGE QUALITY EVALUATION PROGRAM

In July 1964, a group was formed to study the problem of evaluating the quality of certain mission photography. Organized by the Plans and Development Staff, NPIC, this group consists of representatives from industrial firms and government agencies for whom such evaluation represents a vital concern. Included are [redacted] NPIC, the Deputy Director for Science and Technology (DD/S&T), and the National Reconnaissance Office (NRO). In addition, there is a technical advisor from the [redacted]

X1
X

25
25

This group is charged with fully investigating edge-trace and GEMS (comparative photography) techniques, and with implementing the most promising method(s) for routine mission-quality assessment. The study is scheduled for completion in the summer of 1965.

3. PHOTO INTERPRETER PERFORMANCE AND TECHNIQUE STUDY

In NPIC's particular intelligence effort, "man" -- the photo interpreter -- is the key element and yet he remains the most unknown factor in the total picture. There are proven techniques for attaching numbers to systems' capability (currently in terms of "modulation transfer function"), but there is no means, to date, of quantitatively accounting for or predicting or enhancing human performance as it relates to the quality and kind of materials available in the interpretation task. This vagueness inhibits our development programs.

In general terms, we want first to ask ourselves what threshold of quality is incontrovertibly set by accountable human factors; then, what degree of image quality is really needed for specific targets (for this will vary), and exactly what details we want to be able to see in various targets; and finally, the question of when stereo and color, for instance, provide more information to the human visual system.

Initially, the program will investigate 3 principal and basic areas of concern: a) the relation between photo interpreter performance and the ground resolution of photography, b) the effects of stereo-image viewing (as opposed to monocular viewing) as well as the effects of mixed-resolution stereo pairs on photo interpreter performance, and c) the effects of color photography on photo interpreter performance.

Other factors of contiguous or future concern are:

- Contrast and brightness range
- Granularity
- Sun altitude and azimuth
- Obliquity
- Infrared photography
- Real color vs false color
- Scene change detection
- Season/terrain
- Searching and viewing time
- Viewing equipment/scale
- Collateral information
- Individual photo interpreter differences

Findings will supply objective measurements that will serve to aid in the development and use of collection systems and exploitation equipment.

[redacted] 25