[redacted]

NPIC# 21/68 - Copy #3 - for action

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Technical Proposal
For A
Common Stage Linkage
For The
High Power Stereoviewer

Approved For Release 2005/02/17 : CIA-RDP78B04770A001400020016-9

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* Prints Attached

1.0 INTRODUCTION

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[redacted] proposes to design, develop and fabricate an attachment for the [redacted] High Power Stereoviewer in accordance with the statement of work, section 5.0. The intent of this attachment is to minimize the time required to re-establish a stereo model when moving to different locations on the chip.

The particular design proposed is a very simple three bar type linkage which uses the present stages, and their motions, without change. The stages can be driven in common or differential from either set of existing control knobs. The proposed system is most compatible with present High Power Viewer operational methods.

Section 2.0 summarizes the requirements for the attachment. Various concepts of how the attachment problem may be solved are analyzed in Section 3.0. The proposed design approach is described in Section 4.0.

2.0 SUMMARY OF REQUIREMENTS

The attachment is to meet the following requirements:

2.1 A minimum modification to the Stereoviewer is desirable and the attachment shall be removable from the instrument.

2.2 The attachment shall allow 1/2 inch independent vertical movement of the stages for focusing.

2.3 The attachment shall provide less than .005 inch backlash or lost motion between the stages.

2.4 Independent motion of the stages shall have less than .003 inch backlash or lost motion.

2.5 4 x 5 inch film holders shall be provided which allow viewing of any 2 x 3 inch area within the 4 x 5 inch format.

2.6 The chips shall remain in focus over any 2 x 3 viewing area while operating at a system magnification of 200X.

3.0 CONCEPT ANALYSIS

Prior to analysis another specific requirement was added to those in paragraph 2.0. As a goal the attachment should not degrade the scanning performance of the present stages. The operator-instrument direct relationship experienced in manual mechanical drive through the control knobs should be maintained. With this requirement as a background, the stages were tested for fineness of adjustment and adjustment speed. Using a cross hair eyepiece and a scale on the stage at highest magnification, four individuals measured their minimum mechanical resolution. That is the smallest amount they could perceptively move the stage. This was averaged at .4 microns. The same four individuals were then asked to drive the stage from one extreme to the other at a fast rate. The readings averaged a scan speed of .25 inch per second in the X direction and close to .3 inch per second in the Y direction.

To meet the stated and generated requirements, four general approaches were considered:

1. Electric Motor Drives
2. Mechanical Coupling
3. Duplex Stage Control
4. Simple Stage Connectors

3.1 Electric Motor Drives

In this approach, electric motors would be connected to each of the stage drives. Each of the (4) motors could be controlled separately or coupled electronically to provide common stage motion. The analysis showed:

a) Servo-motors with the required shaft encoders and circuitry would be costly relative to the basic instrument.

b) Synchronous motors or stepper motors do not provide both the control resolution and acceptable speed without gear changes.

c) Motors do not provide the direct control feeling obtained through direct knob drive.

3.2 Mechanical Coupling

This concept consists of coupling the existing stage drive knobs together with a mechanical drive train so that either, or both stages could be operated by turning the present knobs. Since the knobs traverse along with the stage, any such coupling would require a number of splines, gears and racks which inherently add backlash and play to the system. It would also be costly.

3.3 Duplex Stage Control

The use of a control pod mounted between the two stages was considered. The pod would be attached to the base of the Viewer and contain drive arms extending to the stages. The present drive knobs would be eliminated and stage control would be from 4 knobs placed at the center of the pod.

This system would necessitate extensive changes to the Viewer, although it would meet the precision requirements of the system. It also is costly in itself.

3.4 The geometry of the present stage location and travel distances makes it unlikely that an X-Y-Z slide arrangement would be successful. This would be a system which adds an entirely new X-Y stage system. The "Y" motion is added on top of the "X" and independent "Z" motion on top of the "Y". The stages can be coupled for common motion. The relative bearing lengths allowed by the maximum and minimum stage separation would involve high bending loads (and deflections) at the wider separations. The approach would also be undesirable from the number of parts required, the manufacturing tolerances or adjustments and the number of locks involved to tighten or release the system.

3.5 Simple Stage Connectors

A number of linkages were considered for a direct connection between the stages. This type of connection between stages must be simple, structurally rigid and require very little rerun. Layout drawings, deflection calculations and an actual mock up on the instrument were used in this analysis. The analysis indicated:

a) It is possible to drive the stages from the existing control knobs while the stages are rigidly connected together.

b) Paragraph 3.1.5 of RFP RD-8-68 requires a 4 x 5 inch chip capability. To meet this specification, it will be necessary to modify the stage in such a way as to restrict the space available for a connection between the stages. It is therefore unlikely that a folding bar or parallelogram mechanism could be used because of the space limitations.

3.5.1 3 Bar Linkage

Analysis of a three bar linkage principle led to discovery of a simple, inexpensive approach that is ideally suited to solving the problem. The three bar structure is arranged as shown in Figure I and is composed of two connecting bars and the side of the stage.

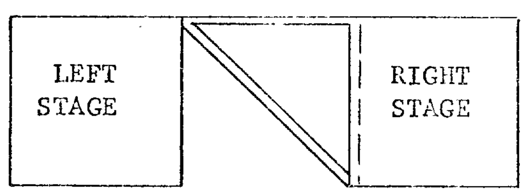

Figure 1 - 3 Bar Connecting Structure

This construction is inherently rigid since any force on the structure is supported solely by tension or compression in the legs or bars. For example, if the right stage is pushed toward the rear of the instrument, the force distribution in the structure is as shown in Figure II.

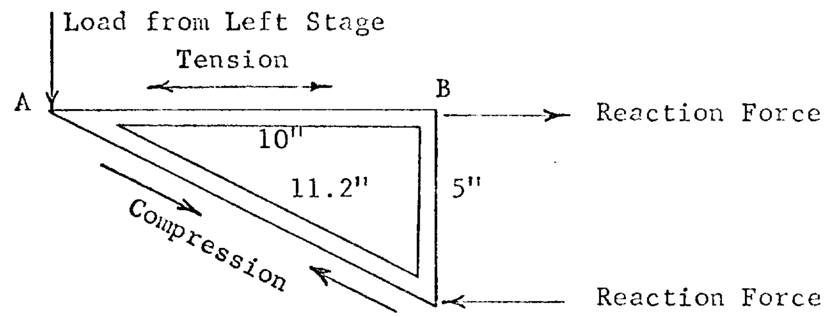

Figure II - 3 Bar Structure - Force Distribution

If the load is 1#, the reaction forces are 2# and the rear link is in the 2# tension and the front link is in 2.2# compression. If 1/4 inch diameter steel bars are used, the deflections could be calculated as:

$$d = \frac{Pl}{AE} = \frac{2 \times 10}{\pi \times (.125)^2 \times 30 \times 10^6} = 1.36 \times 10^{-5} \text{ inches due to extension}$$

and

$$d = \frac{2.2 \times 11.2}{\pi \times (.125)^2 \times 30 \times 10^6} = 1.67 \times 10^{-5} \text{ inches due to compression}$$

The resulting displacement of point A relative to point B can be found by simple trigonometry to be 6.4×10^{-5} inches.

In comparison, if a single wide plate were used to connect the stages, the deflection of point A would be caused by bending in the plate. To restrict the deflection to the same as the 3 bar linkage, the width of 1/4" thick steel plate would have to be:

$$W = \sqrt[3]{\frac{4Pl^3}{Ebd}} = \sqrt[3]{\frac{4000}{30 \times 64 \times .25}}$$

$$W = \sqrt[3]{8.32}$$

Width $\doteq$ 2.0 inches

Thus the 3 bar approach, with its flexibility for vertical focus and convenient means for converting to differential motion, provides the necessary rigidity in a simple, light weight manner.

Comparing the 3 bar structure to the alternative methods of connecting the stages shows that the bar structure has the following advantages:

a) It contains no moving parts in the driving mode and is inherently free of backlash.

b) The structure requires a minimum of space.

c) Only minor assembly changes are needed to the existing instrument. The attachment can be easily removed from the instrument by means of only four screws.

d) The structure is inherently rigid since no bending deflections are encountered.

e) The relative simplicity of the system minimizes cost.

The 3 bar structure was mocked up and attached to a stereo-viewer. (Figure IIIA). In this mock up the stages moved within .002 inch when driven in one direction along the y axis. Due to the normal fits and clearances in the stage bearings of the standard High Power Stereoviewer, up to .015 inch backlash occurred when the direction of movement was reversed. A production model of the 3 bar linkage with its telescoping fits, used with instruments with possible greater wear and looser fits from usage, may have slightly more play.

Because the 3 Bar linkage uses the existing stages as they are, backlash values may exceed specification requirements. Of course this can be removed by a simple reversing procedure.

The 3 bar linkage is proposed because it is felt its many advantages (simplicity, lower cost, ease of operation, ease of detachment and assembly, etc.) far outweight the backlash that may be encountered with some existing instruments. This approach is assessed as complying with the stated design intent of "minimizing the time necessary to re-establish a stereo model".

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[redacted] would be pleased to supply the mock up parts pictured in Figure IIIA for customer evaluation of the approach on their instruments. Though this mock up only provides for one stage to stage configuration and focus position, the application of this simple solution may be evaluated.

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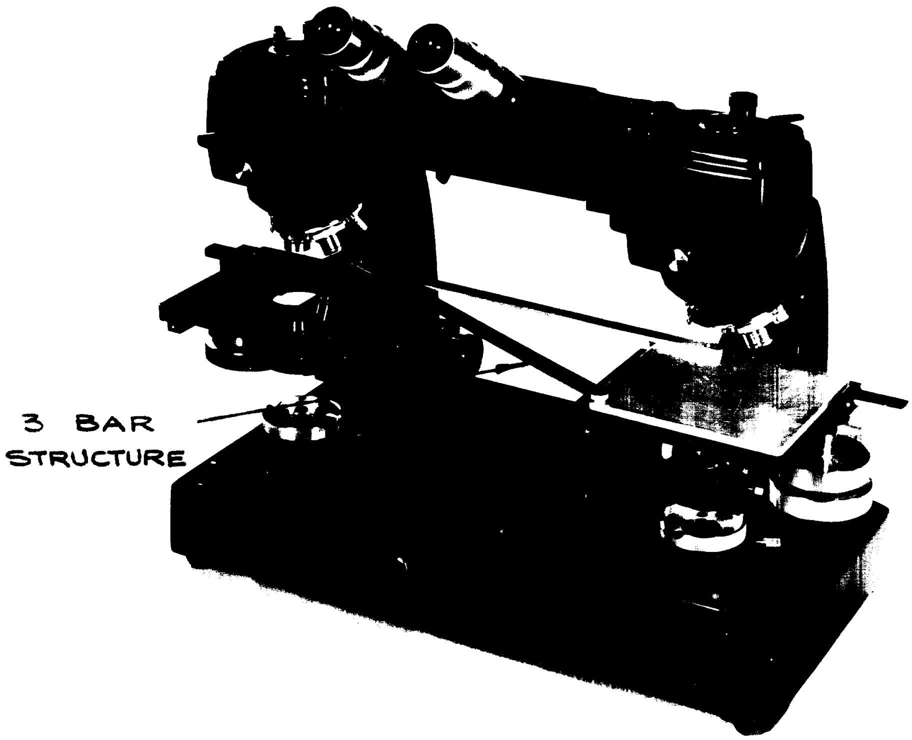


FIGURE III A

4.0 DESIGN DESCRIPTION

The simplicity of design, operation and attachment of the proposed three bar linkage is best described by a series of figures. Figures V and VI are preliminary layouts showing the attachment and connecting bar construction. These will be discussed in detail later.

Figure III illustrates how the two connecting bars telescope together to allow various stage separations. The right stage assembly actually makes up the 3rd bar.

Referring to Figure III:

A) Shows the position of the connecting structure at the nominal stage position.

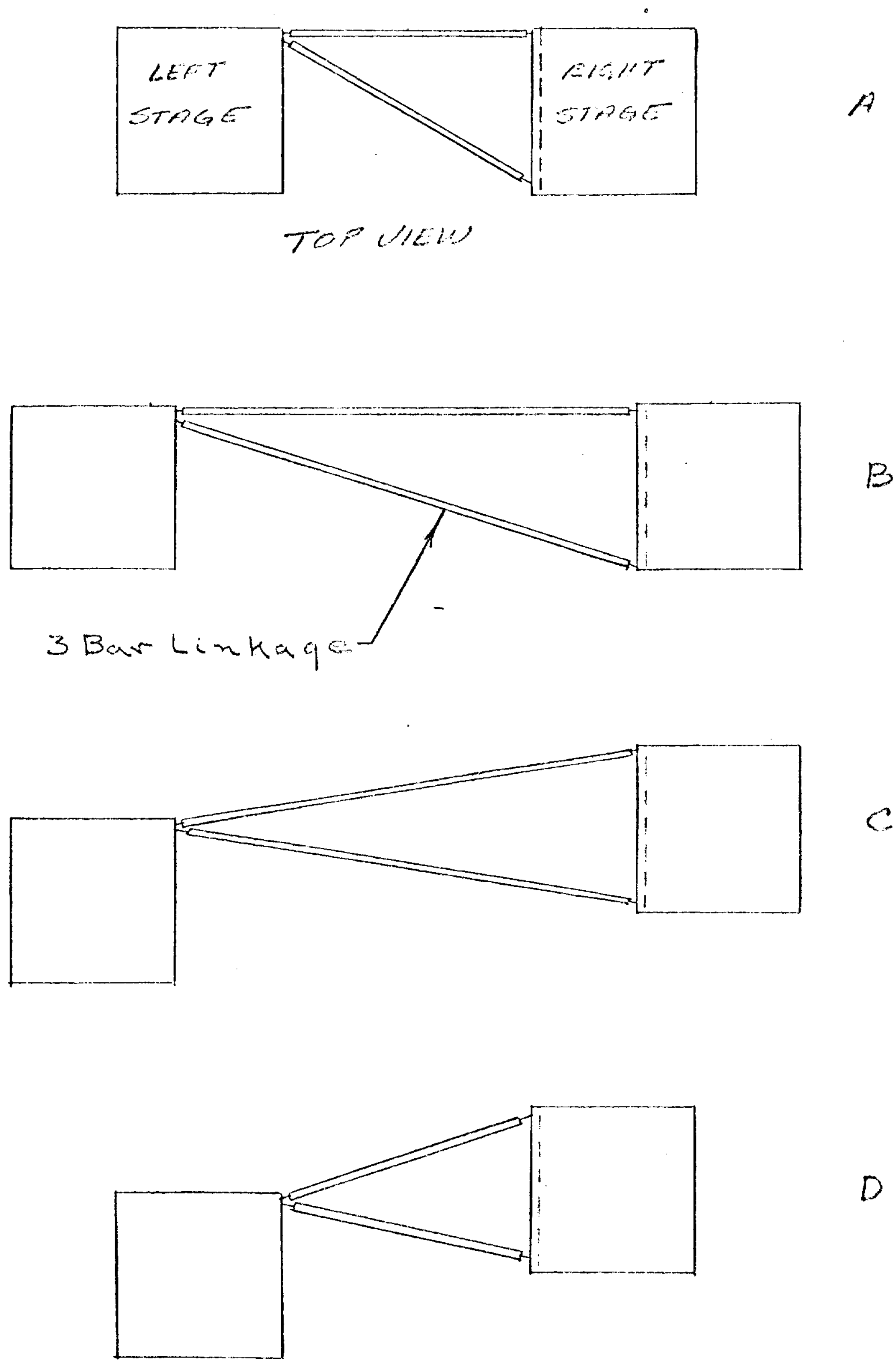
B) Shows the structure at maximum stage separation in X.

C) Shows the structure at maximum stage separation in X and Y.

D) Shows the minimum stage separation in X and the maximum in Y.

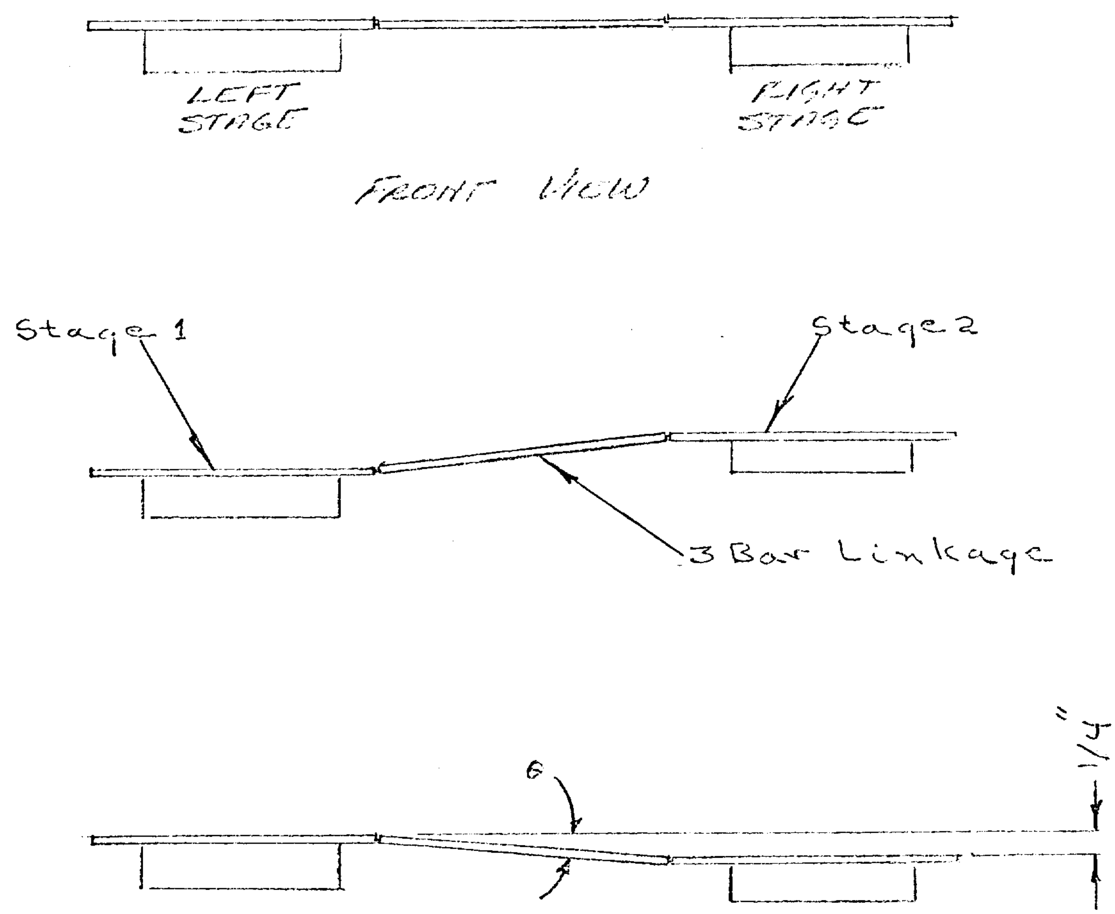
To achieve the range of independent motion required two telescoping sections are required in each connecting bar. These are shown two times size in detail 1 of Figure VI. Knurled rings A and B are locks.

For independent motion the operator unlocks the connecting bars with the A rings. See Figure V. If this does not provide sufficient range of motion the B rings are also used to unlock the second telescoping section. For common motion the operator locks whichever of the A or B rings that are unlocked. All stage motion is accomplished through the present drive knobs, both independent and common.



"X"-"Y" Adjustment

Figure III



Focusing Adjustment

Figure IV

Larger stage plates and film clips are provided to accommodate the larger film chips. The clip configurations can easily be modified to pivot if required, for varying chip orientations.

The connecting bars are terminated in balls which permit vertical motion of either stage for focus. Figure IV illustrates how the 3 bar structure would function during focus adjustment. The stages could be raised or lowered through the same range as available on the present Stereoviewers. Obviously, a slight change in stage separation will occur due to the consine of the inclination angle θ. For a $\pm 1/4$" adjustment however, the stage separation would change less than .008 inches (at minimum stage separation).

The High Power Stereoviewer was not designed for simultaneous scanning of the stages and, therefore, there are inherent aspects in the design and construction of the basic motion mechanisms which must be considered, if they are to be used in conjunction with a simple linkage. The separate stage motions of existing instruments were not aligned with respect to each other of course. Within each stage the orthogonality of the X and Y motions are held within 30' of angle. Thus within any instrument, rigid connection of the stages could result in binding during common stage motion.

No adjustment may be required on most instruments while others may require some readjustment (such as arm position, stage motion adjustment, and pod location in the arm if affected by the other adjustments). When required, this service could be supplied by [redacted] Since these tolerances are STAT inherent in the design of all existing High Power Stereoviewers some instruments may require adjustment when used with any attachment device that rigidly couples the existing stages.

5.0 STATEMENT OF WORK

[redacted] proposes to design and fabricate one attachment to the [redacted] High Power Stereoviewer, in accordance with the Development Objectives, 29 Sept. 1967 except that backlash shall be consistent with the statements of Paragraph 3.5.1 of this proposal.

Clarification: Paragraph 3.1.3 of the Development Objectives refers to the present stage motion as 2 x 3 inches whereas the instrument specification calls for 50 x 75 millimeters. The proposed approach does not change the motion provided in the basic instrument.

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[redacted]

December 11, 1967

Attention: James Mc.
Subject: Request for Proposal No. RD-8-68
Project No. 02318

Gentlemen:

Enclosed are two copies of our Technical Proposal and Cost break-down for the subject request. Under separate cover, three copies of each are being forwarded directly to your Technical Representative.

The excellent performance, reliability and operator satisfaction of the High Power Stereoviewer is well known within your activity. The addition of the requested common stage will enhance the function of this instrument. [redacted] with your guidance and direction, was responsib[redacted] Power Stereoviewer from its conception in the design stages to the present position of production orders. Our intimate knowledge of the High Power Stereoviewer, its tolerances, specifications and applications make [redacted] uniquely qualified to perform the proposed development. Key personnel associated with the High Power Stereoviewer development also, will be available for work on the Common Stage, either directly or as required on a consulting basis.

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As indicated on the enclosed DD Form 633-4, firm fixed price for the prototype unit is [redacted] It is our best judgement that delivery can be made 14 weeks after receipt of a contract. For planning purposes, budgetary selling prices for 10 units are [redacted] each and for 100 units [redacted] each.

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Please contact the writer for any questions concerning this proposal.

Very truly yours

[redacted]

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Program Administrator
Photogrammetric & Military Systems

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[redacted]

Encs. 2

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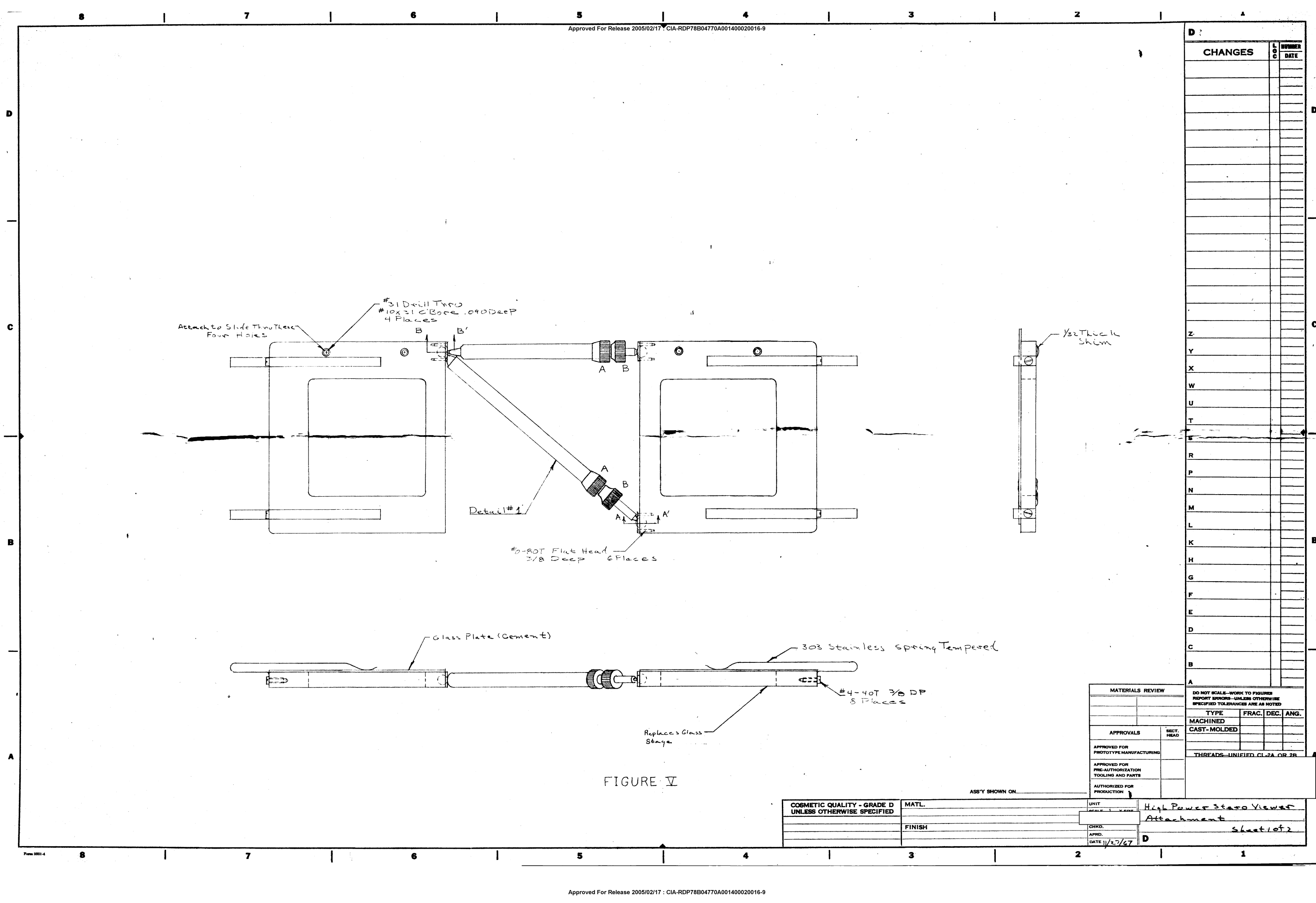
Attach to Slide Thru These Four Holes
#31 Drill Thru
#10x31 C'Bore .090 Deep
4 Places
B
B'
A
B
Detail #1
#0-80T Flat Head
3/8 Deep 6 Places
A
A'
1/32 Thick Shim
Glass Plate (Cement)
303 Stainless Spring Tempered
#4-40T 3/8 DP
8 Places
Replaces Glass Stage
CHANGES
MATERIALS REVIEW
APPROVALS
SECT. HEAD
APPROVED FOR PROTOTYPE MANUFACTURING
APPROVED FOR PRE-AUTHORIZATION TOOLING AND PARTS
AUTHORIZED FOR PRODUCTION
DO NOT SCALE—WORK TO FIGURES
REPORT ERRORS—UNLESS OTHERWISE SPECIFIED TOLERANCES ARE AS NOTED
TYPE
FRAC.
DEC.
ANG.
MACHINED
CAST-MOLDED
THREADS—UNIFIED CL-2A OR 2B
ASS'Y SHOWN ON
COSMETIC QUALITY - GRADE D UNLESS OTHERWISE SPECIFIED
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High Power Stero Viewer
Attachment
Sheet 1 of 2
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FIGURE V

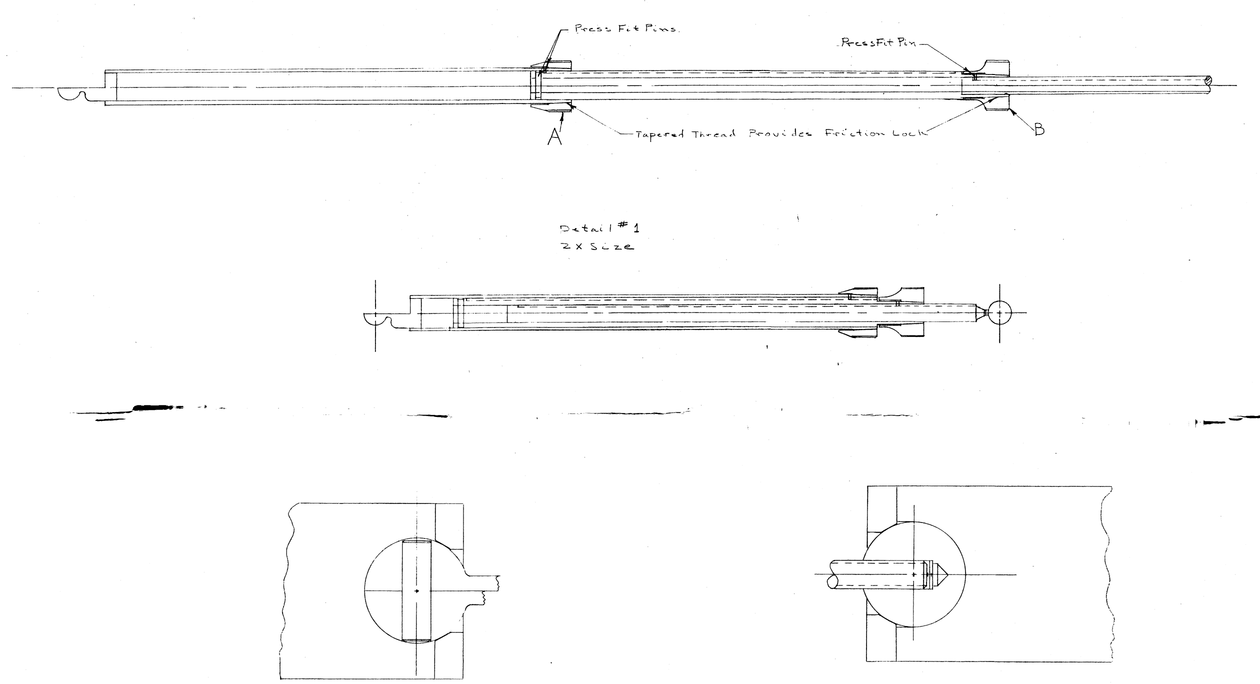

FIGURE VI

CHANGES | LOC | NUMBER | DATE

MATERIALS REVIEW

APPROVALS | SECT. HEAD

APPROVED FOR PROTOTYPE MANUFACTURING

APPROVED FOR PRE-AUTHORIZATION, TOOLING AND PARTS

AUTHORIZED FOR PRODUCTION

DO NOT SCALE—WORK TO FIGURES
REPORT ERRORS—UNLESS OTHERWISE SPECIFIED TOLERANCES ARE AS NOTED

TYPE	FRAC.	DEC.	ANG.
MACHINED			
CAST-MOLDED			

THREADS—UNIFIED CL-2A OR 2B

ASS'Y SHOWN ON

COSMETIC QUALITY - GRADE D
UNLESS OTHERWISE SPECIFIED

MATL.

FINISH

UNIT
SCALE X SIZE
CHKD.
APRD.
DATE 11/27/67

High Power Stereo Viewer
Attachment
Sheet 2 of 2

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Form 2981-4

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DRAWINGS AND PHOTOS

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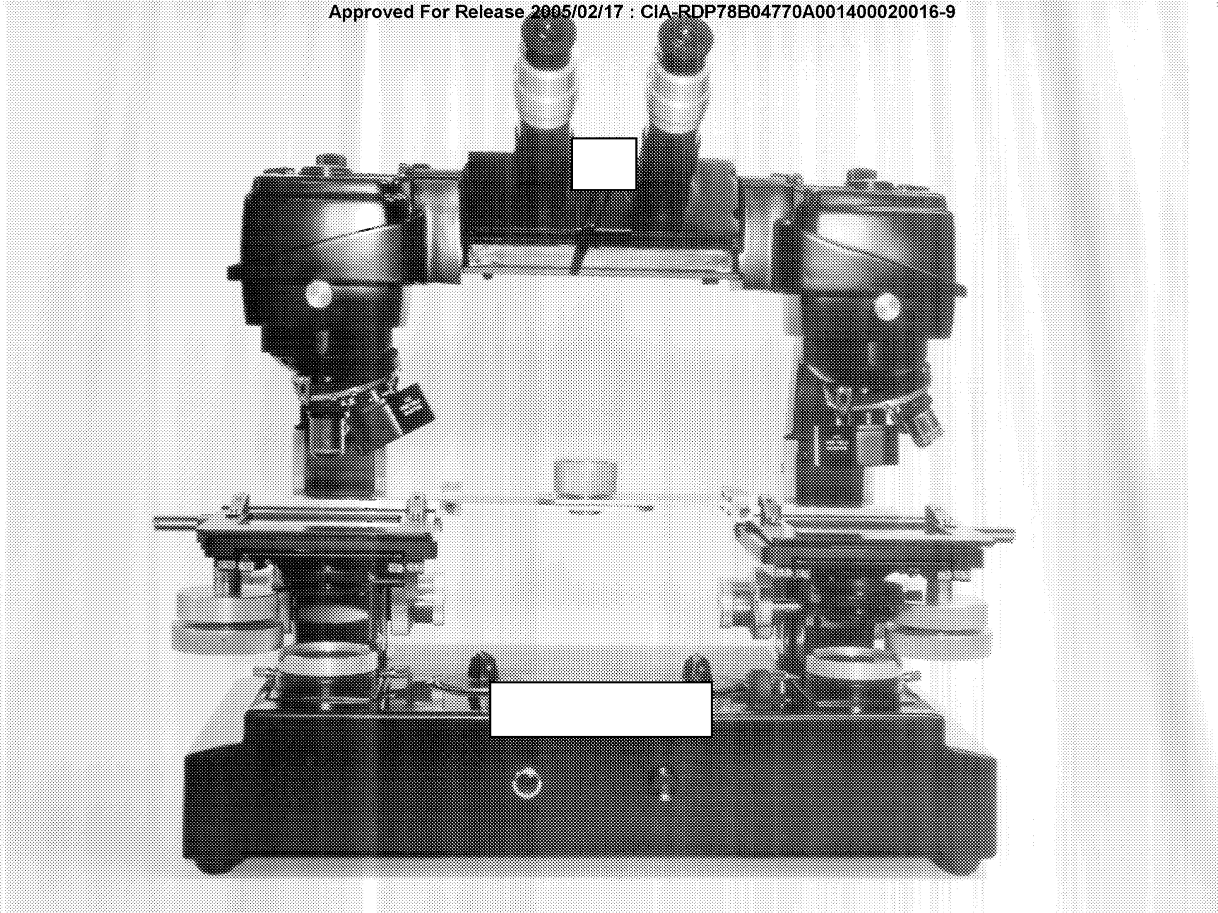

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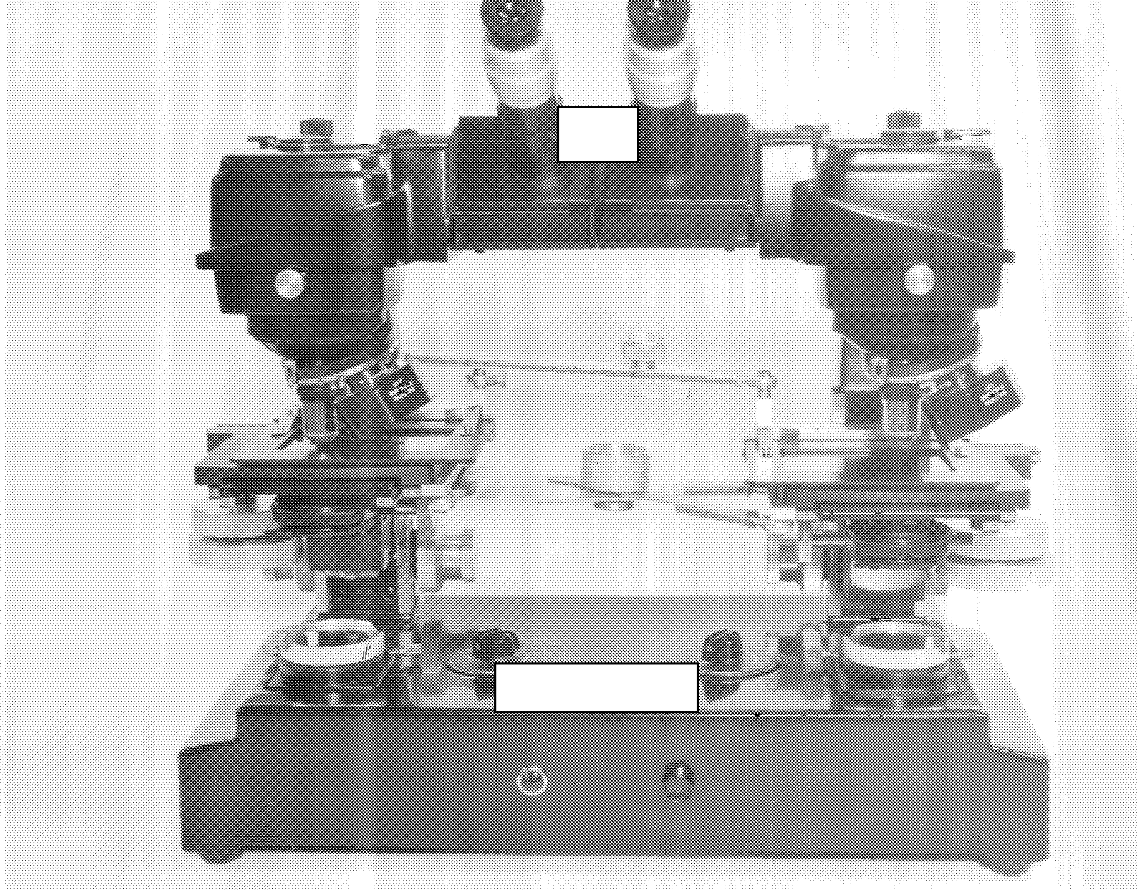

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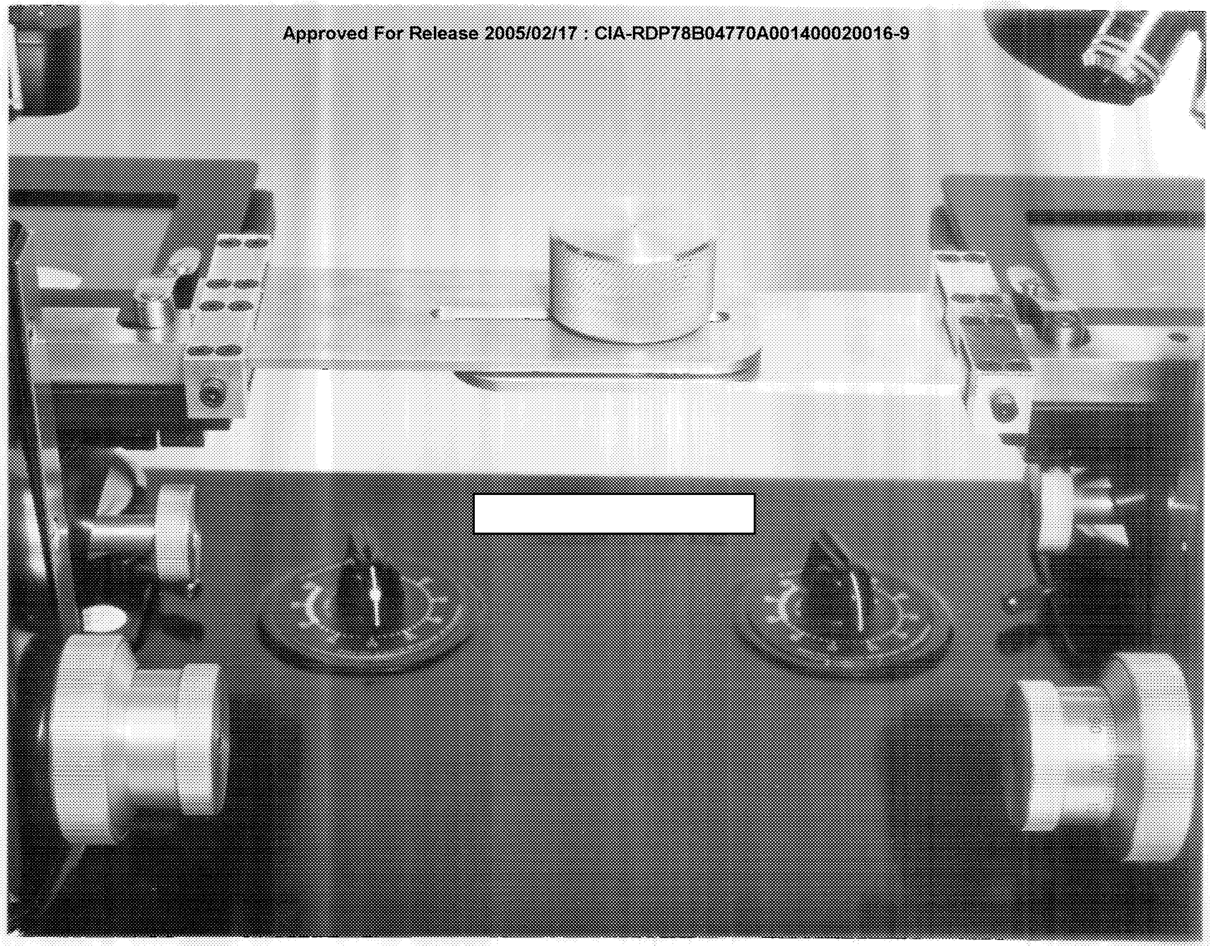

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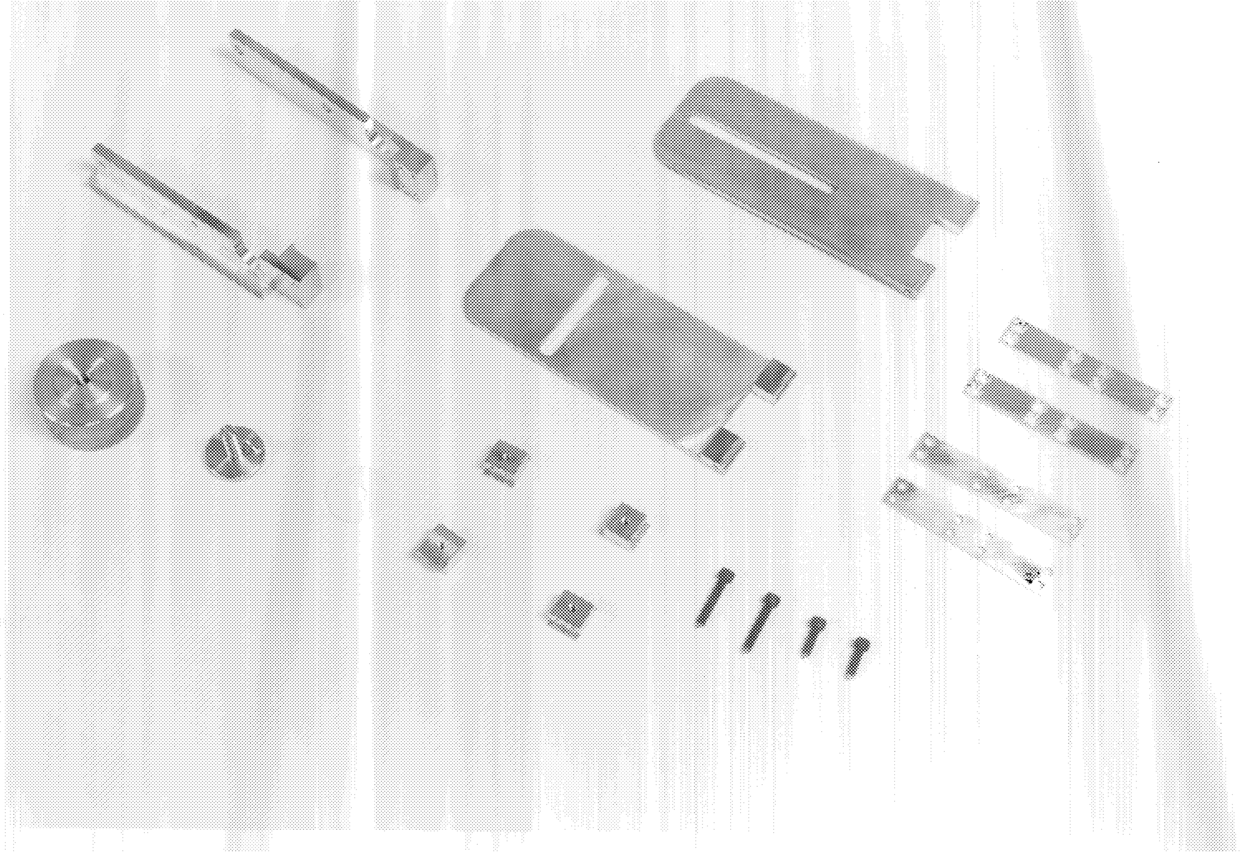

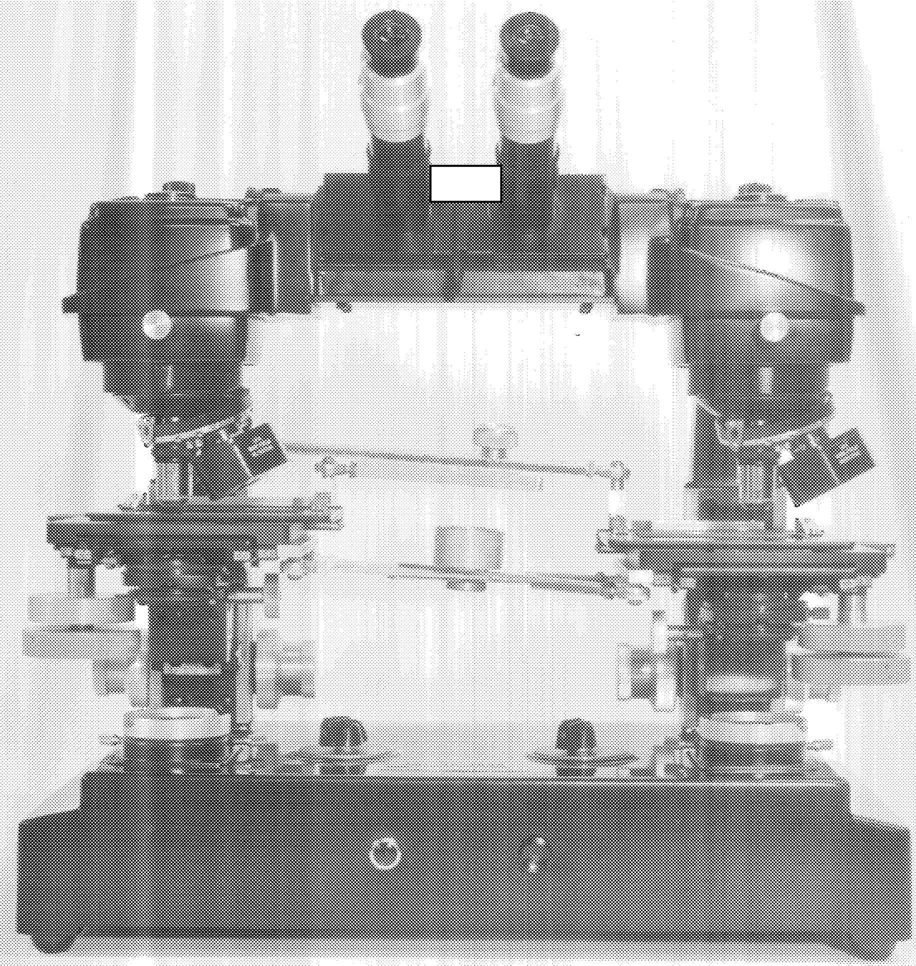

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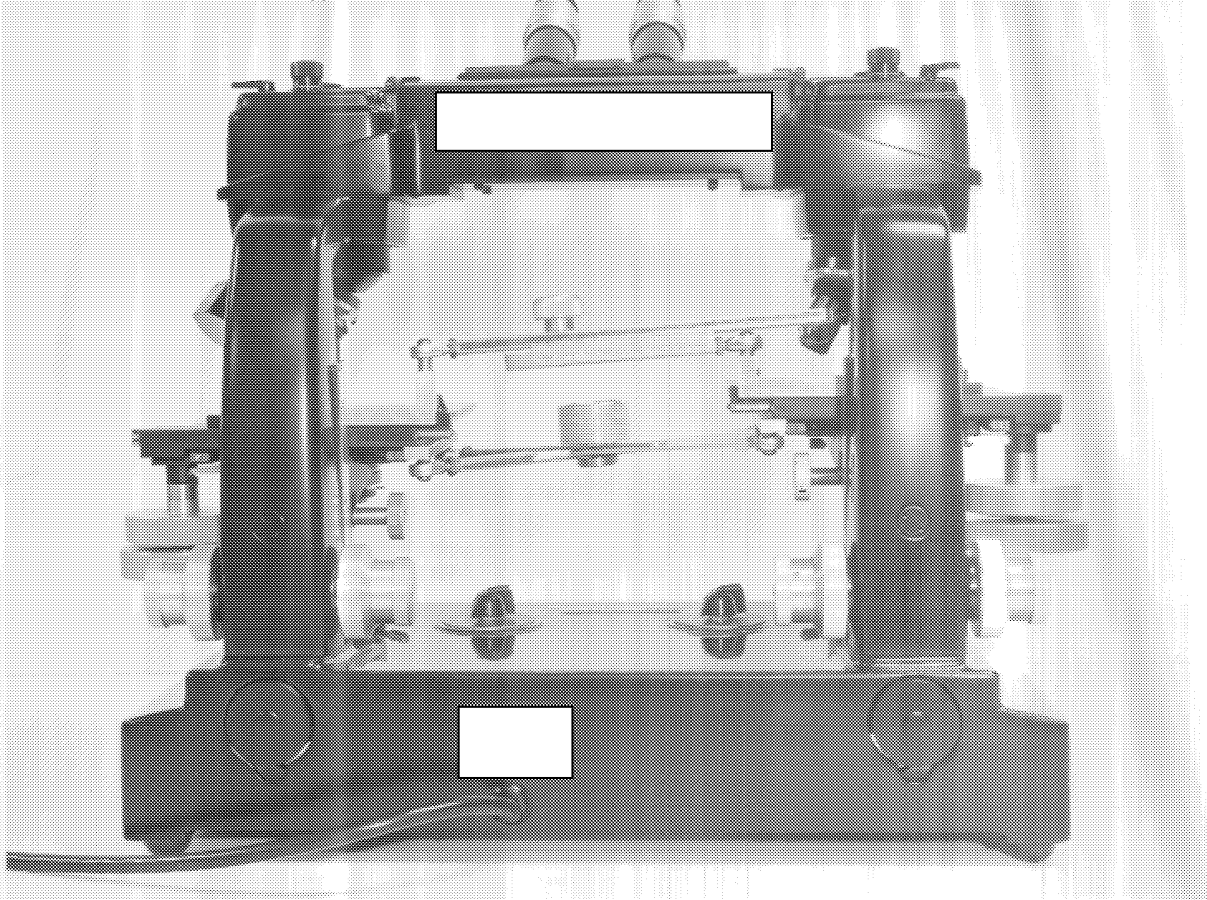

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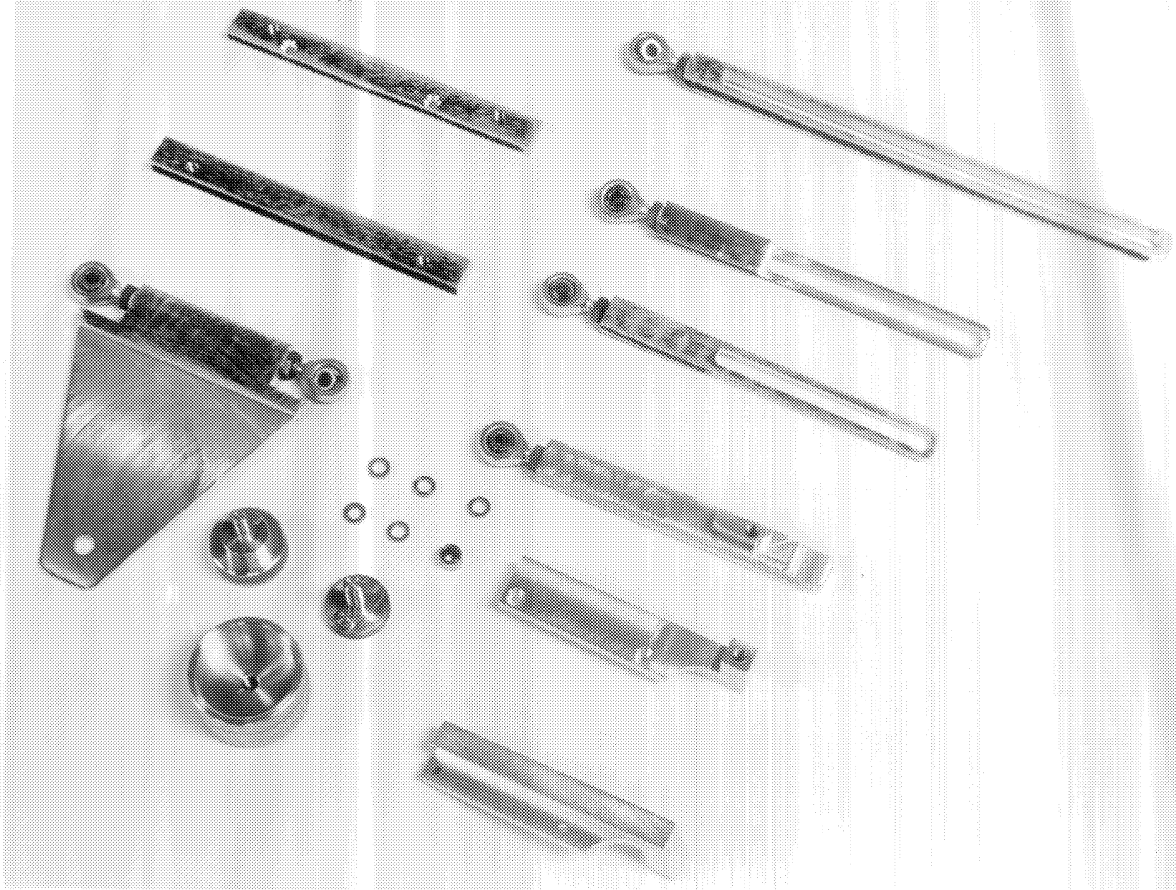

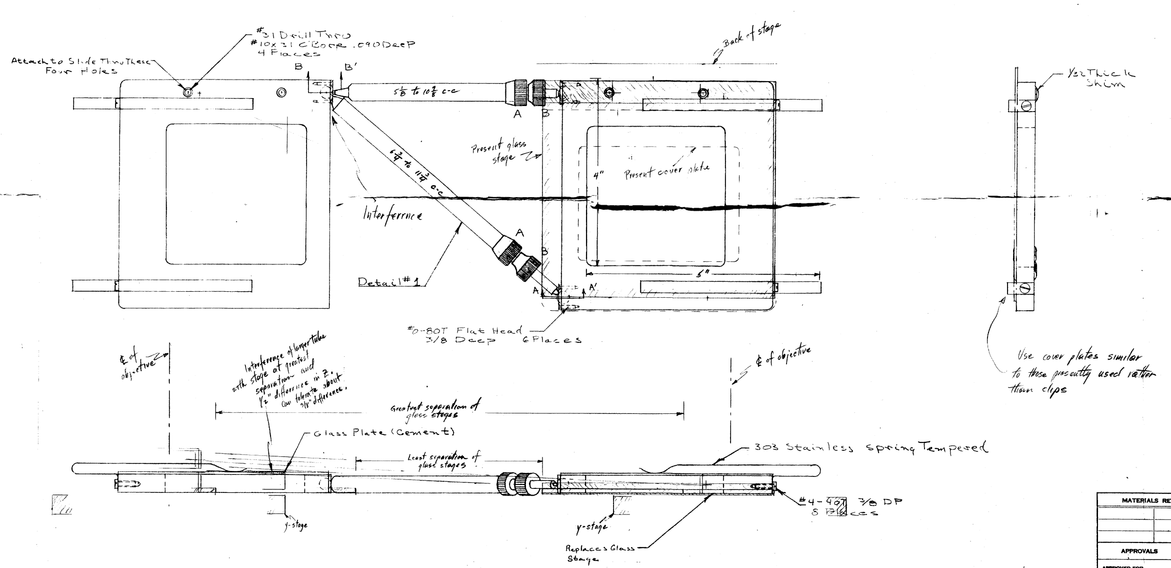

FIGURE V

CHANGES

MATERIALS REVIEW

DO NOT SCALE—WORK TO FIGURES
REPORT ERRORS—UNLESS OTHERWISE SPECIFIED TOLERANCES ARE AS NOTED

TYPE	FRAC.	DEC.	ANG.
MACHINED			
CAST-MOLDED			

THREADS—UNIFIED CL-2A OR 2B

APPROVALS	SECT. HEAD
APPROVED FOR PROTOTYPE MANUFACTURING	
APPROVED FOR PRE-AUTHORIZATION TOOLING AND PARTS	
AUTHORIZED FOR PRODUCTION	

ASS'Y SHOWN ON

COSMETIC QUALITY - GRADE D UNLESS OTHERWISE SPECIFIED

MATL.

FINISH

High Power Stero Viewer Attachment

Sheet 1 of 2

APRD.

DATE 11/27/67

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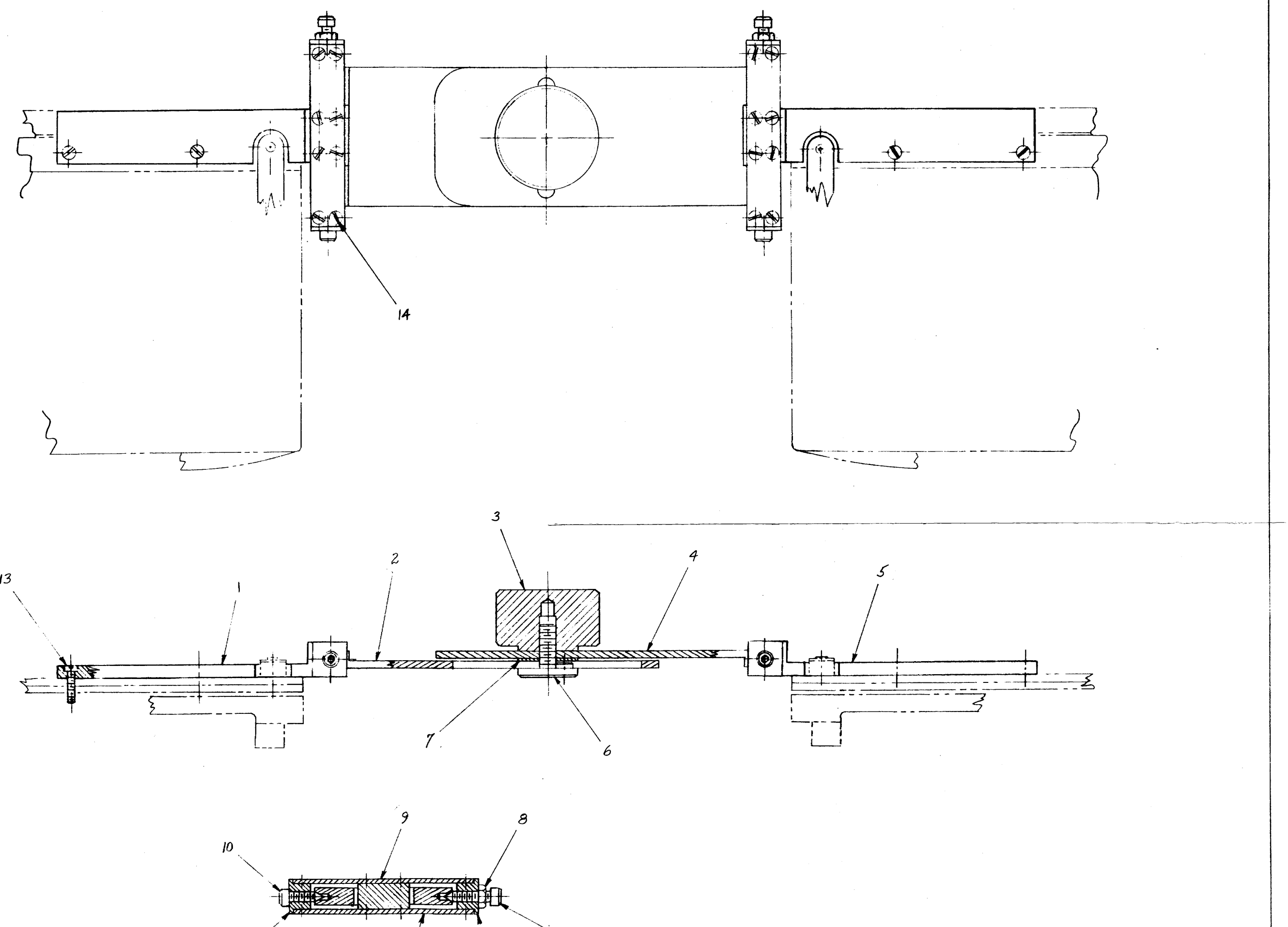
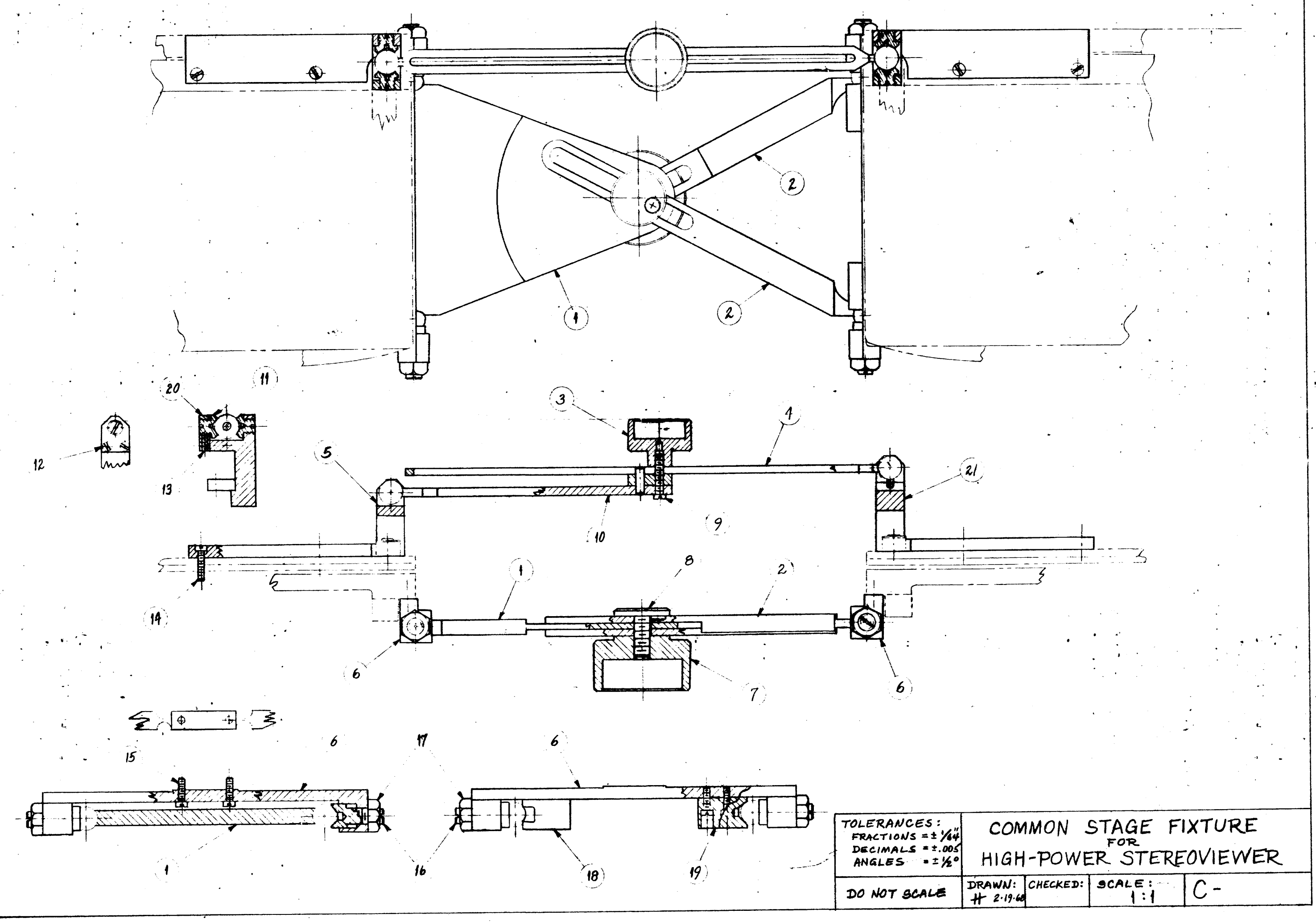


TOLERANCES: FRACTIONS = ± 1/64" DECIMALS = ±.005 ANGLES = ± 1/2°	COMMON STAGE FIXTURE FOR HIGH-POWER STEREOVIEWER		
DO NOT SCALE	DRAWN: # 7-2-68	CHECKED:	SCALE: 1:1



TOLERANCES: FRACTIONS = ± 1/64" DECIMALS = ±.005 ANGLES = ± 1/2°	COMMON STAGE FIXTURE FOR HIGH-POWER STEREOVIEWER		
DO NOT SCALE	DRAWN: 2.19.68	CHECKED:	SCALE: 1:1	C-

$$\sigma = \frac{3\theta e^{0.57}}{(2.11 \times 10^{-7})\, R^{0.57}} + \frac{P}{be}$$

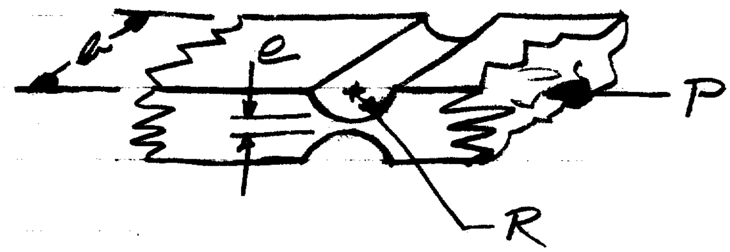
$\theta = \frac{1}{2}\,\frac{0.018}{2} = 0.0045$ rad.

$b = 3/16$ in

$e = 0.03$ in.

$P = 3$ lb.

$R = .125$ in



$$\sigma = \frac{3(4.5\times10^{-3})(3\times10^{-2})^{0.57}}{(2.11\times10^{-7})(1.25\times10^{-1})^{0.57}} + \frac{3(16)}{3(3\times10^{-2})}$$

$$= \frac{3(4.5)(1.87)(.0723)(10^{-3})}{2.11(1.126)(0.269)(10^{-7})} + 533$$

$$= \frac{13.5(1.87)(7.23)(10^{-5})}{2.11(1.126)(2.69)(10^{-8})} + 533$$

$= 29000$ psi

2024 T3 : $S_y = 50$ ksi

$$N = \frac{50}{29} = 1.73$$

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