HR-640

OPERATORS MANUAL

HR-640 INITIAL SET UP

It is recommended that the following procedure be used to set up the instrument before you attempt to use it.

1.) Inspect the exterior of the instrument for any noticeable defects. If any are found contact Instruments SA, Inc.

2.) Place the instrument on a firm table. The leveling legs should rest upon the foot pads provided. There are 5 (five) legs with 2 at the slit end of the instrument. These 2 plus the middle one at the other end should be used to set the instrument position. The other 2 legs are provided to keep the instrument from tipping if it should be bumped. The locking nuts can be engaged to maintain the adjusted position.

3.) Remove the enclosure and access covers by removing the pan head screws (15 total).

CAUTION: The optical surfaces of the mirrors are easily damaged. They must NEVER be touched with any object.

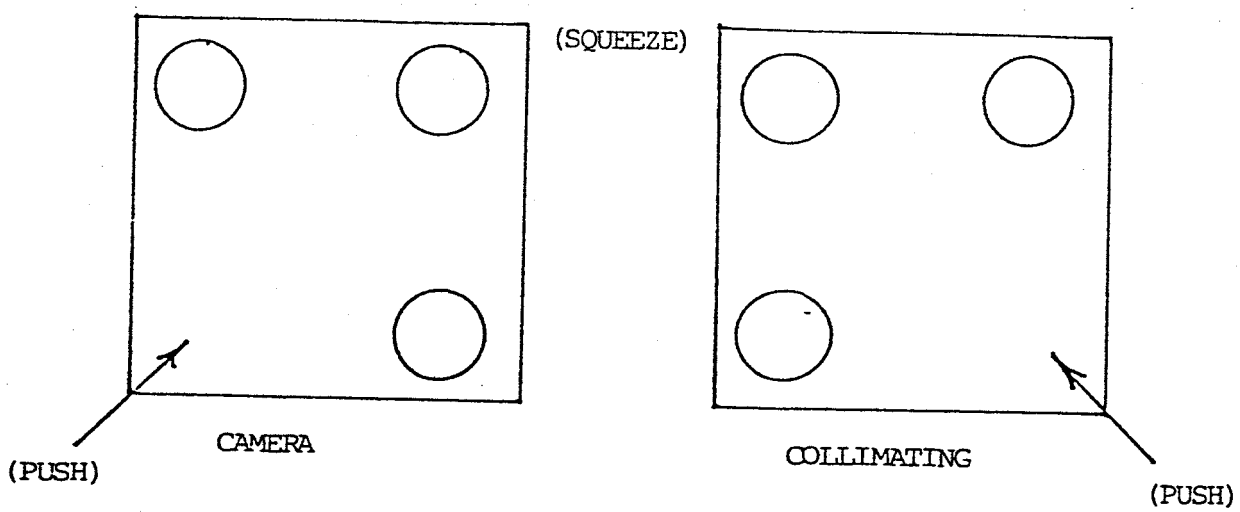
4.) The collimating and camera mirrors are held on spring tensioned mounts. They may need to be reset after shipping. The mirror mount assembly consists of a plate holding the mirror with the plate spring loaded on a large angle bracket which has 3 (three)

Thumb screws. The plate has 3 (three) pads which should be centered on the thumb screws. During shipping the plate may slip down.

To reset the plate position, gently push the mirror plate corner that doesn't have a pad in and up (see arrow on diagram) while gently squeezing (plate to bracket) the diagonal corner to pull the plate back to its centered position.

Reset both mirrors.

REAR VIEW OF MIRROR MOUNTS



5.) Before the grating can be installed or the controller cable can be connected, the restraining bolt must be removed. While holding the grating platform, carefully remove the bolt (the head is painted red). Allow the platform to rotate slowly and gently restore contact between the sine arm and sine bar.

6.) Grating Installation (Refer to the drawing): Remove the grating assembly from its storing/shipping container; DO NOT REMOVE THE GRATING COVER MASK. Place the grating assembly on the platform

so the 3 (three) points of the mount align on top of the 3 (three) pads on the platform. Gently tighten the captive screw until the entire assembly just starts to rotate.

- Proper positioning of the grating assembly can be assured by gently rocking the assembly. Place a finger on the top-back of the holder and push gently towards the main mirrors. The mount should lift up off the back of the platform and tip slightly. Gently relaxing the pressure will restore contact with the platform. If any resistance or binding of the captive screw is observed, loosen and retighten the captive screw as stated above.

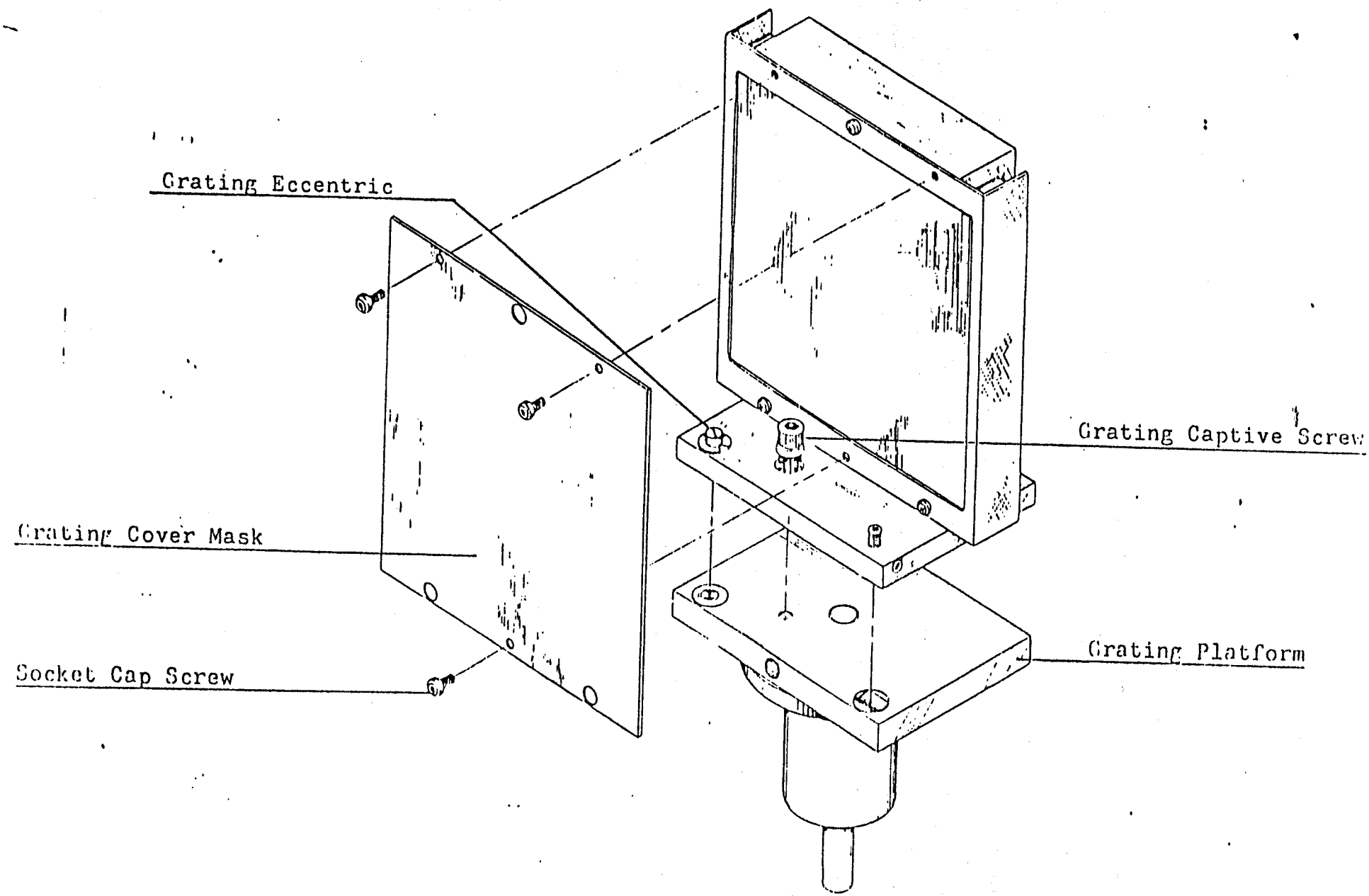
CAUTION: THE OPTICAL SURFACE OF THE GRATING IS EASILY DAMAGED. IT MUST NEVER BE TOUCHED WITH ANY OBJECT.

- Remove the grating cover mask by removing ONLY the 3 (three) socket cap screws. When removing the grating from the instrument, always reinstall the grating cover mask first to prevent its surface from being damaged. Always store the gratings safely with the cover mask in place and in its container.

7.) Replace the enclosure and access covers and tighten all screws.

8.) Remove the tape and caps from the slit assemblies.

9.) Refer to the Controller Instruction Manual before connecting the cable to the HR-640. Various sections of the HR-640 Instruction Manual should be consulted for more details on its operation.


Grating Eccentric
Grating Captive Screw
Grating Cover Mask
Grating Platform
Socket Cap Screw

HR-640 SPECTROGRAPH MONOCHROMATOR OPERATIONS MANUAL

I. Introduction:

1.1 The HR-640 Spectrograph/Monochromator is an instrument which is specifically designed to be operated in the following modes:

-Spectrograph for use with a vidicon or any solid state detector;
-Spectrograph for use with a Polaroid Camera Back;
-Scanning monochromator with PMT detectors;

1.2 Unpacking and Shipping -

The HR-640 is shipped in cartons specifically designed to reduce the possibility of damage in transit. If the carton is damaged or after unpacking, any signs of damage become apparent, a claim should be filled with the carrier immediately.

It is recommended that the carton and packing materials be saved for future storing or shipping of the instrument. If the instrument must be returned, contact Instruments SA, Inc. for prior approval. When returning the instrument to the factory, give a full description of the reason for return. If a malfunction is involved, try to describe the difficulty clearly and concisely. When shipping the instrument, repackage in the original carton, or make sure that enough padding material surrounds the instrument to prevent damage during shipment.

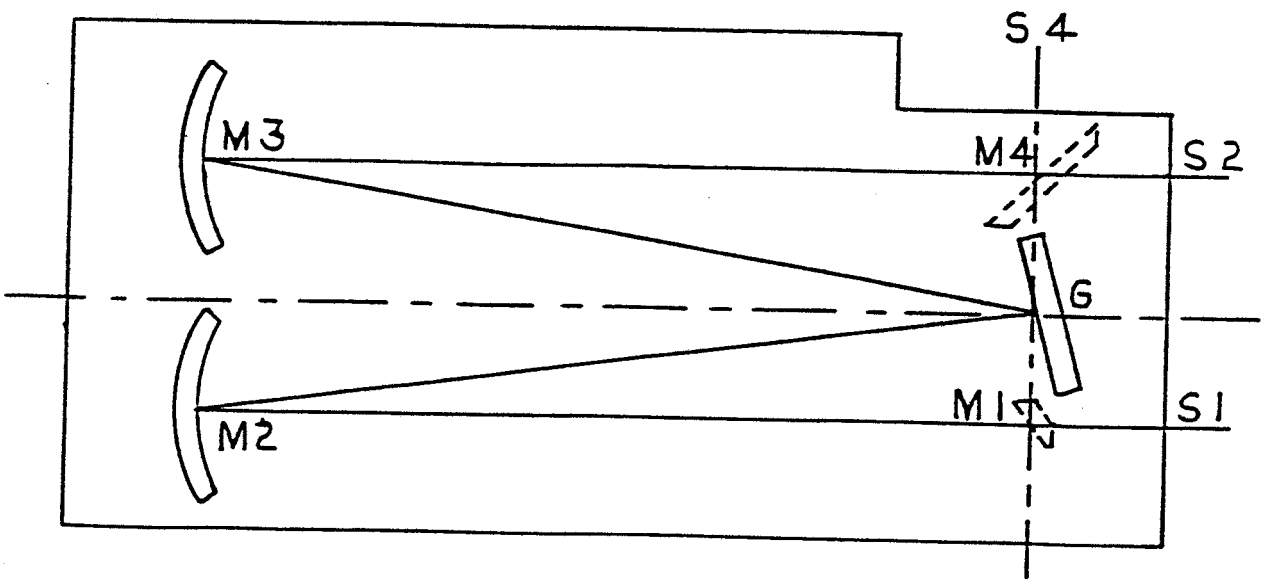
Upon receipt of approval for return, ship via UPS or other carrier PREPAID to the Instruments SA, Inc. Factory (see cover for address).

1.3 Instrument Identification -

Check the identification numbers on the grating and verify that the groove density matches that which is ordered.
Contact Instruments SA, Inc. immediated if these numbers are not the same.

2. General:

2.1 Optical Diagram -



The light beam enters through the entrance slit S_1 or S_3. The beam is then reflected by the collimator mirror M_2 which renders it parallel and directs it to grating G. The grating diffracts the light and sends a collimated spectrum to M_3 which focusses the image of the entrance slit at S_2 or as a spectrum at S_4. Wavelength scanning at the exit slit plane is accomplished by rotation of the grating.

2.2 Resolution -

Resolution can be expressed in two forms:

-the width of the narrowest bandpass $\Delta\lambda$ that can be isolated at wavelength λ.
-the resolving power - $R = \frac{\lambda}{\Delta\lambda}$

2.3 Diffraction -

Theoretical resolving power of a grating is:

$Ro = kN$ Where k = order of diffraction
N = number of grooves engraved on the total area of the grating

It is assumed that the true resolving power R of a grating is one half the theoretical resolving power Ro:

$$R = \frac{k}{2}N$$

Examples:

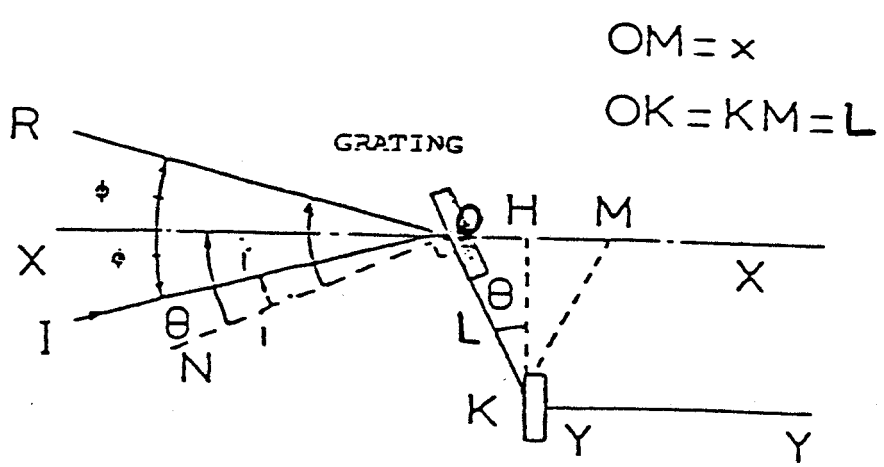
-A grating 110mm in width with 1200g/mm, working in the first order has a practical resolving power:

$$R = \frac{1}{2} 110\text{mm} \times 1200 = 66{,}000$$

-A grating 110mm in width with 600g/mm, working in the first order, has a practical resolving power:

$$R = \frac{1}{2} 110\text{mm} \times 600 = 33{,}000$$

3. Sine Law - Wavelength Movement:



The grating diffracts the light in accordance with the sine law -

$$\sin \alpha + \sin \beta = \underline{N}k\lambda$$

Where α : angle of incidence
β : angle of diffraction
N : grating spacing
K : order
λ : diffracted wavelength

If 2 ϕ is the angle between the incident wave and the diffracted wave

If θ is the angle between the axis of symmetry X'X of the unit and the line perpendicular to the grating, formula (1) can be written:

$$\lambda \frac{2N}{\lambda} \cos \phi - \sin \theta$$

Assuming, now, two equal lengths OK and KM such that -

0 on the rotational axis of the grating
OK be parallel to the grating plane
M moves along the monochromator axis of Symmetry X'X

If X the abscissa of M relative to 0,
it can be seen that

$$\sin 0 = \frac{X}{2L}$$

hense $$\lambda = \frac{1}{k} \frac{N}{L} \cos \phi . X$$

Mechanically, Point K rests on a plane which moves along the Y'Y parallel to X'X

A constant coefficient of proportionality exists between X and Y.

Practically speaking, for a 1200g/mm grating working in the first order, the following equation is obtained:

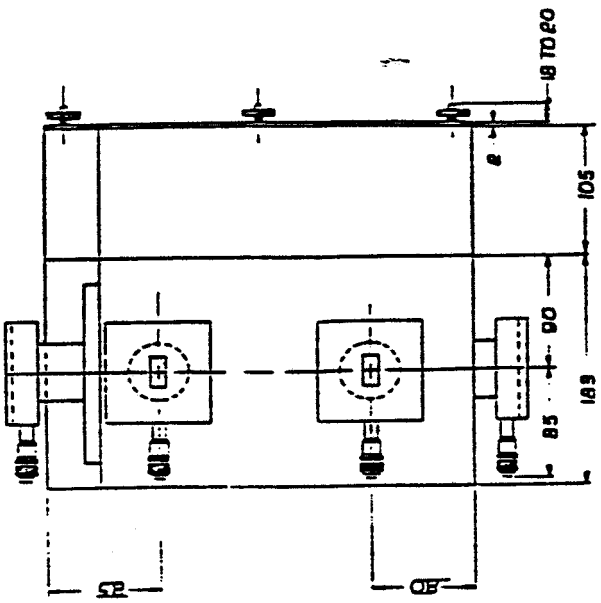
$$\text{Å} = 200.y_{mm}$$

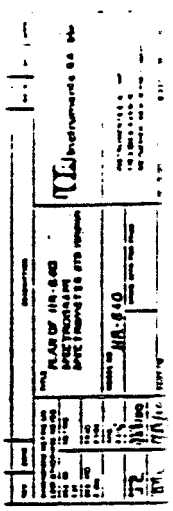
Therefore, it suffices to know the value of y to identify the wavelenc
A linear variation of y results in a linear variation of the wavelength.

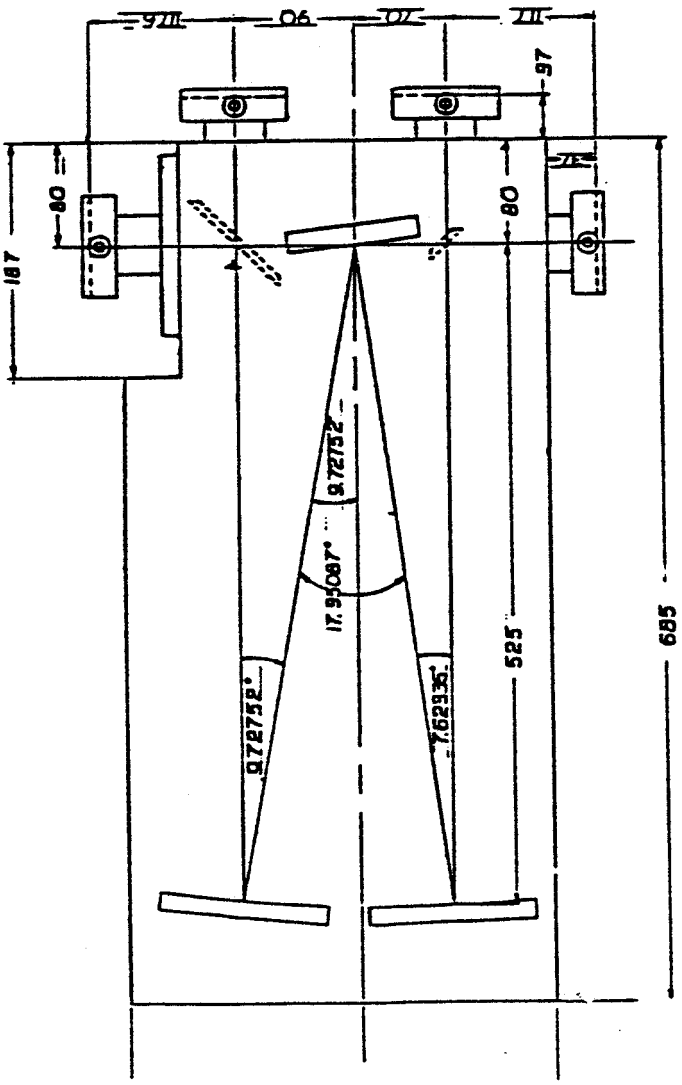
4. Specifications:

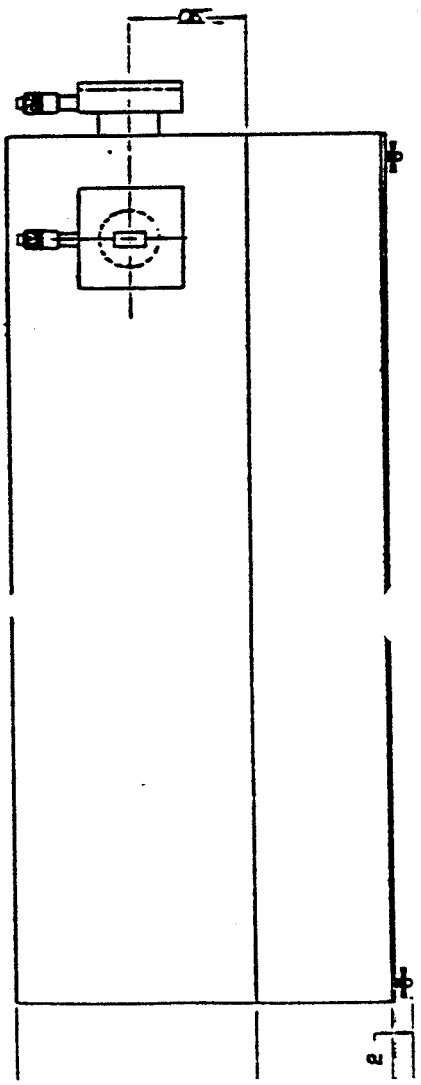
Focal Length	0.64 meter coma corrected Czerny-Turner configuration
Aperture	F/5.2 or F/7.5 depending upon the grating size
Gratings	110 x 110mm Kinematically mounted 76 x 76mm Kinematically mounted
Dispersion	12 Å/mm w/a 1200g/mm holographic grating. Other holographic and ruled gratings are available in densities from 30-3600 g/mm.
Spectral Range	0 - 1.5 micron with 1200g/mm grating and out to 60 micron with a 30 g/mm grating.
Resolution	0.20 Å with 76 x 76 mm, 1200 g/mm grating at 3131 Å
Stray Light Rejection	10^{-5} at 10Å from 6328 Å laser line.
Wavelength Display	Reads to 0.1 Å direct with a 1200 g/mm grating
Scanning Speeds	1 to 1200 Å/min with a 1200 g/mm grati
Slit Dimensions	Variable = continuously adjustable fro 2mm (w) x 20mm (h)
Lateral entrance or exit	Optional
Nitrogen Purge	Optional
Size	Length = 722mm Width = 300mm Height = 290mm

5. Dimension Drawing:

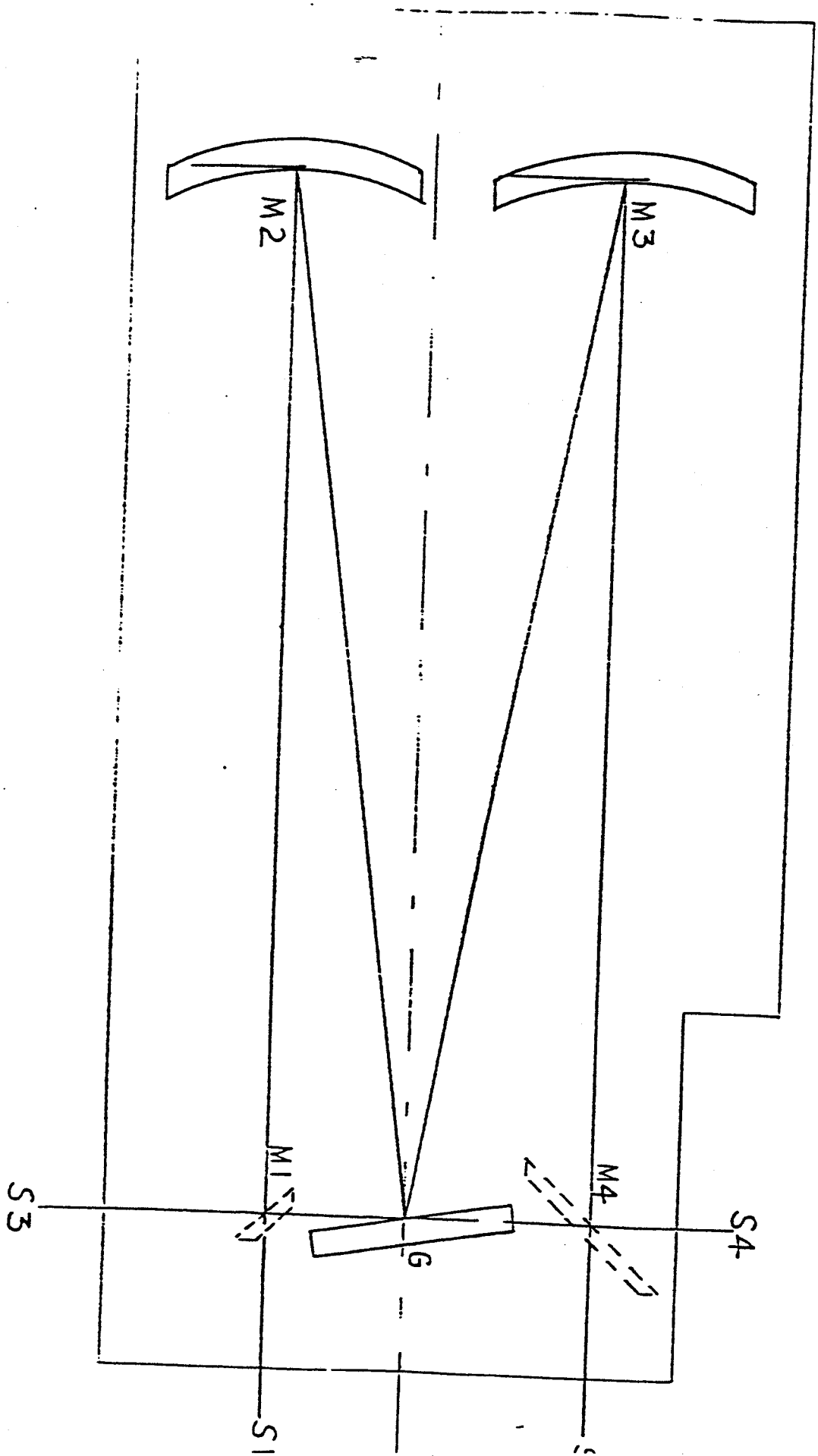








6. Standard Optical Configuration:



6. OPERATION:

6.1 Check Out -

It is recommended that the following procedures be followed to check out the monochromator before you attempt to use it.

A. Inspect the exterior of the monochromator for any noticeable defects. If any are present, contact Instruments SA, Inc.
B. Remove the flat access cover and the enclosure cover by removing the screws. Carefully remove the restraining bolt from the grating platform while holding the platform. Allow the platform to return gently to a rest position since it is spring loaded. Only after this has been done can the grating be installed.
C. Remove the tape from the slit spindles. Remove the end caps from the slit faces.
D. Remove the two small clamps on the collimating and camera mirrors. (None)

CAUTION: The optical surfaces of the mirrors are easily damaged. They must never be touched with any objects.

6.2 Slits -

The variable slit assembly consists of a slit housing which fits directly into a slit support bracket. The slit housing is comprised of many delicate precision machined components which includes the slit blades. Great care should be used when operating slits as to maintain optimum performance.

The slits open from 0-2mm in width by a micrometer spindle adjustment. Each small division on the micrometer spindle corresponds to a 2.5 micron movement of the slit blades.

The micrometer spindle should rotate freely and the slit blades should open and close smoothly and evenly. If the slits do not operate properly, contact Instruments SA, Inc. immediately.

The slit height adjusts from 0-20mm via a slide located on the outside of the slit housing. Each small division on the slit slide equals 1mm.

The fixed slit assembly is not adjustable but preset at the factory when the instrument is aligned.

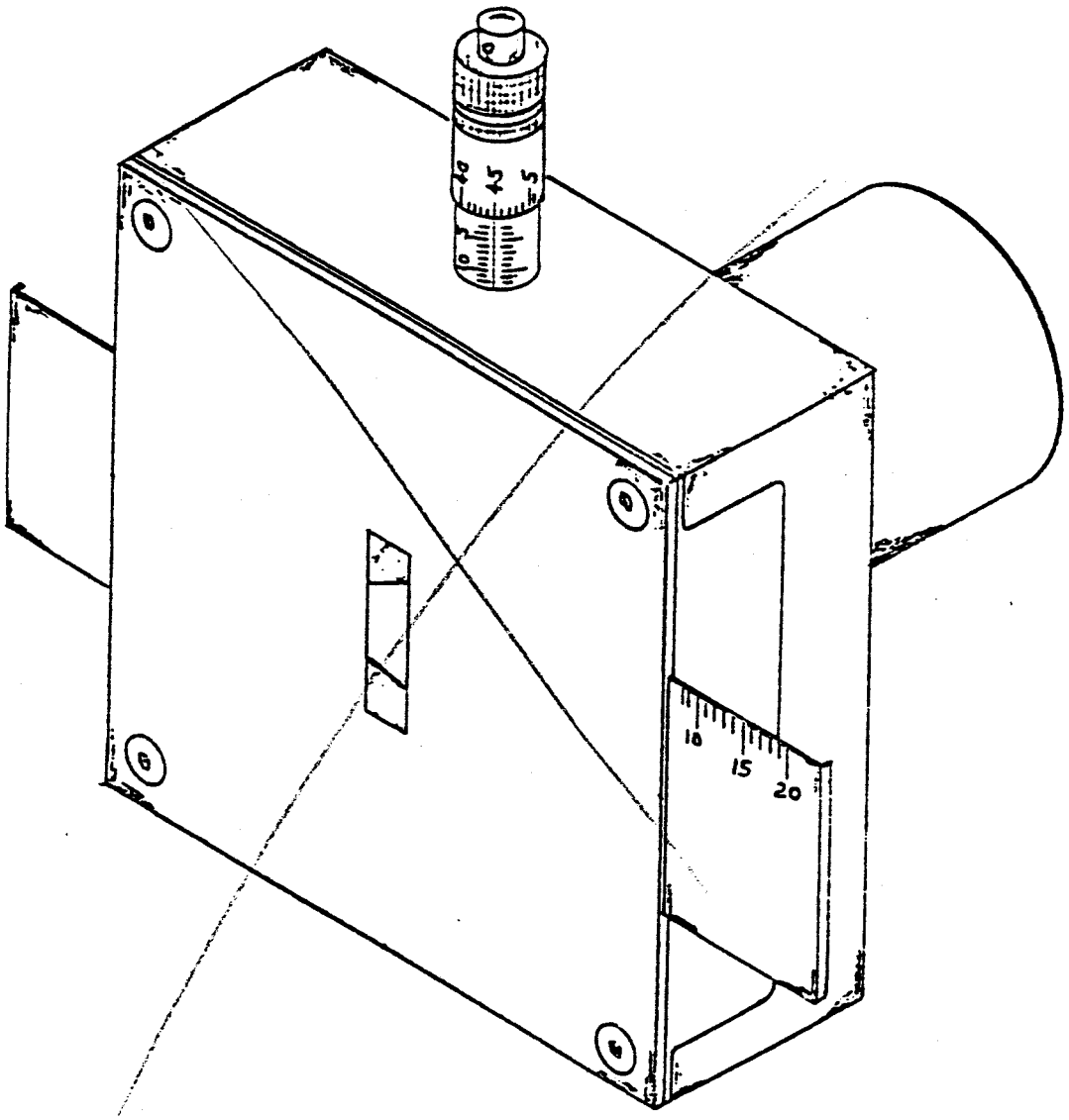


FIGURE 1

ENTRANCE SLIT

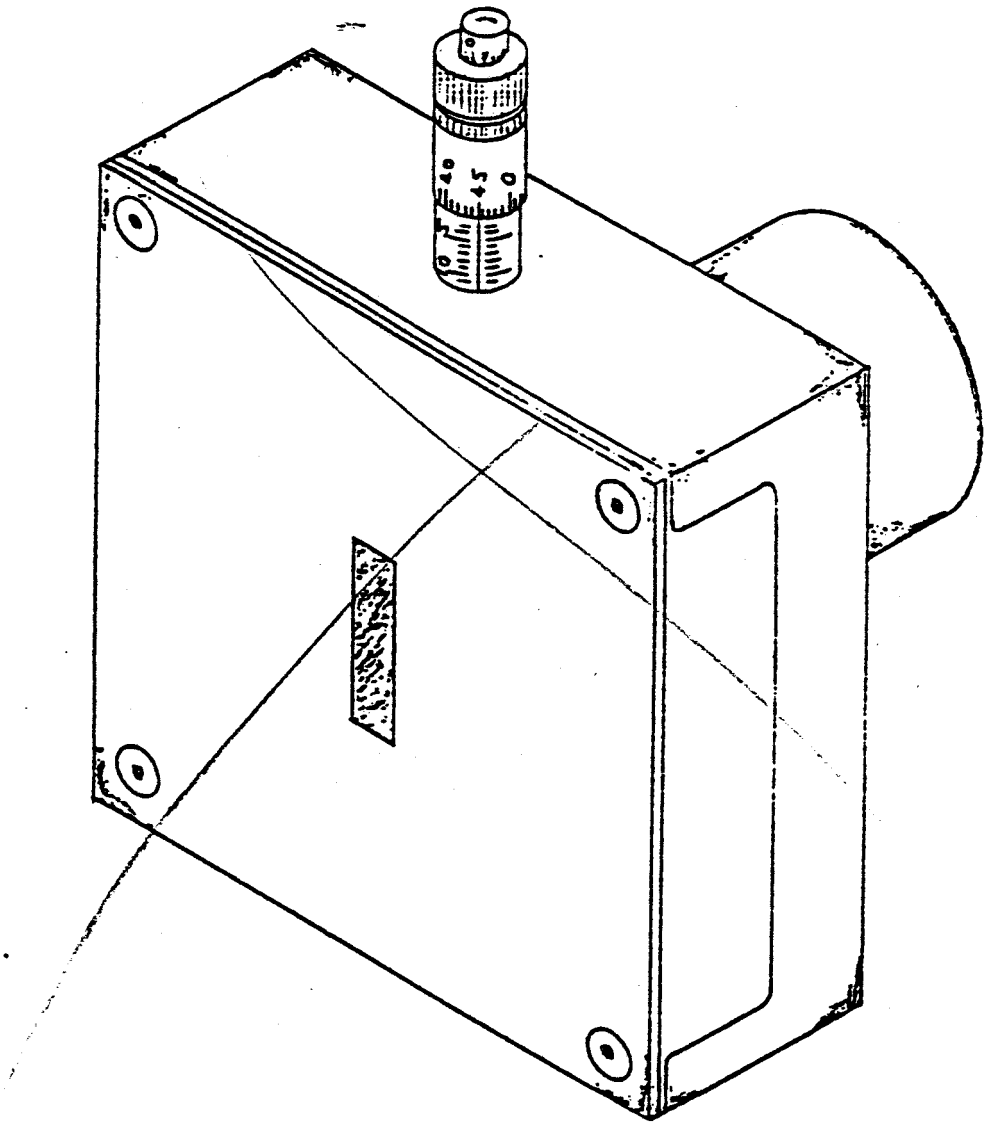


FIGURE 2

EXIT SLIT

6.3 Counter -

The counter is driven by the scanning motor. It is direct reading in angstroms with the smallest increment equal to 0.1 Å. The HR-640 is calibrated and reads direct for a 1200g/mm grating. For other gratings the conversion for wavelength is inversly proportional to the groove density. The following is a conversion table:

Groove density	x factor	Smallest Increment (Å)
2400	0.5	0.05
1800	0.67	0.067
1200	1	0.1
600	2	0.2
300	4	0.4

6.4 Grating Installation and Change -

The HR-640 can accept both ruled and holographic gratings. These gratings are easily interchangeable as they are kinematically mounted in the instrument. All the gratings are prealigned in their mounts prior to installation.(Fig.3)

The gratings are shipped in their own case which identifies the grating number, groove density and serial number of the monochromator.

a) Installation of Grating:
- .remove access cover on the HR-640 by removing 8 binding head screws;
- .remove grating assembly from its shipping container
- .place grating mount on platform inside unit
- .tighten captive screw gently until grating assembly just starts to rotate
- .remove grating cover mask by removing (3) socket cap screw as shown in figure
- .take great care not to touch the grating surface with any object
- .replace access cover and secure

b) Grating Removal:
- .repeat above steps in reverse

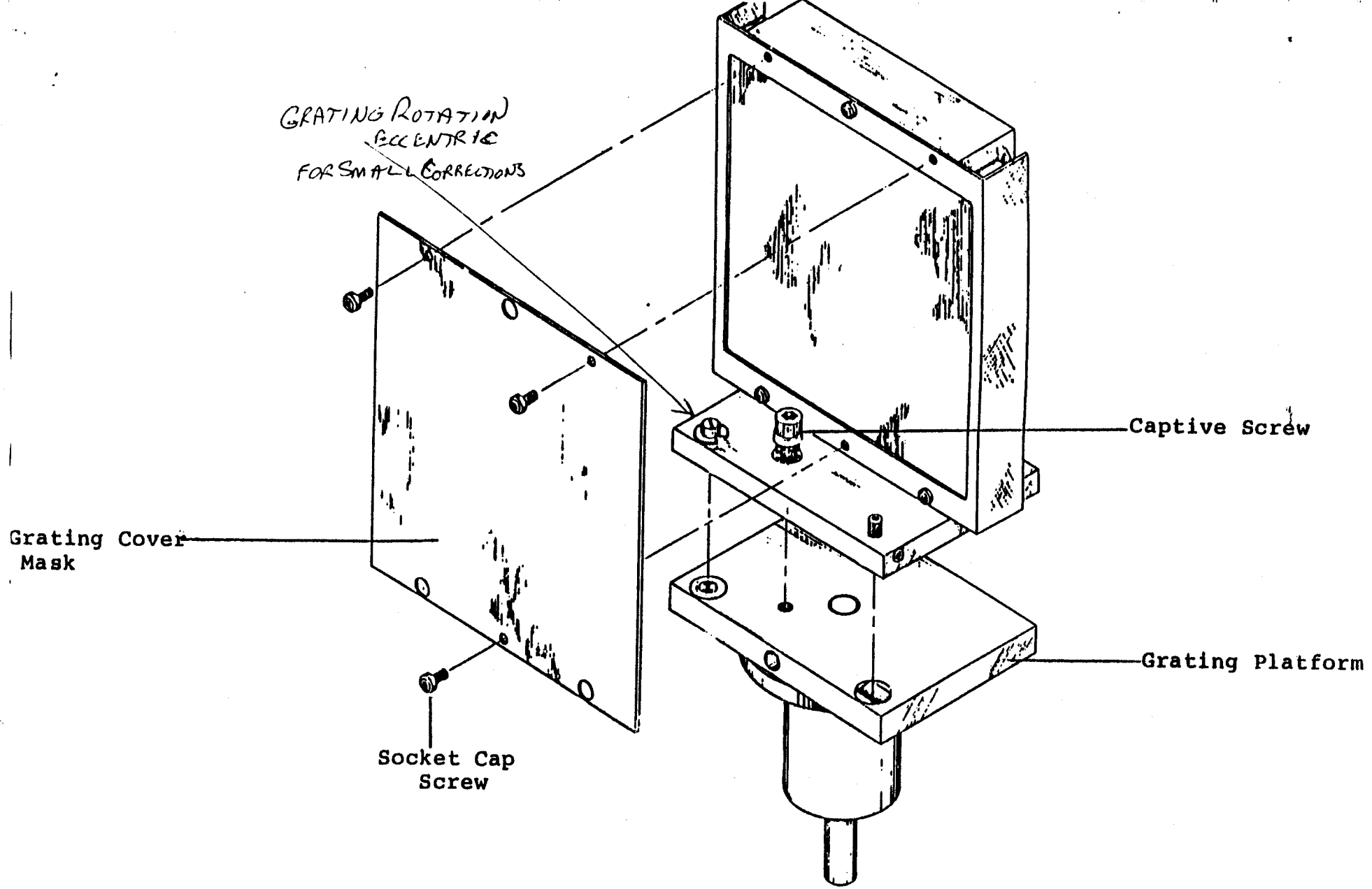


FIGURE 3

HR-640 GRATING

6.5 Lateral entrance and exit mirrors -

The HR-640 can be equipped with lateral entrance or lateral exit ports. The lateral ports require an electronically operated plane mirror which is mounted in the monochromator (fig. 4)

The mirror is mounted on a platform and a guide shaft. It is moved into position by a motor which moves in the vertical plane to locate the desired entrance or exit. During calibration, the mirror is positioned through a laser alignment.

For the axial entrance or exit use of the instrument, make sure the switch located near the counter is in the down position. The green L.E.D. light shows the mirror is down and out of the optical path (fig. 5).

For the lateral entrance or exit, the switch is in its up position. The red L.E.D. light indicates that the mirror is up in the optical path (fig. 5).

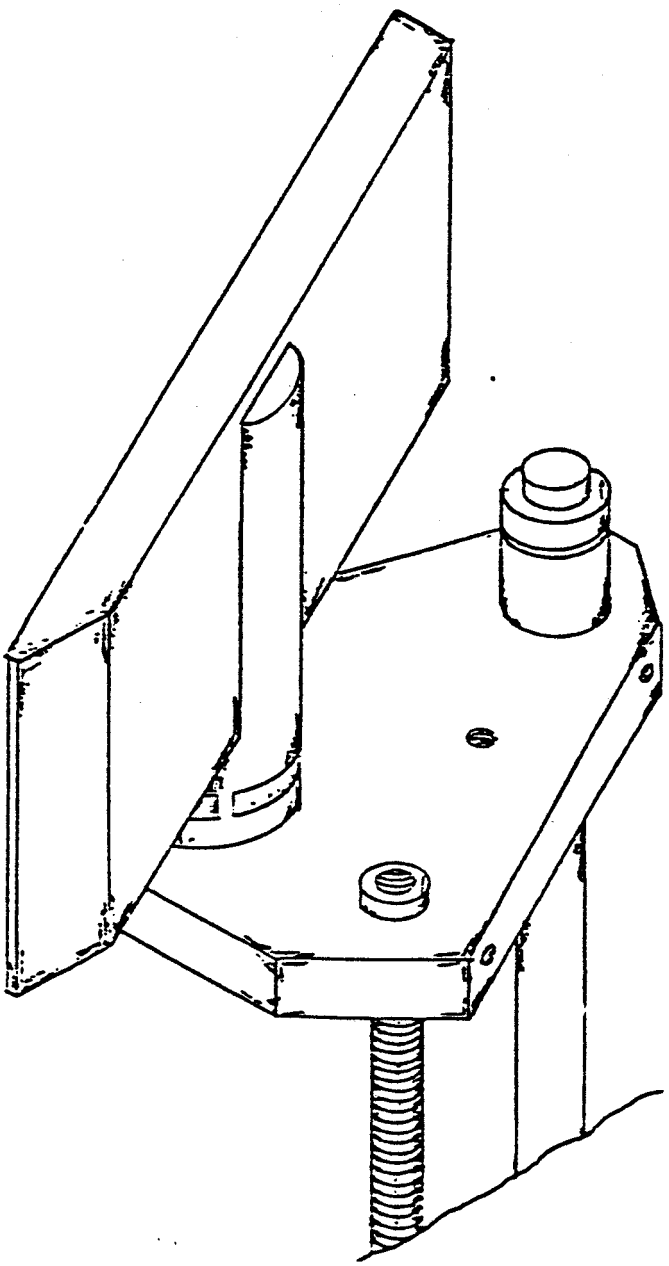


FIGURE 4

Electronically Controll
Lateral Entrance or Exi
Mirror

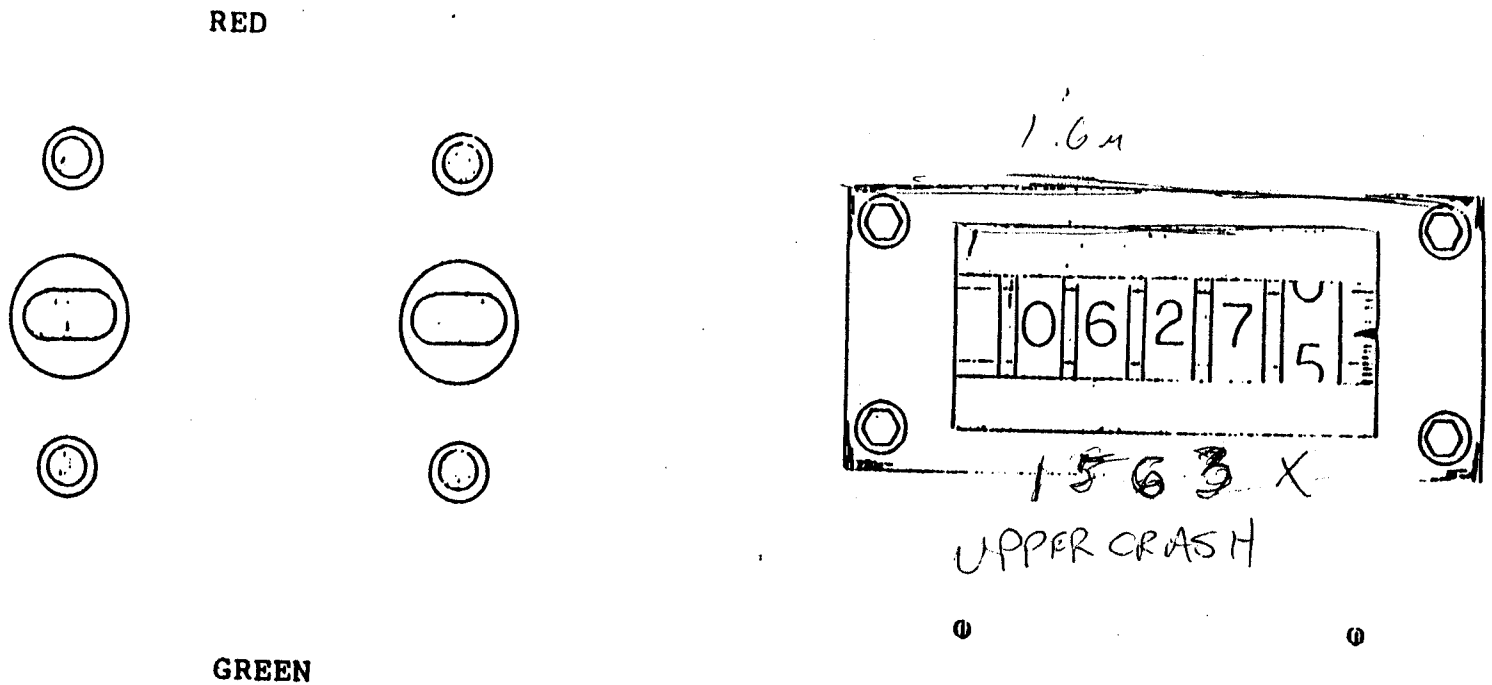


FIGURE 5

COUNTER AND LATERAL MIRROR SWITCHES

6.6 Scanning Mode to Spectrograph Mode -

The HR-640 can be used as a scanning monochromator or as a spectrograph. Switching from one mode to the other is easily performed.

When the HR-640 is used in the single channel mode, with PMT's, silicon photo cells, etc., a slit housing is used. The slit housings may be located in the axial or lateral positions.

CAUTION: Do not remove or move the slit housing as the slit alignment will be lost.

A PMT housing is secured to the HR-640 via the PMT mounting plate and spacer block (fig. 6).

The lateral exit position is used for multichannel detection. This exit can accept uncooled or cooled vidicons, linear arrays, or a camera back.

The cooled vidicon housing mates directly to the lateral exit plate via (4) bolt locations (fig.7).

The uncooled detectors, vidicons, arrays, mate to the lateral exit port via a multichannel adaptor (fig. 8&9).

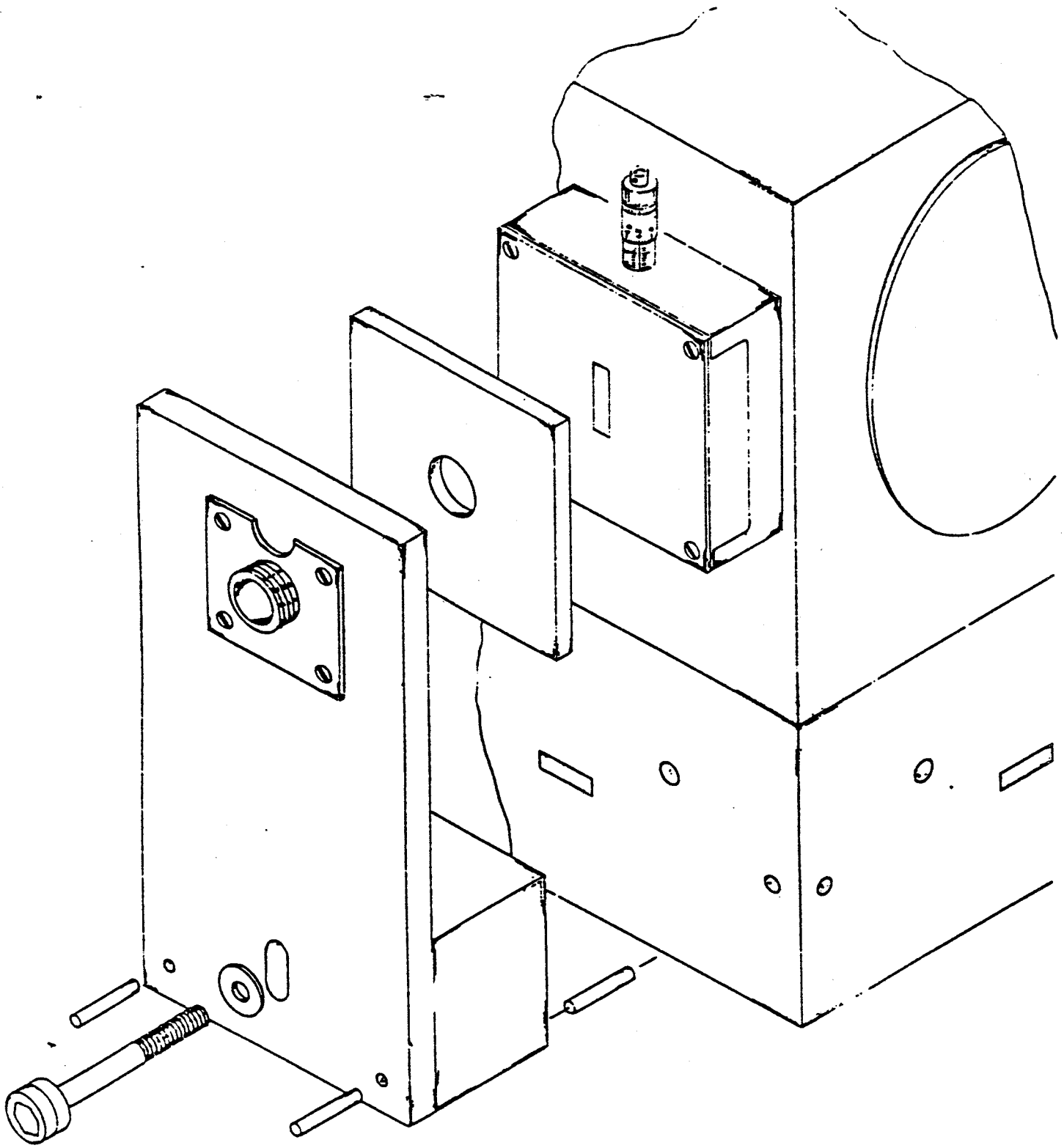


FIGURE 6

PMT Housing Plate and
Spacer Block

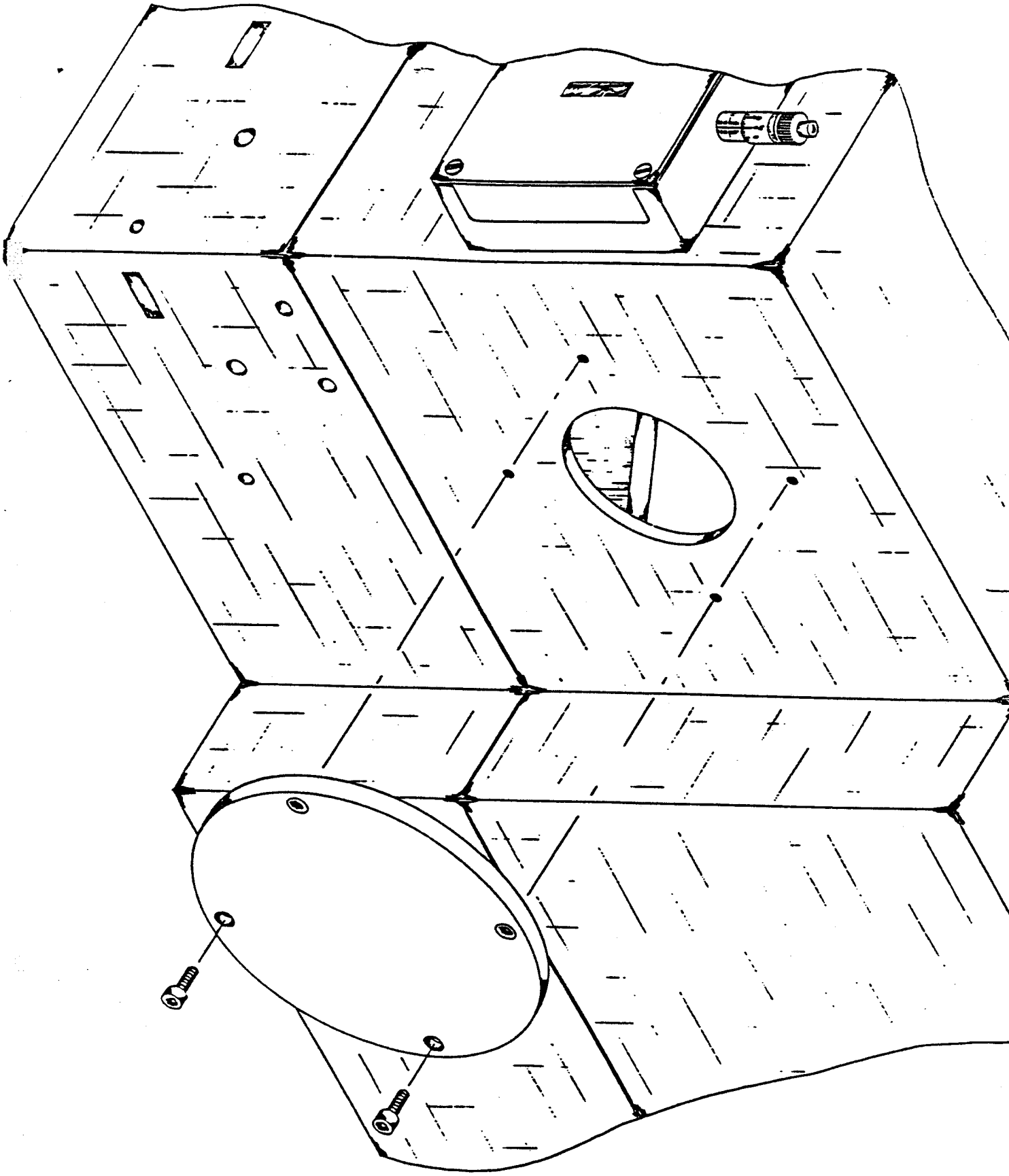


Figure 7

6.7 Collimating Mirror Reducing Aperature Mask -

For use in Spectrograph mode (figure 10), with 110x110mm grating only. A reducing aperture mask may be installed on the collimating mirror by using 3M3 socket cap screws after removing access cover. Great care should be used to avoid touching the mirror surface.

6.8 General -

Performance studies have shown that when a light source is used with the HR-640, optimum throughput, resolution and stray light rejection is achieved when the source image is focused at the entrance slit. In addition, the optics used to focus the light source should match the aperture of the HR-640 (F/5.2, F/7.5).

6.9 Nitrogen Purge Option -

Remove set screw and install fitting as shown in figure 10a.

7. Maintenance:

7.1 General -

An HR-640 does not require any regular maintenance under normal conditions, and may never require service. Do not hesitate to call or write Instruments SA, Inc. if anything seems to be wrong with your HR-640. Describe all symptoms specifically. Do Not attempt to correct any problem during the warranty period without factory authorization, as the warranty will be void.

Caution: The optical surfaces of the grating and mirrors are easily damaged. They may never be touched with any objects. The optical surfaces of the HR-640 are carefully inspected before shipment, damages to the surfaces will not be covered under warranty.

7.2 Removing the Top Cover -

When changing gratings, it will be necessary to remove the top cover.

This cover is secured by screws. Loosen screws and remove cover.

7.3 Alignment -

Complete alignment of the HR-640 is a very tedious and delicate procedure. We recommend that you do not attempt to align the HR-640.

If periodic alignments are necessary, please contact our service department and ask about our extended service contracts.

If you have any questions concerning the alignment procedure, please contact the HR-640 Product Manager at the ISA facility.

8. WARRANTY

Instruments S.A., Inc. warrants each instrument of its own manufacture to be free from defects in material and workmanship for a period of one year. Obligations under this warranty shall be limited to repair of replacement at our option, of any instrument returned, shipment prepaid, to our factory for that purpose within one (1) year of delivery to the original purchaser, provided prior authorization for such return has been given by an authorized representative of Instruments S.A., Inc.

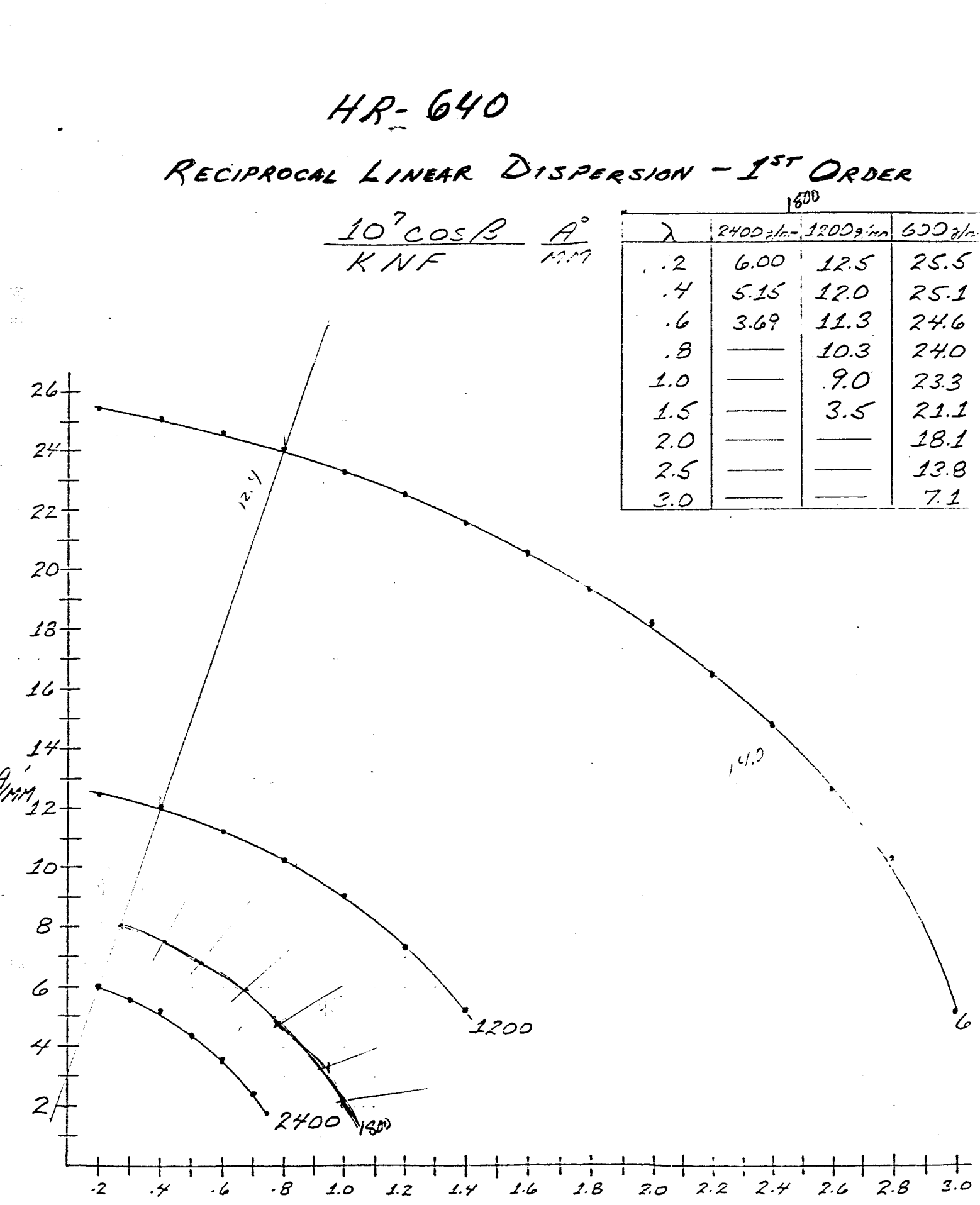
The warranty does not apply if damage to the instrument has been caused by neglect, operation in an adverse environment, or normal wear and tear.

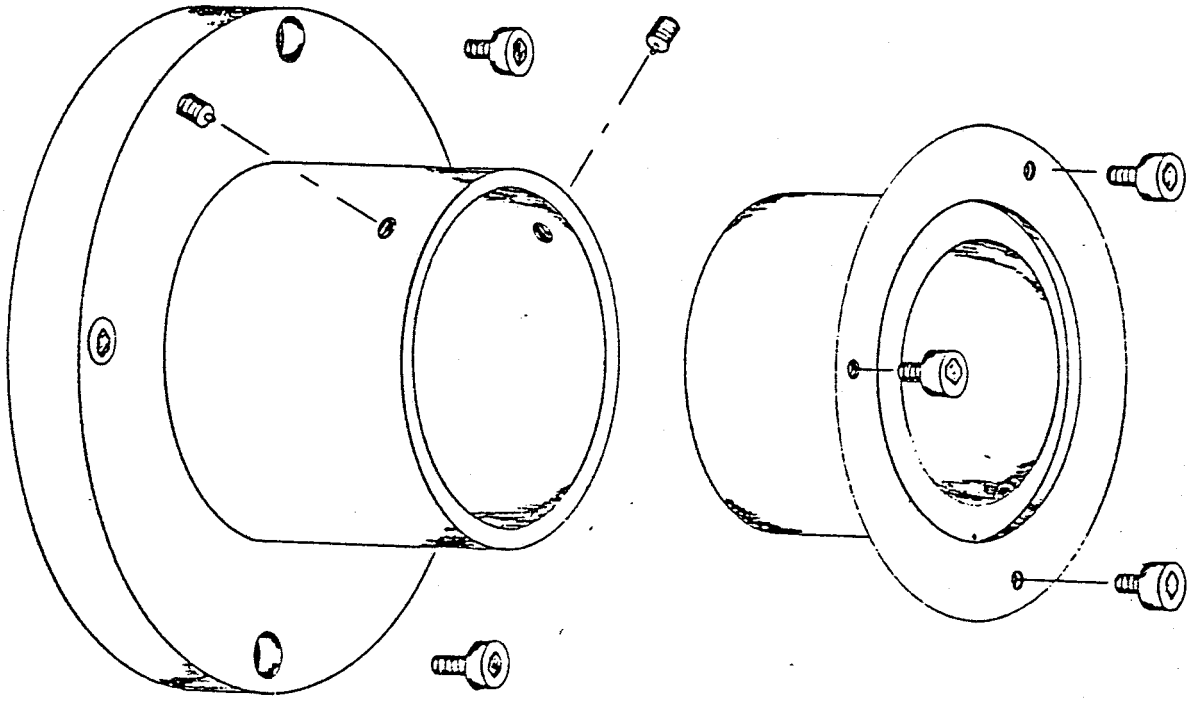
HR-640

Reciprocal Linear Dispersion – 1st Order

$$\frac{10^7 \cos\beta}{KNF} \quad \frac{A^\circ}{MM}$$

λ	2400 g/mm	1200 g/mm	600 g/mm
.2	6.00	12.5	25.5
.4	5.15	12.0	25.1
.6	3.69	11.3	24.6
.8	——	10.3	24.0
1.0	——	9.0	23.3
1.5	——	3.5	21.1
2.0	——	——	18.1
2.5	——	——	13.8
3.0	——	——	7.1



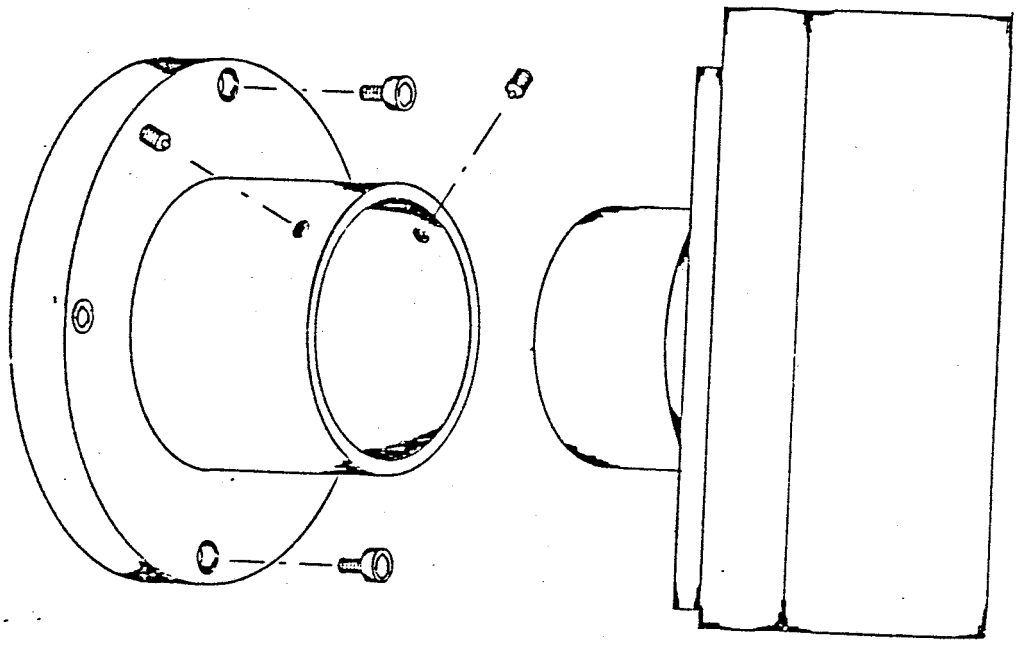


Array Adaptor Plate

Uncooled Array Adaptor

FIGURE 8

Uncooled Array Adaptor

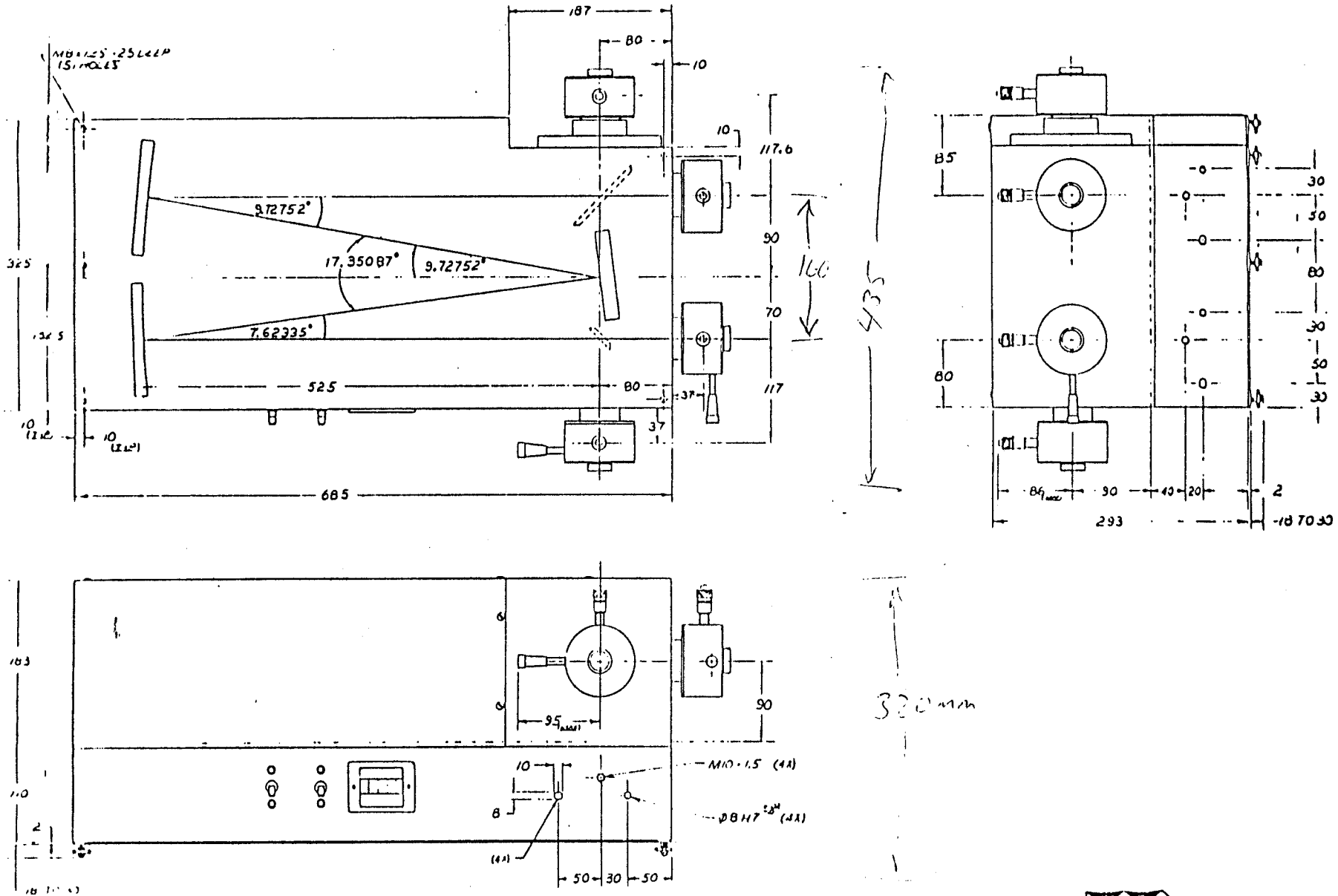


Camera Back Adaptor

Camera Back

FIGURE 9

Camera Back Plus Adaptor



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HR 640 LAYOUT