# VERSATILE, HIGH PRECISION STEREO

# POINT TRANSFER DEVICE

JULY AND AUGUST 1963

PROGRESS REPORT

JOB #552

The following work has been accomplished during this reporting period. The comments are organized under major sub-assemblies in the instrument.

1. OBJECTIVE ASSEMBLY

Configuration of objective assembly has been laid out and lens focal lengths determined. Several lenses have been obtained, or ordered, for evaluation. Preliminary tests have been made on several of them. None have been selected until more complete tests are completed. The Zoom magnifier mechanism used on #287 Stereo Viewer is to be incorporated as the variable magnification element. A turret mechanism, similar to that in the #344 and #373 Viewers, is to index and support the objective lenses. Detail design of the objective assembly has not started, but is expected to begin during the next reporting period.

2. EYEPIECE ASSEMBLY

The folded path configuration presented in the proposal for eyepiece assembly was found to have several shortcomings. The principle disadvantage was rotation of image, about 68°, when eye stations were interchanged. Secondly, the plane of image reversion was across the width of the film rather than along its length. Thirdly, the dove prisms, originally shown, would have been of extremely large proportions, and the optical path lengthened considerably by its use. The mirror equivalent of the dove prism was also considered, but suffered similar disadvantages.

2. EYEPIECE ASSEMBLY (Contd.)

In an effort to overcome the above problems, and still get the required optics in a compact package, an alternate scheme was devised that is slightly longer, but provides great versatility. The optical schematic of this approach is shown in Figure 1. Since mirrors that arrange the various modes work in a collimated light path, the path length between collimating and telescope lenses is not critical. Therefore, image quality will be influenced only by the surface characteristics of the mirrors used, and the rigidity and accuracy of their mounts.

Optical Schematic of Eyepiece Assembly shown in one plane, although Collimator and Telescope paths are folded to shorten overall length of unit.

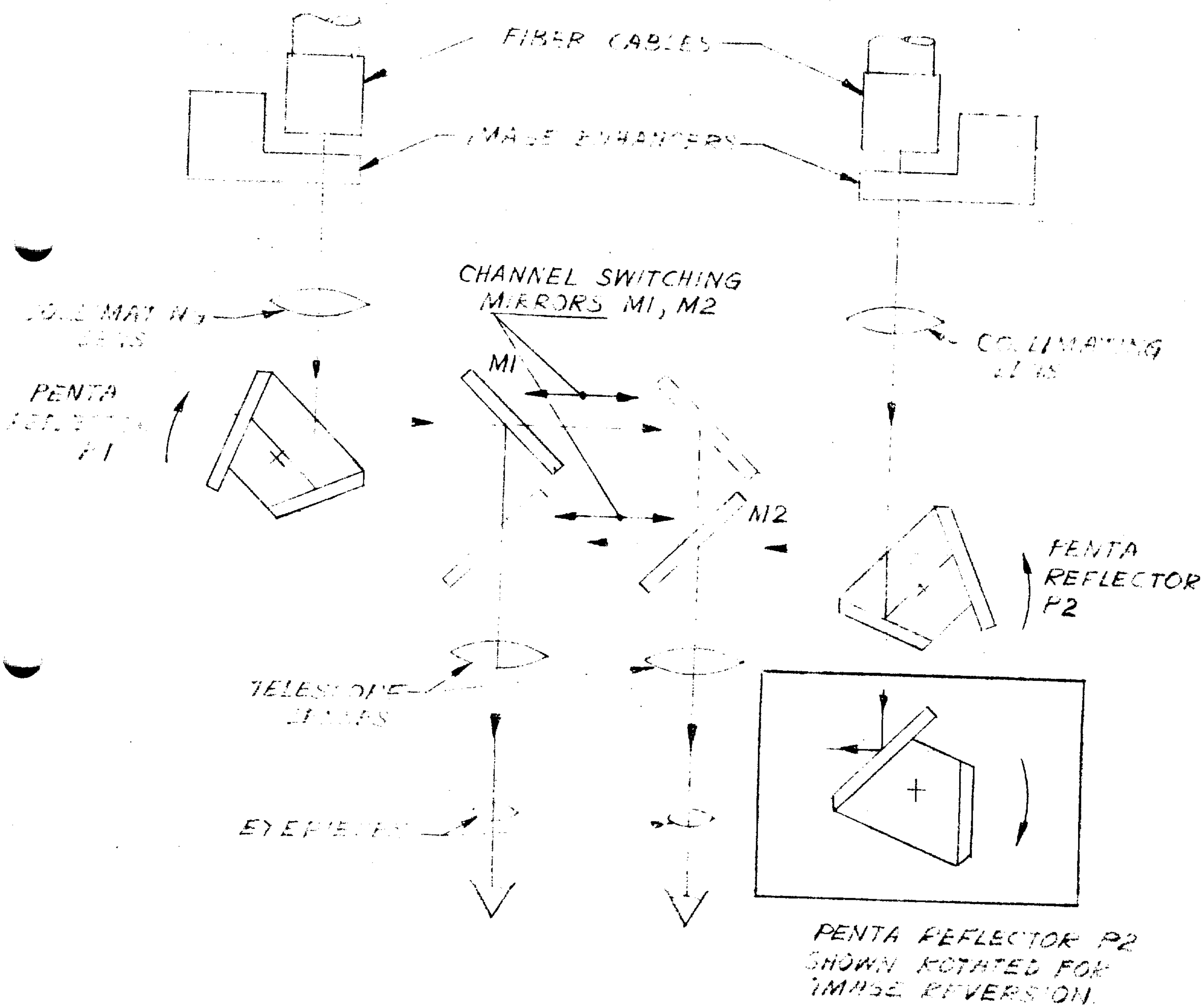


FIG. 1

OPTICAL SCHEMATIC OF EYEPIECE ASSEMBLY

#552 STEREO VIEWER



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2. EYEPIECE ASSEMBLY (Contd.)

There will be a number of modes possible with the eyepiece assembly as it is now designed. The following are fundamental ways of using this eyepiece.

There will be three modes made possible by use of switching mirrors: Stereo, Pseudo-Stereo and Image Reversion. These are accomplished by the motion of mirrors M1 and M2 and the Penta reflectors shown in Figure 1.

For stereo, mirrors M1 and M2 are shown in the heavy lines for the two mirrors directly in front of the telescope lenses. Tracing the path through the optical schematic you will see that the image will go through the penta reflectors, and then on to M1 or M2 and then to the eye. (Right objective lens to right eyelens, left objective lens to left eyelens.)

When M1 and M2 are brought to the dotted positions, as in Figure 1, Pseudo-Stereo will be accomplished through the reverse of eye stations with respect to the right and left hand objective assemblies.

Image reversion is handled by the use of a plain mirror and a penta reflector in each of the channels. In Figure 1 it is seen that the path is normal, no reversion, as shown with the penta reflector. When the penta reflector is turned approximately 120°, as shown in the inset Figure 1, a plain mirror will be put into its place causing one less reflection and therefore, a reversion in the right-left plane will be noted. Reversion in right and left channels is independent of each other and independent also of the motions of mirrors M1 and M2.

2. EYEPIECE ASSEMBLY (Contd.)

A second function in the eyepiece assembly is image rotation. This capability is brought about through twisting of the fiber bundle from a knob located at the front panel. The extent of the adjustment is readily seen by a dial at the front, and is unlimited in their range of ± 180°. The dial will read at approximately 2° or 5° intervals. Either channel fiber cable can be rotated at any time and also independently of other optical functions in the eyepiece assembly.

A third function in the eyepiece assembly is the image enhancement of the fiber optic cable display. This is a device that will integrate the defects of the image of the fiber optics, minimizing the mosaic structure and possible broken fibers in the cable. This way the presentation is a relatively clean image of the film being studied. Because the cable enhancement mechanisms are at either end, both ends are related, and therefore, when the fiber cable is rotated at one end to accomplish the image rotation mentioned before, the image enhancer mechanism will also have to be rotated. This coupling is easily done by connecting the rotating cable end in the motor with gears. To optimize mechanisms synchronization in the image enhancing process, one fine phasing control will be necessary at the front panel of the eyepiece assembly. This adjustment causes a small but noticeable change in the angular relationship between the mechanisms at either end of a cable.

A fourth function in the eyepiece assembly will be the interpupillary adjustment and focus of the eyepieces. The eyepieces are to be individually focused to handle small differences between the operators eyes. An interpupillary distance scale will be in millimeters, and will give the operator the extent of interpupillary adjustment. The eyepieces will not be sliding, but rather rotating about a point off the axis of the eyepiece itself. This will

2. EYEPIECE ASSEMBLY (Contd.)

essentially be a straight line motion where the eyepiece itself is, and should in no way cause discomfort or difficulty in achieving a comfortable position for viewing. To accomplish the interpupillary adjustment the operator need only grasp any one of the eyepieces and push or pull sideways to get the proper adjustment. The image seen by the operator will be in focus at all times, regardless of the adjustment and will need no further positioning of the eye lens if the interpupillary distance is changed during the initial adjustments for the operator. Eyepiece assembly suspension will allow positioning of the eyepiece as required. Angular adjustment of 30° causes a problem here in that the fiber cable coming out of the rear of the assembly interferes with the objective assembly when the extreme lower Z, Y, and angular adjustments are made on the eyepiece assembly. What we have done to avoid this problem is to somewhat limit the angular adjustment of the eyepiece assembly and to have the eyepiece by itself rather than the entire assembly bring about the angular adjustment. With this, the linkage mounting the eyepiece assembly to the cabinet proper will be used primarily for the Z and Y adjustments, and to some extent an angular adjustment. The links will be locked at their joints by friction. A counterbalance will be installed to take most of the weight of the eyepiece assembly from the operators hands during the adjustment of the eyepiece position. The degree of counterbalancing will be such that the unit will not fall or rise significantly if all the locks are released at one time.

[redacted]

3. FRAME ASSEMBLY

Rigidized frame features a one piece iron alloy casting, weighing approximately 1500 lbs., with integral cross bracing and stiffeners to maximize rigidity. Continuously supported ways will have machined-in alignment, assuring long term stability. Casting sections are designed to give minimum deflections under adverse installation conditions. Integral leveling jacks, with vibration isolating pads, will support viewer at installation site. Equipment will be transported within the site by built-in casters.

Overall length will be 84" providing wide, stable carriages for both X and Y axis motions.

Ways consist of one round and one flat hardened precision ground members for each carriage. A pair of ball bushings and ball bearings engage these ways, respectively, providing rigid and low friction carriage guidance.

4. SCAN DRIVE ASSEMBLY

Precision ground ball screws provide low friction and low backlash for sensitive carriage positioning. Nut is mounted axially rigid, and will tolerate some radial misalignment. Backlash and ball preload can easily be adjusted for wear and desired torque level. Ball screw assemblies can be easily removed for servicing.




Drive motors will be of stepping type. [redacted] Slo-Syn Model SS250-1027 appears to be the likely candidate. Further tests are needed before final selection can be made. In general, the problem being studied concerns the fact that torque output declines as stepping frequency increases with motors under consideration. To keep lowest frequency at a rate where motion will appear continuous, and to have 100x speed range of motor speed will require a high stepping rate that is accompanied by signifigantly reduced torque. Therefore, as a compromise, stepping rates will have a maximum around 300 steps per second and have the required torque output. Also, a very

[redacted]

4. SCAN DRIVE ASSEMBLY (Contd.)

low stepping rate will be available so that precise positioning is enhanced. With the screw lead gearing and motors selected, each step will represent .0004" and .004" respectively, when low or high speed gear ratios are engaged.

The design objective of this equipment discussed above is to provide a highly stable and sensitive drive mechanism for positioning the optics over the film being studied in this viewer.

5. LIGHT BOX AND FILM DRIVE ASSEMBLY

Light Box structure will consist of two (2) facing channel iron alloy castings supporting the vacuum hold-down plates, the general illumination lamp banks and film loading and drive mechanisms. Suitable internal clearances will be provided for the high intensity light source and loop forming mechanisms. Rigid attachment to frame will be at ends and middle of light box assembly.

Vacuum film hold-down technique with edge guides, similar to those seen in the [redacted] AR-26A Viewers, will be used. 
Some improvements are needed, however, to minimize handling of film during film pull-down and bring operator assurance of positive film pull-down, regardless of film width or length. Special concern will be placed on film chip and 35-70mm hold-down techniques. Detailed study and design work will be started during next reporting period in this design area.

The Film Drive will permit manual transport of 35mm to 9" widths of negative and positive films. Two (2) handles are brought out at the writing top front apron. One (1) handle will control both spools in the tandem pair at each end of light box assembly. Whether viewing of a pair or single film strip, no difficulties should be experienced in equipment operation. For single film strip operation, each handle will drive film in one direction. Dual film strip viewing requires each handle to drive the respective film loop in either direction. To change from positive to negative

5. LIGHT BOX AND FILM DRIVE ASSEMBLY (Contd.)

films, a lever is positioned to correct drive train for positive drive direction.

Incorporated in the film drive is an electric brake that locks handles to prevent film transport and possible scratching when pulled down on vacuum plate.

Rapid insertions and removal of film and spools will be featured in the spool supports and film guides. The spool driving center will be fixed. A sliding spindle with its fixed journal opposite the driving center permits spool to be partially supported and guided while being aligned and engaged with driving center pins. The spindle is then driven home and locked. This arrangement affords no loose pieces to be misplaced and flexibility to rapidly accept 35mm, 70mm, 5" and 9½" film widths up to 500 ft., capacity spools.

The means to grip film during the automatic threading cycle has not been determined. The distaste for masking tape has been recognized, and effort will be made to avoid its use.

6. LOOP FORMING MECHANISM

Chain supported rollers form a film loop by forcing film through a slot between the viewing areas. With this scheme, film is supported and guided by highly polished, free-turning rollers so the film damage is remote. Up to 16 feet of film can be drawn into loop forming slot.

The chain path has been designed to permit use of the four (4) lens turret without collisions with loop forming mechanism above the film plane. Also, this design permits no obstacles to interfere with viewing the complete illuminated formats.

[redacted]

7. JOY STICK

Two (2) Joysticks, of the type used in many of  [redacted] Viewers, for the two axis scan control, are to be coupled with a pantograph linkage for control from a single handle. Control handle will contain a push button for engaging high speed scanning drive gear ratios.

8. WORK TO BE ACCOMPLISHED DURING NEXT REPORTING PERIOD

1. Continue design efforts in optical, mechanical and electrical areas, especially in objective and high intensity light source assembly.
2. Begin detailing of eyepiece, frame and scan drive parts.
3. Order long lead items such as fiber, optics cables, ball screws, frame castings, cabinets.
4. Breadboard scan control system for study of optical magnification feedback schemes, visual effects of step frequencies and control flexibility.
5. Investigate vacuum hold-down devices. Study existing equipment using this technique and collect design parameters.
6. Define overall and control area configuration.
7. Continue development work on laser marking optics.