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**STATUS REPORT**

for period

1 November through 30 November 1970

U. S. GOVERNMENT

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The report period represented herein covers the period 1 November through 30 November 1970.

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30 November 1970

# STEREOCOMPARATOR

## INDEX

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# STEREOCOMPARATOR

## PROGRAM SUMMARY

| | |
|---|---|
| Scheduled Percentage of Completion | 98.9% |
| Actual Percentage This Date | 96.0% |

This report period includes the performance of the Part I In-Plant Acceptance Test. In this report (see Task 45) is the acceptance test data, a summary, and conclusions.

All the acceptance test values were achieved or exceeded, with the exception of the maximum stage speed and the minimum film clamping time. [redacted] feels that these two parameters are not consequential in terms of Stereocomparator performance, and that the values achieved are fully adequate for the purpose. STAT

The significant parameters, such as resolution, are substantially exceeded, and the Part I tests show that the Stereocomparator is performing very satisfactorily.

The Part I Acceptance Test, amended to reflect the actual work performed and results achieved during the testing, are included in the Appendix to this report.

The revised interferometers perform extremely well (see Task 22), and the correlator performance is excellent (see Task 24).

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The computer program work must be completed before the Part II Acceptance Tests can be run. It is presently anticipated that the week of December 14 schedule for final in-plant acceptance testing will be achieved. (5 Jan 71)

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# STEREOCOMPARATOR

## Task 22

## Interferometer, Measuring Assembly

| | |
|---|---|
| Scheduled Percentage of Completion | 100% |
| Actual Percentage This Date | 95% |

During the last report period significant changes in the interferometer system were implemented which yielded greatly improved performance.

As stated in previous reports, it was found that the original Twyman-Green interferometer configuration did not yield performance considered sufficiently accurate and trouble-free for use in the Stereocomparator. Specifically, the problems encountered were:

1) Mirror non-flatness caused phase shifts of the fringes with attendant counting errors.

2) Return beams into the lasers caused the laser servo locks to become unstable - consequently, it was necessary to deviate the return beam

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from the incident beam axis, which caused a measuring scale error and DC shifts in the electronic detecting circuitry.

3) Differential phase-shifts between the two channels in each interferometer which are quadrature-analyzed to determine direction of motion.

The combination of the above problems produced a highly unsatisfactory system performance. The three problem areas have been remedied, and an excellent operating system has resulted. Specifically,

a) The solution to problem (1) above was to obtain mirrors of much heavier and more precise construction, and to mount them in an improved manner.

b) The solution to problem (2) above was to redesign the interferometer assemblies to incorporate optical arrangements which extinguish the return beam by means of selective polarization devices and by deviating the return beam

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with a Rochon prism to a point where the beam could meet the reference beam and yet not return to the laser.

Earlier attempts to mitigate the return beam problem by extending the beam path length were unsuccessful due to the large amount of beam jitter introduced by air currents causing refractions near the laser. These refractions became significant due to the long path length, and the peculiarities introduced by the folded optical path (never fully explained) combined to make the system less than satisfactory.

Happily, however, the present interferometer system eliminates all of the difficulties experienced with the laser return beams and off-axis operation.

c) The solution to problem (3) above is discussed below.

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A certain amount of phase shift variation between the interferometer channels is permitted, with the criticalness being a function of speed. Generally speaking, a variation of $\pm 45^{\circ}$ at top stage speeds will not cause counting errors.

Now, various mechanical factors, such as stage pitch and yaw, can cause phase variations by tilting the fringes. A yaw change of only 2 arc-seconds will tilt the fringes about 45 degrees. Since one half this magnitude of yaw is experienced during accelerations and due to non-perfect way straightness, it can be seen that the permissible variation in the phase between the interferometer fringe detecting electronics is on the order of only 20 degrees.

Now, as explained in past reports, photosensitive field-effect transistors were used for detectors. These devices showed high gain and low noise characteristics combined with quite good risetimes (1 $\mu$sec). These devices were incorporated into circuits which were

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highly stable with time and temperature, and yielded a good wide-band system. However, certain unexplained phase shifts existed which could not be checked by electrical means; i.e., the response of the system to light input appeared different than for a dummy electrically simulated signal applied at the photosensitive FET gate.

When, as a result of the change in mechanical configuration being made, it became necessary to re-lay-out the interferometer circuit boards, it was decided to attempt an investigation of the phase-shift phenomena.

A light-emitting diode (LED) was obtained which has a turn on/turn off time of about 5 nanosec. This was mounted in a block so as to radiate into the FET window. A current driver for the LED was fashioned and the system was driven by a signal generator. Using a wide-band X-Y oscilloscope, a Lissajous figure showing the LED current versus FET output voltage was obtained. The FET showed considerable phase shift within the frequency range of interest, amounting to more than 360 degrees at the frequency corresponding to the higher rates of stage travel. Moreover, tests on several units showed this phase shift versus frequency to be variable from FET to FET. An analysis of the equivalent circuit of the FET showed that this complex phase shift was due to non-linear division of displacement currents between the drain and source at higher frequencies. These effects were shown to be dependent upon device parameters which have a significant spread from unit to unit. In fact, the only reason the system worked at all is that the phase shifts seem to track to a certain degree.

It was then decided that a search should be made for a better photo detector. Various types of phototransistors (bipolar) and photo-diodes were tested. The best unit was determined to be a PIN diode (Schottky barrier.

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device) which exhibited very low phase shifts with low load resistances. Unfortunately, the output level with low load resistances is so small as to be virtually useless for our purposes. However, it was found that with higher load resistances, the output level increased but the capacitances in the diode, input amplifier, and wiring caused a roll-off commencing at about 50kHz. It was determined, however, that the roll-off was a simple pole, with an equation of the form

$$\frac{e_o}{\lambda i} = \frac{k}{1 + jw\tau}$$

where $e_o$ is output voltage

$\lambda i$ is light input

k is a circuit constant

jw is frequency

$\tau$ is the RC time constant of the diode circuit

Thus, the phase shift at high frequencies is -90 degrees maximum. This immediately suggested a feedback network as a means of holding down phase shift. Accordingly, a circuit was constructed which uses a FET source-follower (good to 100MHz) driving an MC1509F video amplifier (good to 40MHz). A voltage divider on the output of the video amplifier is tied to the load resistor on the diode to provide the feedback. The use of extremely wide-band amplifiers guaranteed that no additional poles would appear at loop gains of more than 1, thus assuring closed-loop stability. A matched pair of FET input amplifiers was used to allow adjustment of the DC operating point and to provide temperature-drift immunity. The resulting circuit is shown in figure T22-A. It will be noted that the PIN diode is a dual device containing two sensors in one package. This allowed elimination of the 90° wedge mirror formerly used, with its attendant losses. Also, since the two devices are fabricated on a single substrate chip simultaneously, excellent matching between channels is assured. The active areas are rectangular and are separated by .005 inch, with a differential output linearly related to fringe

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displacement, which was precisely what was needed. To complete the design, the whole assembly was fabricated into a cordwood module of very small size with both channels laid out perfectly symmetrically to balance and minimize stray capacitances. The outputs are differential also, using a twisted pair to eliminate noise pickup in each channel. A nickel-plated copper case completes the assembly, providing electrical shielding.

This unit was tested and found to have perfectly flat response to 3.5 MHz with no phase shift, about 10 times as high as encountered in the system. There was no phase difference between channels to 5MHz, which is as high as our signal generator goes. It was found that the unit has a 1-volt output and exhibited a 50dB (300:1) signal-to-noise ratio and absolutely no parasitic oscillation or instability. Thus, we now have an interferometer fringe detector which is completely satisfactory in every respect.

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In order to provide sufficient signal power to traverse the cables to the logic rack, a new circuit was designed which fulfills this need. (See Figure T22-B.) This unit provides several features which are explained below.

As has been explained in previous reports, the laser uses a phase-lock loop to maintain the output wavelength constant. This system contains a movable mirror which modulates the cavity length to change the laser frequency. The system uses a 12kHz carrier and slope detects the output of the photocell which monitors the output level of the laser as the mirror is modulated, adding a DC component to the modulation to maintain a precise cavity length. This 12kHz carrier naturally appears in the output at a level of approximately 10% of the "DC" output level. This carrier must, of course, be ignored by the interferometer, and this has been accomplished by merely setting the detecting circuitry threshold above this level. However, any drift in DC output level is reflected in the interferometer circuits and the 12kHz carrier does appear as a

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noise source to the system, although the system can be adjusted to ignore it. However, any drift in the threshold adjustment may throw the system to a point where the carrier could be mistaken as fringe counts. The circuit described below greatly reduces this possibility.

The circuit consists of a transistor level shifter for the differential output from the interferometer detector assembly described above, followed by a variable-gain (AGC) video amplifier and a cable driver. Also included is a ± 6 volt power supply regulator which drops the ± 15 volt power used for the cable drivers to a highly stable ± 6 volts for the video amplifiers and interferometer detectors.

The AGC is a relatively wide-band circuit (20kHz) which is controlled by an auxiliary photosensor which receives light from a beam splitter ahead of the interferometer (i.e., this photosensor monitors the laser level only.). Thus, any 12kHz carrier or DC shift appearing in the laser beam

These drawings belong with the Status Report
for period 1 November through 30 November 1970

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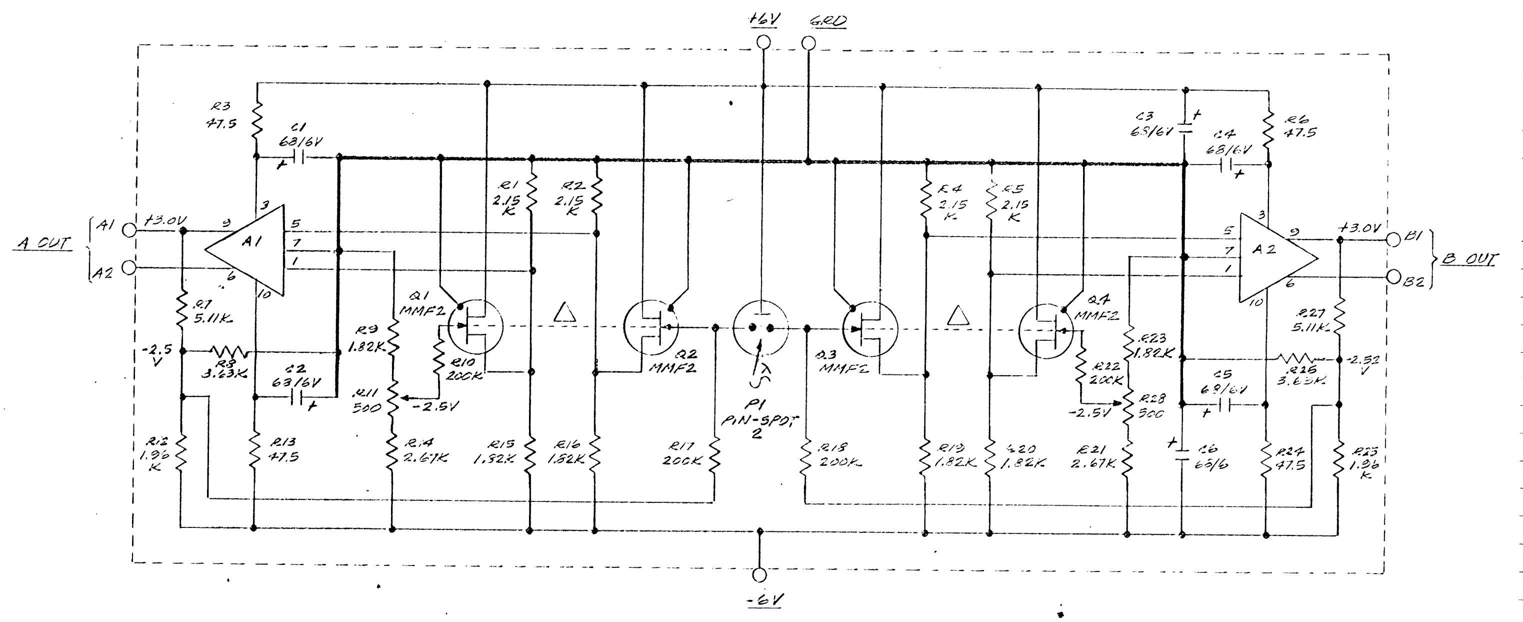
| SYM | DESCRIPTION | DATE | BY | APPD. |
| --- | --- | --- | --- | --- |




5 FIELD EFFECT TRANSISTORS Q1 AND Q2, Q3 AND Q4 ARE MATCHED PAIRS WITH $V_{GS1} = V_{GS2}$ AT $I_D$ = 0.75 mA AND MUST BE REPLACED IN PAIRS.

4 A1 AND A2 ARE MOTOROLA TYPE MC1509-F

3 CAPACITANCE VALUES ARE IN MICROFARADS.

2 ALL RESISTOR ARE TYPE 1/8W, 1%, METAL FILM MIL STD RN55

1. RESISTANCE VALUES ARE IN OHMS, K=1,000

NOTES 1. 125 ✓ FINISH UNLESS OTHERWISE SPECIFIED

| REQD | ITEM | PART NUMBER | DESCRIPTION | MATERIAL | MATL SPEC |
| --- | --- | --- | --- | --- | --- |

LIST OF MATERIAL

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
BREAK ALL SHARP EDGES.
TOLERANCES ON.
FRACTIONAL ± DECIMAL ± ANGULAR ±

HEAT TREAT

FINISH

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| NEXT ASSY | USED ON |
| --- | --- |
| C9400 | J.0392 |
| APPLICATION | |

DATE

TITLE SCHEMATIC DIAGRAM PHOTOSENSOR/PREAMP ASSY STEREOSCAN

DRAWING NUMBER C9405

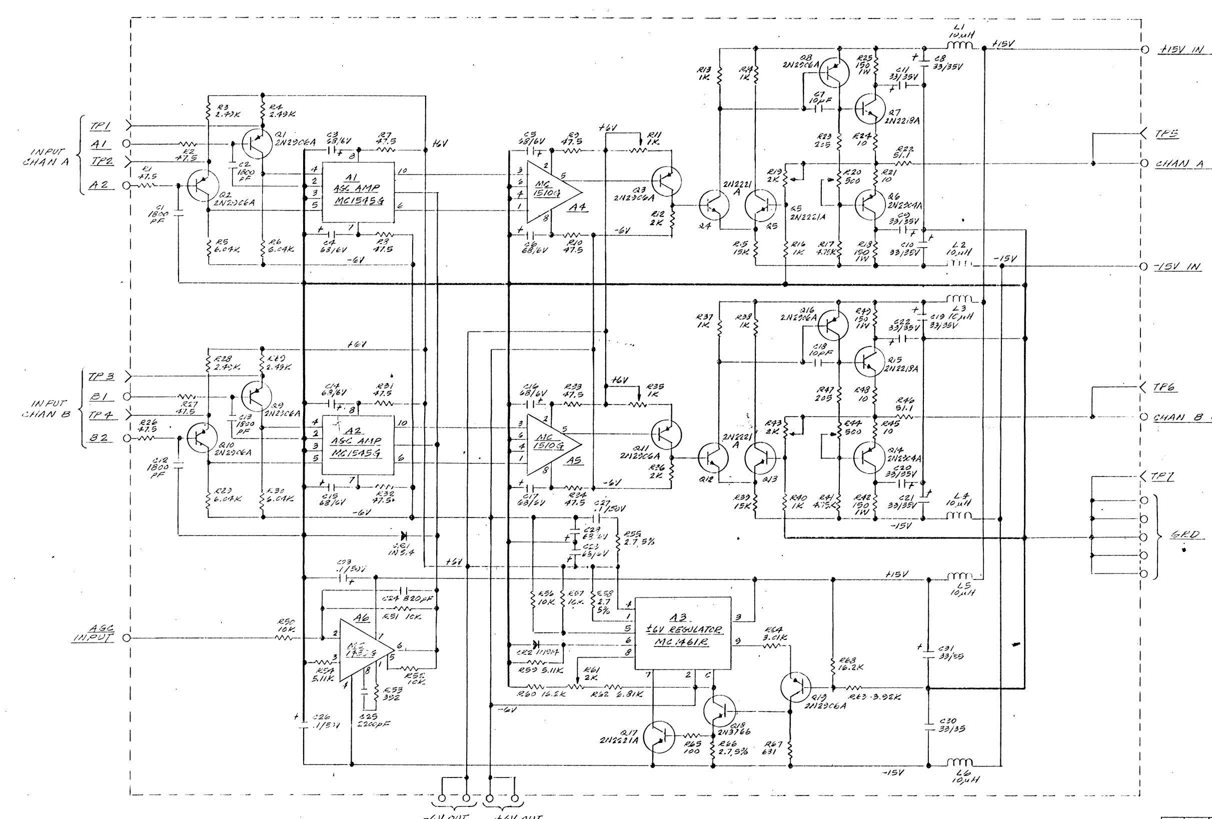
SCALE NONE

STAT STAT

PRINTED ON CATAFRINT NO. 161-8

| SYM | DESCRIPTION | DATE | BY | APPD |
|---|---|---|---|---|

REVISIONS




D8495

T22 B

3 ALL CAPACITANCE VALUES ARE IN MICROFARADS.
2 ALL RESISTORS ARE TYPE
1 ALL RESISTANCE VALUES ARE IN OHMS, K=1,000

NOTES 1.—125 FINISH UNLESS OTHERWISE SPECIFIED

| REQD | ITEM | PART NUMBER | DESCRIPTION | MATERIAL | MATL SPEC |
|---|---|---|---|---|---|

LIST OF MATERIAL



| NEXT ASSY | USED ON |
|---|---|
| D8490 | J0.342 |
| APPLICATION | |

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES.
BREAK ALL SHARP EDGES.
TOLERANCES ON
FRACTIONS ± DECIMALS ± ANGLES ±
HEAT TREAT
FINISH

DATE 11-10-70
11/10/70

TITLE
SCHEMATIC DIAGRAM
AGC/BOOSTER AMP PC BD
STEREOSCAN

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D8495

SCALE NONE

is sensed and applied to the AGC input. With proper adjustment of circuit gain and level, this AGC signal causes the variable-gain video amplifier to modulate the interferometer signals in a fashion which exactly cancels the effect of the carrier noise or light level (DC) shift. This circuit has been shown to greatly reduce the noise in the interferometer circuits for increased counting reliability. The circuit shows flat response to beyond 1.5MHz with no differential phase shift even with the long cables attached. The output levels can be perfectly standardized both with respect to the DC and AC components, and performance of the systems has been highly satisfactory.

Thus, except for minor tasks such as construction of metal perforated covers for the interferometer assemblies, this task is complete.

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STEREOCOMPARATOR

Task 24

Image Analysis System

| | |
|---|---|
| Scheduled Percentage of Completion | 100% |
| Actual Percentage This Date | 98% |

During the last report period the Image Analysis System was adjusted and made operational.

It was found that during installation several connecting cable wires had become broken. These were repaired.

Mechanical alignment of the Vidissector heads was performed after electrical zero adjustment of the various correlator circuits was performed. Basically, the procedure was to place a pair of identical photographs on the Stereocomparator stages and to align the photographs so that corresponding points on the photographs were in registration with the reticle spots. The optical trains were adjusted to their calibrated positions for equal transformation in each train.

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The vidissector heads were then positioned in the optical bridge so that the parallax, scale, and skew signals all read zero. The vidissector heads were then locked into position. This completed the alignment. Alignment was checked by moving the stages differentially in X or in Y alone and measuring the crosstalk of X into Y and vice-versa. It was found that the amount of Y parallax introduced when the X parallax was varied to its maximum pull-in value was about 1/2 the minimum detectable difference specified for this unit. Additionally, the first-order outputs were checked to see that they remained at zero. This was the case, with a maximum reading of about 1/4 the specification minimum detectable difference appearing at full parallax. Thus, the system was judged to be installed and aligned in a satisfactory manner.

Next, a pair of stereo frame photographs were placed on the stage and the stage positions and optics were set by observing the monitor panel meters and adjusting for minimum error indications. The stereo model thus produced was then viewed, and although it was entirely arbitrary and not aligned to the flight base, it presented a very pleasing 3-dimensional effect with good registration.

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Finally, the correlator was connected to the Stereocomparator interface. A few interface miswires were corrected, and a modification of the Stereocomparator Drive Program No. 3 was written to connect in the correlator parallax loops to the stages. The program was set up so that when the correlation quality signal came up to "Good", the joystick and trackball controls were transferred to the left stage only, and the correlator became the only command source for the right stage.

The program was loaded and run. It was found that the correlator held the Stereo model together very well by means of parallax corrections only, and it was found possible to maintain lock-on with stage velocities in excess of 1 complete change of field of view per second.

Performance was considered quite satisfactory, considering the inelegant software used. Scanning the photographs, it became obvious that

a) the loop gain of the stage servo varies linearly with magnification, as expected.

b) the pull-in range of the correlator seems adequate.

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It will be necessary to incorporate the appropriate scale factors into the software to assure servo loop stability under all conditions, of course.

A number of false correlations were obtained due to the confusing nature of some areas of the photography, which consists of an urban area. Parking lots full of cars and highly regular rows of buildings tended to produce false lockons as would be expected. The correlation quality signal appeared to drop out quite reliably when the objects in view did not show a reasonable degree of correspondence. Scanning out over bodies of water, for example, where there was no detail to analyze, which gave immediate dropout.

One very encouraging characteristic which was noted was that coming to the edge of one of the films had very little effect, even when the frame border occupied as much as 50% of the field of view.

The first-order correction loops are much more complicated to implement in the software and were thus not checked in the simple scratch-up program used. These loops will be checked out with the real operating software, but performance appears satisfactory in that when the optics are moved manually, the correct first-order error signals appear.

Thus, the Image Analysis System is considered properly installed and operating satisfactorily, and this Task is complete.

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Task 43

COMPUTER PROGRAMMING AND SERVICES

| | |
|---|---|
| Scheduled Percentage of Completion | 100% |
| Actual Percentage This Date | 95% |

The Informatics Inc. report on the status of the computer program effort for the Stereocomparator is included on the following page.

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During October work on the final integration continued. The foreground program was integrated into the Stereocomparator. This was done with a dummy version of the background which simulates the real thing. In this form, the foreground demonstrated its ability to dispatch the interrupts from the real-time clock. It also was shown that the foreground tracking program correctly drives the stages in response to operator commands via the joy-stick and trackballs. Since they were unavailable during October, the foreground's ability to drive the optics has not yet been demonstrated.

Also during October, an object library was compiled. It consists of four tapes, containing the latest versions of all sub-routines. The tapes contain everything such that the entire program can be loaded into core, in executable form, using a special version of the loader which was created for this purpose.

The work on this project is being interrupted from October 26 to November 23, 1970 due to illness of the Informatics staff member responsible for the computer programming. When work resumes, the above-mentioned library tapes will be used to create the final version of the Stereocomparator program, and pre-acceptance testing will begin.

The programming for project 342 is 99% complete.

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STEREOCOMPARATOR

Task 45

ACCEPTANCE TEST IN FABRICATION PLANT

| | |
|---|---|
| Scheduled Percentage of Completion | 100% |
| Actual Percentage This Date | 85% |

The Part I Acceptance Test was run on November 17, 18, and 19, 1970.

The test results, summaries, and conclusions are contained in the following pages.

# IN-PLANT ACCEPTANCE TEST

## PART I

## SUMMARY OF TEST RESULTS

| Test Procedure Item | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| | Test Procedure Section | | | | | |
| 1 | OK | OK | $OK_3$ | a(5)(d) - $F_5$<br>a(6)(d) - $OK_6$<br>b(5)(d) - $F_7$<br>b(6)(d) - $OK_8$<br>c(1)(c) - $F_9$<br>c(1)(d) - $OK_{10}$<br>d(1)(d) - $F_{11}$<br>d(1)(e) - $OK_{12}$ | $F_{14}$ | OK |
| 2 | OK | OK | $OK_4$ | $OK_{13}$ | $OK_{15}$ | OK |
| 3 | OK | OK | | | | $NT_{16}$ |
| 4 | OK | OK | | | | $OK_{17}$ |
| 5 | OK | OK | | | | $OK_{18}$ |
| 6 | $NT_1$ | OK | | | | $OK_{19}$ |
| 7 | OK | OK | | | | |
| 8 | OK | OK | | | | |
| 9 | $OK_2$ | OK | | | | |
| 10 | OK | OK | | | | |
| 11 | OK | OK | | | | |
| 12 | OK | OK | | | | |
| 13 | OK | OK | | | | |
| 14 | OK | | | | | |

OK = Equipment passed test satisfactorily.

NT = Not Tested

F = Failed

Subscripts: See numbered references on the following pages.

# IN-PLANT ACCEPTANCE TEST

## PART I

## SUBSCRIPT NOTES AND TEST RESULTS

| Subscript No. | Test Item No. | |
|---|---|---|
| 1. | (A-6) | The automatic light level control system could not be operated. The beam splitter supplying light to this system had been broken. A new beam splitter is on order, and Test No. 6 in Section A of Part I of the test procedures will be performed after installation at the site. |
| 2. | (A-9) | The test was passed satisfactorily. However, it was noted that the left panel meter for image rotation did not read zero degrees when the image was upright. This panel meter will be adjusted at the time of final installation. |
| 3. | (C-1) | Trackball Sensitivity (Low Speed) The test was passed satisfactorily with the following test results: |

| Left Stage - X Direction: | Left Rotation | Right Rotation |
|---|---|---|
| | 31.4 | 31.5 |
| | 31.5 | 31.5 |
| | 31.6 | 31.4 |

Average: 31.48 micrometers of stage movement.

| Left Stage - Y Direction: | Forward | Backward |
|---|---|---|
| | 31.5 | 31.5 |
| | 31.5 | 31.5 |
| | 31.4 | 31.5 |

Average: 31.48 micrometers of stage movement.

| Subscript No. | Test Item No. | |
|---|---|---|
| 3. | (C-1) | Trackball Sensitivity (Low Speed) - (Continued) |

Right Stage - X Direction:

| Left Rotation | Right Rotation |
|---|---|
| 31.5 | 31.7 |
| 31.5 | 31.6 |
| 31.6 | 31.4 |

Average: 31.55 micrometers of stage movement.

Right Stage - Y Direction:

| Forward | Backward |
|---|---|
| 31.5 | 31.5 |
| 31.5 | 31.2 |
| 31.5 | 31.5 |

Average: 31.45 micrometers of stage movement.

| | | |
|---|---|---|
| 4. | (C-2) | Trackball Sensitivity (High Speed) |

The test was passed satisfactorily with the following test results:

Left Stage - X Direction:

| Left Rotation | Right Rotation |
|---|---|
| 1017.4 | 997.4 |
| 1042.6 | 971.8 |
| 992.3 | |

Average: 1024.3 micrometers of stage movement.

Left Stage - Y Direction:

| Forward | Backward |
|---|---|
| 1012.9 | 997.2 |
| 1002.3 | 1002.3 |
| 1037.7 | 992.2 |

Average: 1007.4 micrometers of stage movement.

| Subscript No. | Test Item No. | |
|---|---|---|
| 4. | (C-2) | Trackball Sensitivity (High Speed) - (Continued) |

Right Stage - X Direction:

| | Left Rotation | Right Rotation |
|---|---|---|
| | 1048.6 | 1048.1 |
| | 1054.1 | 1059.8 |

Average: 1052.7 micrometers of stage movement.

Right Stage - Y Direction:

| | Forward | Backward |
|---|---|---|
| | 994.8 | 1008.0 |
| | 1008.1 | 1002.5 |
| | 997.7 | 1007.7 |

Average: 1003.1 micrometers of stage movement.

Stages

5. (D-1a(5)(d) The high speed stage motion in both X and Y directions was originally designed for 3 inches per second. The drive motors selected and installed were printed circuit type. These motors rotated with a cogging action. When observed with the highest magnification, the stages did not move smoothly. Inland motors and tachometers were substituted and were found to give a very smooth and generally satisfactory performance. The original servo power supplies were not discarded because of the time delay and the large cost associated with new power supplies. These power supplies have the capability of driving the stages at between two and two and a half inches per second maximum speed. This speed was judged to be fully adequate for application to the Stereocomparator.

| Subscript No. | Test Item No. | |
|---|---|---|
| 5. | D.1a(5)(d) (Continued) | |

The test results for Left Stage X Direction Maximum Stage Motion follow:

| First Run | Second Run |
|---|---|
| 2.70" | 2.50" |
| 2.40" | 2.70" |
| 2.50" | 2.30" |
| 2.35" | 2.50" |
| 2.90" | 2.30" |
| **Average** | **Average** |
| 2.57 Inches per second | 2.46 inches per second |

6. D.1a(6)(d) The speed of the low speed mode of the stages is controlled by the computer. This is true for the trackball output and the joystick output. Since the low speed trackball test (See Subscript 3 above) had been passed satisfactorily, and since the joystick did indeed manipulate the left stage, it was conceded by the customer that the test was satisfactory and had been passed.

7. D.b(5)(d) See Subscript 5 above.

The test results for Left Stage Y Direction Maximum Stage Motion follow:

| First Run | Second Run |
|---|---|
| 2.8" | 2.7" |
| 2.8" | 2.7" |
| 2.6" | 2.7" |
| 2.7" | 2.7" |
| 2.8" | 2.7" |
| **Average** | **Average** |
| 2.74 inches per second | 2.7 inches per second |

| Subscript No. | Test Item No. | |
|---|---|---|
| 8. | D.1b(6)(d) | See Subscript 6 above. |
| 9. | D.1c(1)(c) | See Subscript 5 above. |

The test results for Right Stage X Direction Maximum Stage Motion follow:

| First Run | Second Run |
|---|---|
| 2.80" | 2.50" |
| 2.50" | 2.30" |
| 2.40" | 2.40" |
| 2.40" | 2.40" |
| 2.30" | 2.40" |
| **Average** | **Average** |
| 2.48" | 2.40" |

10. D.1c(1)(d) Since a setup for stage measurements had been made for the Right Stage X Direction, High Speed, it was decided to use the same arrangement for Low Speed. The test values confirmed that the operation was satisfactory, and the test was passed. The following values were obtained for Right Stage X Direction Minimum Stage Motion:

110.6 seconds per 1000 micrometers

104.4 seconds per 1000 micrometers

Average

107.5 seconds per 1000 micrometers



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| Subscript No. | Test Item No. | |
|---|---|---|
| 11. | D.1d(1)(d) | See Subscript 5 above. |

The test results for Right Stage Y Direction Maximum Stage Motion follow:

| First Run | Second Run |
|---|---|
| 2.50" | 2.50" |
| 2.80" | 2.40" |
| 2.40" | 2.50" |
| 2.60" | 2.40" |
| 2.30" | 2.40" |
| Average | Average |
| 2.52 inches per second | 2.44 inches per second |

| | | |
|---|---|---|
| 12. | D.1d(1)(e) | See Subscript 10 above. |

The test results for Right Stage Y Direction Minimum Stage Motion follow:

105.5 seconds per 1000 micrometers

| | | |
|---|---|---|
| 13. | D.2 | Stage Positioning |

The test was passed satisfactorily. The test results follow:

Left Stage X axis: Nixie tube readout average within ±0.126 micrometers repeatability.

Left Stage Y axis: Nixie tube readout average within ±0.126 micrometers repeatability.

Right Stage X axis: Nixie tube readout average within ±0.139 micrometers repeatability.

Right Stage Y axis: Nixie tube readout average within ±0.125 micrometers repeatability.

| Subscript No. | Test Item No. | |
|---|---|---|
| 14 | E.1 | The clamping time requirement is "approximately 20 seconds." The test discloses the fact that it is not possible to meet this time. The test values below indicate clamping time for the wider film, particularly the .004 thick material, to be between one-half and one minute. It was noted that the first time a particular area of film was clamped, the time for the film to become flat on the platen was much faster than for subsequent clampings. |

For example, an initial time of 10 seconds was not uncommon. After five or six clampings, it was noted that the time had progressed steadily up to perhaps two minutes. It appears that the edges of the film become shaped to the vacuum nozzles after repetitive or long time clamping. This change in shape causes a premature sealoff of the nozzles which has the effect of slowing down the removal of air between the film and the platen. The thinner the film, the worse this condition could be expected to become.

Therefore, a maximum clamping time of five minutes should be considered realistic. In reviewing the operation of the Stereocomparator, it is anticipated that the initializing procedures would be in excess of 10 to 15 minutes. Therefore, the clamping speeds attained should not create any difficulties.

| Subscript No. | Test Item No. | |
|---|---|---|
| 14 | E.1 | (Continued) |

The clamping speeds attained are listed as follows:

9-1/2" wide, 0.004" thick film

| Left Stage | Right Stage |
|---|---|
| 7.0 sec. | 53.0 sec. |
| 22.0 | 47.0 |
| 21.5 | 42.0 |
| 37.0 | 45.0 |
| 32.0 | 25.0 |
| Average: 23.9 seconds | Average: 42.4 seconds |

| Subscript No. | Test Item No. | |
|---|---|---|
| 15 | E.2 | See Subscript 14 above. |

The clamping speeds attained are listed as follows:

6.6" wide, 0.004" thick film

| Left Stage | Right Stage |
|---|---|
| 17.0 sec. | 36.0 sec. |
| 28.0 | 46.0 |
| 40.0 | 53.0 |
| 24.0 | 65.0 |
| 47.0 | 95.0 |
| Average: 31.2 seconds | Average: 59.0 seconds |

6.6" wide, 0.002" thick film

| | |
|---|---|
| 26.0 sec. | 54.0 sec. |
| 33.0 | 38.0 |
| 29.0 | 52.0 |
| 34.0 | 46.0 |
| 51.0 | 32.0 |
| Average: 34.6 seconds | Average: 44.4 seconds |

| Subscript No. | Test Item No. | |
|---|---|---|
| 15 | E.2 | (Continued) |

70 mm wide, 0.004" thick film

| Left Stage | Right Stage |
|---|---|
| 1.5 sec. | 2.0 sec. |
| 2.0 | 1.5 |
| 1.5 | 1.0 |
| 2.0 | 1.5 |
| 2.0 | 1.0 |
| Average: 1.8 seconds | Average: 1.4 seconds |

16 F.3 Fine Focusing and Image Wander

The image wander test as performed at the plant of the optical fabricator is extremely complex. It is virtually impossible to check image wander during focusing without optical instrumentation. The customer deemed it inappropriate to measure this parameter during the acceptance test, because of the extensive time required.

It should be noted that the equipment had previously passed the test at the optical fabricator's plant and could be so certified; also, the test at NRI was not realistic when considered in connection with the actual operating use of the Stereocomparator.

A more realistic test is planned to substitute for the "Image Wander During Focusing." This new test will be called "Image Alignment Repeatability at a Focal Plane." This test will determine the repeatability of image alignment as the system is defocused to a point above the image plane and refocused at the image plane, as compared to defocusing to a point below the image plane and refocused back on the image plane.

A procedure has been developed to perform this test. It is believed that the new test will not only be more applicable but will require much less equipment for its performance.

| Subscript No. | Test Item No. | |
|---|---|---|
| 17 | F.4 | Anamorph Ratio |

The test was passed satisfactorily with the following Test results: (Three runs of each measurement)

Left Side Anamorph Ratio

| Vertical Stretch Axis Ratio: 1:2.0 | | Horizontal Nonstretch Axis Ratio: 1.1:0 |
|---|---|---|
| Eyepiece Scale | 238.6 | 238.3 |
| " " | 227.0 | 227.0 |
| Difference | 11.6 | 11.3 |
| Eyepiece Scale | 238.6 | 238.3 |
| " " | 227.0 | 227.0 |
| Difference | 11.6 | 11.3 |
| Eyepiece Scale | 238.5 | 238.3 |
| " " | 227.0 | 227.0 |
| | 11.5 | 11.3 |
| Ratio = 1:2.0 ± 0.6% | Ave. 11.57 | Ave. 11.3 Ratio = 1:1.0 ± 0% |

Right Side Anamorph Ratio

| Vertical Stretch Axis Ratio: 1:2.0 | | Horizontal Nonstretch Axis Ratio: 1.1:0 |
|---|---|---|
| Eyepiece Scale | 238.7 | 238.3 |
| " " | 227.0 | 227.0 |
| Difference | 11.7 | 11.3 |
| Eyepiece Scale | 238.6 | 238.3 |
| " " | 227.0 | 227.0 |
| Difference | 11.6 | 11.3 |
| Eyepiece Scale | 238.7 | 238.3 |
| " " | 227.0 | 227.0 |
| Difference | 11.6 | 11.3 |
| Average | 11.63 | 11.3 |
| Ratio | 1:2.0 ± 0.3% | Ratio 1:1.0 ± 0% |

| Subscript No. | Test Item No. | |
|---|---|---|
| 18 | F.5 | Zoom Range |

The test was passed satisfactorily with the following test results:

F.5b Left Stage Magnification Ratio - 80mm Objective

a. With Mechanical Stops Removed

10X magnification

| | |
|---|---|
| Eyepiece Scale | 232 = 0 |
| | 237 = 97.5; 97.5; 97.5 |

100X magnification

| | |
|---|---|
| Eyepiece Scale | 232 = 0 |
| | 237 = 9.78; 9.75; 9.75 |
| Magnification Ratio: | 9.97X; 10.00X; 10.00X; Ave.: 9.99X |

b. With Mechanical Stops in Place

10X magnification

| | |
|---|---|
| Eyepiece Scale | 232 = 0 |
| | 237 = 97.8; 97.8; 97.8 |

100X magnification

| | |
|---|---|
| Eyepiece Scale | 232 = 0 |
| | 237 = 9.90; 9.80; 9.90 |
| Magnification Ratio: | 9.89X; 9.98X; 9.88X. Ave.: 9.92X |

F-5c Right Stage Magnification Ratio - 80mm Objective

With mechanical stops in place

10X magnification

| | |
|---|---|
| Eyepiece scale | 230 = 0 |
| | 235 = 98.6; 98.3; 98.6 |

100X magnification

| | |
|---|---|
| Eyepiece scale | 230 = 0 |
| | 235 = 9.90; 9.90; 9.85 |
| Magnification Ratio: | 9.98X, 9.95X; 10.01. Ave.: 9.98X |

Subscript No. 19 Test Item No. F-6

The test data shows the test has passed satisfactorily.

WHITE LIGHT, Left Stage

| | 40mm | | | | 80mm | | | |
|---|---|---|---|---|---|---|---|---|
| | 20X | 37X | 123X | 200X | 10X | 55X | 100X | |
| **On Axis** | | | | | | | | |
| Saggital | 151 | 269 | 960 | 1078 | 67 | 302 | 538 | STAT |
| Tangential | 151 | 269 | 960 | 1078 | 67 | 302 | 538 | |
| Customer - Saggital | 170 | 269 | 761 | 960 | 67 | 302 | 538 | |
| Customer - Tangential | 170 | 269 | 761 | 960 | 67 | 302 | 538 | |
| Contractual | 80 | 180 | 550 | 800 | 45 | | 400 | |
| **1/3 of Field** | | | | | | | | |
| - Saggital | 170 | 269 | 960 | 960 | 67 | 240 | 480 | STAT |
| - Tangential | 151 | 269 | 960 | 1078 | 60 | 269 | 538 | |
| Customer - Saggital | 170 | 269 | 761 | 960 | 67 | 302 | 538 | |
| Customer - Tangential | 151 | 240 | 761 | 960 | 67 | 302 | 538 | |
| Contractual | 60 | 120 | 475 | 700 | 40 | | 300 | |
| **Edge of Field - Horizontal Right** | | | | | | | | |
| - Saggital | 135 | 269 | 960 | 1078 | 60 | 269 | 480 | STAT |
| - Tangential | 120 | 240 | 854 | 1078 | 67 | 269 | 480 | |
| Customer - Saggital | 151 | 240 | 761 | 960 | 67 | 302 | 538 | |
| Customer - Tangential | 135 | 214 | 679 | 960 | 67 | 269 | 480 | |
| Contractual | 45 | 100 | 430 | 550 | 40 | | 275 | |
| **Edge of Field - Vertical Top** | | | | | | | | |
| - Saggital | 135 | 240 | 761 | 960 | 60 | 269 | 538 | STAT |
| - Tangential | 135 | 240 | 761 | 960 | 60 | 269 | 480 | |
| Customer - Saggital | 135 | 240 | 679 | 854 | 67 | 302 | 480 | |
| Customer - Tangential | 151 | 269 | 761 | 960 | 67 | 302 | 538 | |
| Contractual | 45 | 100 | 430 | 550 | 40 | | 275 | |

WHITE LIGHT, Right Stage

| | 40mm | | | | 80mm | | | |
|---|---|---|---|---|---|---|---|---|
| | 20X | 37X | 123X | 200X | 10X | 55X | 100X | |
| **On Axis** | | | | | | | | |
| - Saggital | 170 | 302 | 1078 | 1078 | 76 | 480 | 761 | STAT |
| - Tangential | 170 | 302 | 1078 | 1078 | 76 | 480 | 761 | |
| Customer - Saggital | 151 | 269 | 761 | 1078 | 76 | 427 | 605 | |
| Customer - Tangential | 151 | 269 | 761 | 1078 | 76 | 427 | 605 | |
| Contractual | 80 | 180 | 550 | 800 | 45 | | 400 | |

| | 20X | 37X | 123X | 200X | 10X | 55X | 100X | |
|---|---|---|---|---|---|---|---|---|
| **1/3 of Field** | | | | | | | | |
| - Saggital | 151 | 269 | 960 | 1078 | 76 | 382 | 761 | STAT |
| - Tangential | 151 | 240 | 854 | 1078 | 76 | 427 | 679 | |
| Customer - Saggital | 151 | 214 | 679 | 1078 | 76 | 427 | 605 | |
| Customer - Tangential | 135 | 214 | 679 | 960 | 76 | 382 | 605 | |
| Contractual | 60 | 120 | 475 | 700 | 40 | | 300 | |

| | 20X | 37X | 123X | 200X | 10X | 55X | 100X | |
|---|---|---|---|---|---|---|---|---|
| **Edge of Field - Horizontal Right** | | | | | | | | |
| - Saggital | 135 | 269 | 605 | 960 | 60 | 382 | 605 | STAT |
| - Tangential | 95 | 240 | 605 | 960 | 67 | 382 | 605 | |
| Customer - Saggital | 135 | 214 | 538 | 1078 | 67 | 382 | 605 | |
| Customer - Tangential | 135 | 214 | 605 | 960 | 67 | 338 | 538 | |
| Contractual | 45 | 100 | 430 | 550 | 40 | | 275 | |

| | 20X | 37X | 123X | 200X | 10X | 55X | 100X | |
|---|---|---|---|---|---|---|---|---|
| **Edge of Field - Vertical Top** | | | | | | | | |
| - Saggital | 95 | 214 | 480 | 960 | 60 | 427 | 605 | STAT |
| - Tangential | 67 | 214 | 427 | 854 | 60 | 382 | 605 | |
| Customer - Saggital | 107 | 170 | 605 | 960 | 67 | 382 | 480 | |
| Customer - Tangential | 107 | 214 | 538 | 960 | 76 | 427 | 480 | |
| Contractual | 45 | 100 | 430 | 550 | 40 | | 275 | |

GREEN LIGHT, Left Stage

| | 40mm | | | | 80mm | | | |
|---|---|---|---|---|---|---|---|---|
| | 20X | 37X | 123X | 200X | 10X | 55X | 100X | |
| **On Axis** | | | | | | | | |
| [redacted] - Saggital | 170 | 269 | 960 | 1078 | 67 | 302 | 538 | STAT |
| - Tangential | 170 | 269 | 960 | 1078 | 67 | 302 | 538 | |
| Customer - Saggital | 170 | 269 | 761 | 960 | 67 | 302 | 538 | |
| Customer - Tangential | 170 | 269 | 761 | 960 | 67 | 302 | 538 | |
| Contractual | 100 | 185 | 615 | 1000 | 50 | | 500 | |
| **1/3 of Field** | | | | | | | | |
| [redacted] - Saggital | 170 | 269 | 960 | 1078 | 67 | 302 | 538 | STAT |
| - Tangential | 151 | 269 | 960 | 1078 | 60 | 302 | 538 | |
| Customer - Saggital | 170 | 269 | 761 | 960 | 67 | 302 | 538 | |
| Customer - Tangential | 151 | 240 | 761 | 960 | 67 | 302 | 538 | |
| Contractual | 100 | 180 | 615 | 1000 | 50 | | 450 | |
| **Edge of Field - Horizontal Right** | | | | | | | | |
| [redacted] - Saggital | 135 | 269 | 854 | 1078 | 60 | 302 | 480 | STAT |
| - Tangential | 135 | 240 | 960 | 1078 | 67 | 269 | 480 | |
| Customer - Saggital | 151 | 240 | 761 | 960 | 67 | 302 | 538 | |
| Customer - Tangential | 135 | 214 | 679 | 960 | 67 | 302 | 480 | |
| Contractual | 55 | 140 | 500 | 700 | 45 | | 385 | |
| **Edge of Field - Vertical Top** | | | | | | | | |
| [redacted] - Saggital | 135 | 269 | 761 | 1078 | 60 | 269 | 538 | STAT |
| - Tangential | 135 | 240 | 761 | 960 | 60 | 269 | 480 | |
| Customer - Saggital | 135 | 240 | 679 | 854 | 67 | 302 | 480 | |
| Customer - Tangential | 170 | 269 | 761 | 960 | 67 | 302 | 538 | |
| Contractual | 55 | 140 | 500 | 700 | 45 | | 385 | |

GREEN LIGHT, Right Stage

| | 40mm | | | | 80mm | | | |
|---|---|---|---|---|---|---|---|---|
| | 20X | 37X | 123X | 200X | 10X | 55X | 100X | |
| **On Axis** | | | | | | | | |
| [redacted] - Saggital | 170 | 302 | 1078 | 1078 | 76 | 538 | 761 | STAT |
| [redacted] - Tangential | 170 | 302 | 1078 | 1078 | 76 | 538 | 761 | |
| Customer - Saggital | 151 | 269 | 761 | 1210 | 76 | 480 | 605 | |
| Customer - Tangential | 151 | 269 | 761 | 1210 | 76 | 480 | 605 | |
| Contractual | 100 | 185 | 615 | 1000 | 50 | | 500 | |
| **1/3 of Field** | | | | | | | | |
| [redacted] - Saggital | 151 | 240 | 1078 | 1078 | 76 | 538 | 761 | STAT |
| [redacted] - Tangential | 151 | 269 | 960 | 1078 | 76 | 427 | 761 | |
| Customer - Saggital | 151 | 214 | 679 | 1078 | 76 | 427 | 605 | |
| Customer - Tangential | 135 | 269 | 679 | 960 | 76 | 382 | 605 | |
| Contractual | 100 | 180 | 615 | 1000 | 50 | | 450 | |
| **Edge of Field - Horizontal Right** | | | | | | | | |
| [redacted] - Saggital | 135 | 269 | 679 | 960 | 60 | 382 | 605 | STAT |
| [redacted] - Tangential | 107 | 240 | 679 | 960 | 67 | 338 | 679 | |
| Customer - Saggital | 135 | 214 | 538 | 1078 | 67 | 382 | 605 | |
| Customer - Tangential | 135 | 214 | 605 | 960 | 67 | 338 | 538 | |
| Contractual | 55 | 140 | 500 | 700 | 45 | | 385 | |
| **Edge of Field - Vertical Top** | | | | | | | | |
| [redacted] - Saggital | 107 | 240 | 480 | 960 | 60 | 382 | 605 | STAT |
| [redacted] - Tangential | 67 | 214 | 427 | 960 | 60 | 382 | 605 | |
| Customer - Saggital | 120 | 191 | 605 | 960 | 67 | 382 | 480 | |
| Customer - Tangential | 107 | 214 | 538 | 960 | 76 | 427 | 480 | |
| Contractual | 55 | 140 | 500 | 700 | 45 | | 385 | |

APP.

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# ACCEPTANCE TEST
# ULTRA HIGH PRECISION
# STEREOCOMPARATOR

STAT

Prepared June 15, 1970
Revised November 25, 1970
File No. 11038

STAT

STAT

# TABLE OF CONTENTS
## MAJOR SECTIONS

# I

## INTRODUCTION

This document describes the materials, objectives, and procedures for an acceptance test to be performed on the Ultra High Precision Stereocomparator.



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## II

## SPECIFICATION

The applicable specification is titled "Performance Specifications for the Ultra High Precision Stereocomparator Revised September 11, 1970.

See Appendix.

# III

# MATERIALS

## A. Operating Stereocomparator

1. The Ultra High Precision Stereocomparator assembly is shown by drawing No. E4585, and other drawings referenced thereon. STAT
2. The Stereocomparator Instrument is depicted in the photograph included herein.
3. The applicable contract is STAT

## B. Test Equipment

1. Mahr Millitron Electronic Comparator Type 1204Z with No. 1306 Gaging Head equipped with No. ME-1 ruby contact point. The gaging head is installed on a No. 815-G base.
2. Starrett 12" scale Type C604R.
3. Digital voltmeter, $\pm$ 15.0 volts D.C., Fairchild type 7050.
4. Stopwatch timer with 0.2" graduations.
5. 1/2" x 1" glass mirror, flat to 1/2 fringe in 2".

## C. Computer Programs

1. Stereocomparator Drive Program #1.
2. Stereocomparator Drive Program #2.
3. Stereocomparator Drive Program #3.
4. Stereocomparator Internal Main Program.

MATERIALS (Continued)

D. Targets, Scales, and Miscellaneous required for the performance of the acceptance tests.

1. Resolution target USAF 1951 high contrast, reduced 240X. Serial No. 4. (Furnished by customer.)
2. Data sheet for 240X reduction resolution target.
3. Calibrated eyepiece scale, 1mm. increments.
4. Calibrated target, 2mm. in 0.01mm. increments.
5. Calibrated target, 1mm. in 0.01mm. increments.
6. Calibrated target, 5mm. in 0.05mm. increments.
7. Calibrated circle target, 0.5mm. diameter.
8. Calibrated distortion target 0.5mm. grid.
9. Calibrated anamorph target, 1:1.0 to 1:2.2. 20X reduction.
10. Eyepiece angle reticle.
11. Cross target.
12. Two eyepiece scale retainers.
13. Calibrated rectangular grid target.
14. Operating Instruction Manual.
15. 2" x 2" film of density 3.0.
16. 2" x 2" film of density 0.1.
17. Items of test photography. (Furnished by customer.)
    a. Large sized detail elements.
    b. Intermediate sized detail elements.
    c. Small sized detail elements.
    d. Premeasured frame photograph with acquisition system data.
    e. Premeasured pan photograph with acquisition system data.
    f. Premeasured strip photograph with acquisition system data.
18. Items of test film strips. (Furnished by customer.)
    a. 9-1/2" wide.
    b. 6.6" wide.
    c. 70mm. wide.

# IV
# OBJECTIVES

The objectives of the acceptance tests are to verify that the Ultra High Precision Stereocomparator system is in accordance with the "Performance Specifications for the Ultra High Precision Stereocomparator, Revised September 11, 1970."

The acceptance test procedures are designed to exercise the Stereocomparator from two aspects:

1. First, to be sure that the various machine elements are operating in a qualitative manner, and additionally, to insure that the significant parameters of the specifications are met.

2. Second, to insure that the Stereocomparator will track typical stereo photographs in stereo and will perform repeatable measurements on the photographs.

Note that if the Stereocomparator retains and tracks in stereo automatically, with suitable stereo photographs, then it can be assumed that all the systems are at an acceptable performance level.

The acceptance test procedure is arranged as follows:

Part I consists of the detailed procedures for the operator interface and the significant parameters of the specifications.

Part II consists of the procedures for exercising the Stereocomparator with regard to typical frame, pan, and strip stereo photographs, together with their associated computer programs.

## V

## PROCEDURE - PART I

All components of the Stereocomparator are to be turned on and to be in their proper operating condition. Refer to the Operator's Manual for the detailed procedure.

A. Console Desk and Panel

1. Press push button on console desk labeled "Manual No Computer No Electronic Correlation" (White).

2. Operate console desk control labeled "Zoom Magnification" for both the left and right sides. Observe that the respective Zoom Magnification indicating meters on the display panel respond.

3. Operate console desk control labeled "Anamorphic Expansion", for both left and right sides. Observe that the respective Anamorphic ratio meters respond.

4. Operate console desk control labeled "Anamorphic Rotation", for both left and right sides. Observe that the respective Anamorphic Rotation degree meters respond.

5. Operate console desk control labeled "Image Rotation", for both left and right sides. Observe that the respective Image Rotation degree meters respond.



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6. Operate console desk control labeled "Image Brightness", for both left and right sides. Observe that the respective Illumination Level percentage meters respond.

7. Operate console desk control labeled "Reticle Size", for both left and right sides. Observe that the respective Reticle Size ratio meters respond.

8. Operate console desk control labeled "Reticle Brightness", for both left and right sides. Observe that the respective Reticle Brightness percentage meters respond.

9. Place a target (grid type, item D13) on the left-hand stage platen, approximately in the center. Locate the target under the objective lens by means of the joystick. (Press push button "Joystick Left" (red)). Set the anamorph ratio to 1 : 1.0. Press the left Low Magnification push button (red) on the console desk. Set the Zoom Magnification to 50X. Switch the eyepiece system so that both eyepieces view the left stage. Trim the position of the grid target by means of the trackball (press push button "Trackball Independent" (yellow)) so that the target is properly located in the field of view. Adjust the focus control on the console desk, observing that the target image can be properly focused.

10. Place a target (grid type, item D13) on the right-hand stage platen, approximately in the center. Locate the target under the objective lens by means of the joystick (press push button "Joystick Right" (green)). Set the anamorph ratio to 1 : 1.0. Press the right Low Magnification push button (green) on the console desk. Set the Zoom Magnification to 50X. Switch the eyepiece system so that both

eyepieces view the right stage. Trim the position of the grid target by means of the trackball so that the target is properly located in the field of view. Adjust the focus control on the console desk, observing that the target image can be properly focused.

11. Operate the platen illumination left side "On-Off" switch on the console desk. Observe that the left side platen illumination turns on and off properly.

12. Adjust the left side Platen Illumination Brightness control on the console desk. Observe that the left side Platen Illumination level changes.

13. Operate the Platen Illumination right side "On-Off" switch on the console desk. Observe that the right side platen illumination turns on and off properly.

14. Adjust the right side Platen Illumination Brightness control on the console desk.. Observe that the right side Platen Illumination level changes.

B. Rack No. 4 - Right Side

The Stereocomparator system has previously been started up by using the established turn-on procedures. The following gauge and flow meter readings are normal. The pressure values should be adjusted at the rack controls, to these normal readings. The flow values should be adjusted at the individual flow controllers mounted at each air bearing.

1. Main High Pressure Air Regulator
   a. Line Pressure: 142, ±10 psig
   b. Metered Pressure: 120 to 130 psig

2. Intermediate Pressure Air Regulator
   a. Line Pressure: 47 psig
   b. Metered Pressure: 38 psig

3. Air Bearings and Guides
   a. Right Side Meters Nos. 1 through 15 0.5 to 1.0 SCFH
   b. Left Side Meters Nos. 16 through 30 0.5 to 1.0 SCFH

4. Air Bearing Preload
   a. Left Side
      (1) Stage Guide 100 ±5 psig
      (2) Saddle Guide 100 ±5 psig
   b. Right Side
      (1) Stage Guide 100 ±5 psig
      (2) Saddle Guide 100 ±5 psig

5. Air Bearing Pressure Regulator 100 ±5 psig

6. Vibration Isolator Pressure Regulator — 90 ± 5 psig

7. Trackball Pressure Regulator — 20 ± 2 psig

8. Cooling Air
   - a. Left Hand 40mm — 30 SCFH
   - b. Left Hand 80mm — 30 SCFH
   - c. Right Hand 40mm — 30 SCFH
   - d. Right Hand 80mm — 30 SCFH

9. Lift up Air through the Vacuum Clamps
   - a. Left Hand — 400 SCFH
   - b. Right Hand — 400 SCFH

10. Standoff at Objectives
    - a. Left Hand — 70 SCFH
    - b. Right Hand — 70 SCFH

11. Lift up at Both Ends
    - a. Left Hand — 90 SCFH
    - b. Right Hand — 90 SCFH

12. Cooling Air Pressure Regulator — 13 ±1 psig

13. Film Control Air Pressure Regulator — 25 ±1 psig

C. Trackball Sensitivity

1. Low Speed Setting - Excerpt from I.C.5.c.(1) of Performance Specifications: "360° of trackball rotation causes 31.4 microns ± 10% of stage movement."

a. Left Stage - X Direction

(1) Press push button "Trackball Independent" (yellow).

(2) Set the left stage in the approximate midposition of travel by rotating the left trackball.

(3) Insert Stereocomparator Drive Program No. 2 in the computer and set up console desk push buttons per the operating instructions.

(4) Measure trackball sensitivity in the following manner:

(a) Place a pencil mark approximately 1/2" long on the surface of the left trackball.

(b) With the controls set per the operating instructions, press the console desk panel push button marked "Trackball Fine" (blue).

(c) Place the mark on the left trackball (by rotating the trackball) so that the mark is just visible at the left edge bezel.

(d) Zero the left side X axis Nixie tube by pressing the left side zero reset push button.

(e) Turn the left trackball to the left until the pencil mark is again (one revolution) just visible at the left edge of the bezel.

(f) Read the Nixie tube position readout.

(g) Repeat the zero setting and rotation of the left trackball three times with rotation to the left and three times with rotation to the right.

(h) Record Nixie tube position offset a total of six times.

(i) The stage displacement indicated by the Nixie tube should be 31.4 micrometers per trackball revolution within ± 10% of 31.4 micrometers.

b. Left Stage - Y Direction

(1) Press push button "Trackball Independent" (yellow).

(2) Set the left stage in the approximate midposition of travel by rotating the left trackball.

(3) Insert Stereocomparator Drive Program No. 2 in the computer and set up console desk push buttons per the operating instructions.

(4) Measure trackball sensitivity in the following manner:

(a) Place a pencil mark approximately 1/2" long on the surface of the left trackball.

(b) With the controls set per the operating instructions, press the console desk panel push button marked "Trackball Fine" (blue).

(c) Place the mark on the left trackball (by rotating the trackball) so that the mark is just visible at the front edge of the bezel.

(d) Zero the left side Y axis Nixie tube by pressing the left side zero reset push button.

(e) Turn the left trackball forward until the pencil mark is again (one revolution) just visible at the front edge of the bezel.

(f) Read the Nixie tube position readout.

(g) Repeat the zero setting and rotation of the left trackball three times with rotation forward and three times with rotation backward.

(h) Record Nixie tube position offset a total of six times.

(i) The stage displacement indicated by the Nixie tube should be 31.4 micrometers per trackball revolution within $\pm$ 10% of 31.4 micrometers.

c. Right Stage - X Direction

(1) Press push button "Trackball Independent" (yellow).

(2) Set the right stage in the approximate midposition of travel by rotating the right trackball.

(3) Insert Stereocomparator Drive Program No. 2 in the computer and set up console desk push buttons per the operating instructions.

(4) Measure the right trackball sensitivity in exactly the same manner as described for the left stage with the following exception: The right trackball is to be rotated to the right so that the pencil mark is just visible at the right edge of the bezel each time. Where push buttons are indicated, use the appropriate push button for the right side.



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(5) The stage displacement indicated by the Nixie tube should be 31.4 micrometers per trackball revolution within ± 10% of 31.4 micrometers.

d. Right Stage - Y Direction

(1) Measure the right trackball sensitivity in exactly the same manner as described for the left stage, performing all operations on the right stage. Where push buttons are indicated, use the appropriate push button for the right side.

(2) The stage displacement indicated by the Nixie tube should be 31.4 micrometers per trackball revolution within ± 10% of 31.4 micrometers.

2. High Speed Setting - Excerpt from I.C.5.c.(2) of Performance Specifications: "360° of trackball rotation causes 1004.8 microns ± 10% of stage movement."

a. Left Stage - X Direction

(1) Press push button "Trackball Independent" (Yellow).

(2) Set the stage in the approximate midposition of travel by rotating the left trackball.

(3) Insert Stereocomparator Drive Program No. 2 in the computer and set up console desk push buttons per the operating instructions.

(4) Measure the left trackball sensitivity in the following Manner:

(a) Place a pencil mark approximately 1/2" long on the surface of the left trackball.

(b) With controls set per the operating instructions, press the console desk panel push button marked "Trackball Coarse" (yellow).

(c) Place mark on left trackball (by rotating the trackball) so that the mark is just visible at the left edge bezel.

(d) Zero the left side X axis Nixie tube by pressing the left side zero reset push button.

(e) Turn the left trackball to the left until the pencil mark is again (one revolution) just visible at the left side of the bezel.

(f) Read the Nixie tube position readout.

(g) Repeat the zero setting and rotation of the trackball three times with rotation to the left and three times with rotation to the right.

(h) Record Nixie tube position offset a total of six times.

(i) The stage displacement indicated by the Nixie tube should be 1004.8 micrometers per trackball revolution within $\pm$ 10% of 1004.8 micrometers.

b. Left Stage - Y Direction

(1) Press push button "Trackball Independent" (yellow).

(2) Set the left stage in the approximate mid-position of travel by rotating the left trackball.

(3) Insert Stereocomparator Drive Program No. 2 in the computer and set up console desk push buttons per the operating instructions.

(4) Measure the left trackball sensitivity in the following manner:

(a) Place a pencil mark approximately 1/2" long on the surface of the left trackball.

(b) With controls set per the operating instructions, press the control console desk panel push button marked "Trackball Coarse" (yellow).

(c) Place mark on left trackball (by rotating the trackball) so that the mark is just visible at the front edge of the bezel.

(d) Zero the left side Y axis Nixie tube by pressing the left side zero reset push button.

(e) Turn the left trackball forward until the pencil mark is again (one revolution) just visible at the front edge of the bezel.

(f) Read the Nixie tube position readout.

(g) Repeat the zero setting and rotation of the trackball three times with rotation forward and three times with rotation backward.

(h) Record Nixie tube position offset a total of six times.

(i) The stage displacement indicated by the Nixie tube should be 1004.8 micrometers per trackball revolution within ± 10% of 1004.8 micrometers.

c. Right Stage - X Direction

(1) Press push button "Trackball Independent" (yellow).

(2) Set the right stage in the approximate midposition of travel by rotating the right trackball.

(3) Insert Stereocomparator Drive Program No. 2 in the computer and set up console desk push buttons per the operating instructions.

(4) Measure the right trackball sensitivity in exactly the same manner as described for the left stage with the following exceptions: The right trackball is to be rotated to the right so that the pencil mark is just visible at the right edge of the bezel each time. Where push buttons are indicated, use the appropriate push button for the right side.

(5) The stage displacement indicated by the Nixie tube should be 1004.8 micrometers per trackball revolution within $\pm$ 10% of 1004.8 micrometers.

d. Right Stage - Y Direction

(1) Measure the right trackball sensitivity in exactly the same manner as described for the left stage, performing all operations on the right stage. Where pushbuttons are indicated, use the appropriate push button for the right side.

(2) The stage displacement indicated by the Nixie tube should be 1004.8 micrometers per trackball revolution within $\pm$ 10% of 1004.8 micrometers.

D. Stages

1. Excerpt from Performance Specifications: "I.A.4.c.(1).Drive Speed (a) Maximum 2 inches/second. (b) Minimum . . . 10 micrometers/second (joystick, while under computer control)."

a. Left Stage - X Direction

(1). Set up 12" scale on top of granite base adjacent to the front air bearing supports.

(2). Place drafting tape on the front center of the right-hand air bearing support of the left stage, and show the center of the air bearing by a pencil mark.

(3). Adjust the scale, moving the stage in the X direction so that the midrange on the scale is the midrange of the stage travel.

(4). Insert the Stereocomparator Drive Program No. 2 in the computer, and set up the console desk push buttons per the operating instructions.

(5). Measure the maximum X direction stage speed in the following manner:

(a). Press the "Joystick Left" push button (red) on the console desk.

(b). Set the stage at the approximate center of its travel with the joystick under high speed mode, using the 12" scale as a position indicator. (High speed mode is commanded by holding down the push button on the top end of the joystick.)

(c). Measure the speed with a stopwatch of least dial indication of 0.2 seconds.

(d). The stage will be traveled through eight inches and timed for travel through its center six inches. The six inch distance traveled should occur in less than three seconds ± 10%.

(6). Measure the minimum X direction stage speed in the following manner:

(a). Operate the stage to its approximate center position using the joystick under low speed mode.

(b). Zero the Nixie tube readout.

(c). Move the joystick just off its center position in the +X direction of stage motion, simultaneously starting the stopwatch.

(d). Observe Nixie tube readout, and when a value of approximately 1,000 micrometers is counted, release the joystick and stop the time of the stopwatch.

(e). Read the Nixie tube readout, and from the elapsed time read on the stopwatch, determine the micrometers per second of stage velocity. The computed value should be not more than ten micrometers per second, $\pm$10% (joystick while under computer control).

b. Left Stage - Y Direction

(1). Set up the 12" scale on top of granite base along the right-hand side of the front air bearing support for the left stage.

(2). Place drafting tape on the right side center of the right-hand air bearing support and show the center of the air bearing by a pencil mark.

(3). Adjust scale, moving the stage in the Y direction so that midrange on the scale is the midrange on the stage travel.

(4). Insert the Stereocomparator Drive Program No. 2 in the computer and set up the console desk push buttons per the operating instructions.

(5). Measure the maximum Y direction stage speed in the following manner:

(a). Press the "Joystick Left" push button (red) on the console desk.

(b). Set the stage at the approximate center of its travel with the joystick under high speed mode, using the 12" scale as a position indicator.

(c). Measure the speed with a stopwatch of least dial indication of 0.2 seconds.

(d). The stage will be traveled through eight inches and timed for travel through its center six inches. The six inch distance traveled should occur in less than two seconds, ±10%

(6). Measure the minimum Y direction stage speed in the following manner:

(a). Operate the stage to its approximate center position using the joystick under low speed mode.

(b). Zero the Nixie tube readout.

(c). Move the joystick just off its center position in the +Y direction of stage motion, simultaneously starting the stopwatch.

(d). Observe Nixie tube readout, and when a value of approximately 1,000 micrometers is counted, release the joystick and stop the time of the stopwatch.

(e). Read the Nixie tube readout, and from the elapsed time read on the stopwatch, determine the micrometers per second of stage velocity. The computed value should be not more than ten micrometers per second, ±10% (joystick while under computer control).

c. Right Stage - X Direction

(1). Follow the procedures described for the Left Stage - X Direction with the following exceptions:

(a). Place drafting tape on the front center of the left-hand air bearing support of the right stage, and show the center of the air bearing by a pencil mark.

(b). Where push buttons are indicated, use the appropriate push button for the right side.

(c). Measure the maximum X Direction stage speed.

(d). Measure the minimum X Direction stage speed.

d. Right Stage - Y Direction

(1). Follow the procedures described for the Left Stage Y Direction with the following exceptions:

(a). Set up 12" scale on top of the granite base along the left-hand side of the front air bearing support for the right stage.

(b). Place drafting tape on the left side center of the left-hand air bearing support, and show the center of the air bearing by a pencil mark.

(c). Where push buttons are indicated, use the appropriate push button for the right side.

(d). Measure the maximum Y Direction stage speed.

(e). Measure the minimum Y Direction stage speed.

2. Excerpt from Performance Specifications: "I.A.4.c.(3). Positioning $\pm$ 0.1582 micrometers, least count."

   a. Measure the repeatability of the left stage X axis position measurement in the following manner:

      (1). Set up the Mahr electronic position gauge so that its ruby probe senses approximately the midtravel position of the stage.

      (2). Zero set the Nixie tube X axis left stage by pushing the zero set X axis push button on the control console display panel.

      (3). Adjust the Mahr gauge to the center of its scale and to its highest sensitivity of 0.2 millionths of an inch per scale division.

      (4). Move the left trackball so that the stage moves in the X direction until the Nixie tube readout shows approximately 10 micrometers. Note that the relation between the stage and the Mahr gauge probe must be such that the stage must be moved away from the probe tip.

      (5). Move the trackball until the Mahr gauge returns to its zero position.

      (6). Read the Nixie tube readout.

      (7). Repeat the 10 micrometer offset position and return to the Mahr gauge zero position, a total of five times. Read the X axis Nixie tube readout each time.

      (8). Average the Nixie tube readings. The Nixie tube readout average should be within the range of $\pm$ 0.1582 micrometers.

b. Measure the repeatability of the left stage Y axis position measurement in the following manner:

(1). Set up Mahr electronic position gauge so that its ruby probe senses approximately the midtravel position of the stage.

(2). Zero set the Nixie tube Y axis left stage by pushing the zero set Y axis push button on control console display panel.

(3). Adjust the Mahr gauge to the center of its scale and to its highest sensitivity of 0.2 millionths of an inch per scale division.

(4). Move the left trackball so that the stage moves in the Y direction until the Nixie tube readout shows approximately 10 micrometers. Note that the relation between the stage and the Mahr gauge probe must be such that the stage must be moved away from the probe tip.

(5). Move the trackball until the Mahr gauge returns to its zero position.

(6). Read Nixie tube readout.

(7). Repeat 10 micrometer offset position and return to the Mahr gauge zero position, a total of five times. Read the Y axis Nixie tube readout each time.

(8). Average the Nixie tube readings. The Nixie tube readouts should be within the range of $\pm$ 0.1582 micrometers.

c. Measure the repeatability of the right stage X axis position measurement in the following manner:

(1). Perform the identical steps as for the left stage X axis, with the following exceptions:

(a) Zero set the Nixie tube X axis right stage by pushing the zero set X axis push button on the control console display panel.

(b). Move the right trackball so that the stage moves in the X direction until the Nixie tube readout shows approximately 10 micrometers.

(c). The Nixie tube readout average should be within the range of $\pm$ 0.1582 micrometers.

d. Measure the repeatability of the right stage Y axis position measurement in the following manner:

(1). Perform the identical steps as for the left stage Y axis, with the following exceptions:

(a). Zero set the Nixie tube Y axis right stage by pushing the zero set Y axis push button on the control console display panel.

(b). Move the right trackball so that the stage moves in the Y direction until the Nixie tube readout shows approximately 10 micrometers.

(c). The Nixie tube readout average should be within the range of $\pm$ 0.1582 micrometers.

E. Film Clamping

Excerpt from Performance Specifications I.A.4.g. (2) and (3).

"(2) Clamping time approximately 20 seconds

(3) Adjustable for 70mm to 9-1/2" wide film x 20" long."

1. Determine the clamping time for 9-1/2" film.

   a. Left Stage

      (1). Load the 9-1/2" width of film (Item D. 18. a.) onto the left stage, adjusting the film width guides in the manner prescribed in the operating instructions. Note that the emulsion side of the film should be up.

      (2). Drive the left side platen to the front of the Stereocomparator and in the position closest to the operator by pressing the push button "View Stage" (yellow).

      (3). Depress the "Left Film Clamp" push button (red) on the console desk.

      (4). Simultaneously, read the stopwatch.

      (5). Observe the surface of the film at an oblique angle in reflected light so that as the film becomes flat on the glass platen, the action of the vacuum can be seen.

      (6). When the film has been sucked down on the platen all around by the vacuum, and the visible air bubbles are less than one inch in diameter, stop the timing by pressing the stopwatch.

      (7). The elapsed time after application of the vacuum should be not more than five minutes.

b. Right Stage

(1). Repeat the procedure described above, except that the 9-1/2" wide film should be loaded onto the right stage, and the "Right Film Clamp" push button (green) on the console desk should be activated.

(2). The elapsed time after application of the vacuum should be not more than five minutes.

2. Determine the clamping time for 6.6" and 70 mm. width film for both the left and right stages.

a. The procedure to be followed is identical to that required for the 9-1/2" film, except that the film edge guides must be reset to the width required for the 6.6" (Item D.18.b.) and 70mm. (Item D.18.c.) width films respectively.

F. Optical Assembly

1. Film Density. Excerpt from Performance Specifications I.B.1.b. "Film Density to accommodate film up to 3.0 density."

a. Left Side

(1). Place the optical system in its manually controlled mode by pressing the push button on the console desk marked "Manual No Computer No Electronic Correlation"(white).

(2). Place a 2" x 2" film, density 3.0, on the approximate center of the left platen.

(3). Move the platen by the action of the joystick under the objective lens.

(4). Set the magnification to 10X using the 80mm objective lens by pressing the push button on the console desk labeled "L MAG LO" (red) and operating the manual magnification control on the desk until the console panel indicator shows approximately 10X magnification.

(5). Operate the manual switching control for the eyepieces so that both eyepieces see the left-hand stage.

(6). Adjust the manual eyepiece brightness control to provide maximum transmission of light.

(7). Adjust the manual illumination brightness control on the console desk until the operator sees an illuminated field in the eyepieces.

(8). Have a second operator insert a 2" x 2" film of density 0.1 into one-half of the field of view on top of the 3.0 density filter already in place. This is done while the first operator observes the image in the eyepieces. The illumination of the system should be sufficient for the observer at the eyepieces to see the edge of the 0.1 density film readily as it is inserted into the field of view. It may be necessary to dim the room lights to a low level for this test.

(9). Set the magnification to 50X by operating the manual magnification control on the desk, and repeat the procedure described in items (5) through (8) above.

(10). Set the magnification to 100X by operating the manual magnification control on the desk, and repeat the procedure described in items (5) through (8) above.

(11). Set the magnification to 25X using the 40mm objective lens by pressing the push button on the console desk labeled "L MAG HI" (red) and operating the manual magnification control on the desk until the console panel indicator shows approximately 25X magnification.

(12). Repeat the procedure described in items (5) through (8) above.

(13). Set the magnification to 100X by operating the manual magnification control on the desk, and repeat the procedure described in items (5) through (8) above.

(14). Set the magnification to 200X by operating the manual magnification control on the desk and repeat the procedure described in items (5) through (8) above.

b. Right Side

(1). Repeat the entire procedure described above with the 2" x 2" films of density 3.0 and 0.1 placed on the right platen.

(2). Where push buttons are indicated, use the appropriate push buttons for the right side.

2. Color Filter. Excerpt from the Performance Specifications I.B.1.c. "Color Filter. Remotely controlled, removable filter 546 millimicrons median transmission wavelength."

a. A color filter is provided in the lamphouse assembly that can be switched in and out of the main illumination system. The action of this color filter is controlled by a switch at the eyepiece assembly. There are separate switches for the left-hand side and for the right-hand side.

b. The eyepiece switching system should be adjusted so that the left eyepiece is looking at the left stage and the right eyepiece is looking at the right stage.

c. With the optical system operating, and at any convenient setting of the optics, check the action of the color filter by switching it in and out of the main optical path while the operator is looking through the eyepieces.

d. Operate the left-hand color filter switch so as to switch the left color filter into position three times.

e. Similarly, operate the right-hand color filter switch so as to switch the right color filter into position three times.

f. Operating the respective color filter switches will allow the operator to determine that the respective color filters are being properly switched into position in the field of vision.

3. Fine Focusing and Image Wander

a. The image wander of the system during focusing cannot be determined by simple observation of a target on the stage. This is because the target goes out of focus, as the objective focusing control is adjusted away from its "focus" position. Thus it is not possible to see the image wander.

b. Determine the image wander due to lack of optical axis stability during focusing, by attaching a small plane surface on the exterior of the lens mount for the 40mm lens on both the left and right side of the Stereocomparator. It is sufficient to perform one pair of X-Y tests on each side of the optical system, since both the 40mm and 80mm lens systems are carried by the same assembly, and any image wander due to the mechanics of focusing will affect both the 40mm and 80mm lens assemblies simultaneously.

(1) Remove the air cooling system from the objective lens assembly of the left optical system.

(2) Place the plane surface on the left 40mm lens mount approximately parallel to the optical axis. The surface should also be oriented about the lens mount approximately parallel to the X axis of the film stage.

(3) Set the Mahr electronic gauge probe against the surface at approximately its midpoint.

(4) Place a 5 mm calibrated target (D.6) on the platen under the objective lens.

(5) Focus accurately on the 5mm target using an anamorph ratio of 1:1.0 and a magnification of 100X.

(6) Zero the Mahr gauge with its scale range set to indicate 0.000,000,2 inch increments.

(7) Use the focus control on the console desk knob marked "Objective Focus" to move the objective lens system upwards, and with it the plane surface, through approximately 1/32".

(8) Focus accurately on the 5mm target using an anamorph ratio of 1:1.0 and a magnification of 100X.

(9) Record the Mahr gauge reading.

(10) Repeat the 1/32" focus control change in the opposite direction (downwards), and refocus accurately on the 5mm target. Again note the Mahr gauge reading.

(11) Repeat the focus control adjustment upwards and downwards, followed each time by accurate refocusing and noting the Mahr gauge readings.

(12) The maximum difference in the Mahr gauge readings on a given axis at the surface should not exceed 0.000,020". This should be based on a total of three readings "upwards" and three readings "downwards."

(13) Relocate the surface 90° around the rim of the 40mm objective lens, so that it is oriented approximately parallel to the Y axis of the film stage.

(14) Set the Mahr electronic gauge probe against the surface at approximately its midpoint.

(15) Focus accurately on the 5mm target using an anamorph ratio of 1:1.0 and a magnification of 100X.

(16) Zero the Mahr gauge with its scale range set to indicate 0.000,000,2" increments.

(17) Use the focus control on the console desk knob marked "Objective Focus" to move the objective lens system upwards, and with it the plane surface, through approximately 1/32". Focus accurately on the 5mm. target. Note the Mahr gauge reading.

(18) Repeat the 1/32" focus control change in the opposite direction (downwards), and refocus accurately on the 5mm target. Again note the Mahr gauge reading.

(19) Repeat the focus control adjustment upwards and downwards followed each time by accurate refocusing and noting the Mahr gauge readings.

(20) The maximum difference in the Mahr gauge readings on a given axis at the surface should not exceed 0.000,020". This should be based on a total of three readings "upwards" and three readings "downwards."

(21) Repeat all the foregoing steps (Items 1 through 20) for the right-hand optical system.

4. Main Anamorph System. Excerpt from Performance Specifications: I.B.5.b. "Range 1:1 to 1:2."

a. The purpose of this test is to measure the two extremes of anamorph ratio.

b. Left Side

(1). Place target (Item D.9, calibrated anamorph target) on the left stage, and calibrated eyepiece scale (Item D.3) in the left eyepiece.

(2). Use the eyepiece reticle as the reference, and place the appropriate region of the target in the field of view.

(3). The Stereocomparator Drive Program No. 1 is read into the computer. The "real time" clock must be stopped during the read-in.

(4). Start the real time clock by pressing the push button "Clock Off" (lighted) on the crossconnect panel in Rack 3.

(5). Start the program at Location 1,000.

(6). Press the button marked "Automatic No Electronic Correlation" (blue) on the console desk. This automatically sets the optical parameters at their midrange. The optical acceptance test is performed by commands from the teletype.

(7). Insert the left side objective lens of 80mm in focal length into the optical path by pressing the console desk pushbutton "L MAG LO" (Red).

(8). Type LMAG, 50 on the teletype. The code word LMAG, followed by a comma and the magnification desired, which in this case is 10X, is to set the main zoom magnification. Press the teletype carriage return key. This automatically sets the main zoom magnification.

(9). Type LANS,1.00 on the teletype. The code word LANS, followed by a comma and the anamorph ratio desired, which in the present case is 1.00 is to set the anamorph ratio. Press the teletype carriage return key. This automatically sets the anamorph ratio to 1:1.00.

(10). Type LANR,90 on the teletype. The code word LANR, followed by a comma and the anamorph rotation desired, which in the present case is 90, is to set the anamorph roation. Press the teletype carriage return key. This automatically sets the anamorph rotation .

(11). Type LI,0 on the teletype. The code word LI, followed by a comma and the optical rotation desired, which in the present case is 0, is to set the optical rotation. Press the teletype carriage return key. This automatically sets the optical rotation.

(12). The anamorph ratio target is now arranged in the field of view so that the variable anamorph ratio elements of the target are located along the X axis of the left stage.

(13). Stop the computer by raising the "MA, SI, and Run" switch into the SI position on the computer control panel in Rack No. 3.

(14). Press the push button marked "Manual, No Computer No Electronic Correlation (White).

(15). Place the target in the appropriate juxtaposition with the eyepiece reticle scale, by selected movement of the left stage X axis left trackball control, and determine and record the anamorph ratio measurement corresponding to 1:1.00.

(16). Start the computer by setting the MA, SI and run switch to its Run position. Press the computer start push button. Rack 3.

(17). Press the push button "Auto, no electronic correlation" (blue).

(18). Readjust the anamorph ratio to 1:2.00 by typing LANS, 2.00 and pressing the carriage return key.

(19). Stop the computer by raising the "MA, SI, and Run" switch into the SI position on the computer control panel in Rack No. 3.

(20). Press the push button marked "Manual, No Computer No Electronic Correlation (White).

(21). Move the appropriate section of the anamorph ratio target into juxtaposition with the eyepiece scale by selected movement of the left stage X axis left track-ball control.

(22). Measure the target ratio length indicated by the target dimension 2.0 with the eyepiece scale, and record the value.

(23). Compare the measurement values for the anamorph ratio settings of 1:1.00 and 1:2.00. The ratio of the measurements should be 2.00 $\pm$ 1%.

(24). Repeat the measuring procedure for computation of ratio a total of three times. The average is used for the acceptance test value.

c. Right Side

(1). Follow the procedure described for the left side above, placing the target and eyepiece reticle on the right side of the Stereocomparator.

(2). In setting the optical parameters with the teletype, type the following code words:

(a). RMAG, 10 for the main zoom magnification.

(b). RANS, 1.00 for the anamorph ratio.

(c). RANR, 90 for the anamorph rotation.

(d). RI, 0 for the optical rotation.

(3) Insert the right side objective lens of 80mm in focal length into the optical path by pressing the console desk push button "R MAG LO" (green).

(4) Where trackball control is required, use the right stage X axis right trackball control.

5. Main Zoom System. Excerpt from Performance Specifications "I.B.6. Zoom Range $\sqrt{10}$ to $\frac{1}{\sqrt{10}}$."

a. The purpose of this test is to measure the overall magnification of the main zoom.

b. Left side

(1) Place target Item D. 6 (Calibrated target, 5mm in 0.01 increments) on the left stage, and calibrated eyepiece scale ( D. 3) [illegible] the left eyepiece.

(2) The Stereocomparator Drive Program No. 1 is read into the computer. The real-time clock must be stopped during the read-in.

(3) Start the real time clock by pressing the push button "Clock Off" (lighted) on the crossconnect panel in Rack 3.

(4) Start the program at Location 1,000.

(5) Press the button marked "Automatic No Electronic Correlation" (blue) on the console desk. This automatically sets the optical parameters at their midrange. The optical acceptance test is performed by commands from the teletype.

(6) Insert the left side objective lens of 80mm in focal length into the optical path by pressing the console desk push button "L MAG LO" (red).

(7) Type LMAG, 10 on the teletype. The code word LMAG, followed by a comma and the magnification desired, which in this case

is 10X, is to set the main zoom magnification. Press the teletype carriage return key. This automatically sets the main zoom magnification.

(8) Type LANS, 1.00 on the teletype. The code word LANS, followed by a comma and the anamorph ratio desired, which in the present case is 1.00 is to set the anamorph ratio. Press the teletype carriage return key. This automatically sets the anamorph ratio to 1:1.00.

(9) Type LANR, 90 on the teletype. The code word LANR, followed by a comma and the anamorph rotation desired, which in the present case is 90, is to set the anamorph rotation. Press the teletype carriage return key. This automatically sets the anamorph rotation.

(10) Type LI, 0 on the teletype. The code word LI, followed by a comma and the optical rotation desired, which in the present case is 0, is to set the optical rotation. Press the teletype carriage return key. This automatically sets the optical rotation.

(11) Stop the computer by raising the "MA, SI, and Run" switch into the SI position on the computer control panel in Rack No. 3.

(12) Press the push button marked "Manual, No Computer No Electronic Correlation (White).

(13) Using the eyepiece reticle as the reference, place the appropriate range of the target in the field of view and measure it.

(14) Start the computer by setting the "MA, SI, and Run" switch to its Run position. Press the computer "Start" push button in Rack 3.

(15) Press the push button "Automatic, No Electronic Correlation" (blue).

(16) Record the measurement.

(17) Readjust the magnification of the system to 100X by teletyping the code word LMAG, 100.

(18) Stop the computer by raising the "MA, SI, and Run" switch into the SI position on the computer control panel in Rack No. 3.

(19) Press the push button marked "Manual, No Computer No Electronic Correlation (white).

(20) Using the eyepiece reticle as reference, place the appropriate range of the target in the field of view and measure it.

(21) Record the measurement.

(22) Repeat this sequence of measurements (at 10X and at 100X) a total of three times each. The average is used for the acceptance test value.

(23) Determine the magnification ratio by dividing the small measurement into the large measurement. The value obtained should be 10.0 ± 1%.

c. Right side

(1) Follow the procedure described for the left side above, placing the target and eyepiece reticle on the right side of the Stereocomparator.

(2) Where activation of a push button is indicated, the appropriate push button for the right side should be pressed.

(3) In setting the magnification, anamorph ratio, anamorph rotation and image rotation parameters with the teletype, change the initial letter of the code word from "L" to "R". For example, to set the magnification for the right side of the system, it is necessary to type the code word RMAG followed by a comma, followed by the magnification parameter and then press the teletype carriage return key.

(4) The sequence of measurements should be repeated three times each at 10X and 100X magnification. After averaging the measurements at each magnification, the small value should be divided into the large value. The resulting ratio should be 10.0 $\pm$ 1%.

6. Optical Resolution

a. The purpose of this test is to measure the optical resolution of the system at various magnifications and for three positions in the field of view, in accordance with Section I.B.10.a. and b. of the Performance Specifications, a copy of which is included at the end of this portion of the test instructions.

b. Left Side

(1) Place Target Item D.1 (Resolution target USAF 1951 high contrast, reduced 240X Serial No. 4) on the left stage.

(2) Place the system in the computer command mode by reference to the operating instructions and by reading the Stereocomparator Drive Program No. 3 into the computer. Note that the real time clock must be stopped during the read-in.

(3) Start the real time clock by pressing the push button "Clock Off" (lighted) on the crossconnect panel in Rack 3.

(4) Start the program in Location 1000 (Octal).

(5) Press the push button on the console desk marked "Automatic No Electronic Correlation (blue). This automatically sets the optical parameters for the midrange.

(6) Operate the main illumination color of light switch so that the stage is illuminated by white light.

(7) Insert the left side objective lens of 40mm focal length into the optical path by operation of the console desk push button L MAG HI (red).

(8) Set the optics by commands from the teletype.

(9) Type the code word LANS on the teletype followed by a comma and the anamorph ratio value of 1.00. Upon pressing the carriage return key, the anamorph ratio on the left side is automatically set at 1 : 1.00.

(10) Type the code word LMAG followed by a comma and the magnification value of 15. Press the carriage return key. The magnification is now automatically set to 30X.

(11) Type LI, 0 on the teletype. The code word LI, followed by a comma and the optical rotation desired, which in the present case is 0, is to set the optical rotation. Press the teletype carriage return key. This automatically sets the optical rotation.

(12) Arrange the target for on-axis viewing by placing it at the center of the field of view.

(13) Read the target. Record the lower of the saggital and tangential values. Note that, strictly speaking, on the optical axis there should be no difference between the saggital and tangential directions.

(14) Translate the stage horizontally and to the right in the field of view to a point approximately 1/3 of the field of view radius from the optical axis.

(15) Read the target. Record the lower of the saggital and tangential values.

(16) Translate the stage horizontally and to the right to a point adjacent to the edge of the field of view. Note: The target must be kept away from the region at the edge of the field of view where distortion could influence the reading of the target.

(17) Read the target. Record the lower of the saggital and tangential values.

(18) Return the target position in the eyepiece to the center of the field of view by translating the stage so that the image proceeds horizontally and to the left.

(19) Translate the stage vertically and upwards to a point approximately 1/3 of the field of view radius from the optical axis.

(20) Read the target. Record the lower of the saggital and tangential values.

(21) Translate the stage vertically and upwards to a point adjacent to the edge of the field of view.

(22) Read the target. Record the lower of the saggital and tangential values.

(23) Repeat the resolution determination procedure outlined above for the magnification values of 38X, 124X, and 200X. These magnifications are obtained by typing LMAG, 19 or LMAG, 62 or LMAG 100 respectively, followed by a carriage return.

(24) Insert the left side objective lens of 80mm focal length into the optical path by operation of the console desk push button L MAG LO (red).

(25) Repeat the resolution determination procedure outlined above for the magnification values of 10X and 100X. (LMAG, 10 or LMAG,100)

(26) Operate the main illumination color of light switch so that the stage is illuminated by monochromatic light.

(27) Repeat the entire procedure described above for focal lengths of 40mm and 80mm at all magnifications listed for White Light above.

c. Right Side

(1) Install the Target Item D.1 (Resolution target USAF 1951 high contrast, reduced 240X Serial No. 4) on the right stage.

(2) Follow the procedure described above for the left side with the following exceptions:

(a) Where push buttons are indicated, substitute the appropriate push buttons on the right side.

(b) To set the anamorph ratio value on the teletype, use the code word RANS, followed by the anamorph ratio value of 1.00.

(c) To set the magnification value on the teletype, use the code word RMAG, followed by the magnification desired.

(d) To set the image rotator use code word RI, 0 to obtain an upright image as viewed at the eyepiece.

# CONTRACTUAL RESOLUTION
# for
# THRESHOLD CONTRAST RATIO

Excerpt from Performance Specifications

I.B.10.a. I.B.10.b.

## WHITE LIGHT

| Magnification | Line Pairs per mm: On Axis | Line Pairs per mm: 1/3 of field | Line Pairs per mm: Edge of field | Line Pairs per mm per magnification: On Axis | Line Pairs per mm per magnification: 1/3 of field | Line Pairs per mm per magnification: Edge of field |
|---|---|---|---|---|---|---|
| F = 40mm | | | | | | |
| 20X | 80 | 60 | 45 | 4.0 | 3.0 | 2.5 |
| 37X | 180 | 120 | 100 | 4.9 | 3.3 | 2.7 |
| 123X | 550 | 475 | 430 | 4.5 | 3.9 | 3.5 |
| 200X | 800 | 700 | 550 | 4.0 | 3.5 | 2.8 |
| F = 80mm | | | | | | |
| 10X | 45 | 40 | 40 | 4.5 | 4.0 | 4.0 |
| 100X | 400 | 300 | 275 | 4.0 | 3.0 | 2.8 |

## MONOCHROMATIC LIGHT

| Magnification | Line Pairs per mm: On Axis | Line Pairs per mm: 1/3 of field | Line Pairs per mm: Edge of field | Line Pairs per mm per magnification: On Axis | Line Pairs per mm per magnification: 1/3 of field | Line Pairs per mm per magnification: Edge of field |
|---|---|---|---|---|---|---|
| F = 40mm | | | | | | |
| 20X | 100 | 100 | 55 | 5.0 | 5.0 | 2.8 |
| 37X | 185 | 180 | 140 | 5.0 | 4.9 | 3.8 |
| 123X | 615 | 615 | 500 | 5.0 | 5.0 | 4.1 |
| 200X | 1000 | 1000 | 700 | 5.0 | 5.0 | 3.5 |
| F = 80mm | | | | | | |
| 10X | 50 | 50 | 45 | 5.0 | 5.0 | 4.5 |
| 100X | 500 | 450 | 385 | 5.0 | 4.5 | 2.9 |

Note 1. Based on 38° Field of View

Note 2. The Line Pairs set forth represent the worst case situation either saggital or tangential.