INSTRUCTION MANUAL

CASSEGRAIN SPECTROGRAPH

For

OBSERVATORIO ASTRONOMICO DI BRERA

JOB 59007

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Prepared by

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PREFACE

This instruction manual is for the Cassegrain Spectrograph manufactured by Boller & Chivens for the Observatorio Astronomico di Brera. The Spectrograph is to be used at the f/7 Cassegrain focus of the 1.37M telescope. This manual provides a brief description of the component parts of the spectrograph, together with their function, alignment and adjustment procedures, and general information on the use of the spectrograph.

1.0 DESCRIPTION OF THE SPECTROGRAPH (Ref. Drawing E-43488)

A description of the functioning parts and assemblies of the spectrograph is necessary to provide the operator with a complete knowledge of the features and proper operation of the spectrograph. This section of the manual should be read carefully before attempting to use the instrument. In most cases, reference should also be made to the assembly and sub-assembly drawings furnished separately from this manual. These drawings include complete parts lists for commercial and special manufactured parts, and will prove invaluable if any maintenance work is required.

Light passes from the telescope through the slit and is collimated by an off-axis parabolic mirror. The collimated light is dispersed by a diffraction grating and is then reimaged by the camera onto the photographic plate. Other features include a decker, filter holder, provisions for an exposure meter, shutter, comparison light system, a 14 cm direct photography camera, and a 45 cm direct photography camera. Drawings E-43488 and D-43800 show the exterior configuration of the spectrograph and the optical diagram.

The spectrograph is basically light-tight and need not be operated in total darkness. If the spectrograph is tested off of the telescope, precautions must be taken to prevent outside light from entering the opening at the upper end.

In very brief form, the operating procedures would be as follows:

a. With the spectrograph mounted on the telescope, set the desired grating angle, slit and decker positions, filter, and collimator focus.

b. With the viewing periscope in the upper position and the comparison periscope knob in the "OUT" position, guide the telescope to position a star on the slit.

c. With the shutter closed, place a loaded plateholder in the camera, ready for starting an exposure. (Note that the red light is on when the shutter is closed). Open the dark slide of the plateholder.

d. To produce a portion of the comparison spectra exposure, select the source desired, push the comparison periscope knob to the "IN" position, start the source and open the shutter for the desired length of time.

e. Open the shutter to start the stellar exposure and operate the telescope controls as necessary to drift the star along the slit.

f. The comparison sequence, part d, should be repeated at the middle and end of the stellar exposure.

The basic procedure for checking alignment of the spectrograph and of the collimator mirror is as follows:

a. Image a point source of light at the center of the slit so that the axis of the point source is normal to the face of the spectrograph mounting flange. Or, place a standard 15 watt bulb in the Neon comparison system.

b. Remove the collimator assembly (item 19 on Drawing E-35093) and place a piece of vellum over the end of the collimator tube. Check to see that the illuminated area is uniform, centered, and 3.5 to 4.0 inches in diameter.

c. With the camera removed, and either the grating or a plane mirror in the grating holder and set near zero, observe the illuminated area of the grating or mirror. Also, rotate the grating in a positive direction and note the extremes of the illuminated area in the direction of dispersion. In either case, if the illuminated area is not symmetrical with the area of the grating face, the collimator mirror should be readjusted. (See Section 2.1).

More detailed instructions for the alignment of the spectrograph are contained in Section 2.0 of this manual.

1.1 FOCAL RATIO CONVERTER (Ref. Drawing C-44614)

1.2 COMPARISON SPECTRUM SYSTEM (Ref. Drawings C-27892, C-35092, and C-44900)

A comparison light source is included in the spectrograph for use in identifying the wavelength of lines on the photographed spectrum. The comparison spectrum system consists of two light sources, an Iron-Argon hollow cathode and a Neon bulb, and a periscope assembly which can inject the comparison source into the light path of the spectrograph when a comparison spectrum is to be photographed.

The neon light source is mounted on one side of the spectrograph and the hollow cathode on the opposite side. The neon source uses a NE-40 neon glow bulb and can be turned on and off by a switch mounted in the same housing as the neon bulb. Attached on the outside of the neon light source housing is a milky white translucent bulb. When the neon source is on, a faint glow is detectable through this bulb.

The hollow cathode tube is argon filled and has an iron cathode. The tube is a Westinghouse WL22611. To change tubes, take off the end cap (part B-35831), unplug the tube, and pull it out.

The light from either comparison source is projected onto the slit through the periscope assembly. The periscope assembly must be pushed in before the comparison light is projected onto the slit. Note that stellar light is blocked from the slit when the comparison periscope is in the "IN" position. The outer knob of the periscope has an engraved arrow which should be turned toward the hollow cathode source when this is used and toward the neon source when this is to be used.

1.3 SLIT AND DECKER ASSEMBLY (Ref. Drawing D-39013)

Light from a star which is focussed by the telescope will converge to a focus at the front surface of the slit jaws inside the spectrograph. The slit assembly consists of two 1-1/2 inch long polished and aluminized jaws. This is a biparting slit and the jaws are continuously adjustable over a range from 5 to 1200 microns. Both jaws move in the direction of the slit length for changes in slit width. The jaws remain parallel up to a slit opening of approximately 500 microns. For larger openings, some tapering of the slit will be noticed. This is due to a special flexure arrangement used in the control mechanism and is not considered serious, as wider slit widths are normally used only for certain test purposes.

The slit width is set by the slit micrometer. This micrometer reads the slit width directly in microns. The slit assembly has been adjusted so the minimum width will remain at 5 microns, even though the micrometer is adjusted to zero. The slit jaws have been adjusted for parallelism to an accuracy of ±1 micron. A knurled ring at the base of the micrometer barrel is a lock and when rotated fully clockwise locks the micrometer barrel against accidental rotation. To release the lock, turn the knurled ring to the full counterclockwise position.

To clean the slit jaws, use of an electrostatic brush or a very soft camel hair brush is recommended. Harder objects should not be placed against the sharp edge of the slit jaws, as these edges are very fragile.

The decker adjustment which is part of the slit assembly consists of a mask-template device placed over the slit jaws. This mask is movable in a direction perpendicular to the slit length and is controlled by a rotating dial located at the outside end of the unit. Rotation of the dial selects any of the slit length combinations indicated in Table 1 and Table 2.

TABLE 1

14 cm CAMERA

Position	Projected Inner Dimension with 14 cm FL Camera	Projected Outer Dimension with 14 cm FL Camera
Comparison Window		
#1 - 2 mm windows, separated by 2 mm	0.44 mm	1.33 mm
#2 - 2 mm windows, separated by 3 mm	0.67 mm	1.56 mm
#3 - 2 mm windows, separated by 5 mm	1.11 mm	2.00 mm
#4 - 3.5 mm windows, separated by 10 mm	2.22 mm	3.78 mm
#5 - 3.5 mm windows, separated by 18 mm	4.00 mm	5.55 mm
Stellar Windows		
#1 - 1 mm window		0.22 mm
#2 - 2 mm window		0.44 mm
#3 - 4 mm window		0.89 mm
#4 - 8 mm window		1.78 mm
#5 - 16 mm window		3.55 mm
#6 - 25 mm window		5.55 mm
Wedge Window		

Width of wedge is variable from 0 to 2.54 mm.

TABLE 2

45 cm CAMERA

Position	Projected Inner Dimension with 45 cm FL Camera	Projected Outer Dimension with 45 cm FL Camera
Comparison Window		
#1 - 2 mm windows, separated by 2 mm	1.43 mm	4.29 mm
#2 - 2 mm windows separated by 3 mm	2.14 mm	5.00 mm
#3 - 2 mm windows, separated by 5 mm	3.57 mm	6.43 mm
#4 - 3.5 mm windows, separated by 10 mm	7.14 mm	12.14 mm
#5 - 3.5 mm windows, separated by 18 mm	12.86 mm	17.86 mm
Stellar Windows		
#1 - 1 mm window		0.71 mm
#2 - 2 mm window		1.43 mm
#3 - 4 mm window		2.86 mm
#4 - 8 mm window		5.71 mm
#5 - 16 mm window		11.43 mm
#6 - 25 mm window		17.86 mm

Wedge Window

Width of wedge is variable from 0 to 2.54 mm.

The entire slit assembly may be removed from the spectrograph by first removing three cap screws on the outside flange, just outside of the decker dial. After removing the screws, carefully remove the slit assembly from the spectrograph. It may be necessary to rotate the decker dial to put the decker in a proper position for clearing the spectrograph body.

1.4 SLIT VIEWER (Ref. Drawing D-41010 and C-41036)

Included on the spectrograph is a two-position periscope, normally used for guiding the telescope by observing reflected starlight off of the aluminized slit jaws. The periscope may be rotated from the normal position, which permits viewing the upper face of the slit jaws, to the lower position which permits viewing a star through the slit. This is accomplished by rotating the assembly by 180° using the handle, part A-41024. Note that the periscope rotates through only one 180° sector.

The perisocpe assembly consists of a pick-up mirror, a pair of symmetrical achromatic lenses, a second diagonal mirror, and a wide-field Clave' eyepiece. The pick-up mirror, part A-41018, for viewing the reflected light off the slit jaws is mounted to the inside of the spectrograph flange. The turning mirror, part A-41040, for viewing through the slit is part of the Filter-Mirror Subassembly (C-41036). The eyepiece can be slid in and out to permit fine focus adjustment by loosening the clamp ring, part B-41013, and the entire right angle assembly can be rotated 360° by loosening the other clamp ring (B-41013). Note that when viewing starlight through the slit, that all light from the slit to the collimator mirror and the rest of the spectrograph is blocked.

1.5 FILTER-MIRROR SUBASSEMBLY (Ref. Drawing C-41036)

This subassembly is shown on Drawing C-41036. It can be rotated to three different positions:

1. "MIRROR" which sends the light coming through the slit to the slit viewer. When it is in this position all the light to the collimator is blocked.

2. "FILTER" if desired, a filter (.49-inch x 1.62-inch x .25 inch thick) can be mounted in its cell. To change filters, remove the entire subassembly from the spectrograph (take out the three mounting screws, item 7), remove the clips (parts A-41042-1 and -2), and place the filter in position. If a thinner filter is desired, shims can be made to make the 0.25-inch total thickness.

3. "CLEAR" this position can be used when a filter is mounted and it is desired to take a spectra without the filter in the light beam.

1.6 SHUTTER (Ref. Drawing D-26703)

A shutter is located along the optical axis between the slit and the collimator mirror. This shutter is used to cut off all light to the interior of the spectrograph when the camera is being loaded. To remove the light shutter from the light path, pull the knob found on the slit side of the spectrograph. A red warning light on the shutter assembly remains off when the spectrograph power is turned on and when the shutter is out of the light beam. The light off thus indicates that the shutter is open.

1.9 GRATING ASSEMBLY (Ref. Drawing D-43671)

The entire grating assembly is removable as a unit assembly from the side of the spectrograph. It must be removed for exchanging gratings. To remove it, first remove the four cap screws holding it in the housing, and then gently pull the grating assembly out, using the two handles. Rods inside the spectrograph guide the assembly in and out to protect the grating from damage during removal. Extreme care should be taken in removing the grating assembly, not to place hands or fingers on the surface of the diffraction grating. In replacing the grating assembly, note that there is a slot in one side of the outer flange which must line up with a fixed pin in the spectrograph body.

The grating assembly permits rotating the grating through a range of angles from normal to the collimator beam (-25°) to +60°. The least division on the dial vernier is 5 arc minutes. The position for autocollimating the collimator beam back to the slit is approximately -25°. Note that there is a + sign engraved on the grating dial and the grating is installed such that the grating angle is positive. Table 3 gives the grating angle for the grating furnished. A lock mounted on the outside of the grating dial locks the grating firmly.

The interchangeable grating cells are held in place by four screws, one at each corner of the cell. Before removing or replacing a grating cell, the plastic cover which is provided for each grating cell should be put in place. Extreme care should be taken to place the plastic cover down, parallel to the face of the gratings, so that there is no possibility of the cover contacting the grating. In installing the grating cell, the engraved arrow on the side of the cell should point to the right when you are standing facing the dial end of the assembly.

One grating was supplied. The grating information is listed in Table 3.

1.7 EXPOSURE METER (Ref. Drawing D-38986)

Only the optical and mounting equipment has been furnished. The exposure meter tube and housing can be easily added later. A small mirror on a push rod is located on the same side of the spectrograph as the slit assembly. When this rod is pushed in, a small 45-degree diagonal mirror is inserted in the forward edge of the collimated beam, and deflects a small amount of the light at right angles to the exposure meter photomultiplier tube mounted on the opposite side of the housing. The mirror was adjusted during alignment and was aimed so that the field lens just forward of the photomultiplier housing imaged the mirror itself on the face of the photomultiplier tube. Note that the image of the mirror on the photomultiplier tube is elliptical.

1.8 f/7 COLLIMATOR (Ref. Drawing E-35093)

The collimator located at the bottom of the spectrograph is an f/7 off-axis portion of a parabolic mirror. This mirror produces a collimated beam on an axis of approximately 9 degrees toward the grating and camera side of the spectrograph. The mirror has a clear aperture of 100mm, although the diameter of an f/7 beam from the slit is 90mm.

The collimator mirror mount provides a focus travel of ±0.75 inches from a nominal position. A dial indicator is provided which reads in 0.001 inch increments, so that each unit of the indicator represents 25μm of motion of the collimator mirror. The extreme focus position corresponds to a reading of zero (farthest from the slit), and a reading of 1.500 (for the mirror in the closest position).

Extreme care must be taken in handling and cleaning the mirror, since the surface is aluminized but not overcoated.

TABLE 3

Camera	Grating	Order	Grating Angle	Centered Wavelength Å	Dispersion Å/mm
14 cm FL	600 l/mm 5000Å	1st	+8° - 38'	4550	114
45 cm FL	600 l/mm 5000Å	1st	+8° - 38'	4550	35

1.10 14 cm DIRECT PHOTOGRAPHY CAMERA (Ref. Drawing D-42440)

This camera consists of the Bowen Optics Module (D-35089) and parts D-40839 (Direct Photo Housing), D-35480 (Lens Holder), and A-35448 (Field Flattener - Thick). The field flattener is epoxied into the lens holder and the lens holder attaches to the direct photo housing by means of three sets of push-pulls. The field flattener was adjusted with the push-pull screws to place it coincident with the focal plane and to take out any tilt in the focal plane.

1.10.1 Schmidt Camera Assembly (Ref. Drawing D-35089)

The camera optics were designed by Dr. Ira Bowen. The optics were aligned at Boller & Chivens. This alignment included centering of the corrector plate with respect to the solid block (using set screws, item 7 on subassembly drawing D-35089) and spacing of corrector with respect to the solid block (using item 2 on subassembly drawing D-35089). The reflective coating on the two surfaces of the solid block is aluminum. The corrector plate and solid block are fused silica with no overcoating.

1.10.2 Plate Holders (Ref. Drawing D-40841)

Two plate holders have been supplied with the spectrograph. To install the plate holder in the camera, place the plate holder in position in part C-35021, subassembly D-40838, turn the clamping retainers (part A-35034, subassembly D-40838) over the edge of the plate holder, and clamp the plate holder in position by turning part A-36928, subassembly D-40838. To move the plate holder to different positions, just unclamp the plate holder (turn part A-36928) and manually slide the plate holder to the new position. To take a spectra, pull the dark

slide and turn part A-35035 until the plate contacts the field flattener. BEFORE SLIDING THE PLATE HOLDER TO A NEW POSITION, BE SURE TO LIFT PLATE OFF OF THE FIELD FLATTENER BY TURNING PART A-35035.

To change photographic plates, flip-up the four plate holder retainers (part A-40844) so the plate is free and lift the plate out. To load a plate, just place the plate in the plate holder flip-down the four retainers over the corners of the plate.

Be careful to keep the photographic plate and field flattener clean because dirt or dust particles could tilt the photographic plate and ruin the resolution.

1.11 45 cm RAYCES CAMERA (Ref. Drawings D-43752 and D-43755)

This camera consists of the 45 cm, f/5 optics module (D-43755) and the f/5 Direct Photography Module D-43752. The camera uses the same plateholders, D-40841, as the 14 cm Bowen camera.

The three sets of push-pull screws, items 1 and 2 of D-43755, are for tilting the optics with respect to the photographic plate. This adjustment has been set by Boller & Chivens. If some tilt developes in the focal plane, this adjustment can be used to realign the camera.

Parts A-43763 and B-43761 of subassembly D-43755 are protective covers to be installed when the optics are exposed.

1.12 STORAGE STAND (Ref. Drawing D-43845)

To install the spectrograph on the telescope, point the telescope to the zenith and lift the spectrograph. When the mounting flange is about 1 cm

from the telescope mounting flange, install the mounting screws and pull the spectrograph up to the mounting surface. After installation, remove the storage stand from the spectrograph.

To remove the spectrograph from the telescope, mount the stand on the spectrograph and reverse the installation procedure.

2.0 ALIGNMENT INSTRUCTIONS

2.1 COLLIMATOR ALIGNMENT (Ref. Drawing E-35093)

The collimator mirror is mounted rigidly in its cell and no adjustments between the mirror and the cell should be made.

The entire mirror cell may be moved along the focus axis and may be adjusted in tilt. The cell is supported to the focus carriage of the collimator assembly through three long cap screws (item 12) which work against three push screws (item 17). The cell is tilted by adjusting the push screws differentially against the pull screws.

The primary alignment of the collimator mirror is accomplished by using a point source of light focused on the slit in such a way that the axis of the light source is normal to the spectrograph mounting face. The light source should also illiminate the entire collimating mirror. With the camera removed from the spectrograph, the area of the grating which is illuminated by the collimator can be seen in a darkened room. The tilt of the collimating mirror should be adjusted to center the illuminated area on the grating. Rotation of the grating turret will assist in observing this alignment. Note that the image will be elongated in the direction of dispersion.

2.2 COMPARISON SOURCE ALIGNMENT (Ref. Drawing C-44900)

The adjustment is that required for the slit illumination mirror (A-39037). The initial adjustment of this mirror can be checked by placing a piece of white paper over the spectrograph slit and operating the comparison source to see if the slit is uniformly illuminated. A second check consists of placing a white surface in the grating assembly in place of the grating and observing the illuminated area to see if the collimator is

fully illuminated. This can also be done by putting a mirror in place of the grating and looking directly at the collimator mirror through the camera opening. In either case if the collimator is not uniformly illuminated, the slit illumination mirror should be adjusted by rotation of its holder after loosening three screws (item 11) or by shimming the mirror. Shimming is required if the illumination is not uniform in the direction of dispersion whereas rotation may be used if the illumination is not uniform perpendicular to the direction of dispersion.

2.3 EXPOSURE METER ALIGNMENT (Ref. Drawing D-38986)

This alignment consists solely of adjusting the flat photometer mirror (item A-38989) with the plunger (B-27765) all the way in. This mirror just intercepts the edge of the collimator beam. With the point source imaged at the center of the slit as in Section 2.1, and the photomultiplier tube assembly removed from the collimator housing, the photometer mirror can be viewed through the field lens opening or the light from the mirror can be imaged on a piece of white paper located at approximately the front face position of the photomultiplier tube. This image should be centered and will appear elliptical in shape.

2.4 BOWEN OPTICS ALIGNMENT

This portion of the instruction manual is to describe a recommended procedure for the initial alignment of the Bowen camera. After the initial alignments are completed, the focusing adjustments for slight focus shifts due to temperature changes or other causes can be made at the spectrograph collimator focus.

2.4.1 Bowen Optics Assembly (Ref. Drawing D-35089)

This assembly was aligned at Boller & Chivens. The initial test for this assembly is to take spectra on the spectrograph to check the resolution of the complete camera assembly.

Should the camera, for any reason, be out of alignment, the proper sequence of adjustments is as follows:

a. Adjust the corrector plate to be parallel with mounting flange.

b. Center the corrector plate with respect to the thick mirror. (Centration).

c. Focus the camera.

These procedures are discussed below in detail.

To adjust the corrector plate parallel to the mounting face, indicate to the three points on the corrector plate surface adjacent to the adjusting screws. Adjust the corrector screws (item 2) as necessary, measuring to the three points described above. Be sure to indicate at the extreme edge of the corrector because of the curvature of the corrector plate surface near the edge.

Centration

Place camera optics module, less the plateholder module on an optical bench, in front of a collimator. Place a pinhole at the focus of the collimator. Adjust the camera position so that the image formed by the camera optics is within 1 or 2mm of the axis of the camera optics. Set up a microscope to examine the image.

The image should be circularly symmetrical. Significant deviations from symmetry indicate coma, caused by decentration of the corrector plate. It will be necessary to recenter the corrector.

Four set screws define the radial position of the corrector. Before tightening a screw to push the corrector, always loosen the opposite screw. Never force a screw as you might break the corrector.

Move the corrector in the direction of the flare of the coma. As you near centration, the adjustment becomes rather critical. When no more improvement can be made in the radial symmetry of the image, make sure that all four adjusting screws are in contact with the corrector, recheck the image and correct again if necessary. Remember, never force the screws, light contact is adequate.

The procedure to focus the camera is as follows:

a. Attach the plateholder module to the Bowen optics module. Using the same set up as described above in the corrector plate centering, move the pin hole back and forth to find the best focus on the field flattener and then measure the distance from the pin hole to the focus of the collimator.

b. Now, calculate the amount the camera is out of focus by using the following formula:

$$\text{Camera focus distance (from collimated position)} = \text{pin hole distance} \times \frac{(\text{F. L. Camera})^2}{(\text{F. L. Collimator})^2}$$

c. Then place the camera on a surface plate such that its corrector plate surface is in an upward direction and indicate with a depth micrometer to the three points on

the corrector plate adjacent to the adjusting screws. (Because of the extreme curvature of the corrector plate at its surface, all readings must be made at the extreme edge). Adjust the three sets of push-pull screws (items 1 and 5) in such a manner that the optical plane of the corrector remains parallel to its original plane.

The adjustment is in the same direction as the pin hole (ie., pin hole away from focus - move camera away from focus).

Another procedure to focus the camera on the plane of the field flattener is as follows:

a. Use the spectrograph collimator and find the best focus in the camera by moving the collimator in specific focus steps. This will tell you how far one has to move the collimator from its collimated position.

b. Now, calculate the amount the camera is out of focus by using the following formula:

$$\text{Camera distance} = \left(\begin{array}{c}\text{Distance collimator is from} \\ \text{its collimating position}\end{array}\right) \times \frac{(\text{F.L. camera})^2}{(\text{F.L. collimator})^2}$$

c. This is the same as step "c" above.

APPENDIX I

STANDARD GRATINGS AVAILABLE

BOLLER & CHIVENS MODEL 31523 CASSEGRAIN SPECTROGRAPH

140 mm BOWEN-SCHMIDT CASSEGRAIN CAMERA *
STANDARD GRATINGS

Catalog Blaze	Grooves Per mm	Grating Angle	1st Order		2nd Order		3rd Order		1974 Base Price US $
			Central λ	Disp. Å/mm	Central λ	Disp. Å/mm	Central λ	Disp. Å/mm	
5000Å	300	4° 18'	4550	224.0					825
5000	600	8° 38'	4550	114.0					825
5000	1200	17° 27'	4550	59.1					1485
5000	1800	26° 45'	4550	39.6					2060
5000	2160	32° 41'	4550	32.7					2725
7500	300	6° 28'	6825	226.0	3412	113.0			825
7500	600	13° 00'	6825	116.0	3412	58.0			825
7500	1200	26° 45'	6825	59.5	3412	29.8			1485
7600	270	5° 53'	6916	251.0	3458	126.0			285
7615	300	6° 33'	6929	226.0	3465	113.0			285
8125	830	19° 42'	7393	85.8	3696	42.9			1000
8465	400	9° 44'	7703	173.0	3852	86.5			825
8465	830.8	20° 34'	7703	85.9	3852	43.0			1000
8600	300	7° 25'	7826	227.0	3913	114.0			825
8700	80	2° 00'	7917	822.0	3958	411.0			825
1.0μ	300	8° 38'	9100	228.0	4550	114.0	3033	76.0	825
1.0μ	600	17° 27'	9100	118.0	4550	59.0	3033	39.3	825
1.0μ	1200	36° 52'	9100	58.1	4550	29.1	3033	19.4	1485
1.1μ	400	13° 00'	1.001	171.0	5005	85.6	3336	57.0	825
1.2μ	400	13° 54'	1.092	175.0	5460	87.5	3640	58.3	825
1.2μ	1200	46° 04'	1.092	55.3	5460	27.7	3640	18.4	1485
1.25μ	150	5° 23'	1.137	449.0	5685	225.0	3790	150.0	825
1.25μ	600	22° 02'	1.137	119.0	5685	59.4	3790	39.6	825
1.3μ	400	15° 00'	1.183	177.0	5915	88.5	3943	59.0	825
1.6μ	400	18° 40'	1.456	178.0	7280	88.8	4853	59.2	825

* For dispersion using the 45 cm Camera divide D by 3.21.

* on SPM [illegible] 19.5 mm ✓ D ✓ 1.393

APPENDIX II

FORMULAS FOR ASTRONOMICAL GRATING SPECTROGRAPHS

FORMULAE FOR ASTRONOMICAL GRATING SPECTROGRAPHS

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March 16, 1973

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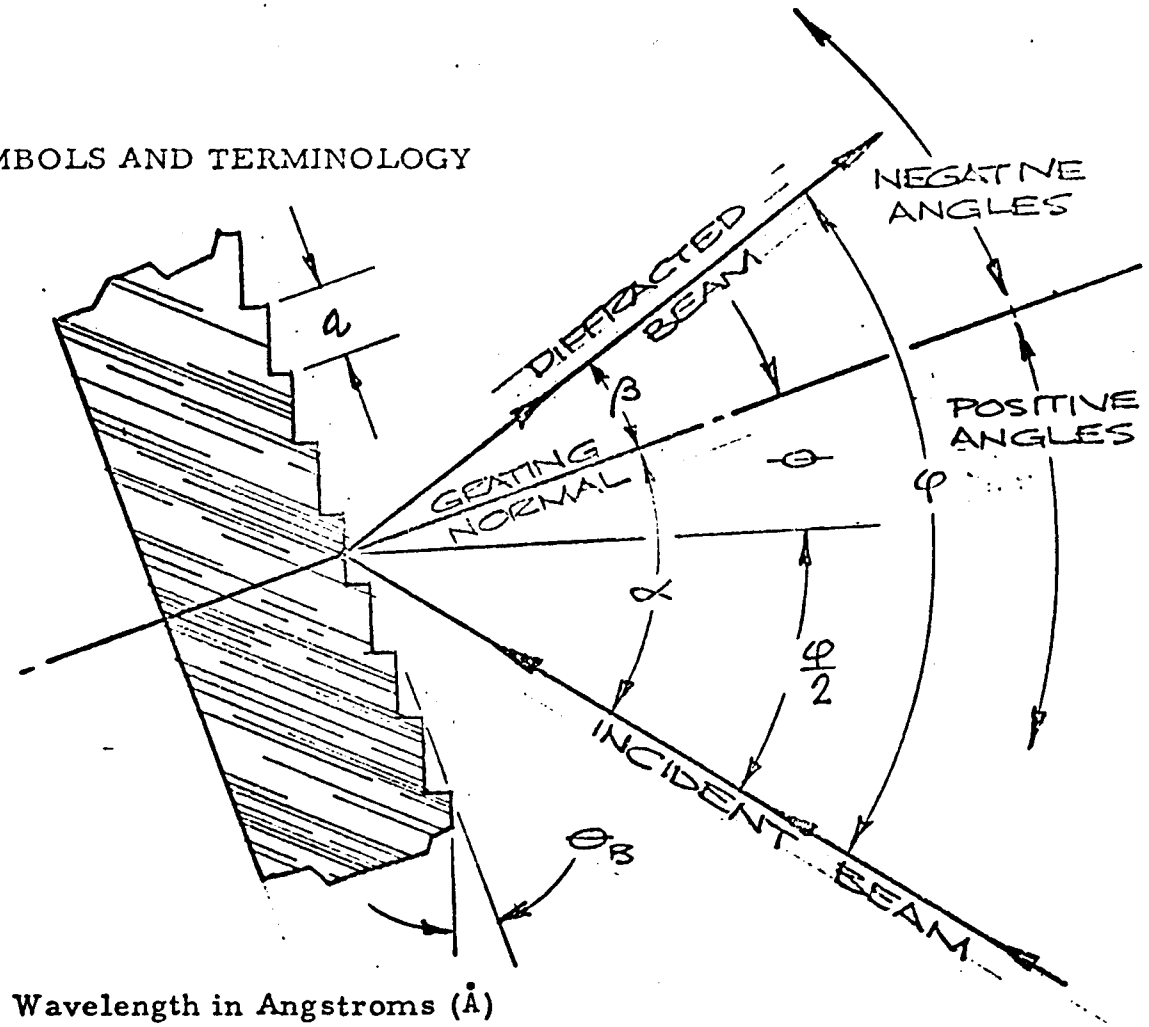
INTRODUCTION

In this paper, the author brings together many formulae that are useful in the design and use of astronomical grating spectrographs. Many of these are standard formulae that are in general use. A few were derived by the author from standard formulae. No attempt has been made to reference the sources or to show the derivation of these formulae. This paper was intended primarily for the use of Perkin-Elmer personnel, however, it is available for general use.

Following the usual practice in astronomy, wavelengths are expressed in Angstroms.

1. SYMBOLS AND TERMINOLOGY



λ	=	Wavelength in Angstroms (Å)
n	=	Grooves/mm
a	=	Groove spacing in Angstroms = $10^7/n$
m	=	Spectral order number
α	=	Angle between incident ray and grating normal
β	=	Angle between reflected ray and grating normal
φ	=	Angle between incident and diffracted rays = $\alpha - \beta$ (Angle between Collimator and Camera)
θ	=	Angle between grating normal and bisector of incident and diffracted rays = $(\alpha + \beta)/2$
λ_b	=	Blaze wavelength in Å (First Order)
λ_c	=	Wavelength at center of dispersed spectra in Å
θ_b	=	Blaze Angle
D	=	Plate Dispersion Å/mm
F	=	Focal length of the spectrograph camera
R	=	Free spectral range (separation, in Angstroms, between adjacent orders)
M	=	Grating magnification
L	=	Length of one free spectral range

SIGN CONVENTION:

Angles on incident side of grating normal are positive.
Angles on opposite side of grating normal are negative.

2. GENERAL CASE

This section is applicable to all grating spectrographs, and particularly to the conventional Cassegrain and coude spectrographs. Echelle spectrographs, Littrow spectrographs and spectrographs using twice through correctors are special cases for which the general case applies, but can be treated in a simplified manner.

2.1 WAVELENGTH RELATIONSHIPS

$$\lambda = \frac{a}{m} (\sin \alpha + \sin \beta) \qquad (1)$$

$$\lambda = \frac{2a}{m} (\sin \theta \cos \varphi/2) \qquad (2)$$

which can be written:

$$\lambda = \frac{2 \times 10^7}{mn} (\sin \theta \cos \varphi/2) \qquad (3)$$

A grating produces many spectra, one for each spectral order. These spectras are superimposed. The overlap relationships can be found in the wavelength relationships of equations. Figure 2 is a chart that shows 8 orders separated to indicate the overlap.

2.2 BLAZE RELATIONSHIPS

For peak performance, at any specific wavelength, the blaze angle should nearly equal the grating angle.

$$\theta_b \approx \theta$$

In grating catalogs, the published blaze wavelength is given for the first order in the Littrow mode, ($\varphi = 0$). In other cases, the working blaze wavelength is given by the expression:

$$\lambda_b' = \frac{\lambda_b}{m} \cos \varphi/2 \qquad (4)$$

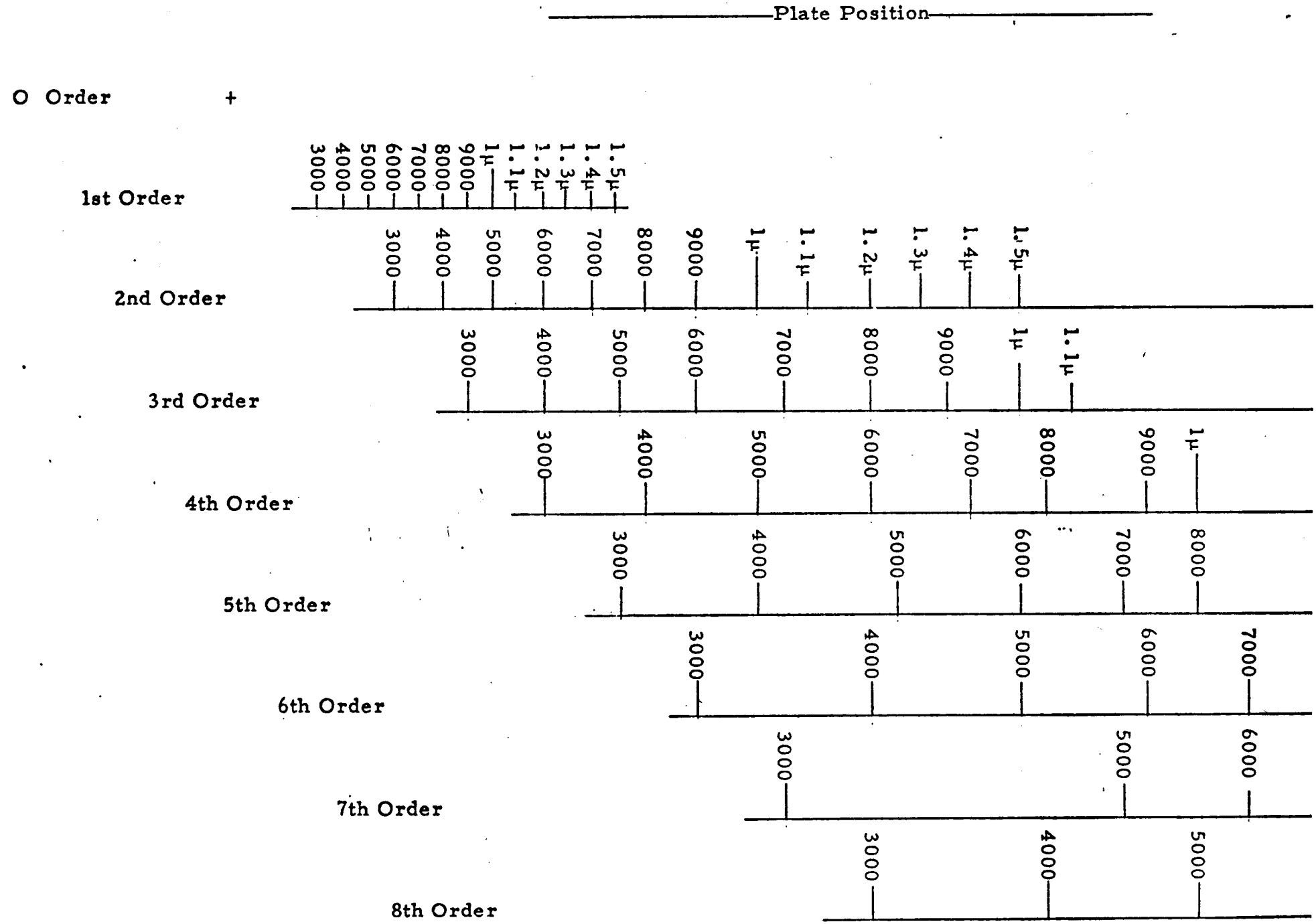


Plate Position
O Order +
1st Order
3000 4000 5000 6000 7000 8000 9000 1μ 1.1μ 1.2μ 1.3μ 1.4μ 1.5μ
2nd Order
3000 4000 5000 6000 7000 8000 9000 1μ 1.1μ 1.2μ 1.3μ 1.4μ 1.5μ
3rd Order
3000 4000 5000 6000 7000 8000 9000 1μ 1.1μ
4th Order
3000 4000 5000 6000 7000 8000 9000 1μ
5th Order
3000 4000 5000 6000 7000 8000
6th Order
3000 4000 5000 6000 7000
7th Order
3000 5000 6000
8th Order
3000 4000 5000

2.3 DISPERSION

$$D = \frac{a \cos \beta}{mF} \tag{5}$$

which can be expressed

$$D = \frac{10^7 \cos \beta}{mnF} \tag{6}$$

or:

$$D = \frac{\lambda_c}{2F} (\cot \theta + \tan \varphi/2) \tag{7}$$

2.4 FREE SPECTRAL RANGE

The free spectral range is the wavelength separation between the adjacent spectra of different orders. The term is used primarily with echelle spectrographs.

$$R = \lambda_c/m \tag{8}$$

The length of a free spectral range is

$$L = R/D = \lambda_c/mD \tag{9}$$

2.5 SPECTRAL LINE CURVATURE

The monochromatic slit images of all spectrographs are curved. Due to the short slits used, this is not apparent in most stellar spectra, but it must be considered in spectrometers particularly with long slits such as spectroheliographs. The following formulas apply:

$$C = \frac{1}{R} = \frac{\sin \alpha + \sin \beta}{F \cos \beta} = \frac{m \lambda}{aF \cos \beta} \tag{10}$$

$$R = \frac{F}{2} (\cot \theta + \tan \varphi/2) \tag{11}$$

In terms of wavelength, the spectral line curvature is:

$$d\lambda/\lambda = h^2/2F^2 \qquad (12)$$

h = slit height (1/2 slit length)

The slit image is concave as viewed from the longer wavelengths.

2.6 MAGNIFICATION CAUSED BY GRATING

Except for the Littrow, and zero order cases, a grating increases or reduces the width of the slit image. There is no change in the slit length. This is known as the anamorphic effect. This effect can be significant, particularly at high angular dispersions. The magnification is equal to:

$$M = \frac{\cos \alpha}{\cos \beta} = \frac{\cos (\theta + \varphi/2)}{\cos (\theta - \varphi/2)} \qquad (13)$$

also

$$M = \frac{1 - \tan \theta \tan \varphi/2}{1 + \tan \theta \tan \varphi/2} \qquad (14)$$

and

$$\tan \theta = \frac{1 - m}{(1 + m) \tan \varphi/2} \qquad (15)$$

for example, if $\varphi = 50°$, and

$$\theta = 30°$$

$$M = \frac{\cos (30° + 50°/2)}{\cos (30° - 50°/2)} = 0.576$$

2.7 ASTIGMATISM

If the incident beam is not collimated, the grating will introduce astigmatism into the dispersed beam by shifting the tangential focus. There is no change in the sagital focus. If we let S_1 be the slit image distance of the incident beam, the distance to the sagital image is

$$S_s = S_1$$

and to the tangential image

$$S_T = S_1/M^2 = S_1 \left(\frac{\cos^2\beta}{\cos^2\alpha}\right) \qquad (16)$$

If the incident beam is truly collimated, there is no astigmatic effect.

3.0 LITTROW CASE

The Littrow configuration is seldom used in stellar spectrographs but very common in solar spectrographs. The collimator also serves as the camera optics. Consequently $\varphi = 0$ and $\alpha = \beta = \theta$. The following formulas apply to this special case:

3.1 WAVELENGTH

$$\lambda = \frac{2a}{m} \sin\theta \text{ (or } \alpha \text{ or } \beta) \qquad (17)$$

3.2 DISPERSION

$$D = \frac{a \cos\theta}{mF} \qquad (18)$$

which may be expressed

$$D = \frac{10^7 \cos\theta}{mnF} \qquad (19)$$

or

$$D = \frac{\lambda_c}{2F \tan\theta} \qquad (20)$$

3.3 SPECTRAL LINE CURVATURE

$$C = 1/R = \frac{2 \tan \theta}{F} \qquad (21)$$

3.4 TWICE THROUGH CORRECTOR CASE

In the spectrographs that use a Schmidt corrector plate that is attached to the grating (twice through corrector), the grating normal must coincide with the camera axis within a very few degrees.

Then: $\alpha \approx \varphi \approx 2\theta$

$\beta \approx 0$

$\cos \beta = 1$

then the following dispersion formulas apply:

$$D = \frac{a}{mF} \qquad (22)$$

or

$$D = \frac{\lambda_c}{F \sin \alpha} \qquad (23)$$

4. ECHELLE SPECTROGRAPHS

Echelle spectrographs use coarse gratings, operating at very high spectral orders and at steep angles. Typical values are:

n; 30 to 100 g/mm

m; 25 to 100

θ; 63° and higher

φ; ≈ 12°

In most eschelle spectrographs, φ, θ and F are constants. We may rearrange equation 7 to read:

$$C_d = \frac{\lambda_c}{D} = \frac{2F}{\cot\theta + \cot\varphi} \qquad (24)$$

We will call C_d the "dispersion constant", and

$$D = \lambda_c / C_d \qquad (25)$$

The length of a free expected range can be stated as

$$L = C_d / m \qquad (26)$$

APPENDIX III

DRAWING LISTS

TASK #100 L- 43488

CU[illegible] BRERA OBSERVATORY, ITALY JOB NO. 59007

GE[illegible]EMBLY CASSEGRAIN SPECTROGRAPH NO. E-43488 DATE 11-5-74

SU[illegible]BLY NO. SHEET 1 OF 2

DRAWING NO.	PART NAME	No. Req'd Per Next Assy.	Old Print	Tracing	Tracing Revised	Vendor Print	Shop Print	No. Req'd This Job	ISSUED FOR						Quan. Fin.
									PURCH	MFR	MACH	FIN	INSP	ASSY	
E-43488	General Assembly	2/1				✓✓	2/18/75								
D-26703	Sub Assembly - Shutter	2/1					△		Separate Issue						
C-27892	Sub Assembly - Neon Lamp Source	1/2					△								
D-35089	Sub Assembly - Bowen Optics	1/2					△								
C-35092	Sub Assembly - Hollow Cath. Tube	1/2					△								
E-35093	Sub Assembly - f/7 Collimator	1/2					△								
C-35819	Sub Assembly - Cathode Tube P.S.	1					△								
D-38986	Sub Assembly - Exposure Meter	2/1					△								
D-39013	Sub Assembly - Slit	2/1					△								
D-40841	Sub Assembly - Plate Holders	2/2					△								
D-41010	Sub Assembly - Slit Viewer	1/2					△								
C-41036	Sub Assembly - Filter/Mirror	1/2					△								
D-42440	Sub Assembly - Direct Photo. Module	1/2					△								
D-43671	Sub Assembly - Grating	1					△								
D-43752	Sub Assembly - f/5 Direct Photo M	1/2					△								
D-43755	Sub Assembly - f/5 Spectro. Camera	1/2					△								
D-43845	Sub Assembly - Storage Stand	2/1					△								
44614	Sub Assembly - Focal Ratio Conver.	1					△								
C-44900	Sub Assembly - Comp. Periscope	2/1					△		Separate Issue						
B-22006	Nameplate	1				✓	11/8/74								
A-26965	Grating Guide Rod	3													
C-35622	Cover Plate (Rocker Assembly)	1													
C-35623-1	Terminal Mounting Plate	1													
C-35624	Terminal Cover	1													
A-36629	Standoff	4													

... EVENS

DRAWING LIST

TASK #100

L- 43488

CUSTOMER BRERA OBSERVATORY, ITALY

JOB NO. 59007

GENERAL ASSEMBLY CASSEGRAIN SPECTROGRAPH NO. E-43488

DATE 11-5-74

SUB ASSEMBLY NO.

SHEET 2 OF 2

DRAWING NO.	PART NAME	No. Req'd per Nxt Assy.	Old Print	Tracing	Tracing Revised	Vendor Print	Shop Print	No. Req'd This Job	ISSUED FOR						Quart Fin.
									PURCH	MFR	MACH	FIN	INSP	ASSY	
B-37196	Cover Plate (Comp. Grating)	1					11/8/74								
B-41064	Terminal End Plate	1					↓								
√ C-41067	Wiring Diagram	Ref. 2					3/21/75								
√ D-43800	Optical Diagram	Ref. 2					2/18/75								
E-43839	Housing (Sheet 1 - Casting Dwg.)	1				✓	2/18/75								
E-43839	Housing (Sheet 2 - Machining Dwg.)	Ref.					1/29/75								

JOB [illegible] STEVENS — ADAMS & RICE — Task #150 — L- 26703

CUSTOMER: BRERA OBSERVATORY, ITALY — JOB NO. 59007

CENTRAL ASSEMBLY: CASSEGRAIN SPECTROGRAPH — NO. E-43488 — DATE 11-5-74

SUB ASSEMBLY: SHUTTER — NO. D-26703 — SHEET 1 OF 1

DRAWING NO.	PART NAME	No. Req'd per Next Assy.	Old Print	Tracing	Tracing Revised	Vendor Print	Shop Print	No. Req'd this Job	ISSUED FOR: PURCH	MFR	MACH	FIN	INSP	ASSY	Current Rel.
D-26703	Sub Assembly - Shutter	1				✓✓	11/8/74								
C-19031	Shutter Shaft Housing	1					↓								
A-19045	Shutter	1													
A-19046	Shutter Shaft Housing Cover	1													
A-22064	Shutter Knob	1													
A-26779	Shutter Shaft	1													
A-29186	Switch Actuator	1													

Task #170 L- 27892

CUSTOMER BRERA OBSERVATORY, ITALY JOB NO. 59007

CONTRACT ASSEMBLY CASSEGRAIN SPECTROGRAPH NO. E-43488 DATE 11-5-74

SUB ASSEMBLY NEON SOURCE NO. C-27892 SHEET 1 OF 1

DRAWING NO.	PART NAME	No. Req'd Per Next Assy.	Old Print	Tracing	Tracing Revised	Vendor Print	Shop Print	No. Req'd This Job	ISSUED FOR						Quant. Fin.
									PURCH	MFR	MACH	FIN	INSP	ASSY	
C-27892	Sub Assembly - Neon Source	1				✓✓	11/8/74								
A-23315	Large Diffuser	1	(12 FOR L-35092)				↓	3							
B-27893	Lamp Base Housing	1					↓								
B-27894	Lamp Cover	1					↓								
B-27895	Base Cover Plate	1					↓								

[illegible] DRAWING LIST Task #200 L- 35089

SUBSYSTEM BRERA OBSERVATORY, ITALY JOB NO. 59007

GENERAL ASSEMBLY CASSEGRAIN SPECTROGRAPH NO. E-43488 DATE 12-19-74

SUB ASSEMBLY BOWEN OPTICS CAMERA NO. D-35089 SHEET 1 OF 1

DRAWING NO.	PART NAME	No. Req'd per Next Assy.	Old Print	Tracing	Tracing Revised	Vendor Print	Shop Print	No. Req'd This Job	ISSUED FOR						Quant. Fin.
									PURCH	MFR	MACH	FIN	INSP	ASSY	
√D-35089	Sub Assembly - Bowen Optics Camera	1				√√	12/19/74								
B-28794	Corrector Cell	1													
B-28795	Corrector Retainer	1													
A-28797	Screw Extension	3													
A-28798	Corrector Cell Seal	1													
C-30887	Optical Diagram	Ref.													
B-30889	Mirror Retainer	1													
C-35427	Bowen Optics	1				✓									
D-35963	Housing	1													
D-42410	Flange	1													

Task #180

L- 35092

CUSTOMER: BRERA OBSERVATORY, ITALY — JOB NO. 59007

GENERAL ASSEMBLY: CASSEGRAIN SPECTROGRAPH — NO. E-43488 — DATE 11-5-74

SUB ASSEMBLY: HOLLOW CATHODE TUBE — NO. C-35092 — SHEET 1 OF 1

DRAWING NO.	PART NAME	No. Req'd Per Nxt Assy.	Old Print	Tracing	Tracing Revised	Vendor Print	Shop Print	No. Req'd This Job	ISSUED FOR						Quant. Fin.
									PURCH	MFR	MACH	FIN	INSP	ASSY	
C-35092	Sub Assembly - Hollow Cathode Tube	1				✓✓	11/8/74	1							
A-23315	Large Diffuser	1					△	2	Issued on L-27892						
B-35825	Cam Modification	1					11/8/74	1							
C-35826	Extension Tube	1					↓	1							
S-43446	Diffuser Cell	1					↓	1							

SOUTHERN RESEARCH ENGINEERING — DRAWING LIST — TASK #120 — L- 35093

CUSTOMER: BRERA OBSERVATORY — JOB NO. 59007

GENERAL ASSEMBLY: CASSEGRAIN SPECTROGRAPH — NO. E-43488 — DATE 11-5-74

SUB ASSEMBLY: COLLIMATOR — NO. E-35093 — SHEET 1 OF 1

DRAWING NO.	PART NAME	No. Req'd per Nxt Assy.	Old Print	Tracing	Tracing Revised	Vendor Print	Shop Print	No. Req'd this Job	ISSUED FOR						Quant. Fin.
									PURCH	MFR	MACH	FIN	INSP	ASSY	
E-35093 B	Sub Assembly - Collimator	1				✓✓	11/5/74								
A-28919	Focusing Knob	1													
A-28920	Focusing Knob Protector	1													
A-28921	Mirror Clip	3													
A-28924	Preload Spring Housing	2													
A-28925	Preload Spring Anchor	4													
A-28928	Idler Nut	1													
B-35243	Mirror f/7	1				✓	5/21/75								
D-35284-1	Housing f/7	1													
D-35285	Mirror Housing	1					11/5/74								
C-35286	Mirror Cell	1													
C-35287	Focusing Plate	1													
C-35288	End Plate	1													
C-35289	Cover	1													
B-35290	Indicator Housing	1													
B-35291	Lead Screw Master	1				✓									
B-35292	Lead Screw	2				✓									
A-35293	Indicator Retainer	1													
A-35294-1	Idler Spacer	1													
A-35294-2	Idler Spacer	1													
A-35295	Mirror Pad	3													
A-36276	Shaft Spacer	3													
A-41061	Guide Button	3													

Task #180

35819

CUSTOMER: BRERA OBSERVATORY, ITALY

JOB NO. 59007

GROUP ASSEMBLY: CASSEGRAIN SPECTROGRAPH NO. E-43488

DATE 11-5-74

SUB ASSEMBLY: CATHODE TUBE POWER SUPPLY NO. C-35819

SHEET 1 OF 1

DRAWING No.	PART NAME	No. Req'd Per Next Assy.	Old Print	Tracing	Tracing Revised	Vendor Print	Shop Print	No. Req'd This Job	ISSUED FOR						Quan. Fin.
									PURCH	MFR	MACH	FIN	INSP	ASSY	
C-35819	Sub Assembly	2) 1				✓✓	11/8/74								
C-35820	Chassis	1													
A-35821	Bracket	2													

DRAWING LIST Task #190 L- 38986

CUSTOMER BRERA OBSERVATORY, ITALY JOB NO. 59007

GENERAL ASSEMBLY CASSEGRAIN SPECTROGRAPH NO. E-43488 DATE 11-5-74

SUB ASSEMBLY EXPOSURE METER NO. D-38986 SHEET 1 OF 1

DRAWING NO.	PART NAME	No. Req'd per Next Assy.	Old Print	Tracing	Tracing Revised	Vendor Print	Shop Print	No. Req'd This Job	ISSUED FOR						Chem. Fin.
									PURCH	MFR	MACH	FIN	INSP	ASSY	
D-38986	Sub Assembly - Exposure Meter	1				✓✓	11/8/74								
B-27765	Photometer Mirror Plunger	1													
B-27767	Photometer Mirror Mounting	1													
A-38832	Filter Retainer	1													
B-38987	Exposure Meter Mount	1													
A-38988	Redirecting Mirror Support	1													
A-38989	Redirecting Mirror	1													

Task #110 59013

CUSTOMER	BRERA OBSERVATORY, ITALY		JOB NO. 59007
GENERAL ASSEMBLY	CASSEGRAIN SPECTROGRAPH	NO. E-43488	DATE 11-6-74
SUB ASSEMBLY	SLIT	NO. D-39013	SHEET 1 OF 1

DRAWING NO.	PART	Qty				Vendor Print	Shop Print	No. Req'd This Job	Issued For: Forge	Wfr	Mach	Fin	[illegible]	[illegible]	Quant. Fin.
D-39013	Sub Assembly - Slit	1				✓✓	11/8/74								
C-19409	Mount	1					△		Issued on Job 58957						
C-19410	Micrometer Mount	1					△		Issued on Job 58957						
B-19414	Decker Guide	2					11/8/74								
B-19416	Decker Dial Index	1					↓								
B-19417	Decker Drive Arm	1					△		Issued on Job 58957						
A-19418	Decker Drive Shaft	1					△								
A-19419	Decker Rack (Mod.)	1					△								
A-19420	Decker Pinion (Mod.)	1					△								
A-19422	Spring Rod	2					△								
A-19423	Micrometer Clamp	1					△								
A-19609	Special Set Screw	4					△		Issued on Job 58957						
C-26755	Decker Knob	1					11/8/74								
B-26756	Decker	1													
B-26758	Decker Dial	1				✓	↓								
A-26759	Shoulder Screw (Mod.)	1					△		Issued on Job 58957						
B-35218	Slit Jaw	1 Ea.					△								
A-35219	Slit Push Rod	1					△								
A-37194	Spring	2					△								
A-37195	Spring Guide	2					△		Issued on Job 58957						
A-27828	Field Lens Cell	1													
A-27829	Field Lens	1													
A-27833	Knurled Captive Screw	2													

PO. [illegible] STEVENS — DRAWING LIST — Task #240 — 40841

CUST. [illegible] BRERA OBSERVATORY, ITALY — JOB NO. 59007

GEN'L ASSEMBLY CASSEGRAIN SPECTROGRAPH — NO. E-43488 — DATE 12-19-74

SUB ASSEMBLY PLATEHOLDERS — NO. D-40841 — SHEET 1 OF 1

DRAWING NO.	PART NAME	No. Req'd for Next Assy.	Old Print	Tracing	Tracing Revised	Vendor Print	Shop Print	No. Req'd This Job	ISSUED FOR						Quant. F.O.
									PURCH	MFR	MACH	FIN	INSP	ASSY	
D-40841	Sub Assembly - Plateholders	1				✓✓	12/19/74	2							
C-35024	Dark Slide Retainer	1						2							
B-35025	Dark Slide	1						2							
A-35032	Dark Slide Handle	1						2							
A-35035	Thumbwheel	1						2							
A-35036	Diaphragm	1						2							
A-35037	Stud	1						2							
A-35038	Slug	3						6							
A-36291	Stop Ring	1						2							
A-36754-1	Dark Slide Stops	2						4							
A-36754-2	Dark Slide Stops	4						8							
A-36903	Thumbwheel Retainer	1						2							
C-40842	Plateholder Body	1						2							
C-40843	Plateholder Housing	1						2							
A-40844	Plate Clip	4						8							
A-40845	Spring Modification	4					Y	8							

Task #140 - 41010

CUSTOMER: BRERA OBSERVATORY, ITALY

GEN'L ASSEMBLY: CASSEGRAIN SPECTROGRAPH NO. E-43488

SUB ASSEMBLY: SLIT VIEWER NO. D-41010

JOB NO. 59007

DATE 11-6-74

SHEET 1 OF 1

DRAWING NO.	PART NAME	No. Reqd per Next Assy.	Old Print	Tracing	Tracing Returned	Vendor Print	Stock Print	No. Reqd This Job	ISSUED FOR						Quant. Fin.
									PURCH	MFR	MACH	FIN	INSP	ASSY	
D-41010 C	Sub Assembly - Slit Viewer	1			12/6	✓✓	11/8/74								
C-41011 A	Eyepiece Mounting Tube	1			12/6										
B-41012	Entrance Cover Plate	1													
B-41013	Lock Collar	2													
B-41014 A	Retainer	1													
B-41015	Lens Tube	1													
B-41016	Mounting Sleeve	1													
B-41017 A	Rotation Collar	1													
A-41018	Mirror	1													
A-41019	Mirror Mount Cap	1													
A-41020-1 A	Lens Cartridge	2													
A-41020-2 A	Stop Cartridge	1													
A-41021	Mirror Mount	1													
A-41022	Mirror Mount Plug	1													
A-41023 A	Stop	2													
A-41024	Handle Modification	1													
A-41025	Retaining Ring	1													
S-43212	Eyepiece Stop	1													
A-43216	Eyepiece Modification	1					11/18/74								
A-43638	Lock Screw	1	1 For L-41136				12/6/74 2								
A-43639	Lock lever	1	"	"			12/6/74 2								

[redacted] DRAWING LIST Task #140 L- 41036

CUSTOMER: BRERA OBSERVATORY, ITALY JOB NO. 59007

GENERAL ASSEMBLY: CASSEGRAIN SPECTROGRAPH NO. E-43488 DATE 11-6-74

SUB ASSEMBLY: FILTER/MIRROR NO. C-41036 SHEET 1 OF 1

DRAWING NO.	PART NAME	No. Req'd per Next Assy.	Old Print	Tracing	Tracing Revised	Vendor Print	Shop Print	No. Req'd This Job	ISSUED FOR						Quant. Fin.
									PURCH	MFR	MACH	FIN	INSP	ASSY	
✓C-41036	Sub Assembly - Filter/Mirror	1				✓✓	11/8/74								
C-41037	Filter/Mirror Housing	1													
C-41038	Filter/Mirror Mount	1													
B-41039	Mirror Mount	1													
A-41040	Mirror	1													
A-41041	Filter	Ref.													
A-41042-1	Filter Clip	1													
A-41042-2	Filter Clip	1													
A-41043	Detent Mount	1													
A-41044	Stop Pin	2													
A-42969	Stop Plate	1													
A-42970	Ball Detent Modification	1													

BOLLER & CHIVENS — DRAWING LIST — Task #230 — D-42440

CUSTOMER	BRERA OBSERVATORY, ITALY		JOB NO. 59007
GENERAL ASSEMBLY	CASSEGRAIN SPECTROGRAPH	NO. E-43488	DATE 12-19-74
SUB ASSEMBLY	DIRECT PHOTOGRAPHY MODULE	NO. D-42440	SHEET 1 OF 1

DRAWING NO.	PART NAME	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Shop Print	No. Reqd This Job	ISSUED FOR PURCH	MFR	MACH	FIN	INSP	ASSY	Quant. Fin.
√ D-42440	Sub Assy-Direct Photography Module	1				✓✓	12/19/74								
D-35089	Sub Assembly - Bowen Optics Cam.	Ref.					Δ		Separate		Issue				
D-40841	Sub Assembly - Plateholders	Ref.					Δ		Separate		Issue				
C-35021 A	Frame	1			[illegible]/75		12/19/74	2							
A-35031-1	End Tab	1					↓	2							
A-35031-2	End Tab	1						2							
A-35034	Latch	2						4							
A-35448	Field Flattener	1						1							
D-35480	Film Holder Mounting Ring	1						1							
A-36926	Washer	2						4							
A-36927-1	Stud	2						4							
A-36928	Lock	2						4							
D-42412	Housing	1													
S-44905	Wedge Spacer Ring	1													

DRAWING LIST TASK #130 L 43671

CUSTOMER BRERA OBSERVATORY, ITALY JOB NO. 59007

GEN. ASSEMBLY CASSEGRAIN SPECTROGRAPH NO. E-43488 DATE 12-18-74

SUB ASSEMBLY GRATING NO. D-43671 SHEET 1 OF 1

DRAWING NO.	PART NAME	No. Req'd For Next Assy.	Old Print	Tracing	Tracing Revised	Vendor Print	Shop Print	No. Req'd This Job	ISSUED FOR						Quant. Fin.
									PURCH	MFR	MACH	FIN	INSP	ASSY	
√ D-43671	Sub Assembly - Grating	1				✓✓	3/10/75								
B-18852	Outboard Support	1					12/19/74								
A-18865	Outboard Pivot	1													
A-19583	Captive Screw	2													
A-19584	Outboard Bearing	1													
C-27738A	Grating Retainer	1													
B-27739	Cover	1													
A-27740	Counterweight	2													
A-27741	Pressure Pad	7													
A-28835	Dial Lock Screw Modification	1													
A-30885	Stud	2													
C-35771	Cell	1													
D-35772	Cell Housing	1													
C-35773	Drive Housing	1													
B-35774	Drive Shaft	1													
B-35775	Drive Knob	1													
B-35776	Dial Modification	1													
A-35777	Bearing Collar	1													

DRAWING LIST | TASK #230 | L- 43752

CUSTOMER: BREA OBSERVATORY | JOB NO. 59007

GENERAL ASSEMBLY: CASSEGRAIN SPECTROGRAPH | NO. E-43488 | DATE 2-7-75

SUB ASSEMBLY: F/5 DIRECT PHOTOGRAPHY MODULE | NO. D-43752 | SHEET 1 OF 1

DRAWING NO.	PART NAME	[illegible]	[illegible] Print	Tracing	[illegible]	Vendor Print	Shop Print	No. Req'd This Job	ISSUED FOR PURCH	MFR	MACH	FIN	INSP	ASSY	Quant. Fin.
✓ D-43752	Sub Assembly	1				✓✓	2/10/75								
D-40841	Sub Assembly - Plate Holder	Ref.					△		Separate Issue						
D-43755	Sub Assembly - F/5 Spectro. Camera	Ref.					△		Separate Issue						
C-35021	Frame	1					△△		Issued on L-42440						
A-35031-1	End Tab	1					△△								
A-35031-2	End Tab	1					△△								
A-35034	Latch	2					△△								
A-36926	Washer	2					△△								
A-36927-1	Stud	2					△△								
A-36928	Lock	2					△△		Issued on L-42440						
D-43753	Housing	1					2/10/75								
D-43754	Plate Holder Mounting Ring	1													
B-44901	Spacer Ring	1													

PROJECT DRAWINGS — DRAWING PARTS LIST — Task #210 — L.- 43755

CUSTOMER: BRERA OBSERVATORY — JOB NO. 59007

GENERAL ASSEMBLY: CASSEGRAJN SPECTROGRAPH — NO. E-43488 — DATE 2-7-75

SUB ASSEMBLY: F/5 SPECTROGRAPHIC CAMERA — NO. D-43755 — SHEET 1 OF 1

DRAWING NO.	PART NAME	No. Req'd Per Next Assy.	Old Print	Tracing	Tracing Revised	Vendor Print	Shop Print	No. Req'd This Job	ISSUED FOR						Current Rev.
									PURCH	MFR	MACH	FIN	ASSY		
√D-43755	Sub Assembly	1				✓✓	2/10/75								
D-43756	Mounting Flange	1													
C-43757	Optical Diagram	Ref.													
C-43758	Housing	1													
B-43759	Primary Retainer	1													
B-43760	Lens Spacer	1													
B-43761	Lens Cap	1													
B-43762	Lens Retainer	1													
A-43763	Plug	1													

DRAWING LIST

Task #100

L- 43845

CUSTOMER: BRERA OBSERVATORY

JOB NO. 59007

CENTRAL ASSEMBLY: CASSEGRAIN SPECTROGRAPH NO. E-43488

DATE 3-21-75

SUB ASSEMBLY: STORAGE STAND NO. D-43845

SHEET 1 OF 1

DRAWING NO.	PART NAME	No. Parts per Next Assy.	Old Print	Tracing	Tracing Revised	Vendor Print	Shop Print	No. Required This Job	ISSUED FOR						Current Rev.
									PURCH	MFR	MACH	FIN	INSP	ASSY	
D-43845	Sub Assembly - Storage Stand	1				✓✓	3/21/75								
D-35843	Stand	1					↓								
A-43846	Guide Pin	2					↓								

DESIGN DRAWING | **DRAWING LIST** | Task #250 | L- 44614

CUSTOMER: BRERA OBSERVATORY | JOB NO. 59007

GENERAL ASSEMBLY: CASSEGRAIN SPECTROGRAPH | NO. E-43488 | DATE 6-2-75

SUB ASSEMBLY: FOCAL RATIO CONVERTER | NO. 44614 | SHEET 1 OF 1

DRAWING NO.	PART NAME	No. Req'd per Next Assy.	Old Print	Tracing	Tracing Revised	Vendor Print	Shop Print	No. Req'd This Job	ISSUED FOR						Current Fin.
									PURCH	MFR	MACH	FIN	INSP	ASSY	
44614	Sub Assembly - Focal Ratio Conv.	1													
B-44613	Focal Ratio Converter Optics	1				SRN LINE ✓	6/2/75								

[redacted] DRAWING LIST TASK #160 L - 44900

CUSTOMER BRERA OBSERVATORY JOB NO. 59007

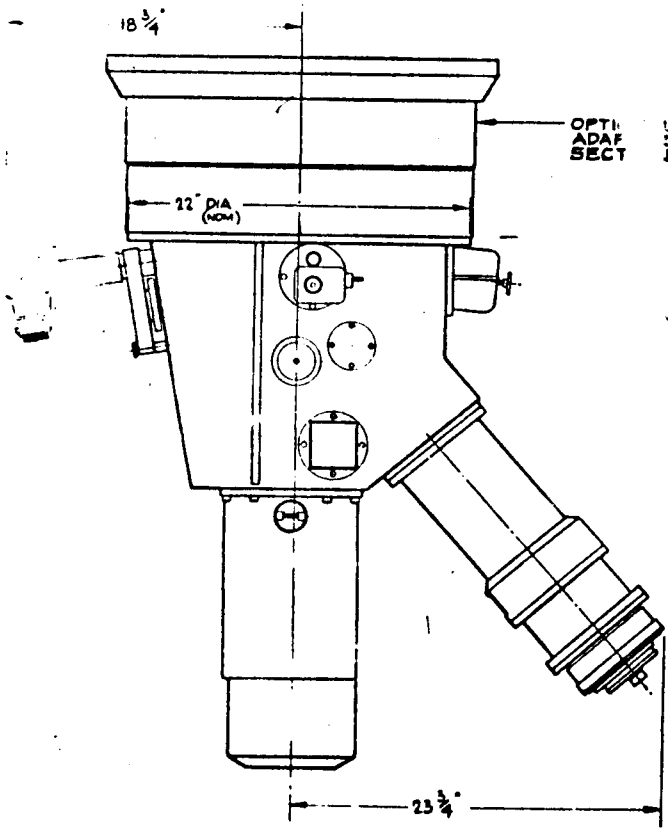
GENERAL ASSEMBLY CASSEGRAIN SPECTROGRAPH NO. E-43488 DATE 11-5-74

SUB ASSEMBLY COMPARISON PERISCOPE NO. C-44900 SHEET 1 OF 1

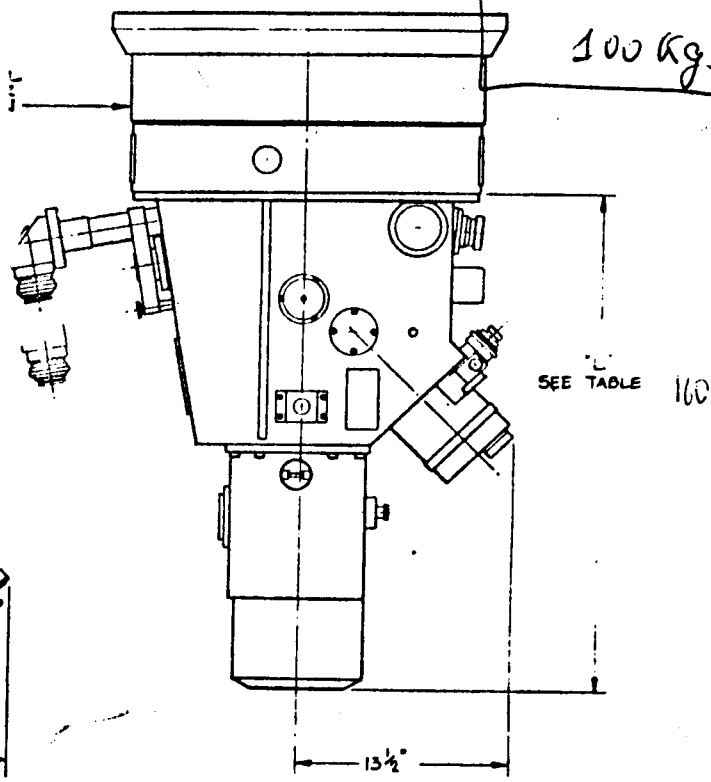
DRAWING NO.	PART NAME	No. Req'd Per Next Assy.	Old Print	Tracing	Tracing Revised	Vendor Print	Shop Print	No. Req'd This Job	ISSUED FOR						Quant Fin.
									PURCH	MFR	MACH	FIN	INSP	ASSY	
C-44900	Sub Assembly - Comp. Periscope	1				✓✓	11/8/74								
B-19053	Mount	1													
A-19056	Knob	1													
A-19057	Bearing Housing	1													
A-19058	Index Plunger	1													
A-19059	Index Spring	1													
A-19060	Rotating Mirror Shaft	1													
A-19061	Rotating Mirror Cell	1													
A-19063	Rotating Mirror Clamp	1													
A-25469	Stop Screw Modification	1													
B-39033	Slit Mirror Support	1													
B-39034	Tube	1													
A-39037	Slit Illumination Mirror	1													
A-39038	Slit Mirror Clip	1													
S-44898	Diagonal Mirror Retainer	1					7/18/74								
S-44899-1	Lens Retainer	1													
S-44899-2	Lens Retainer	1													
S-44899-3	Lens Retainer	1													

BO'..LER & CHIVL 'S MODEL 31523 CASSEGRAIN SPL :TROGRAPHS

90×90×130
100 kg.



YPICAL SPECTROGRAPH
TH IMAGE TUBE CAMERA
0 mm. COLLIMATOR



TYPICAL SPECTROGRAPH
WITH 100 mm. SCHMIDT CAMERA
AND 75 mm. COLLIMATOR

GENERAL DESCRIPTION

Boller & Chivens Model 31523 designates a family of highly efficient grating spectrographs designed for use at the Cassegrain focus of telescopes with apertures 30 inches in diameter or larger. Dispersions of 40 to 550 A/mm can be used by the proper selection of cameras and gratings. Two types of cameras are available, flat field S idts for direct spectral photography and Sc idt Cassegrain cameras, with image tubes, for image intensified photography. Many optional features are available from existing designs and we can furnish custom designed components to serve specialized requirements.

Our figures on this data sheet show the configuration and the optical arrangement of two typical examples of the Model 31523 Cassegrain spectrograph. The adapter section is designed to fit each specific telescope or it can be guided by an offset guider.

The standard collimator diameters are available, 75 mm., 90 mm., and 100 mm. The smaller collimator is adequate for Boller & Chivens' Schmidt photographic cameras, particularly when the spectrograph is used on smaller telescopes. With image tube cameras, the larger collimator is preferred, especially with faster telescopes. The 90 mm. diameter is frequently selected in preference to the larger collimator, to limit the vignetting of the off-axis field. The focal ratio of the collimator will be selected to match the telescope on which it will be used. Although the length of the instrument usually depends on the focal ratio of the collimator, it may be shortened by using a special UV-transmitting conversion lens. The structure is unusually rigid to minimize deflections during long exposures.

Each spectrograph is thoroughly tested at our plant. With each spectrograph, we furnish three parfocalized plateholders, a stand for storage and maintenance, hardwood boxes for the cameras, plateholders and gratings, and a technical manual.

MECHANICAL SPECIFICATIONS

Telescope F/D	Length "L" (in) 75 mm. Collimator	Length "L" (in) 90 mm. Collimator	Length "L" (in) 100 mm. Collimator
8	31.5	35.8	38.9
10	37.5	42.9	46.8
12	43.5	50.0	54.7
14	49.5	57.1	62.6
16	55.5	→ 64.1 ←	70
18	61.5	71.2	7

RAPPORTO INTERNO n° 7

CALCOLO TEORICO DELLA EFFICIENZA RELATIVA DEI RETICOLI PER LO SPETTROGRAFO B&C DEL TELESCOPIO RUTHS DA 137 CM DI MERATE.

R. FALOMO

MAGGIO 1982

OSSERVATORIO ASTRONOMICO DI BRERA

Via Brera, 28 - 20121 MILANO

Via E. Bianchi, 46 - 22055 MERATE (CO)

ITALY

Lo scopo di questo lavoro é di fissare un riferimento per i lavori spettroscopici che necessitino una calibrazione cromatica, per lo spettrografo B & C del telescopio Ruths.

I - INTRODUZIONE

Il telescopio Ruths dell'Osservatorio astronomico di Brera - Merate nella sua attuale configurazione viene impiegato per lavori di spettrografia utilizzando uno spettrografo della Boller and Chivens (vedi manuale d'uso della B & C) con un collimatore f/7 da $\sim$ 63 cm e due camere Bowen-Schimdt una da 14 cm (FL) e l'altra da 45 cm.

La scala sul piano della fenditura é di circa 19.2 "/mm mentre sul piano focale delle camere, tenuto conto che l'ingrandimento é 0.22 con la camera corta e 0.71 con la camera lunga, é rispettivamente di 87.28 "/mm e 27.04 "/mm.

Attualmente sono disponibili 5 reticoli di diffrazione le cui caratteristiche sono riportate in tabella 3.

Nella tabella 2 sono invece riportate le lunghezze d'onda centrali dello spettro osservato (al I° ordine) in funzione dell'angolo i di inclinazione del reticolo. Il range spettrale al primo ordine può essere dedotto infine dalla tabella 1.

TABELLA 1

RETICOLO tr/mm	400	600	1200
Camera 14 cm	6100	4000	2000
Camera 45 cm	1900	1200	650

Range spettrale

Camera 14.5 cm
Merate

TABELLA 3

Cat. N	(1) tratti/mm	(2) a (Å)	(3) θ_B	(4) λ_B	(5) M	(6) disp. 14 (Å/mm)	(7) disp. 45 (Å/mm)
35-53-17-590	400	25.000	13°54'	10920	0.79	175	54
35-53-17-580	400	25.000	9°44'	7703	0.85	173	54
35-53-17-260	600	16.667	8°38'	4550	0.87	114	35
35-53-17-350	600	16.667	13°00'	6825	0.81	116	36
35-53-17-530	1200	8.333	36°52'	9100	0.49	58	18

(1) numero tratti per mm

(2) a = inverso del n° di tratti per Å

(3) θ_B = angolo di blaze

(4) λ_B = lamda di blaze in configurazione non-littrow. (λ_o = lamda di blaze in catalogo)

$$\lambda_B = \lambda_o \cos \tfrac{1}{2} (\alpha - \theta_B) = \lambda_o \cos \tfrac{\phi}{2} = 0.91\ \lambda_o$$

$$\beta_B = i - \phi/2 \quad ; \quad \frac{n \lambda \theta}{a} = \text{sen}\alpha + \text{sen}\beta_B$$

(5) ingrandimento causato dal reticolo

$$M = \frac{\cos\alpha}{\cos\beta} = \frac{1 - \text{tang}\,\theta\,\text{tang}\,\phi/2}{1 + \text{tang}\,\theta\,\text{tang}\,\phi/2}$$

(6) dispersione con la camera da 14 cm in Å/mm

(7) dispersione con la camera da 45 cm in Å/mm

GRATING WITH 400 GROOVES/mm

INCLINATION ANGLE	CENTRAL WAVELENGTH
5	3965.32
6	4755.77
7	5544.69
8	6331.96
9	7117.30
10	7900.47
11	8681.24
12	9459.36
13	10234.60

GRATING WITH 1200 GROOVES/MM

INCLINATION ANGLE	CENTRAL WAVELENGTH
13	3411.40
14	3668.76
15	3925.01
16	4180.06
17	4433.84
18	4686.26
19	4937.26
20	5186.76
21	5434.68
22	5680.94
23	5925.47
24	6168.19
25	6409.04
26	6647.94
27	6884.81
28	7119.58
29	7352.18
30	7582.55
31	7810.60
32	8036.28
33	8259.51
34	8480.22
35	8698.35
36	8913.83
37	9126.60
38	9336.58
39	9543.72
40	9747.96

GRATING WITH 600 GROOVES/MM

INCLINATION ANGLE	CENTRAL WAVELENGTH
8	4221.14
9	4744.68
10	5266.77
11	5787.26
12	6305.99
13	6822.79
14	7337.52
15	7850.02
16	8360.12
17	8867.67
18	9372.53
19	9874.53
20	10373.52

TAB 2

II - CALCOLO DELLA EFFICIENZA DEI RETICOLI

Usiamo le stesse notazioni del manuale B & C, come in fig.1. Quando il raggio diffratto é al centro dello spettro osservato, allora:

i = inclinazione del reticolo

$\alpha = 24.5 + i$

La distribuzione di luce $I(\beta)$ nello spettro prodotto da una luce bianca é (D.Gray, The observations and analysis of stellar photospheres, 1976, pag.58):

$$I(\beta) = \frac{\operatorname{sen}^2 A}{A^2} \qquad (1)$$

dove A vale:

$$A = n\pi \{ \cos\theta_\beta - [\operatorname{sen}\theta_\beta / \operatorname{tg} \tfrac{1}{2} (\alpha+\beta)] \} \qquad (2)$$

La relazione tra l'angolo β e la lunghezza d'onda λ é:

$$\beta = \operatorname{arcsen} [\frac{\lambda n}{a} - \operatorname{sen}\alpha] \qquad (3)$$

La λ_c al centro dello spettro osservato vale:

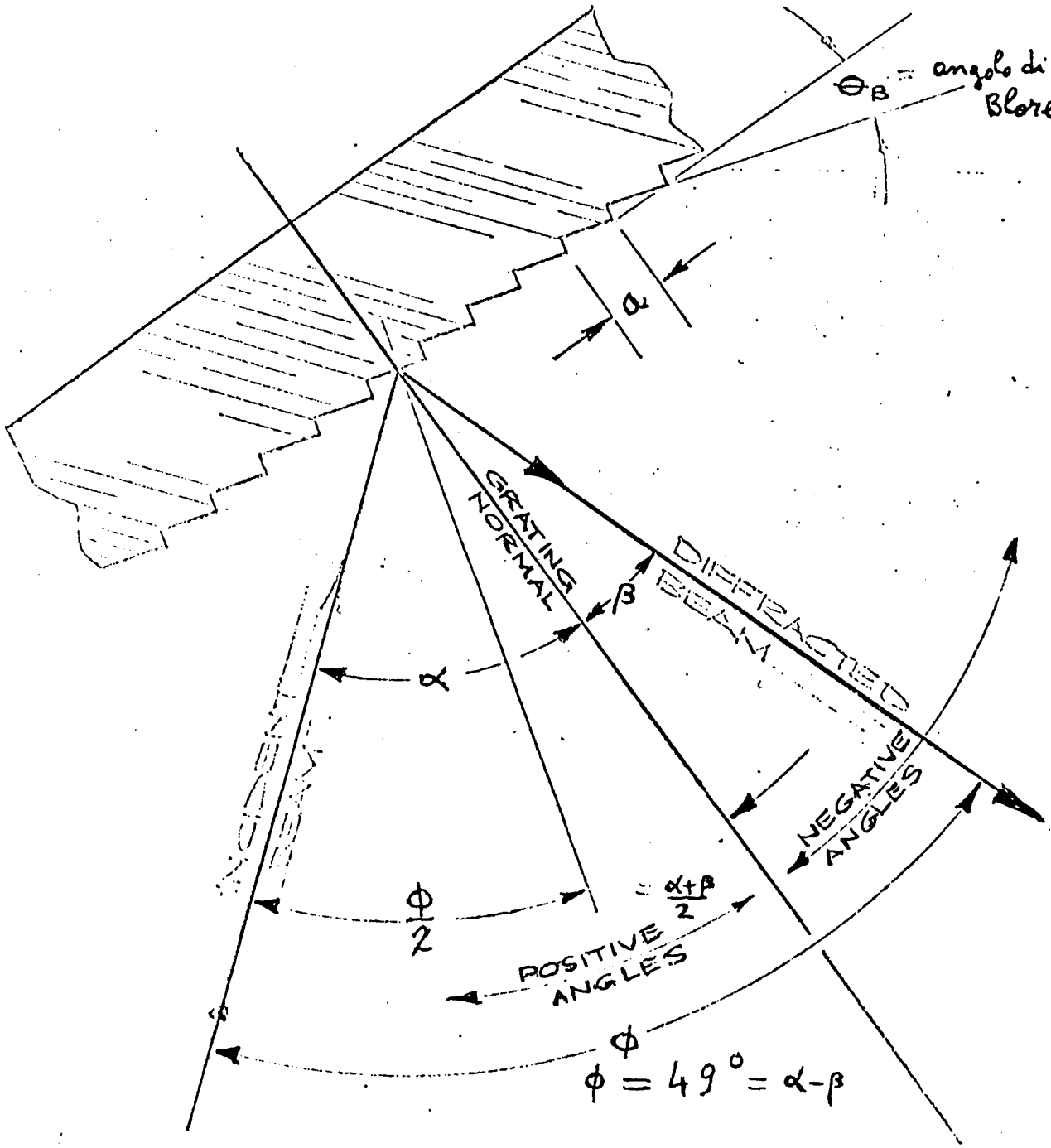
$$\lambda_c = \frac{a}{n} (\operatorname{sen}\alpha + \operatorname{sen}\beta_c)$$

$$\beta_c = -\frac{\phi}{2} + i = -24.5 + i$$

Utilizzando le relazioni (1), (2) e (3) e i dati di tab 1 é stata calcolata l'efficenza relativa dei 5 reticoli disponibili. Le curve delle fig 2, 3, 4, 5 e 6 riportano l'efficenza in funzione della lunghezza d'onda. Il tratto continuo si riferisce al primo ordine, quello tratteggiato al secondo ordine.

RINGRAZIAMENTI

Desidero ringraziare il Sig. G.Malaspina per la realizzazione al computer dei grafici di questo lavoro.



λ = lunghezza d'onda in Å

n = n° d'ordine dello spettro

θ_B = angolo di Blaze

α = angolo tra raggio incidente e la normale al reticolo

β = " " " riflesso " " " "

φ = angolo tra il raggio incidente e diffratto = α - β

(angolo tra collimatore e cmaera)

a = larghezza dei tratti in Å

FIG 1

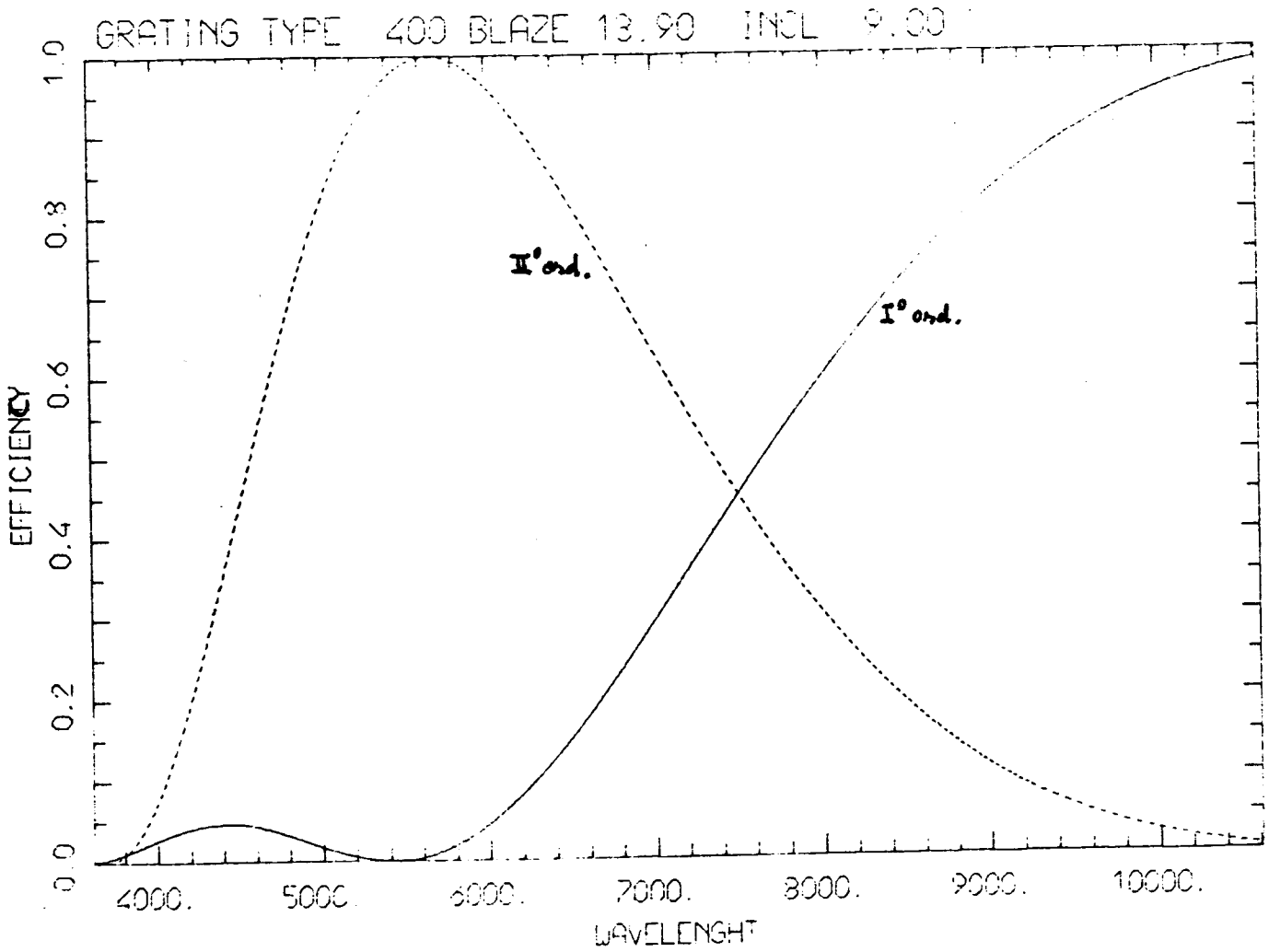
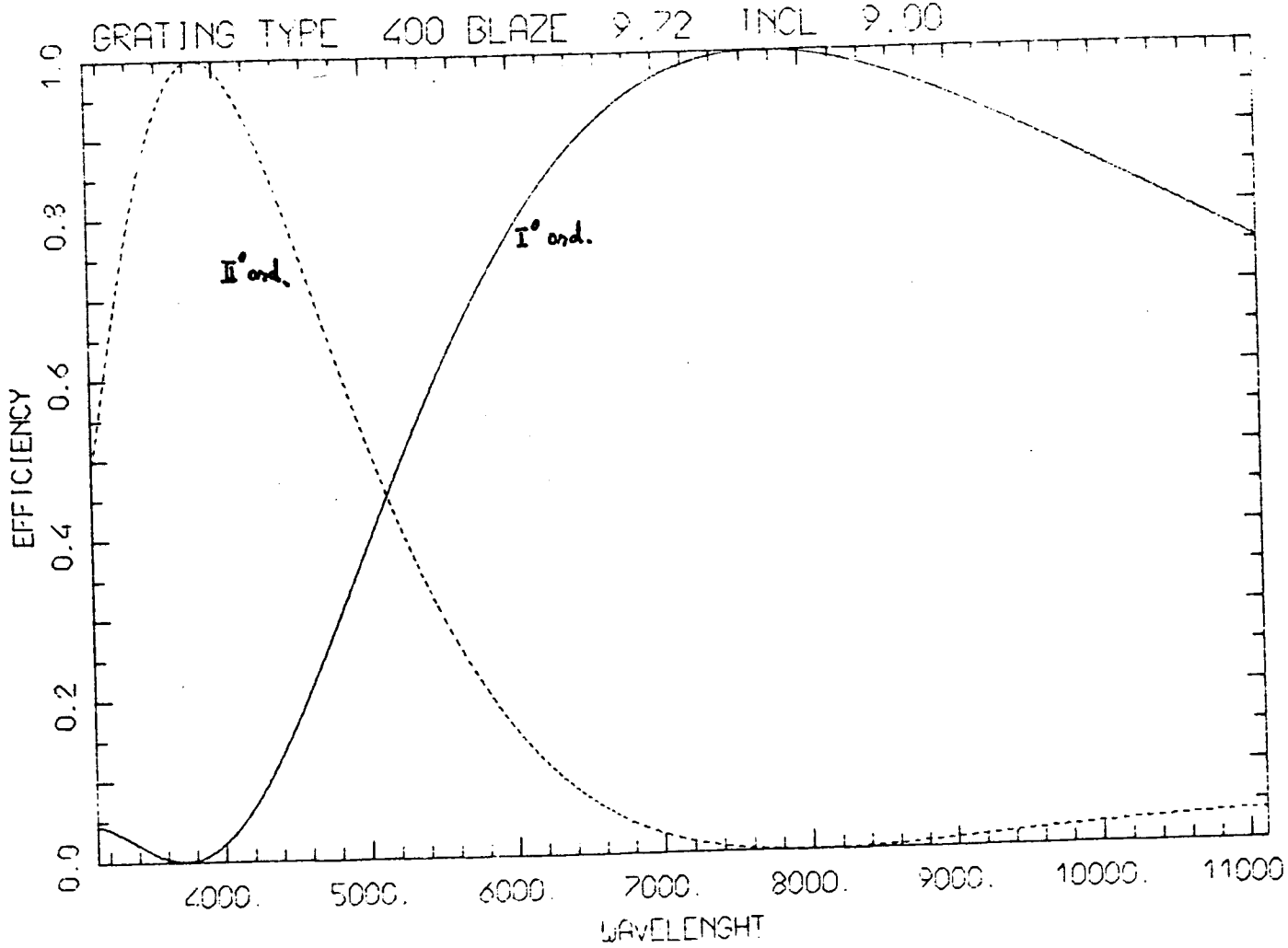

GRATING TYPE 400 BLAZE 13.90 INCL 9.00
EFFICIENCY
0.0
0.2
0.4
0.6
0.8
1.0
II° ord.
I° ord.
4000.
5000.
6000.
7000.
8000.
9000.
10000.
WAVELENGHT

Fig 3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EFFICIENCY
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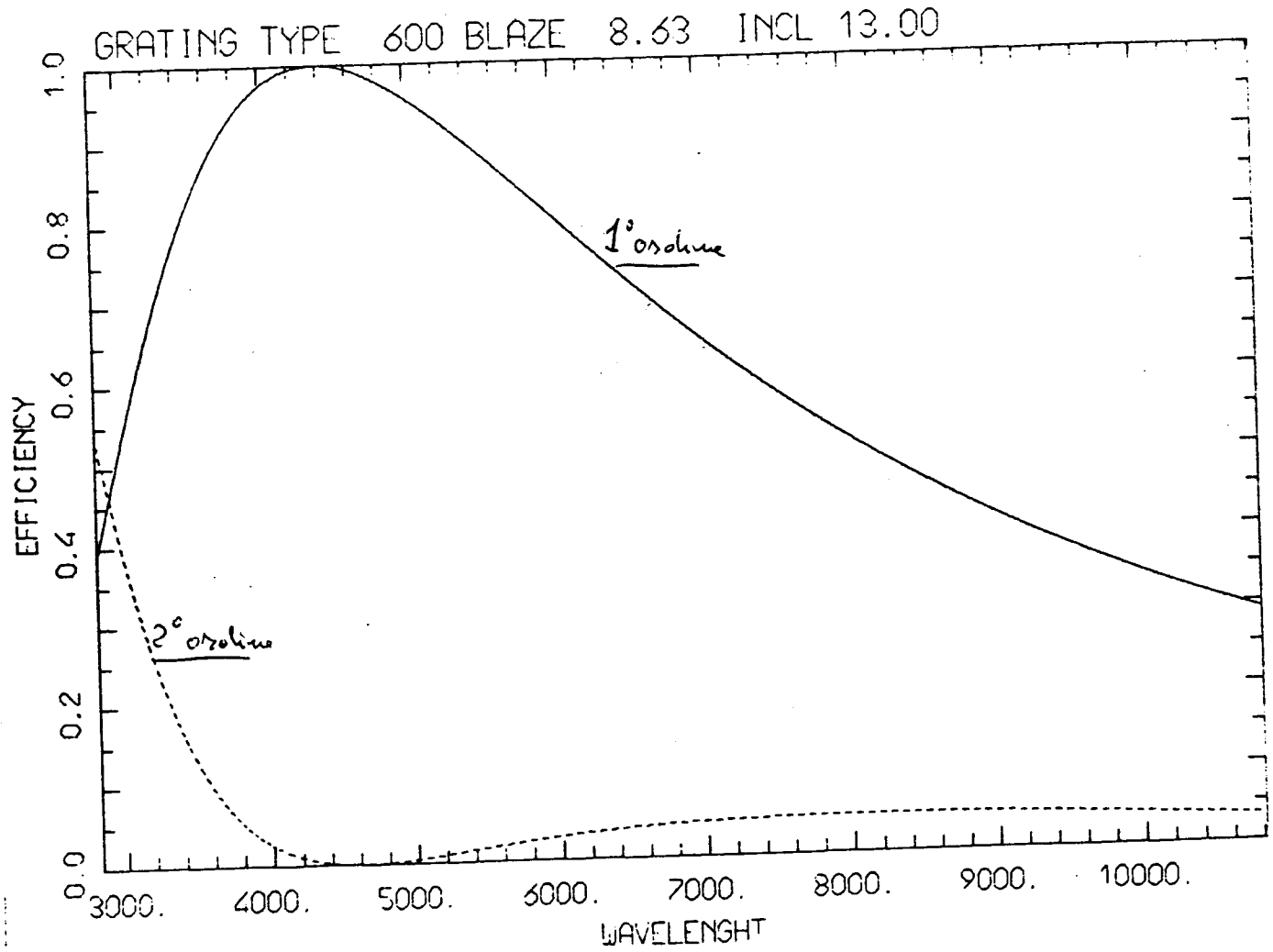
0.6
0.8
1.0
II° ord.
I° ord.
4000.
5000.
6000.
7000.
8000.
9000.
10000.
11000.
WAVELENGHT

Fig 2


GRATING TYPE 600 BLAZE 8.63 INCL 13.00
EFFICIENCY
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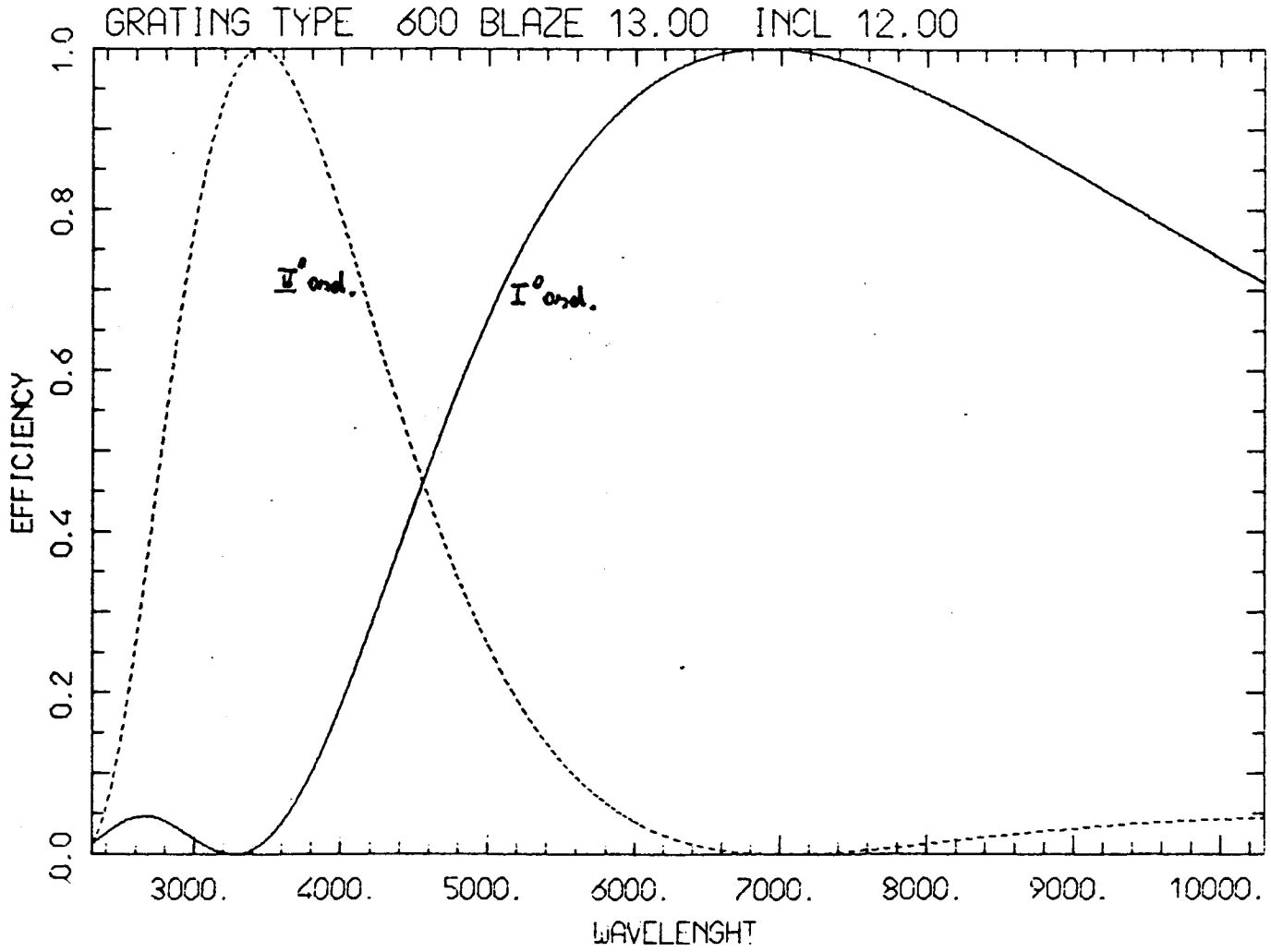
0.4
0.2
0.0
1° ordine
2° ordine
3000.
4000.
5000.
6000.
7000.
8000.
9000.
10000.
WAVELENGHT

Fig 4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EFFICIENCY
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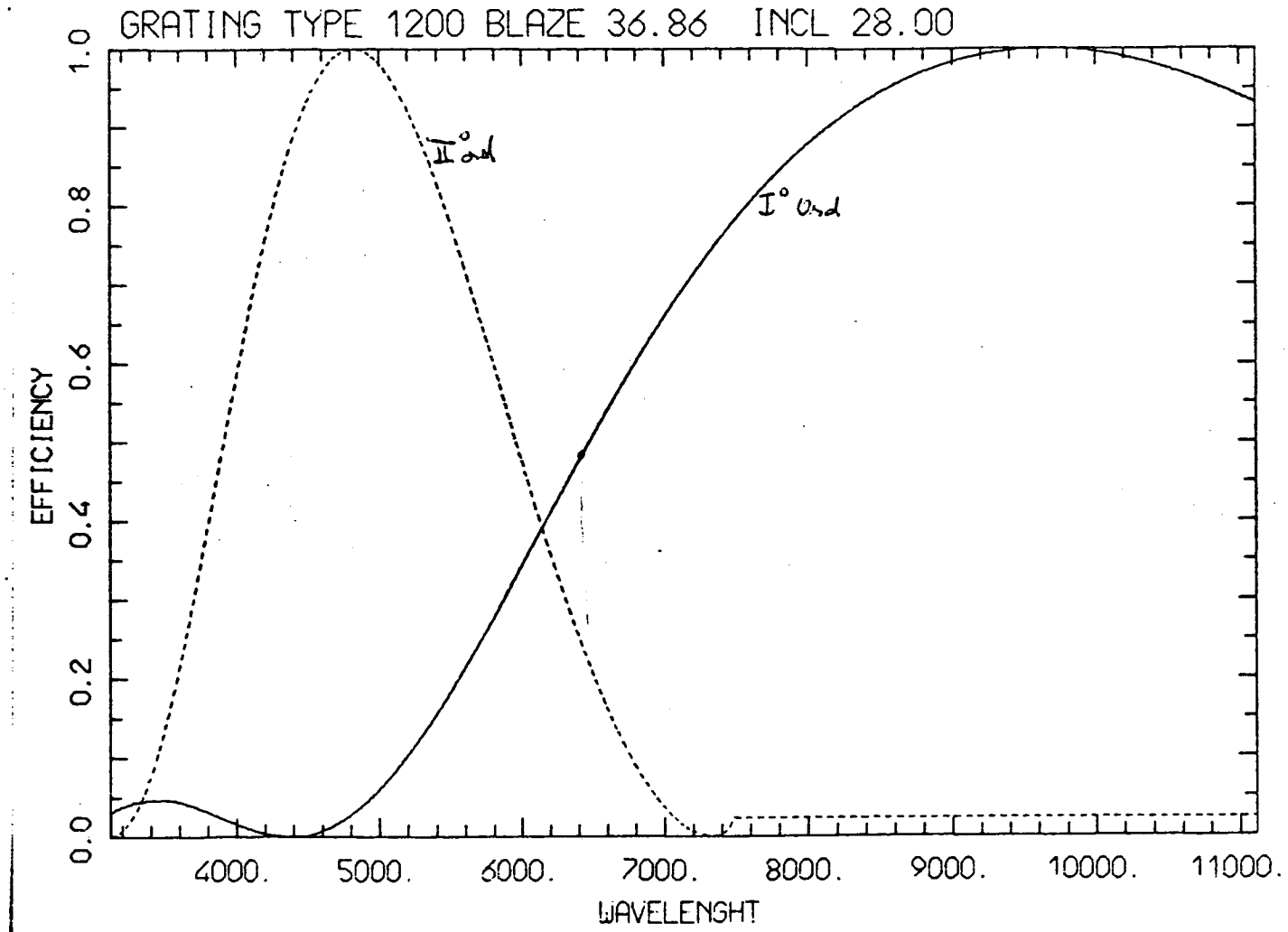
0.4
0.6
0.8
1.0
II° ord.
I° ord.
3000.
4000.
5000.
6000.
7000.
8000.
9000.
10000.
WAVELENGHT

Fig 5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EFFICIENCY
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0.2
0.4
0.6
0.8
1.0
II°ord
I°ord
4000.
5000.
6000.
7000.
8000.
9000.
10000.
11000.
WAVELENGHT

Fig 5

TABLE 1

The emission lines of the H-C Fe-A source of the B&C spectrograph

	Wavelength (A)	Identification	Notes	
1	10830.337	A	Low Intensity	Good
2	10470.054	A	Low Intensity	Good
3	9784.503	A		Good
4	9657.786	A		Good
5	9354.220	A	Low Intensity	Good
6	9224.499	A		Good
7	9122.975	A I		Good
8	8667.942	A I		Good
9	8521.442	A I		Good
10	8424.647	A I	(blend	Good
11	8408.2	A I	(blend	Good
12	8264.522	A I		Good
13	8115.311	A I	(blend	Good
14	8103.692	A I	(blend	Good
15	8014.786	A I	[blend	Not good
16	8006.156	A I	[blend	Not good
17	7948.175	A I		Good
18	7723.761	A I	Blend	Good
19	7635.106	A I		Good
20	7514.650	A I	(blend	Good
21	7503.868	A I	(blend	Good
22	7383.981	A I		Good
23	7272.9	A I		Good
24	7147.042	A I	Low intensity	Good
25	7067.2	A I		Good
26	6965.431	A I		Good
27	6871.3	A I	Low intensity	Good
28	6752.8	A I	Low intensity	Not good
29	6677.993	Fe I	Low intensity	Not good
30	6416.3	A I	Low intensity	Good
31	6172.4	A II	Blend	Good
32	6114.9	A II	Low intensity	Good
33	6043.2	A I	(blend	Good
34	6032.1	A I	(blend	Good
35	5912.1	A I	Low intensity	Good
36	5888.6	A I	Low intensity	Good
37	5495.9	A I	Blend	Not good
38	5455.613	Fe I	(blend	Not good
39	5446.920	Fe I	(blend	Not good
40	5429.699	Fe I		Not good
41	5405.778	Fe I	(blend	Not good
42	5397.131	Fe I	(blend	Not good
43	5371.493	Fe I		Good
44	5328.534	Fe I		Not Good
45	5270.360	Fe I		Not Good
46	5227.192	Fe I		Not Good
47	5167.491	Fe I		Not Good
48	5141.8	A II	Low intensity	Not good
49	5062.070	A II	Low intensity	Not good
50	5017.160	A II	Blend	Not good
51	4965.120	A II	(blend	Good

52	4957.603	Fe I	(blend	Good
53	4879.9	A II	Blend	Good
54	4847.900	A II	Low intensity	Good
55	4806.070	A II	Low intensity	Good
56	4764.890	A II		Good
57	4735.930	A II	(blend	Not good
58	4726.910	A II	(blend	Not good
59	4657.940	A II		Good
60	4609.600	A II		Good
61	4589.930	A II	(blend	Good
62	4579.344	A II	(blend	Good
63	4545.080	A II		Good
64	4510.733	A I	Low intensity	Not good
65	4481.830	A II	Low intensity	Not good
66	4404.8	Fe I	-	Good
67	4383.547	Fe I	Blend	Good
68	4325.8	Fe I		Good
69	4200.	A I - Fe I	Blend	Good
70	4158.591	A I		Good
71	4103.910	A II	Low intensity	Good
72	4045.815	Fe I		Good
73	3886.284	Fe I	Blend	Good
74	3859.		Blend	Not good
75	3705.567	Fe I	Blend	Good
76	3679.915	Fe I	Low intensity	Good
77	3647.844	Fe I		Good
78	3631.464	Fe I		Good
79	3618.769	Fe I		Not good
80	3608.861	Fe I		Not good
81	3581.195	Fe I	Blend	Good

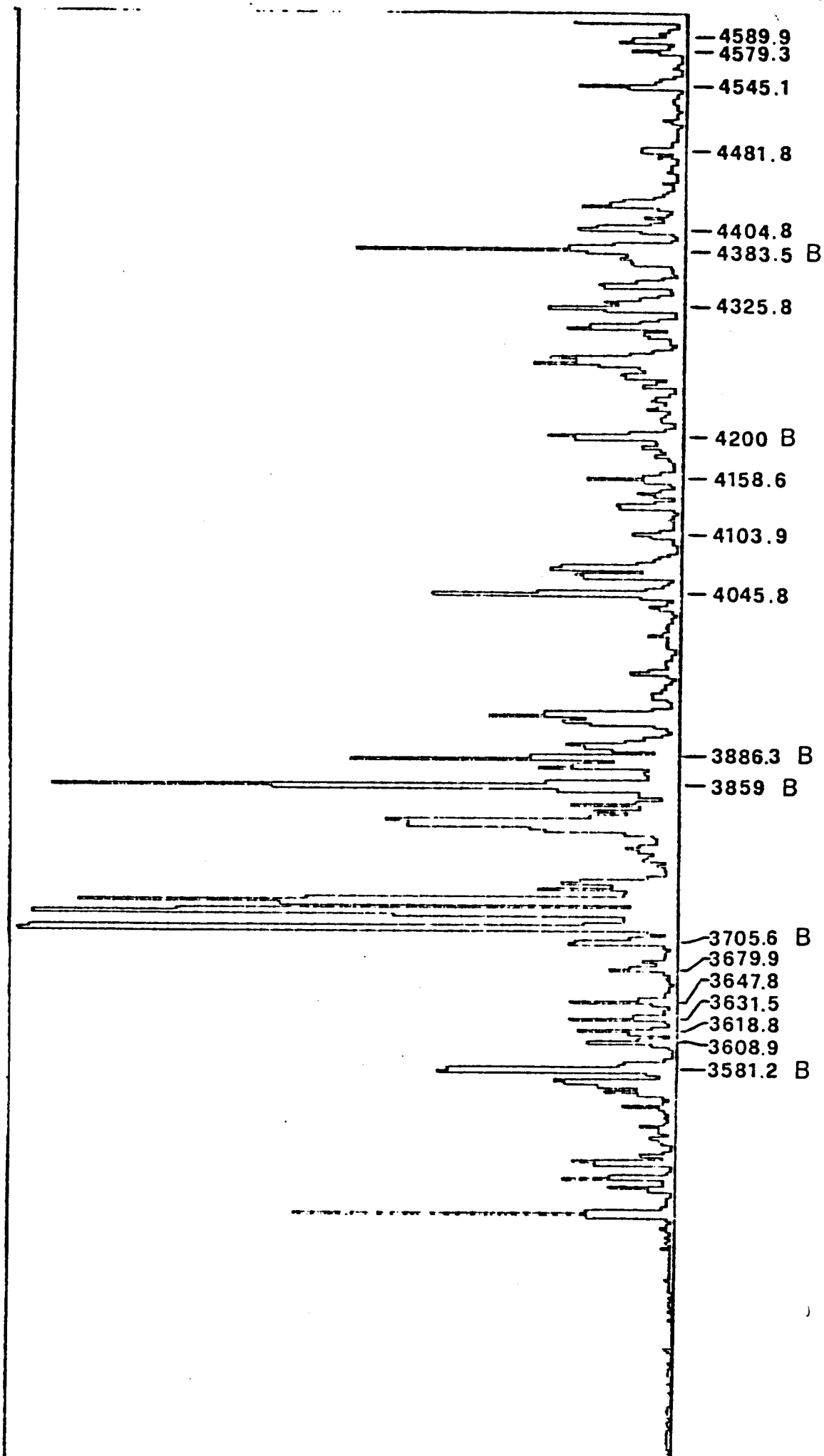
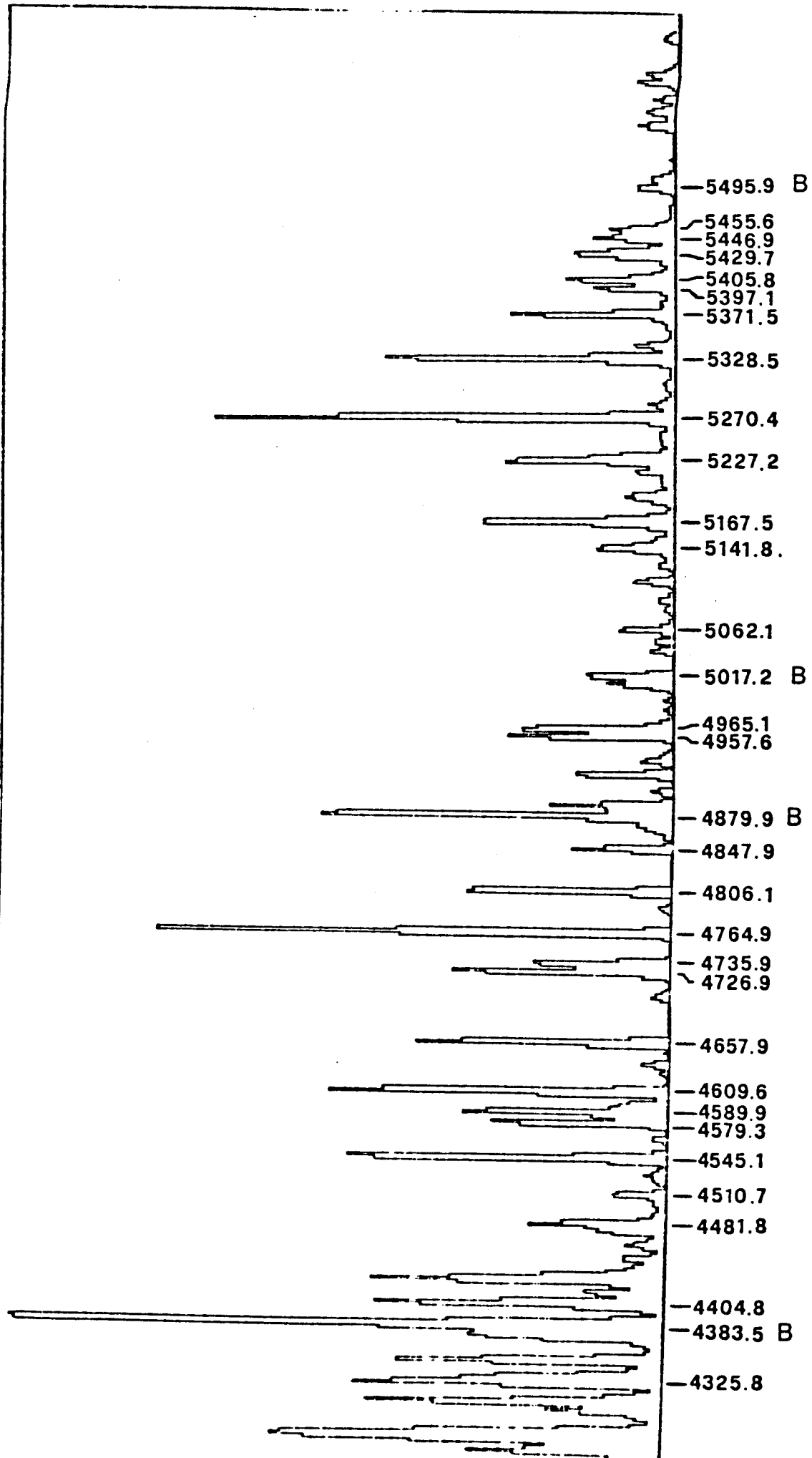

4589.9
4579.3
4545.1
4481.8
4404.8
4383.5 B
4325.8
4200 B
4158.6
4103.9
4045.8
3886.3 B
3859 B
3705.6 B
3679.9
3647.8
3631.5
3618.8
3608.9
3581.2 B

Fig. 1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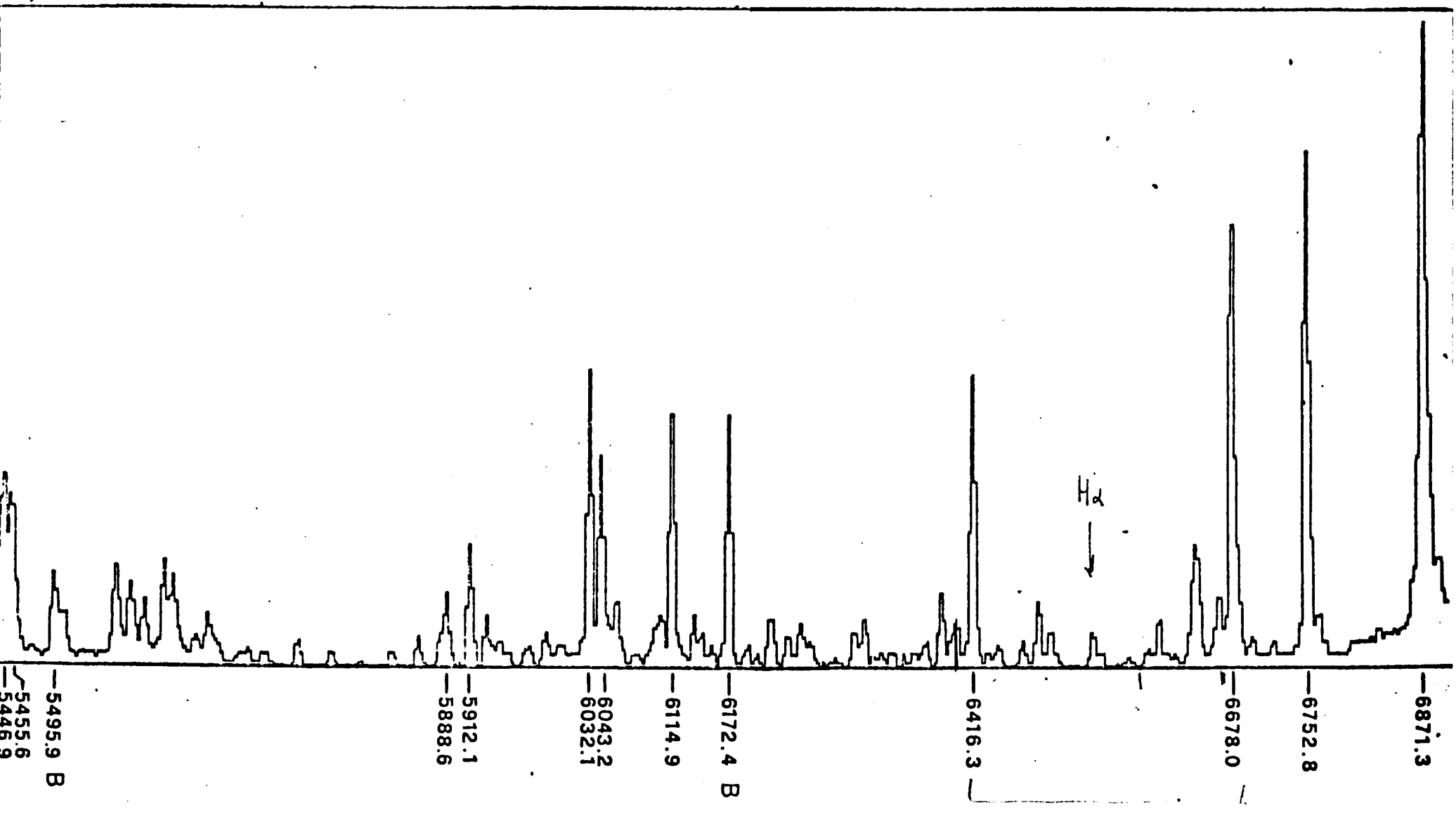
5455.6
5446.9
5429.7
5405.8
5397.1
5371.5
5328.5
5270.4
5227.2
5167.5
5141.8.
5062.1
5017.2 B
4965.1
4957.6
4879.9 B
4847.9
4806.1
4764.9
4735.9
4726.9
4657.9
4609.6
4589.9
4579.3
4545.1
4510.7
4481.8
4404.8
4383.5 B
4325.8
Fe An

Fig. 2

Fig. 3


Fe Ar
5455.6
5446.9
5495.9 B
5888.6
5912.1
6032.1
6043.2
6114.9
6172.4 B
Hα
6416.3
6678.0
6752.8
6871.3

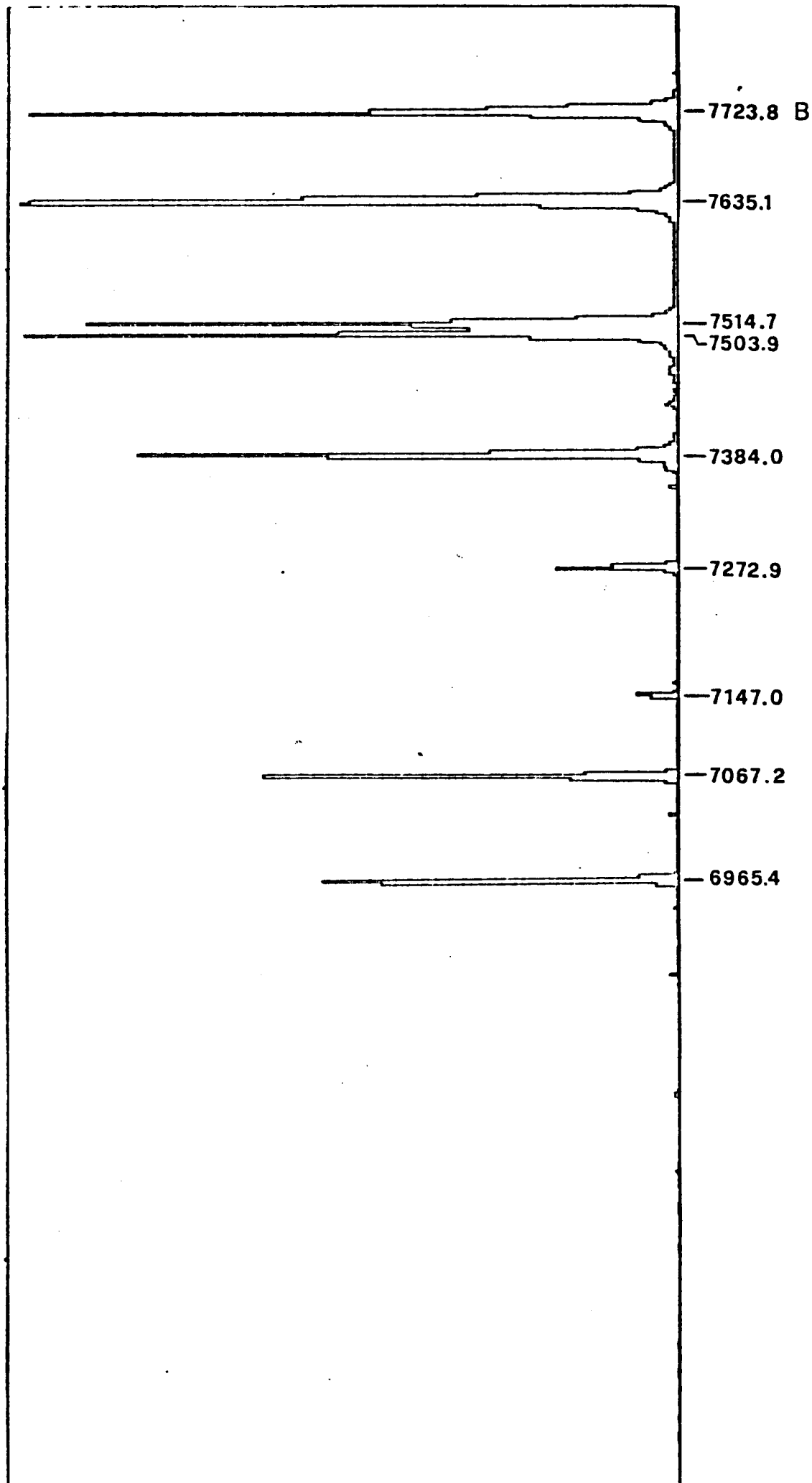

7723.8 B
7635.1
7514.7
7503.9
7384.0
7272.9
7147.0
7067.2
6965.4
Fe An

Fig. 4

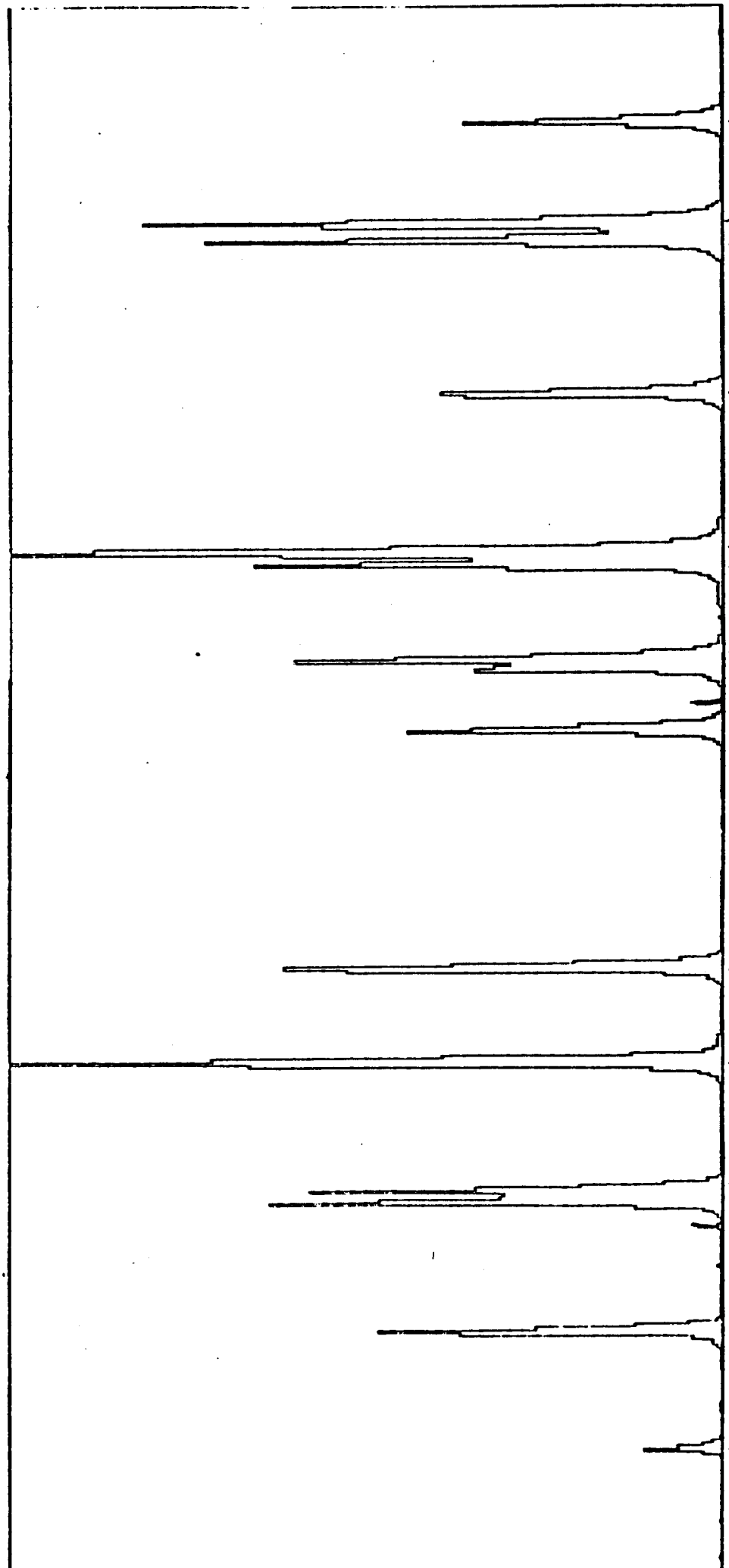

8521.4
8424.6
8408.2
8264.5
8115.3
8103.7
8014.8
8006.2
7948.2
7723.8
7635.1
7514.7
7503.9
7384.0
7272.9
B

Fig. 5

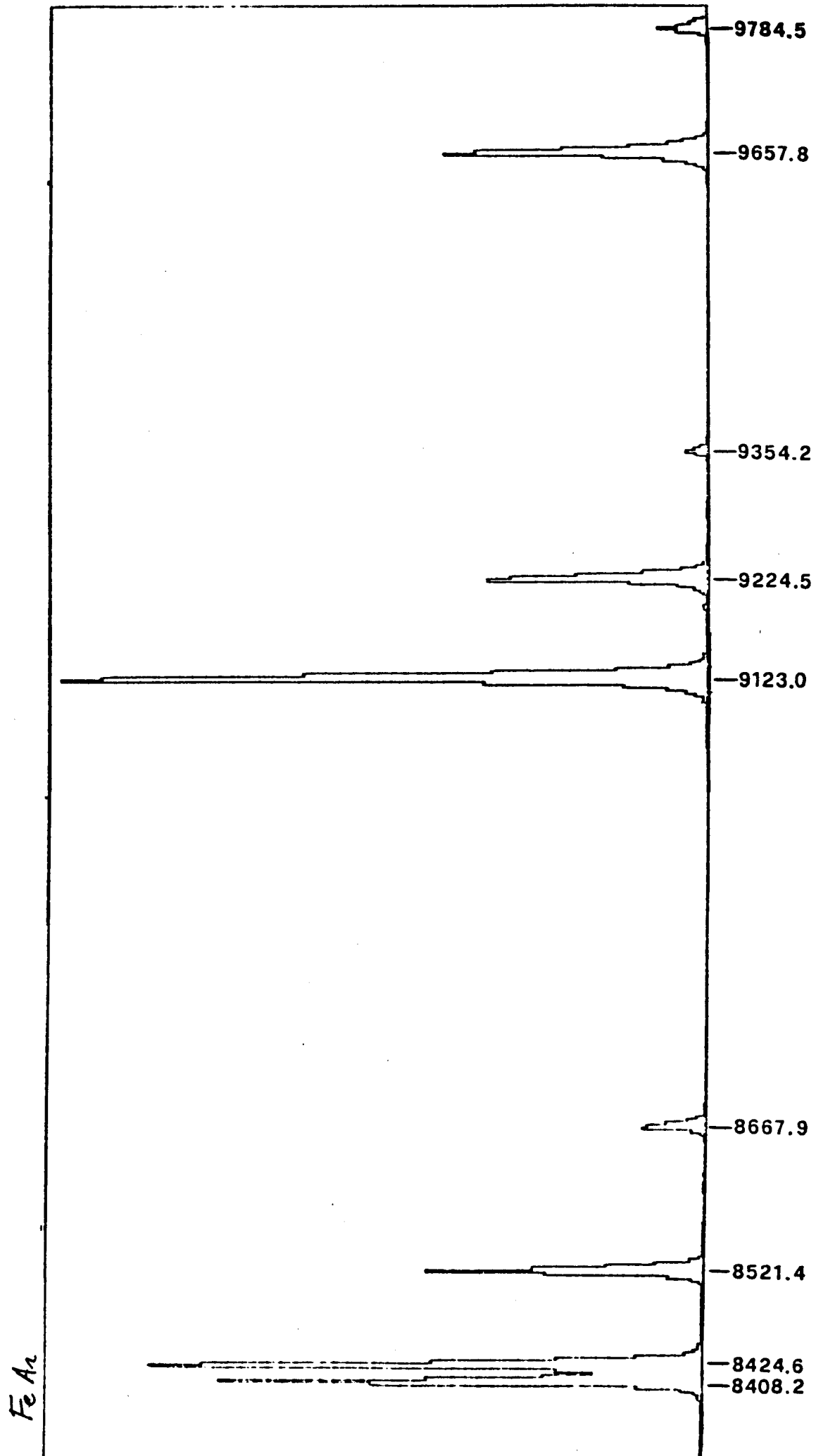


Fig. 6

RETICOLI

RETICOLO 400 TR/MM

Angolo	Lamda	Angolo	Lamda	Angolo	Lamda	Angolo	Lamda
4.9	3886.3	5.0	3965.4	5.1	4044.5	5.2	4123.6
5.3	4202.7	5.4	4281.7	5.5	4360.8	5.6	4439.8
5.7	4518.9	5.8	4597.9	5.9	4676.9	6.0	4755.8
6.1	4834.8	6.2	4913.8	6.3	4992.7	6.4	5071.6
6.5	5150.5	6.6	5229.4	6.7	5308.3	6.8	5387.1
6.9	5466.0	7.0	5544.8	7.1	5623.6	7.2	5702.4
7.3	5781.2	7.4	5859.9	7.5	5938.7	7.6	6017.4
7.7	6096.1	7.8	6174.8	7.9	6253.5	8.0	6332.1
8.1	6410.7	8.2	6489.3	8.3	6567.9	8.4	6646.5
8.5	6725.0	8.6	6803.6	8.7	6882.1	8.8	6960.6
8.9	7039.0	9.0	7117.5	9.1	7195.9	9.2	7274.3
9.3	7352.7	9.4	7431.0	9.5	7509.3	9.6	7587.7
9.7	7665.9	9.8	7744.2	9.9	7822.4	10.0	7900.7
10.1	7978.8	10.2	8057.0	10.3	8135.1	10.4	8213.3
10.5	8291.4	10.6	8369.4	10.7	8447.5	10.8	8525.5
10.9	8603.5	11.0	8681.4	11.1	8759.4	11.2	8837.3
11.3	8915.2	11.4	8993.0	11.5	9070.9	11.6	9148.7
11.7	9226.4	11.8	9304.2	11.9	9381.9	12.0	9459.6
12.1	9537.2	12.2	9614.9	12.3	9692.5	12.4	9770.0
12.5	9847.6	12.6	9925.1	12.7	10002.6	12.8	10080.0
12.9	10157.4	13.0	10234.8	13.1	10312.2	13.2	10389.5
13.3	10466.8	13.4	10544.1	13.5	10621.3	13.6	10698.5
13.7	10775.7	13.8	10852.8	13.9	10929.9	14.0	11007.0
14.1	11084.0	14.2	11161.0	14.3	11238.0	14.4	11314.9
14.5	11391.8	14.6	11468.7	14.7	11545.5	14.8	11622.3
14.9	11699.0	15.0	11775.8	15.1	3965.4	5.0	3965.4

LE LUNGHEZZE D'ONDA DEL 2° ORDINE SI OTTENGONO DA QUELLE DEL PRIMO ORDINE DIVIDENDO PER 2.

ESEMPIO:

Reticolo 400 tr/mm

$i = 12.7 \qquad \lambda(1^\circ ord) = 10002$

$$\lambda(2^\circ ord) = \frac{10002}{2} = 5001$$

RETICOLO 600 TR/MM

Angolo	Lamda	Angolo	Lamda	Angolo	Lamda	Angolo	Lamda
4.9	2590.9	5.0	2643.6	5.1	2696.3	5.2	2749.1
5.3	2801.8	5.4	2854.5	5.5	2907.2	5.6	2959.9
5.7	3012.6	5.8	3065.2	5.9	3117.9	6.0	3170.6
6.1	3223.2	6.2	3275.8	6.3	3328.5	6.4	3381.1
6.5	3433.7	6.6	3486.3	6.7	3538.9	6.8	3591.4
6.9	3644.0	7.0	3696.5	7.1	3749.1	7.2	3801.6
7.3	3854.1	7.4	3906.6	7.5	3959.1	7.6	4011.6
7.7	4064.1	7.8	4116.5	7.9	4169.0	8.0	4221.4
8.1	4273.8	8.2	4326.2	8.3	4378.6	8.4	4431.0
8.5	4483.4	8.6	4535.7	8.7	4588.0	8.8	4640.4
8.9	4692.7	9.0	4745.0	9.1	4797.3	9.2	4849.5
9.3	4901.8	9.4	4954.0	9.5	5006.2	9.6	5058.4
9.7	5110.6	9.8	5162.8	9.9	5215.0	10.0	5267.1
10.1	5319.2	10.2	5371.3	10.3	5423.4	10.4	5475.5
10.5	5527.6	10.6	5579.6	10.7	5631.6	10.8	5683.7
10.9	5735.6	11.0	5787.6	11.1	5839.6	11.2	5891.5
11.3	5943.4	11.4	5995.3	11.5	6047.2	11.6	6099.1
11.7	6150.9	11.8	6202.8	11.9	6254.6	12.0	6306.4
12.1	6358.2	12.2	6409.9	12.3	6461.6	12.4	6513.4
12.5	6565.1	12.6	6616.7	12.7	6668.4	12.8	6720.0
12.9	6771.6	13.0	6823.2	13.1	6874.8	13.2	6926.3
13.3	6977.9	13.4	7029.4	13.5	7080.9	13.6	7132.3
13.7	7183.8	13.8	7235.2	13.9	7286.6	14.0	7338.0
14.1	7389.3	14.2	7440.7	14.3	7492.0	14.4	7543.3
14.5	7594.5	14.6	7645.8	14.7	7697.0	14.8	7748.2
14.9	7799.4	15.0	7850.5	15.1	7901.6	15.2	7952.7
15.3	8003.8	15.4	8054.9	15.5	8105.9	15.6	8156.9
15.7	8207.9	15.8	8258.8	15.9	8309.7	16.0	8360.6
16.1	8411.5	16.2	8462.4	16.3	8513.2	16.4	8564.0
16.5	8614.8	16.6	8665.5	16.7	8716.2	16.8	8766.9
16.9	8817.6	17.0	8868.2	17.1	8918.8	17.2	8969.4
17.3	9020.0	17.4	9070.5	17.5	9121.0	17.6	9171.5
17.7	9221.9	17.8	9272.4	17.9	9322.7	18.0	9373.1
18.1	9423.4	18.2	9473.8	18.3	9524.0	18.4	9574.3
18.5	9624.5	18.6	9674.7	18.7	9724.8	18.8	9775.0
18.9	9825.1	19.0	9875.1	19.1	9925.2	19.2	9975.2
19.3	10025.2	19.4	10075.1	19.5	10125.0	19.6	10174.9
19.7	10224.8	19.8	10274.6	19.9	10324.4	20.0	10374.2

Rosso { RG 630 nuova 1mm
~~RG631~~

Giallo GG 451 1m

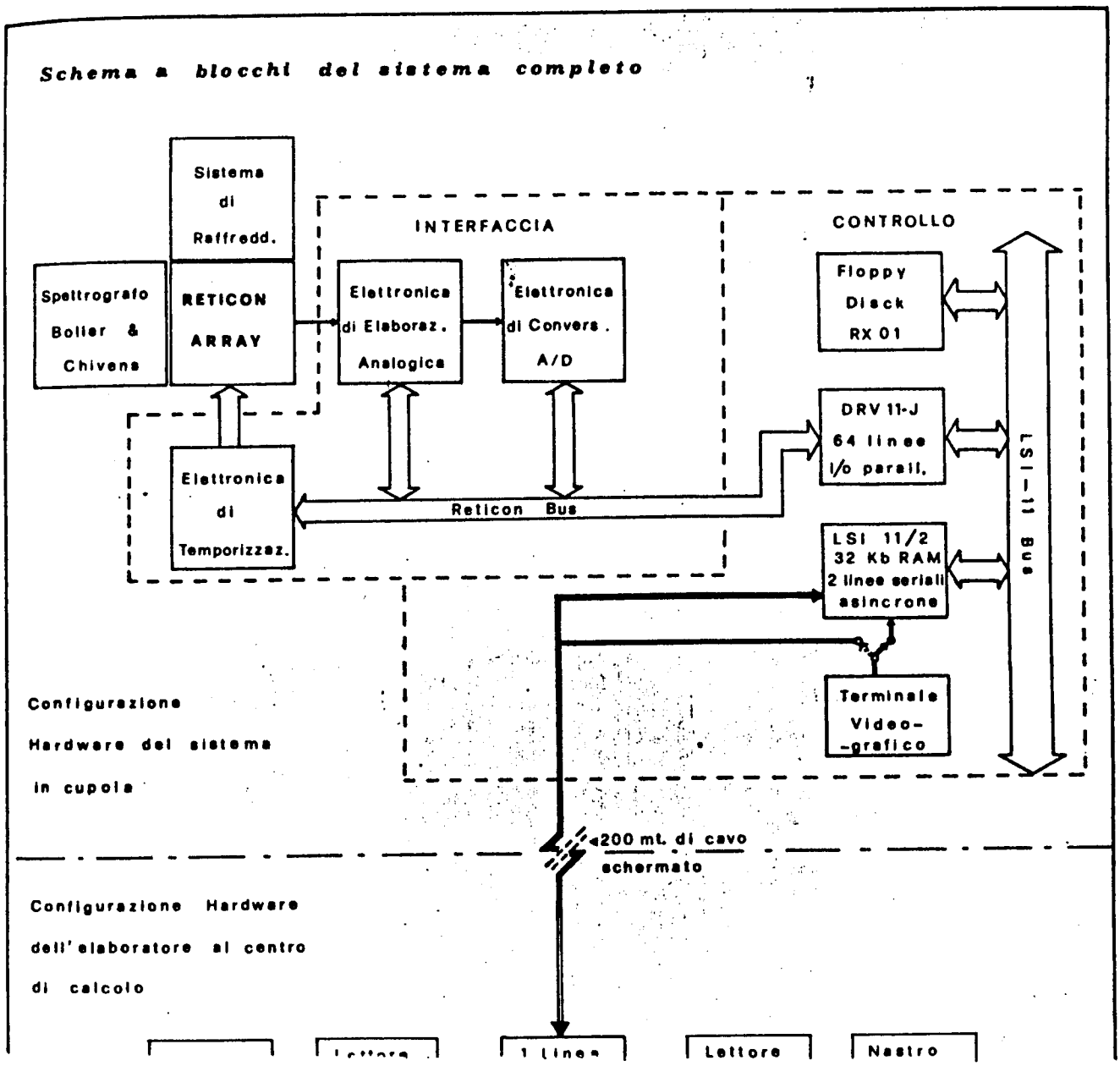
BG 23-14 ~~1~~

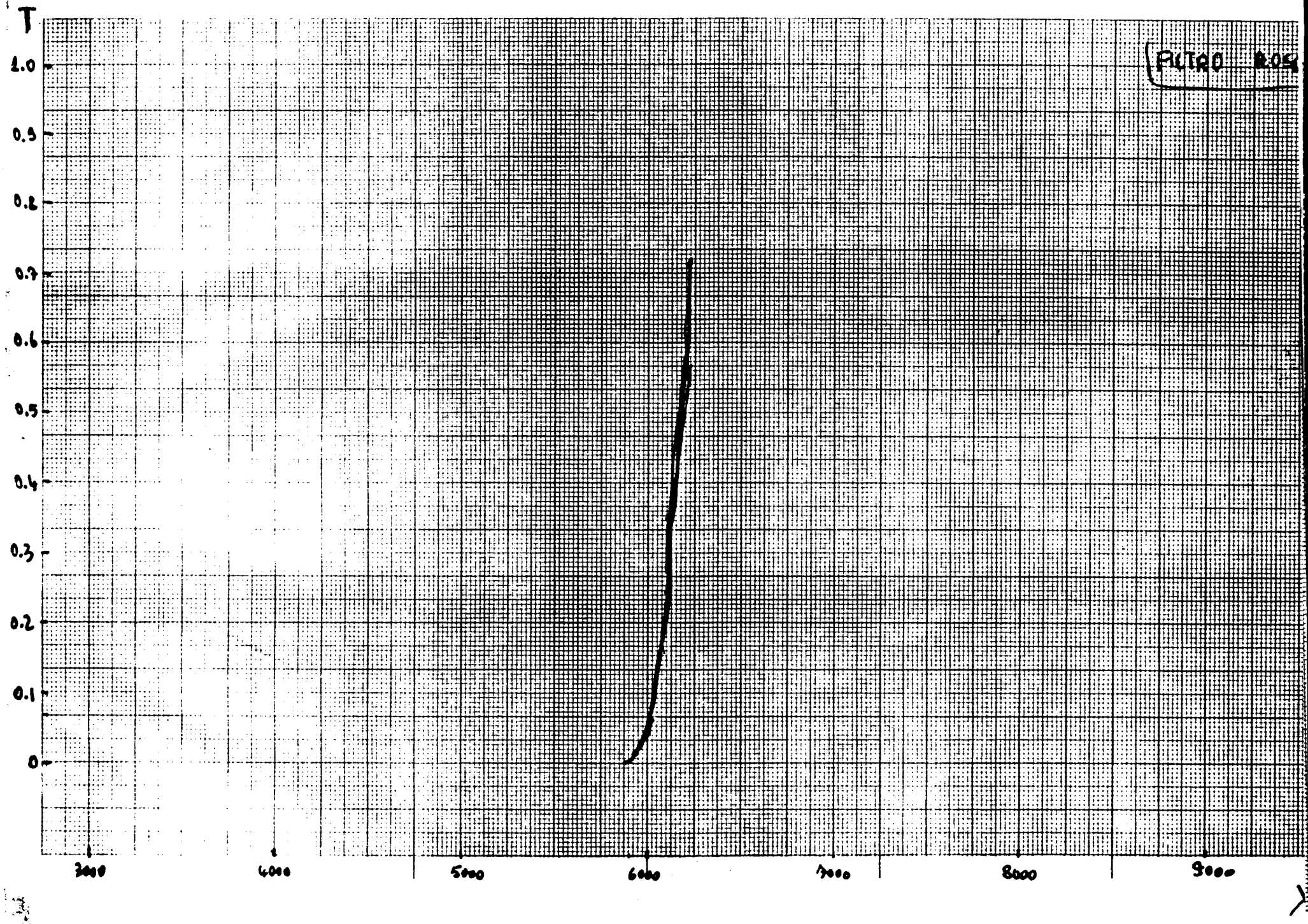
OG3 (OG590) (filtro rosso)
RG610 (RG1) } 1 mm.

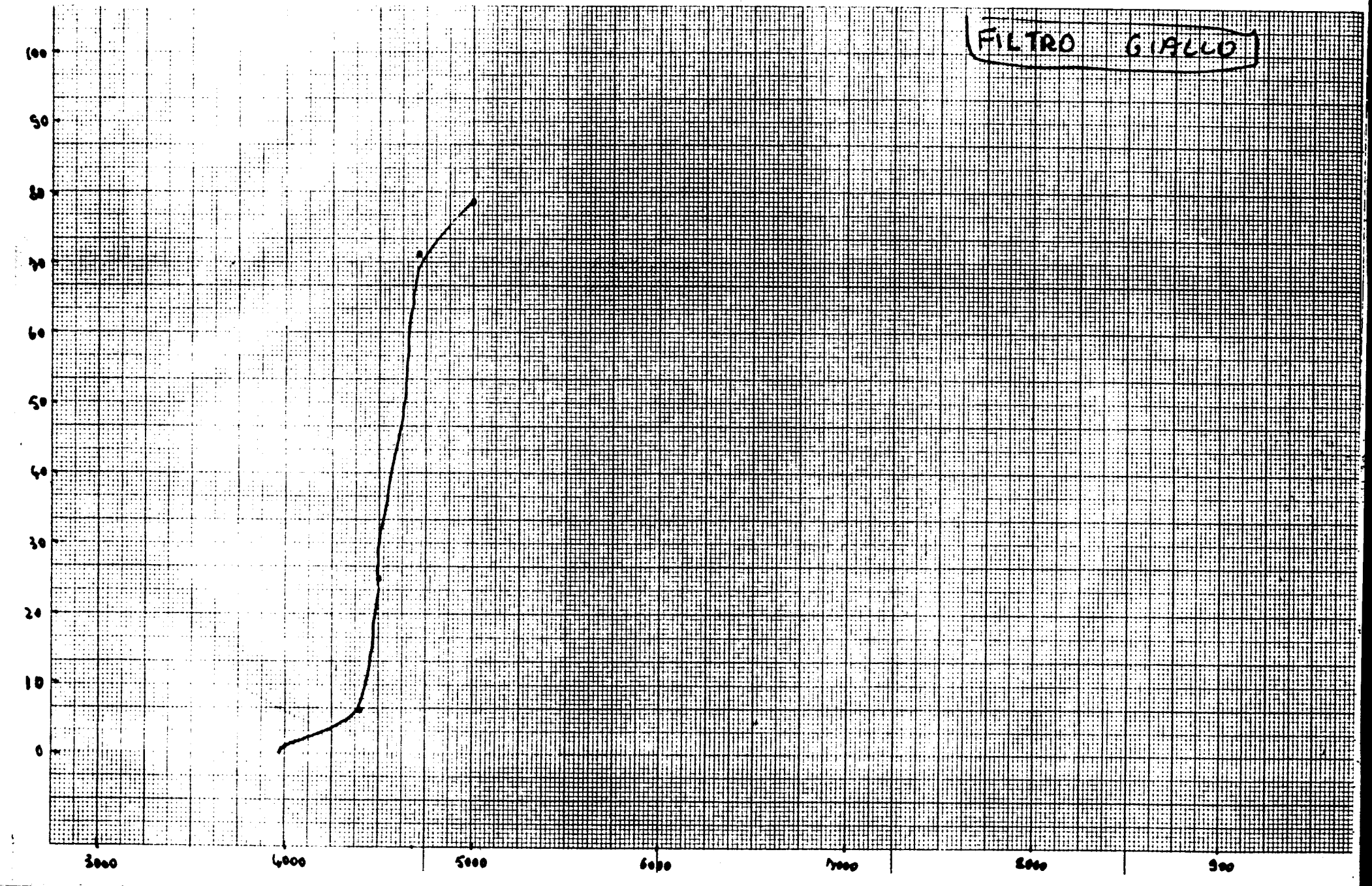
BG ~~39~~ 38 (blu) 1 mm.

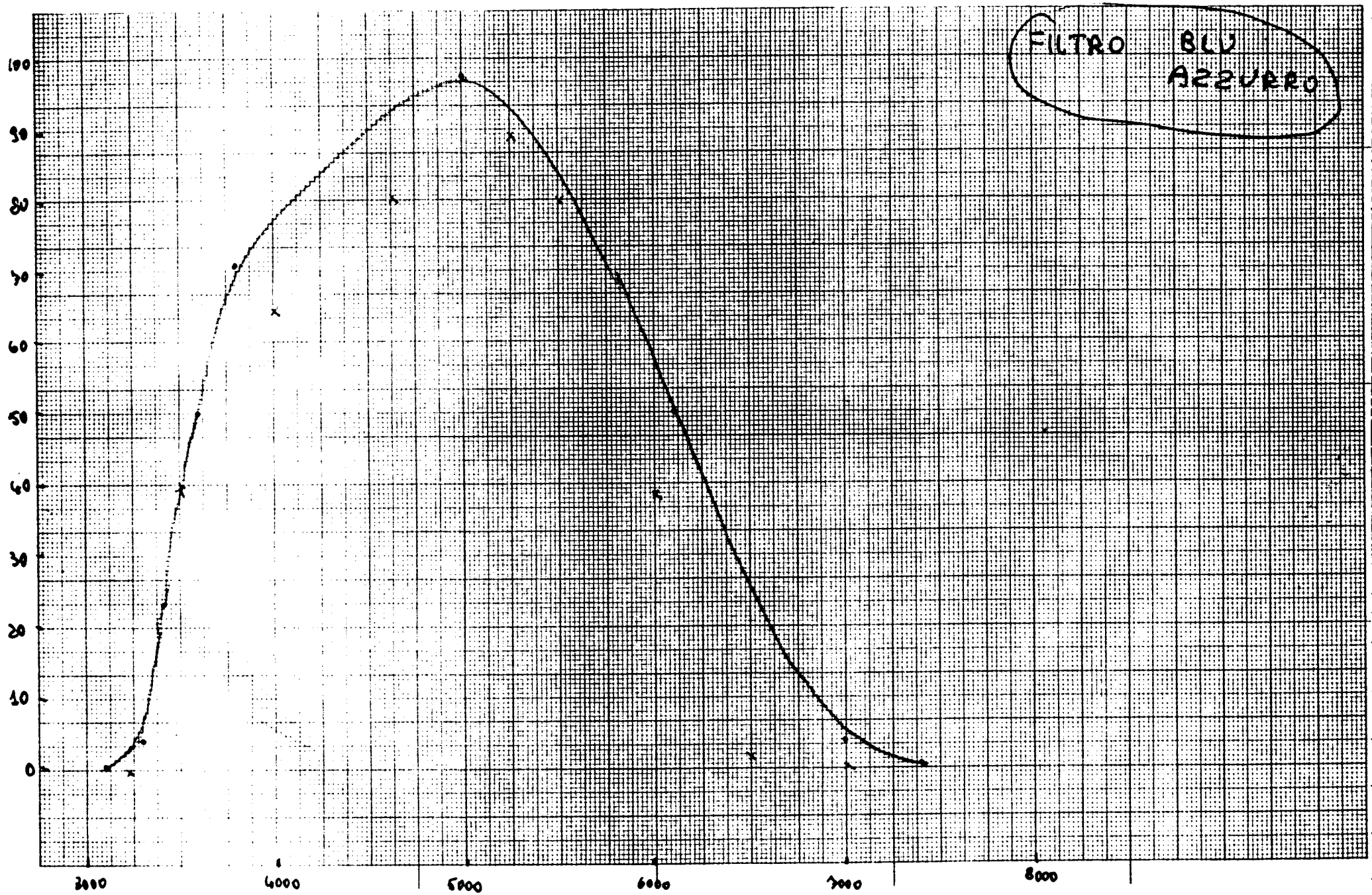
GG 435 (giallo)
455

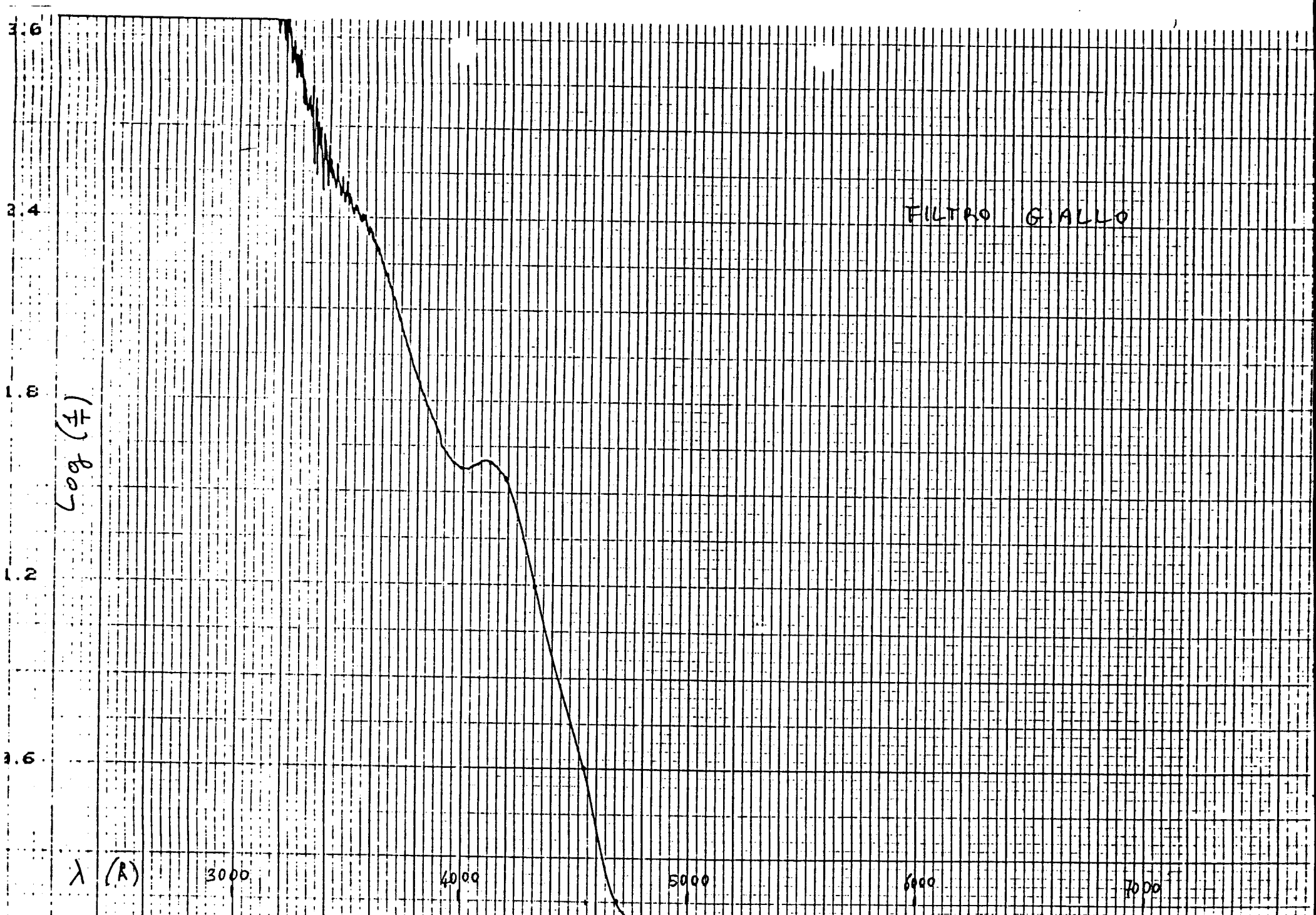
Schema a blocchi del sistema completo

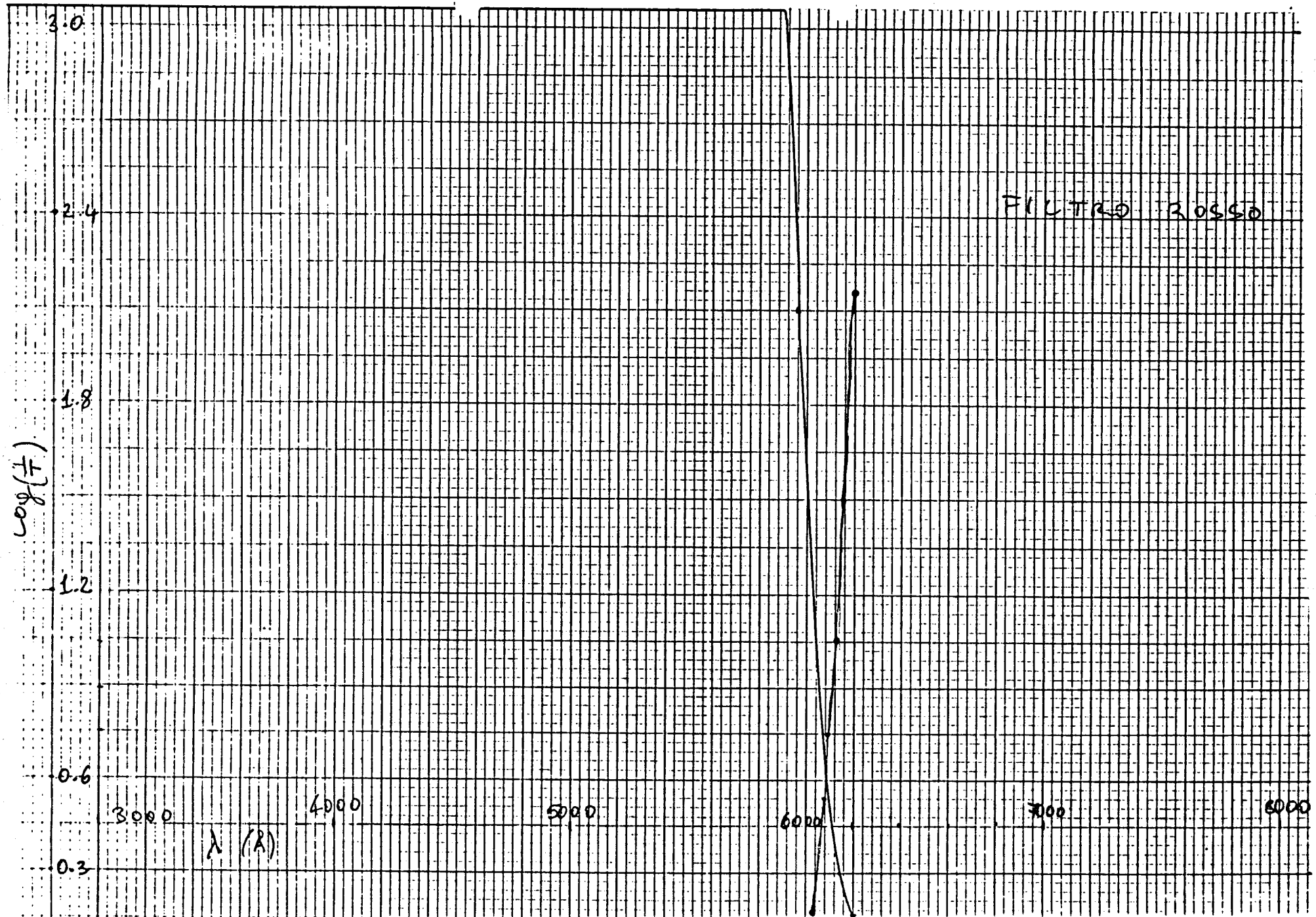



T
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
4000
5000
6000
8000
9000


FILTRO GIALLO
100
90
80
70
60
50
40
30
20
10
0
3000
4000
5000
6000
7000
8000
900


FILTRO BLU AZZURRO
100
90
80
70
60
50
40
30
20
10
0
3000
4000
5000
6000
7000
8000

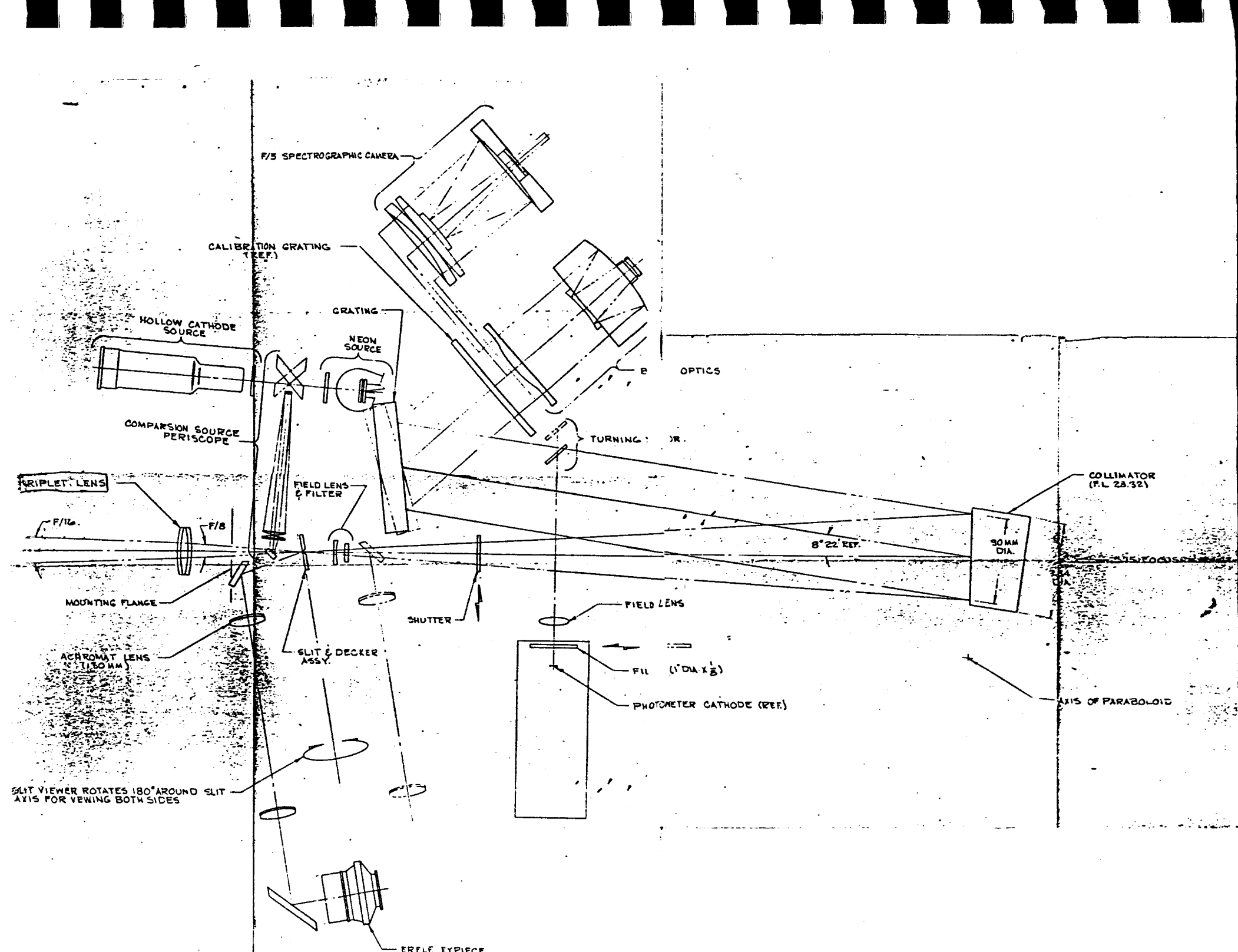

FILTRO GIALLO
Log (1/T)
3.6
3.4
1.8
1.2
.6
λ (Å)
3000
4000
5000
6000
7000

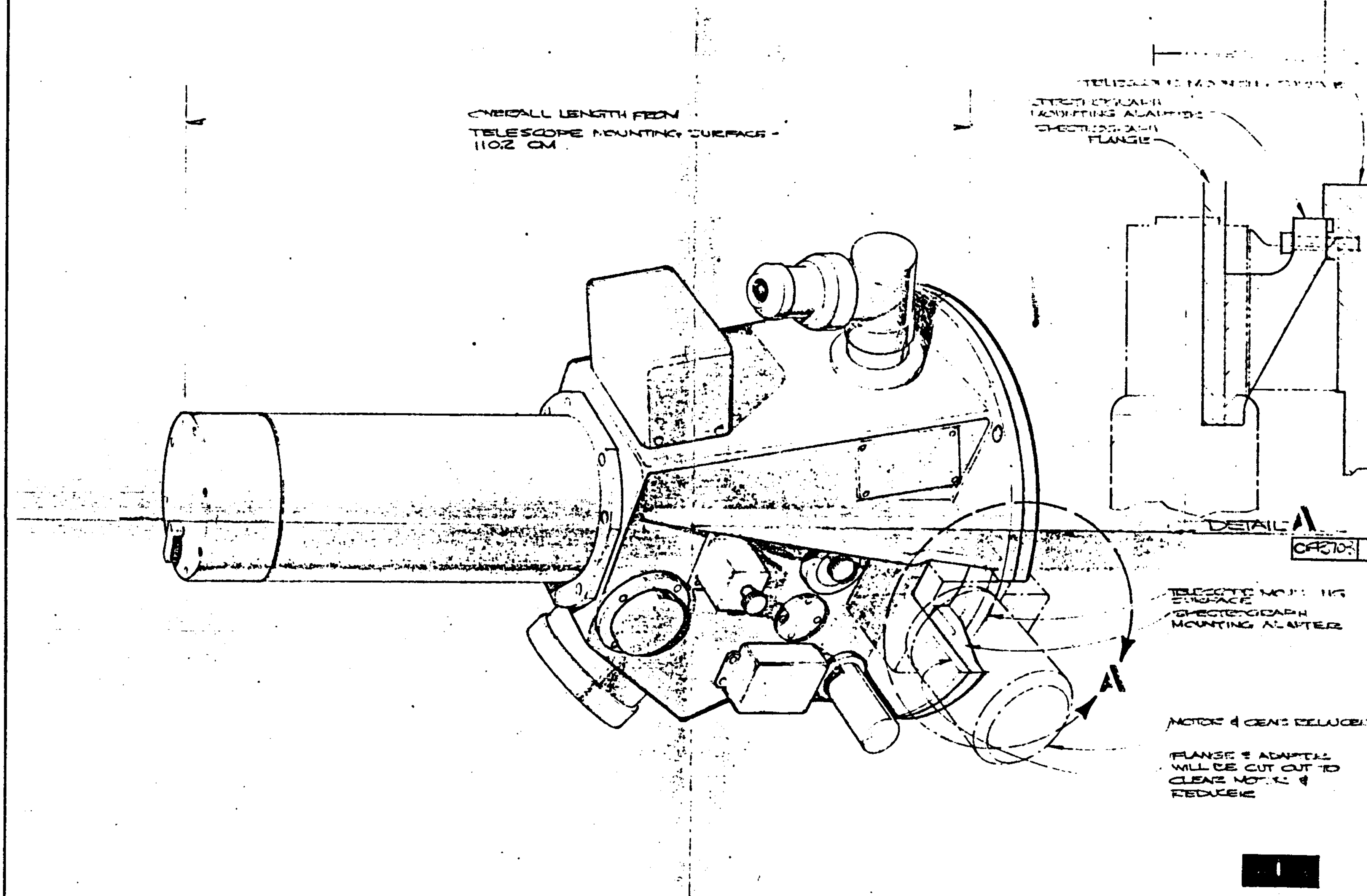

FILTRO PASSO
3.0
2.4
1.8
1.2
0.6
0.3
log(1/τ)
3000
4000
5000
6000
λ (Å)


FILTRO AZUL
3,6
2,4
1,8
1,2
0,6
$\log(\frac{1}{T})$
λ (Å)
3000
4000
5000
6000
7000

LISTA DISEGNI SPETTROGRAFO BOLLER & CHIVENS

1) VISIONE PROSPETTICA
2) VISTA D'ASSIEME
3) SCHEMA OTTICO
4) SCHEMA ELETTRICO GENERALE
5) CAMERA FOTOGRAFICA F/5
6) MODULO PER FOTOGRAFIA DIRETTA CAMERA F/5
7) CAMERA FOTOGRAFICA CORTA (Bowen optics)
8) MODULO PER FOTOGRAFIA DIRETTA CAMERA CORTA
9) COLLIMATORE
10) GRUPPO PORTA RETICOLO
11) CONVERTITORE DI FOCALE
12) GRUPPO PORTA FILTRO E SPECCHIETTO
13) VISORE DI FENDITURA
14) GRUPPO PER L'ILLUMINAZIONE DELLA FENDITURA
15) GRUPPO FENDITURA
16) ESPOSIMETRO
17) PORTALASTRE
18) OTTURATORE
19) LAMPADA HOLLOW CATHODE (lampada ferro)
20) LAMPADA AL NEON
21) SCHEMA ELETTRICO ALIMENTAZIONE LAMPADE
22) CARRELLO DI SOSTEGNO DELLO SPETTROGRAFO
23) FLANGIA DI ATTACCO DELLO SPETTROGRAFO
24) ADATTATORE PER LA FLANGIA D'ATTACCO


F/5 SPECTROGRAPHIC CAMERA
CALIBRATION GRATING (REF.)
GRATING
HOLLOW CATHODE SOURCE
NEON SOURCE
OPTICS
COMPARISON SOURCE PERISCOPE
TURNING
TRIPLET LENS
FIELD LENS & FILTER
COLLIMATOR (F.L. 23.32)
F/16.
F/8
8°22' REF.
90 MM DIA.
MOUNTING FLANGE
SHUTTER
FIELD LENS
ACHROMAT LENS (150 MM)
SLIT & DECKER ASSY.
FIL (1" DIA. x)
PHOTOMETER CATHODE (REF.)
AXIS OF PARABOLOID
SLIT VIEWER ROTATES 180° AROUND SLIT AXIS FOR VEWING BOTH SIDES



TOLERANCE:
FRACT. ± 1/32
.XX ± .01
.XXX ± .005
ANG ± 1/2°

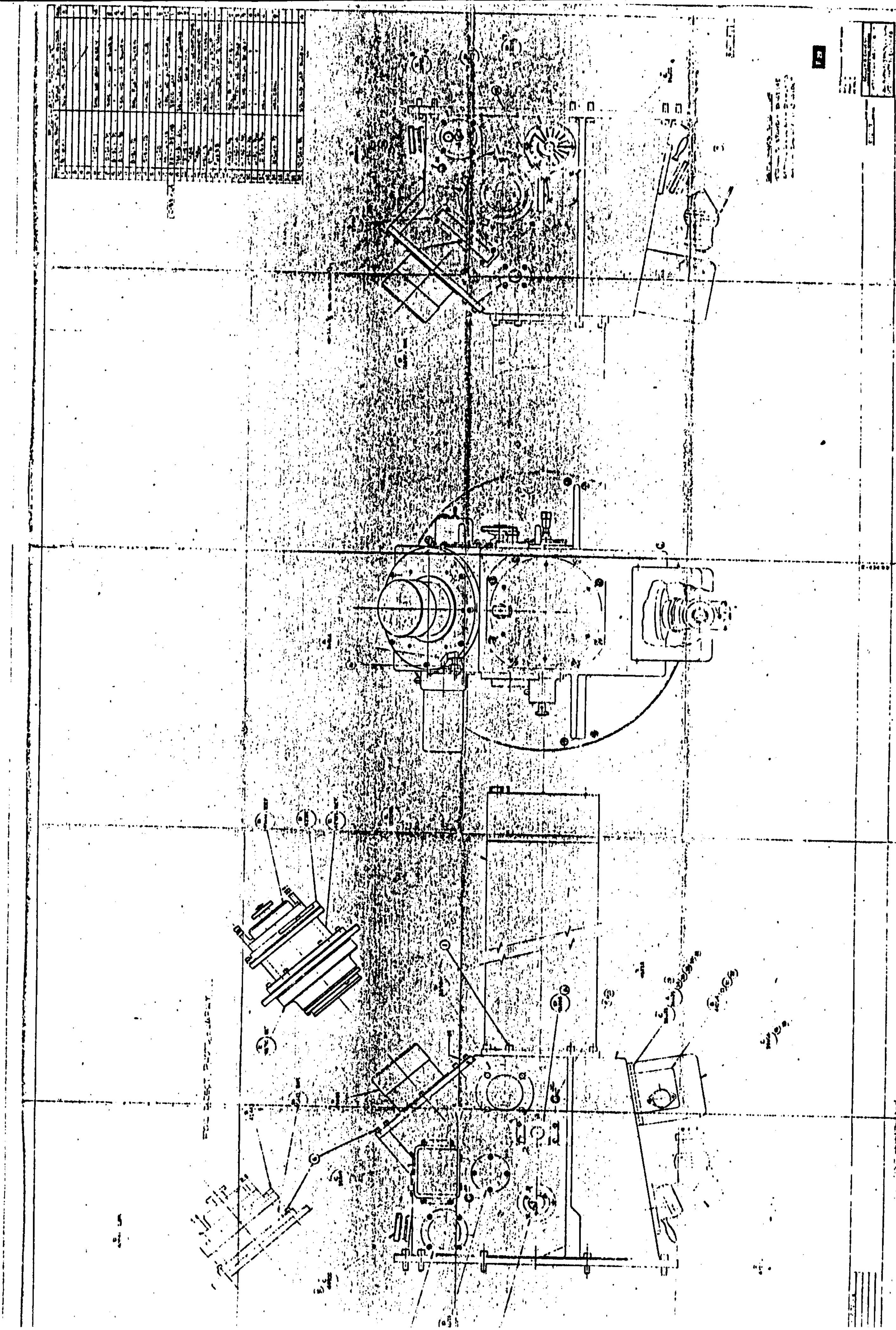
DR.	
CK.	
AP.	
P.E.	

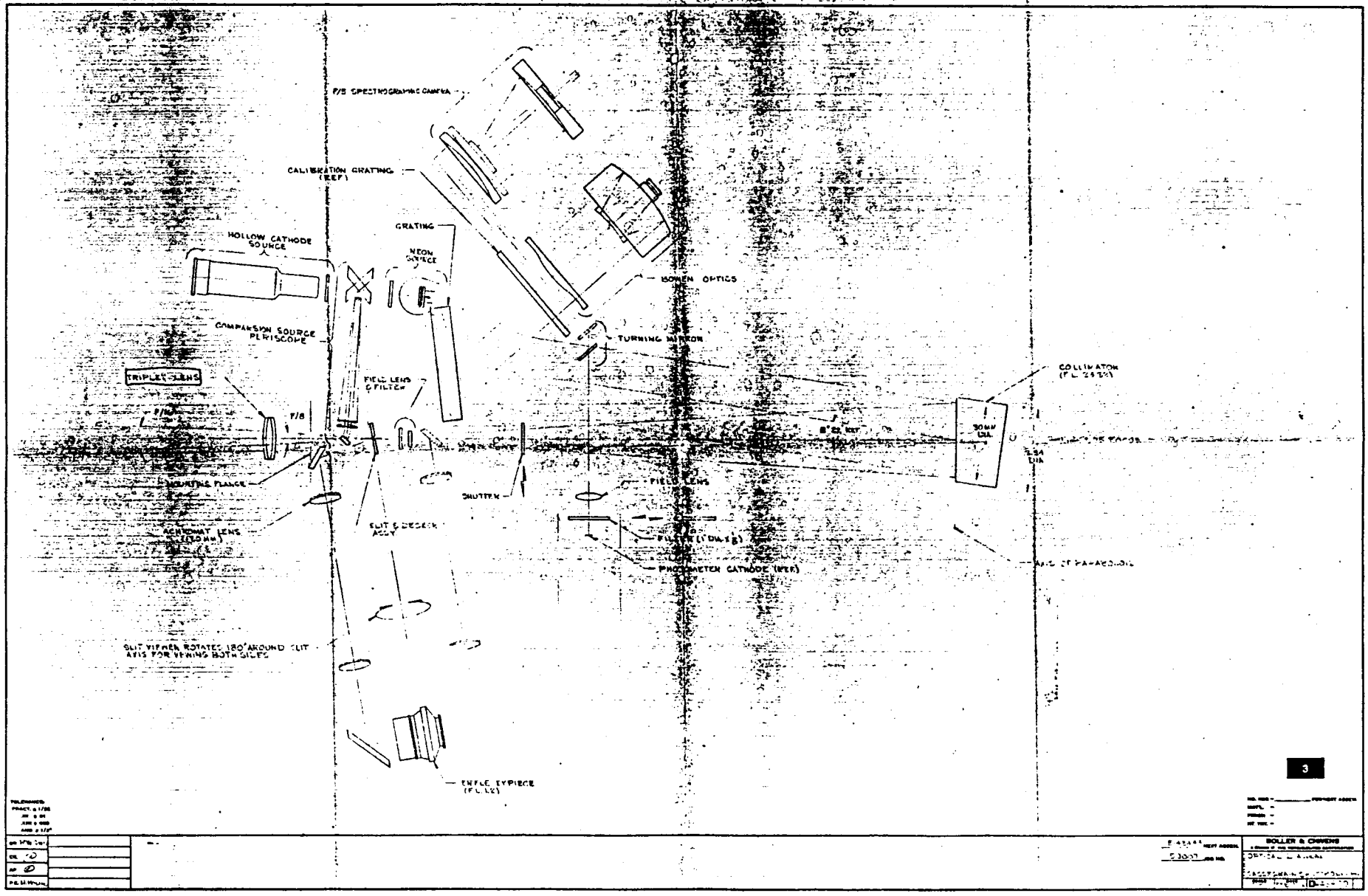
NO. REQ - ______ PER NEXT ASSEM.
MAT'L -
FINISH -
HT. TRT. -

______ NEXT ASSEM.
04003-098 JOB NO.

BOLLER & CHIVENS
a division of THE PERKIN-ELMER CORPORATION

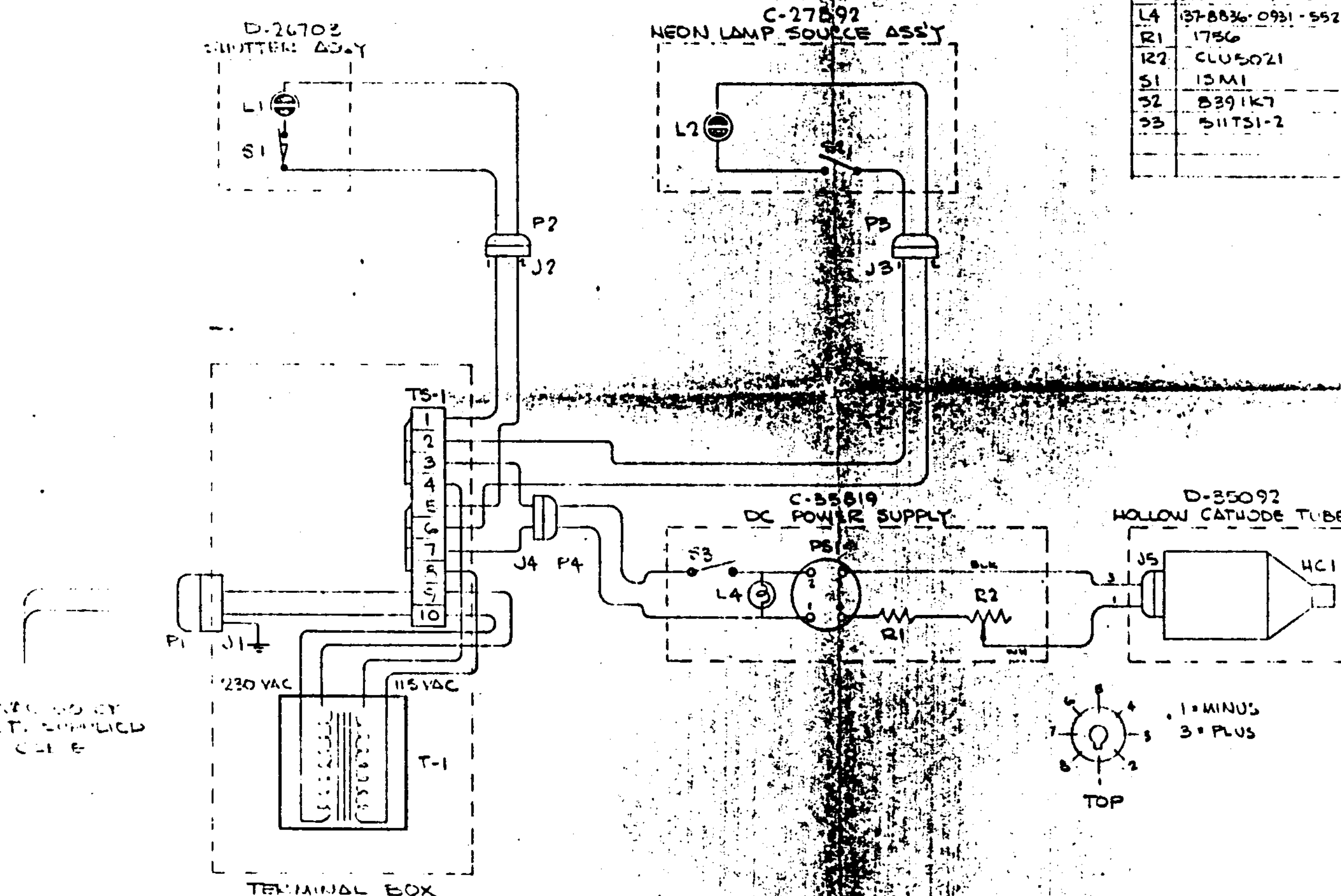
CASSEGRAIN SPECTROGRAPH




F/8 SPECTROGRAPHIC CAMERA
CALIBRATION GRATING (REF)
GRATING
HOLLOW CATHODE SOURCE
NEON SOURCE
BOWEN OPTICS
COMPARISON SOURCE PERISCOPE
TURNING MIRROR
COLLIMATOR (F.L. 24 3/4")
TRIPLET LENS
F/8
FIELD LENS & FILTER
SHUTTER
FIELD LENS
ACHROMAT LENS (F.L. 10 DIA. 1 3/8)
SLIT & DECKER ASSY
PHOTOMETER CATHODE (REF)
SLIT VIEWER ROTATES 180° AROUND SLIT AXIS FOR VIEWING BOTH SIDES
ERFLE EYEPIECE (F.L. 1.2")
3

PURCHASE PARTS LIST

ITEM	PART NUMBER	DESCRIPTION
P1	7484	HUBBLE TWIST LOCK CONNECTOR
J1	7486	" " INLET
P2, P3, P4	754-3-30SN	DEUTSCH BULKHEAD CONN.
J2, J3, J4	757-3PN-059	" CABLE CONN.
TS1	37 TB 12	KULKA TERMINAL STRIP
J5	X5-8	POMONA ELECTRONICS CXTAL SOC.
T-1	F6383	STANCOR STEP DOWN TRANSFORMER
PS1	HV 400	FERROTRAN DC POWER SUPPLY
HC1	WL-22611	WESTINGHOUSE HOLLOW CATHODE TUBE
L1	NE-2D	DIALCO NEON LAMP
L2	NE-40	G.E. NEON LAMP
L3	514-2512-0435-302	DIALCO LENS CAP ASS'Y
L4	137-8836-0931-552	" " "
R1	1756	OHMITE RESISTOR (12W-11K)
R2	CLU5021	" TRIM POT (2W-5000 Ω)
S1	15M1	MICROSWITCH LIMIT SWITCH
S2	8391K7	CUTLER-HAMMER TOGGLE SWITCH
S3	511TS1-2	MICROSWITCH LIMIT SWITCH



18 AWG WIRE

1. CONNECTOR WIRING 1 BLACK 3 N/C 2 BROWN

4

C-41067

TOLERANCE: FRACT. ± 1/32 .XX ± .01 .XXX ± .005 ANG ± 1/2°

DR. TJC
CK M HOLLIS

E43488 E 40944 NEXT ASSEM.
59007 58770 JOB NO.

NO. REQ – REF – PER NEXT ASSEM.
MAT'L –
FINISH –
HT. TRT. –

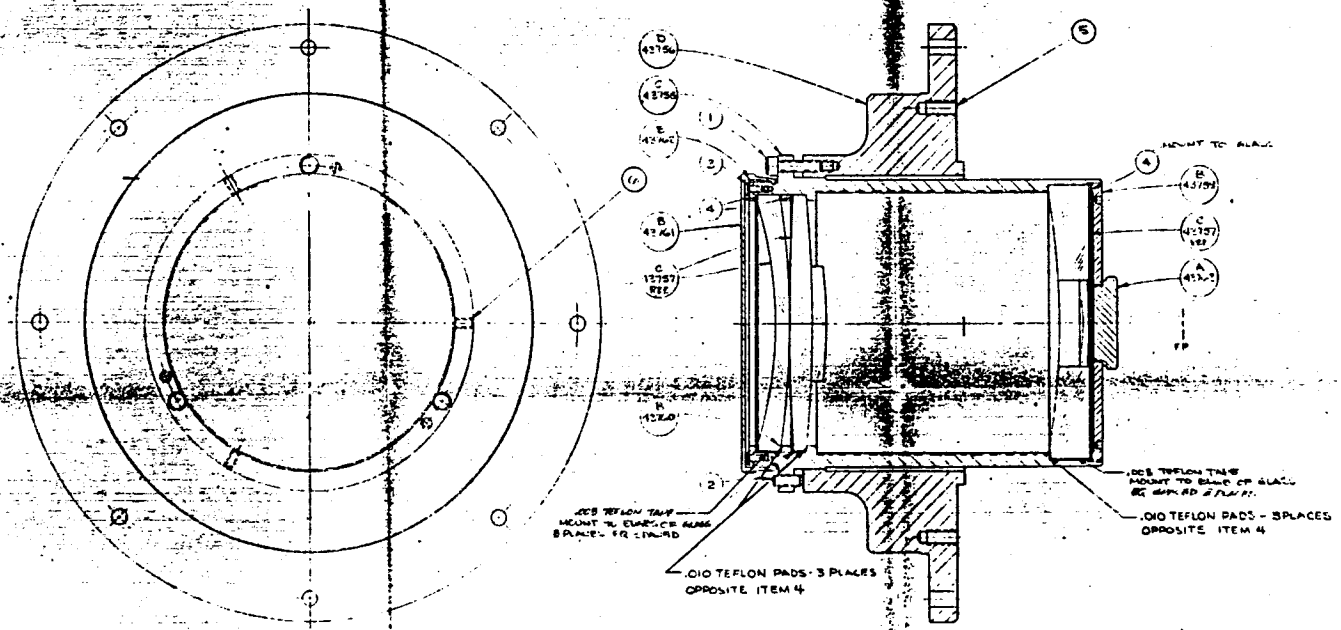
BOLLER & CHIVENS
A division of THE PERKIN-ELMER CORPORATION

WIRING DIAGRAM

COUDE SPECTROGRAPH

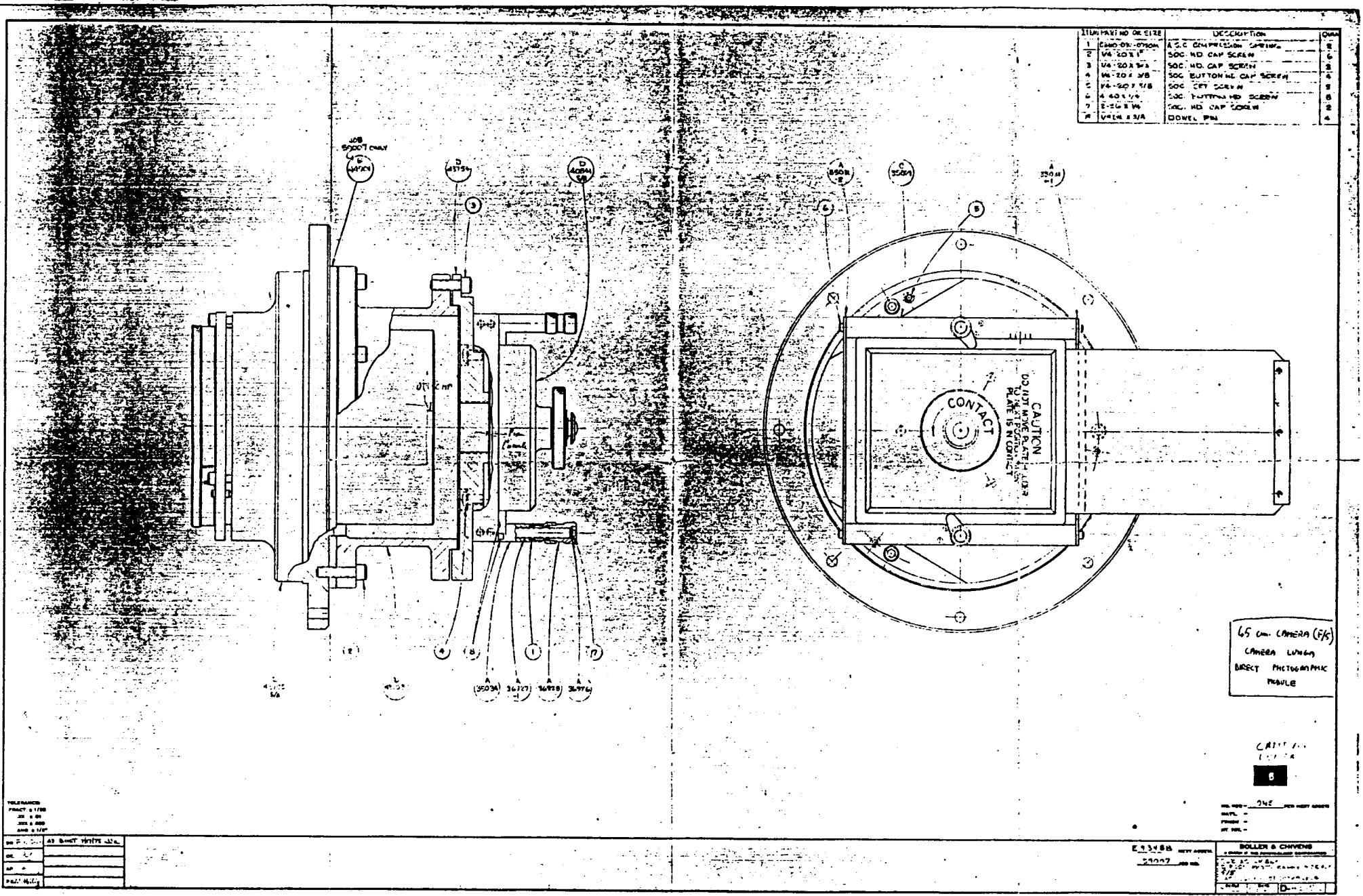
C-41067

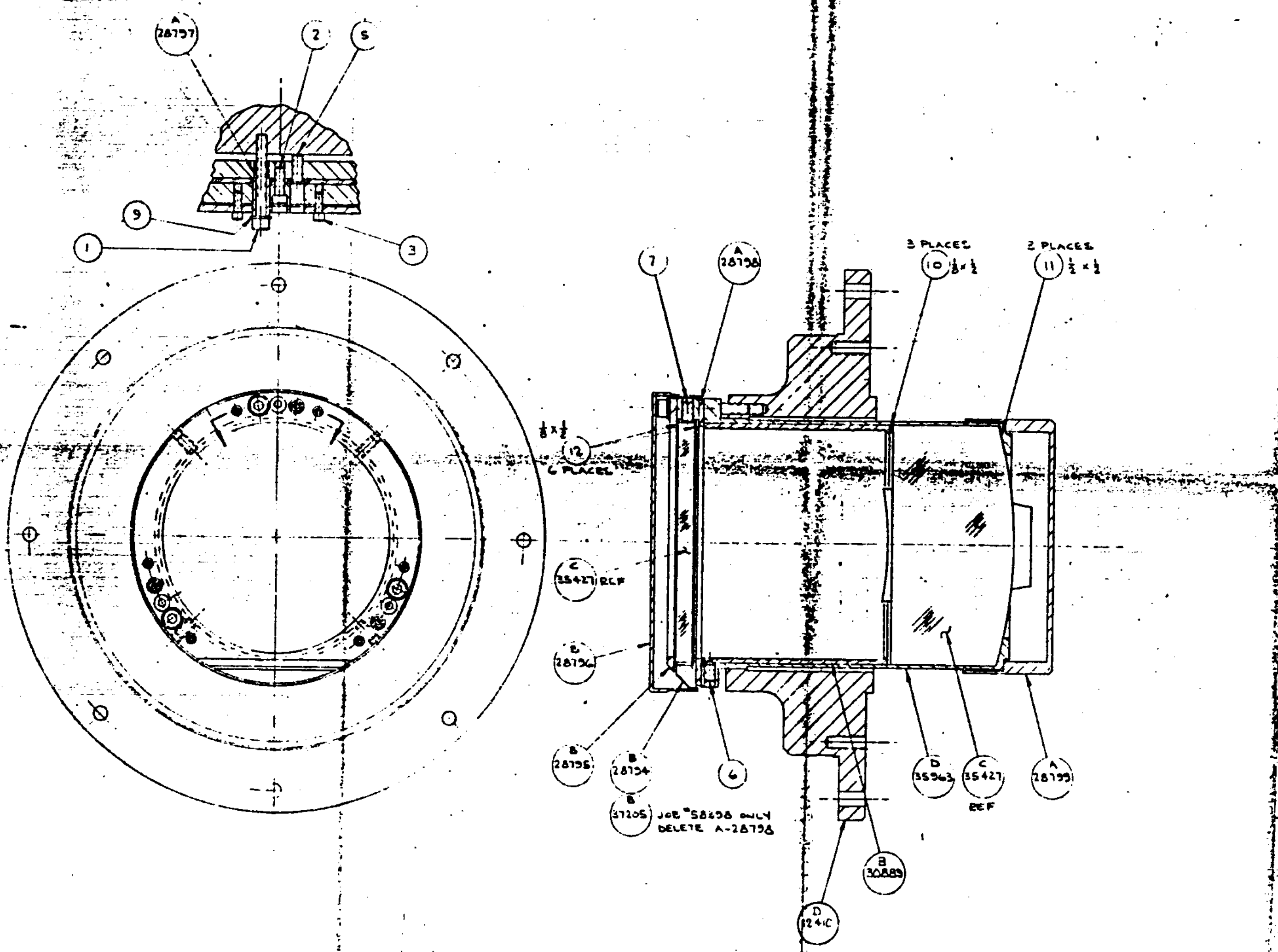
ITEM	PART NO. OR SIZE	DESCRIPTION	QUAN
1	10-24 X 3/16	SOC. HD. CAP SCREW	3
2	10-24 X 1/2	SOC. SET SCREW	3
3	4-40 X 1/4	BUTTON HD SOC CAP SCREW	6
4	.032 THICK	ETCHED TEFLON (3 PLACES)	A/R
5	MPS-4GN-032	MYLICON INSERT	6
6	#6-32 x 3/16	NYLON SET SCREW	6



B

BOLLER & CHIVENS


CONTACT
CAUTION
DO NOT MOVE PLATEN LOCK
PLATE IS IN CONTACT
45 cm. CAMERA (F/5)
CAMERA LUMEN
DIRECT PHOTOGRAPHIC
MODULE



PURCHASED PARTS LIST

ITEM	SIZE OR PART NO.	DESCRIPTION	QTY
1	#10-24 x 1 1/2 LG	SOCKET HD CAP SCR ST. STL	3
2	# 8-32 x 1/2 LG	" " " " " "	3
3	# 4-40 x 3/8 LG	" " " " " "	6
4			
5	#10-24 x 1/2 LG	SOCKET SET SCR ST STL	3
6	#10-24 x 3/8 LG	SOCKET SET SCR CONE PT	4
7	#10-24 x 3/8 LG	NYLON SET SCREW	4
8			
9	#10	FLAT WASHER ST STL	3
10	.04 THICK	CERFLENO	A/R
11	.005 THICK	TEFLON TAPE	A/R
12	.010 THICK	TEFLON TAPE ETCHED	A/R
13			
14			
15			
16			

14 in. CAMERA (F/2)
CAMERA CELTA
OPTICS MODULE

7

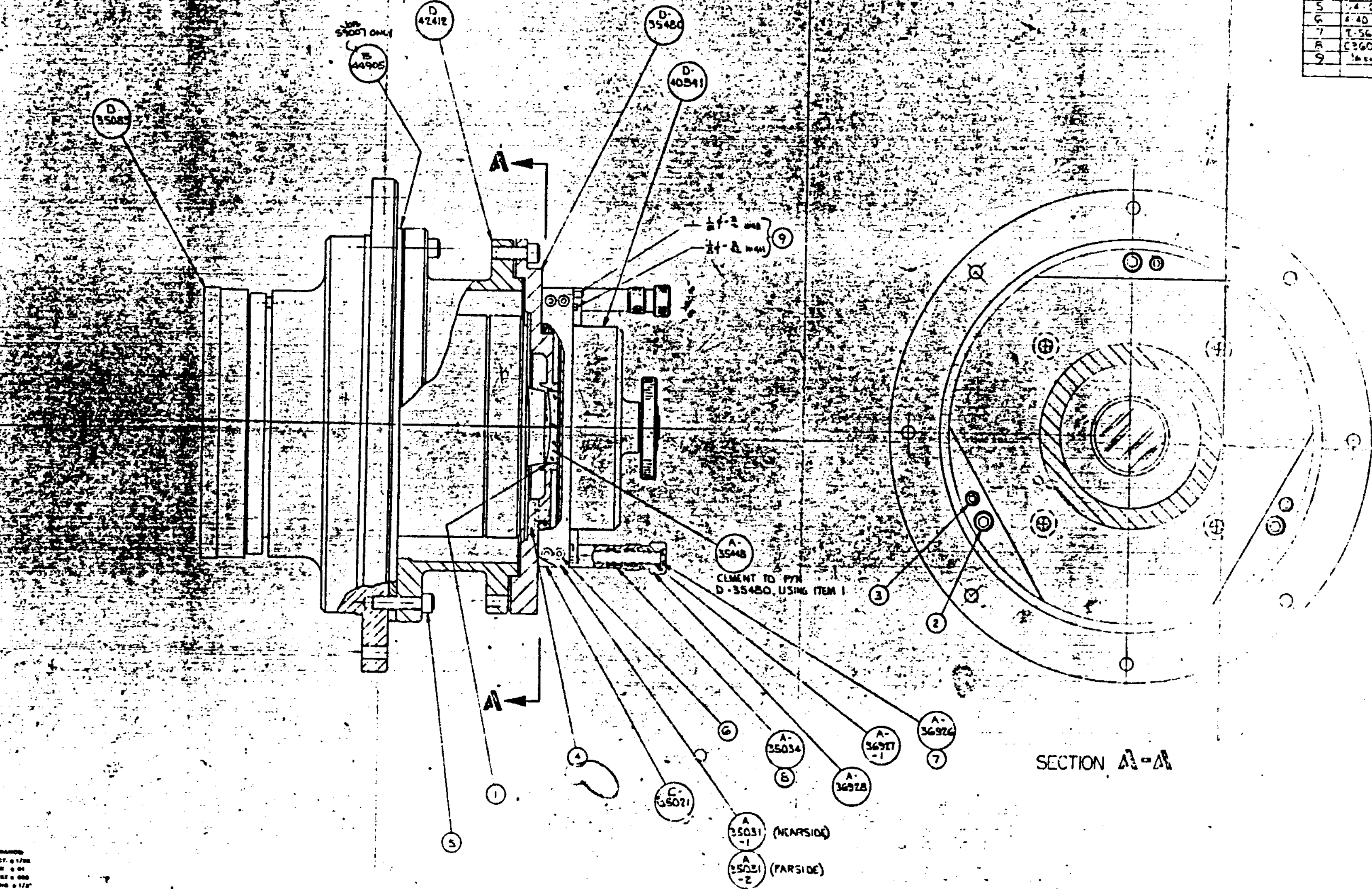
NO. REQ. – ONE PER NEXT ASSEM.
MATL – NOTED
FINISH –
WT. TOT. –

B-38712 D-36226
59007 58930 A171, 58898, 58419, 58427 NEXT ASSEM. JOB NO.

BOLLER & CHIVENS
SUB ASSEMBLY
BOWEN OPTICS
CASSEGRAIN SPECTROGRAPH
D-36224 B

TOLERANCES:
FRACT. ± 1/64
.XX ± .01
.XXX ± .005
ANG. ± 1/2°

ITEM NO	PART NO. OR SIZE	DESCRIPTION	QTY A/P
1	RTV-108	G.E. ADH. SEALANT	
2	1/4-20 X 5/8	SOC HD CAP SCR	3
3	1/4-20 X 3/8	SOC SET SCR	3
4	1/4-20 X [illegible]	SOC [illegible]	4
5	1/4-20 X 1	SOC HD CAP SCR	[illegible]
6	4-40 X 1/4	SOC BUTTON HD CAP SCR	[illegible]
7	2-56 X 3/8	[illegible]	[illegible]
8	C360-032-0750M	ASC COMP SPRING	[illegible]
9	[illegible]	STEEL DOWEL	4



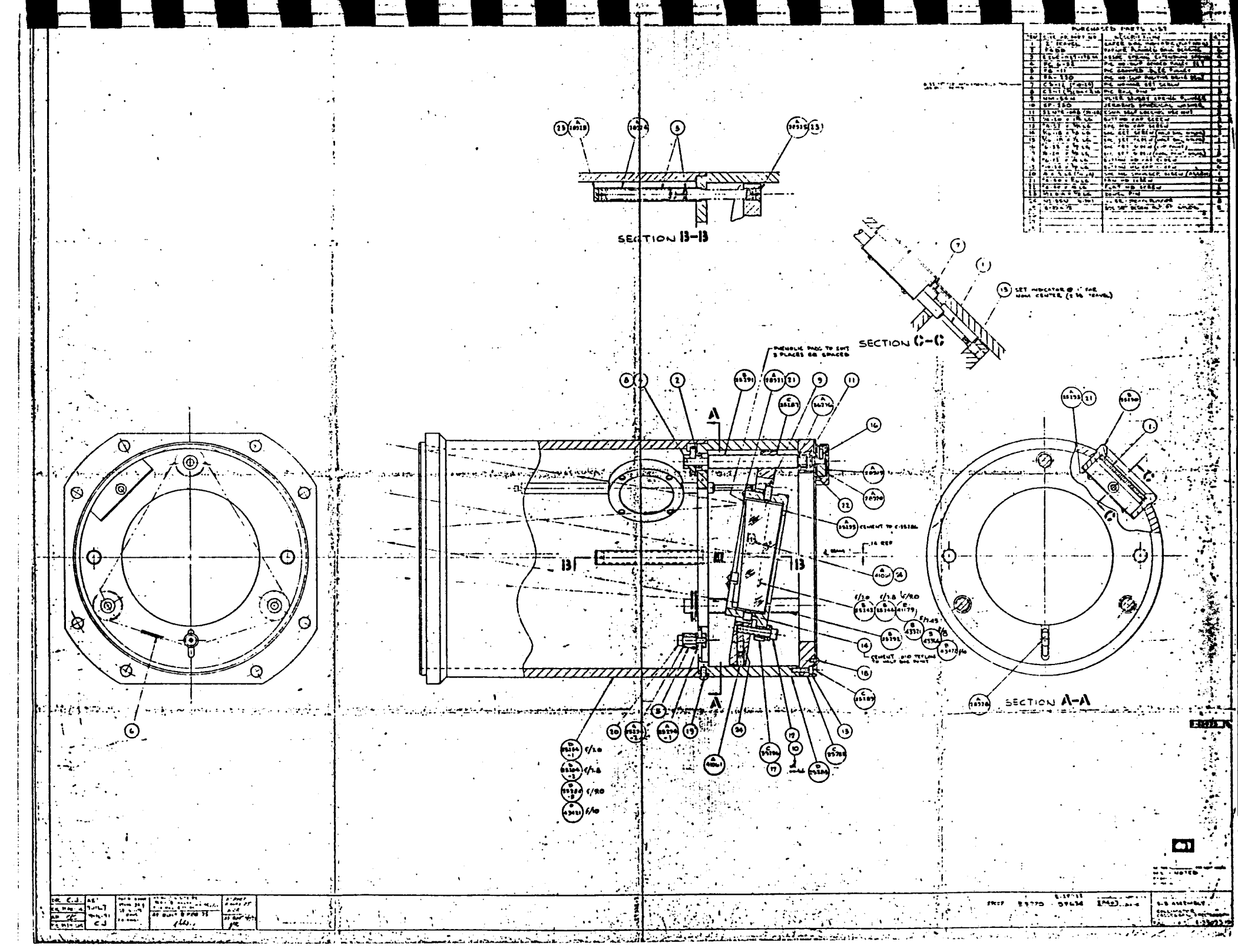
16 cm. CAMERA (F/11)
CAMERA COATA
DIRECT PHOTOGRAPHIC
MODULE

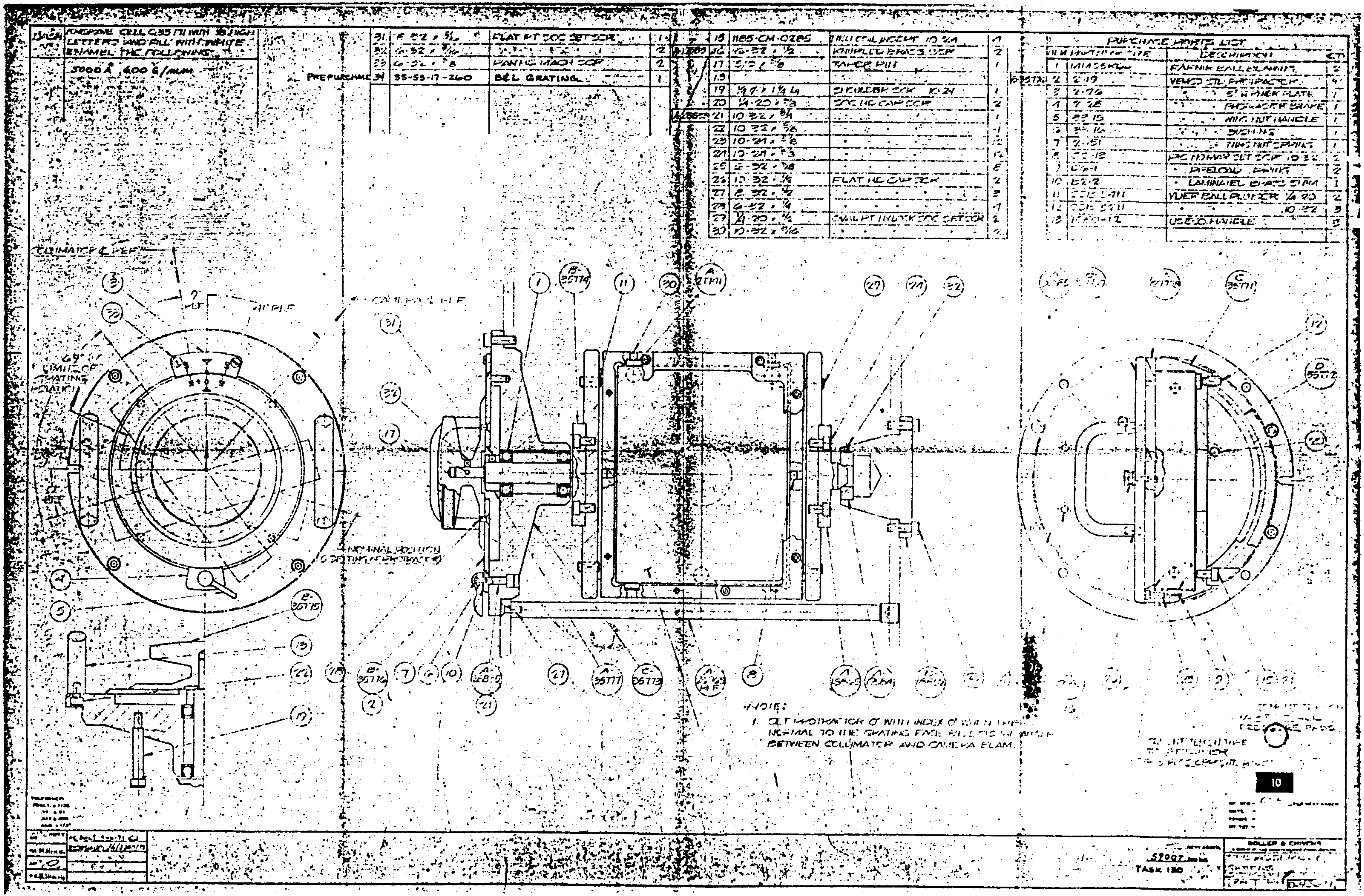
B

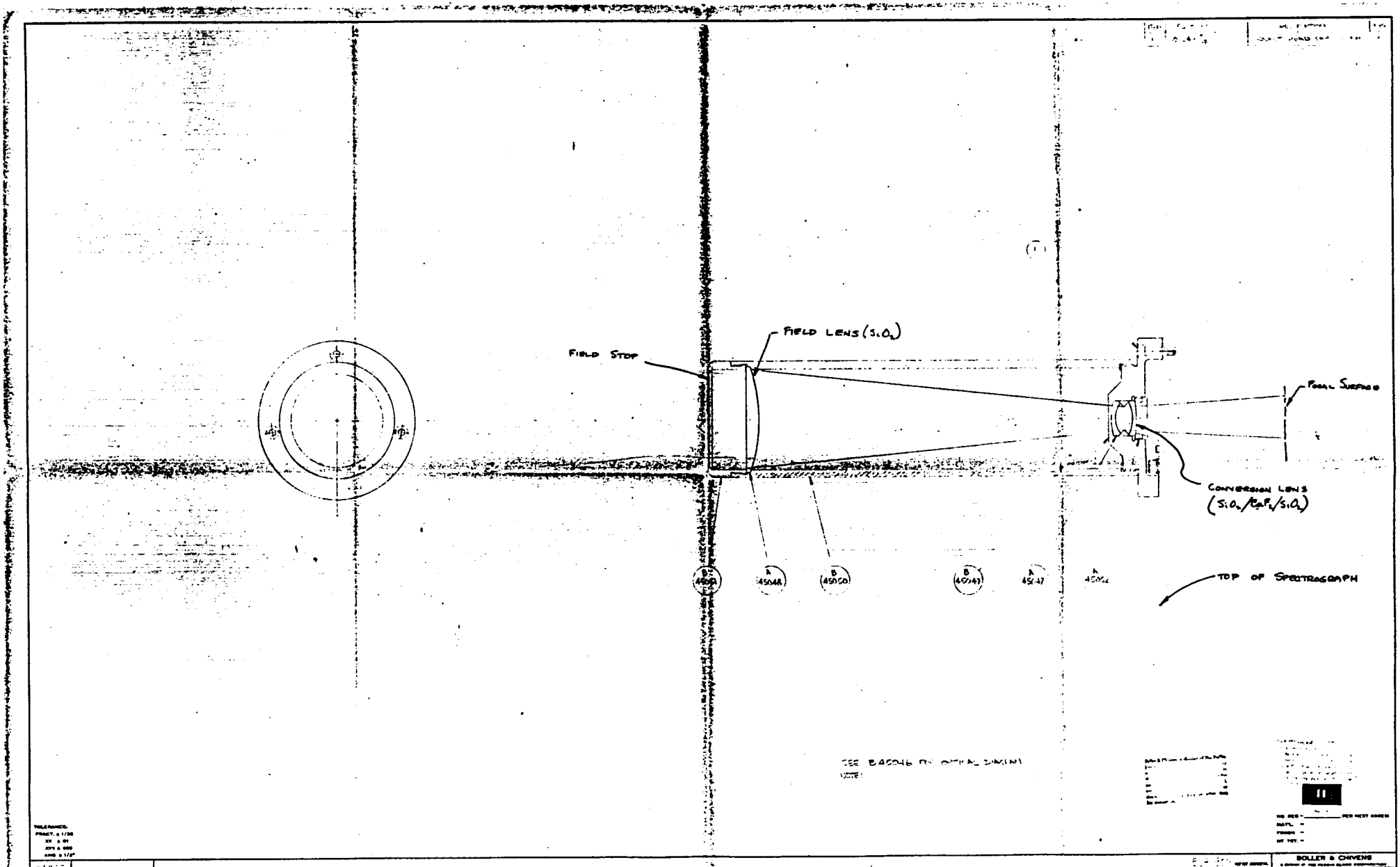
1-40444
SB170

BOLLER & CHIVENS

D-[illegible]


SECTION B-B
SECTION C-C
SECTION A-A
PURCHASED PARTS LIST


ENGRAVE CELL C35 711 WITH 1/8 HIGH LETTERS AND FILL WITH WHITE ENAMEL THE FOLLOWING:
5000 Å, 600 ℓ/mm
PREPURCHASE 34 35-53-17-260 B&L GRATING
FLAT PT SOC SET SCR
PAN HD MACH SCR
KNURLED BRASS SCR
TAPER PIN
SOC HD CAP SCR
FLAT HD CAP SCR
PURCHASE PARTS LIST
DESCRIPTION
LAMINATED BRASS SHIM
COLLIMATOR ℄ REF
CAMERA ℄ REF
NOMINAL POSITION OF GRATING PROTRACTOR
NOTE:
1. SET PROTRACTOR 0° WITH INDEX 0° WHEN THE NORMAL TO THE GRATING FACE BISECTS THE ANGLE BETWEEN COLLIMATOR AND CAMERA BEAM.
10
BOLLER & CHIVENS
S9007
TASK 180

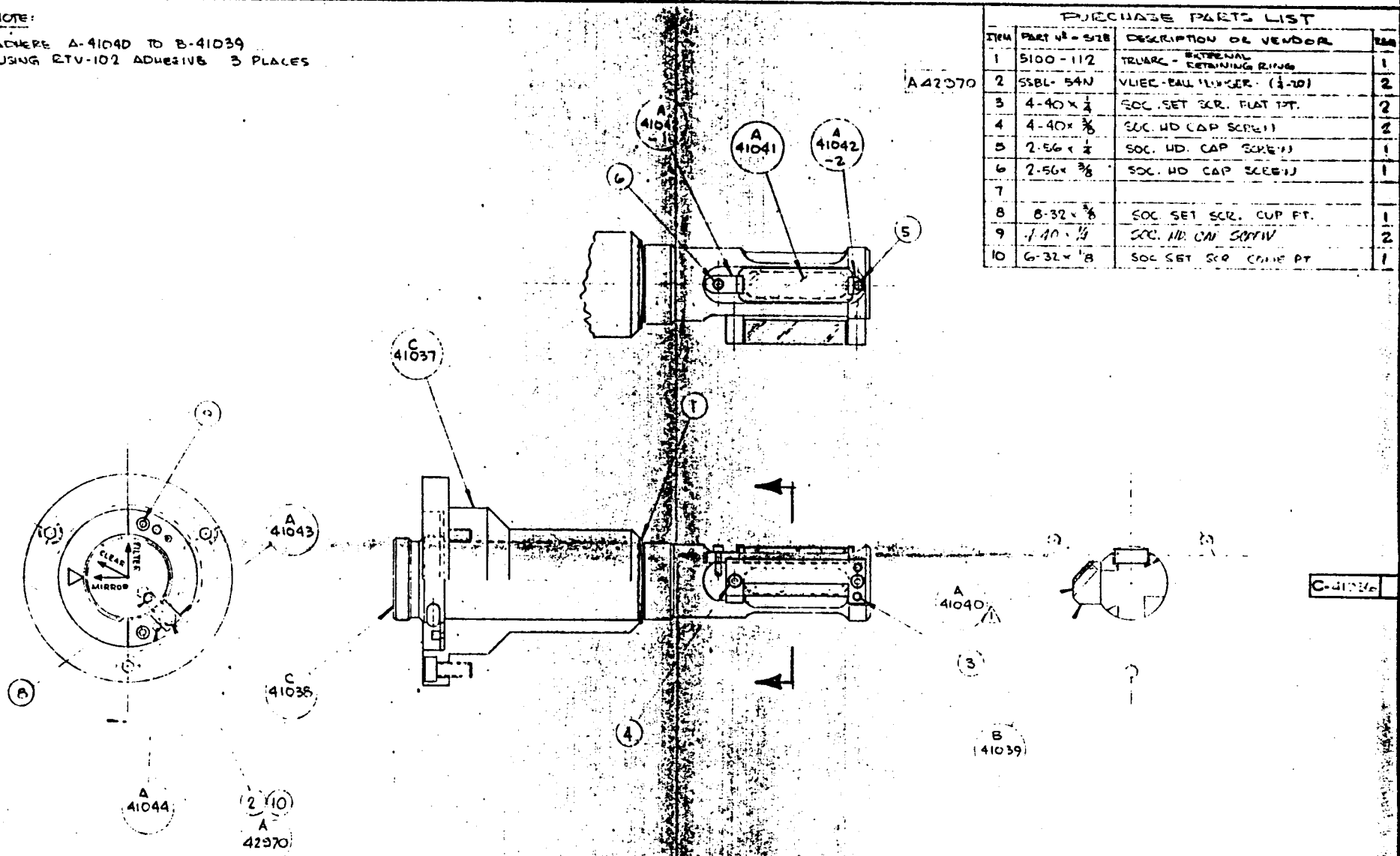

FIELD LENS (S.O.$_2$)
FIELD STOP
FOCAL SURFACE
CONVERSION LENS
(S.O.$_4$/F$_2$F$_3$/S.O.$_5$)
TOP OF SPECTROGRAPH
B 45048
B 45050
B 40343
A 45047
A 45044

NOTE:

⚠ ADHERE A-41040 TO B-41039 USING RTV-102 ADHESIVE 3 PLACES

A 42970

PURCHASE PARTS LIST			
ITEM	PART № - SIZE	DESCRIPTION OR VENDOR	REQ
1	5100-112	TRUARC - EXTERNAL RETAINING RING	1
2	SSBL-54N	VLIEC-BALL PLUNGER (1/4-20)	2
3	4-40 x 1/4	SOC. SET SCR. FLAT PT.	2
4	4-40 x 3/8	SOC. HD CAP SCREW	2
5	2-56 x 1/4	SOC. HD. CAP SCREW	1
6	2-56 x 3/8	SOC. HD CAP SCREW	1
7			
8	8-32 x 3/8	SOC SET SCR. CUP PT.	1
9	4-40 x 1/4	SOC. HD. CAP SCREW	2
10	6-32 x 1/8	SOC SET SCR CONE PT	1



12

TOLERANCE:
FRACT. ± 1/32
.XX ± .01
.XXX ± .005
ANG. ± 1/2°

NO. REQ - 0116 PER NEXT ASSEM.
MATL -
FINISH -
HT TRT. -

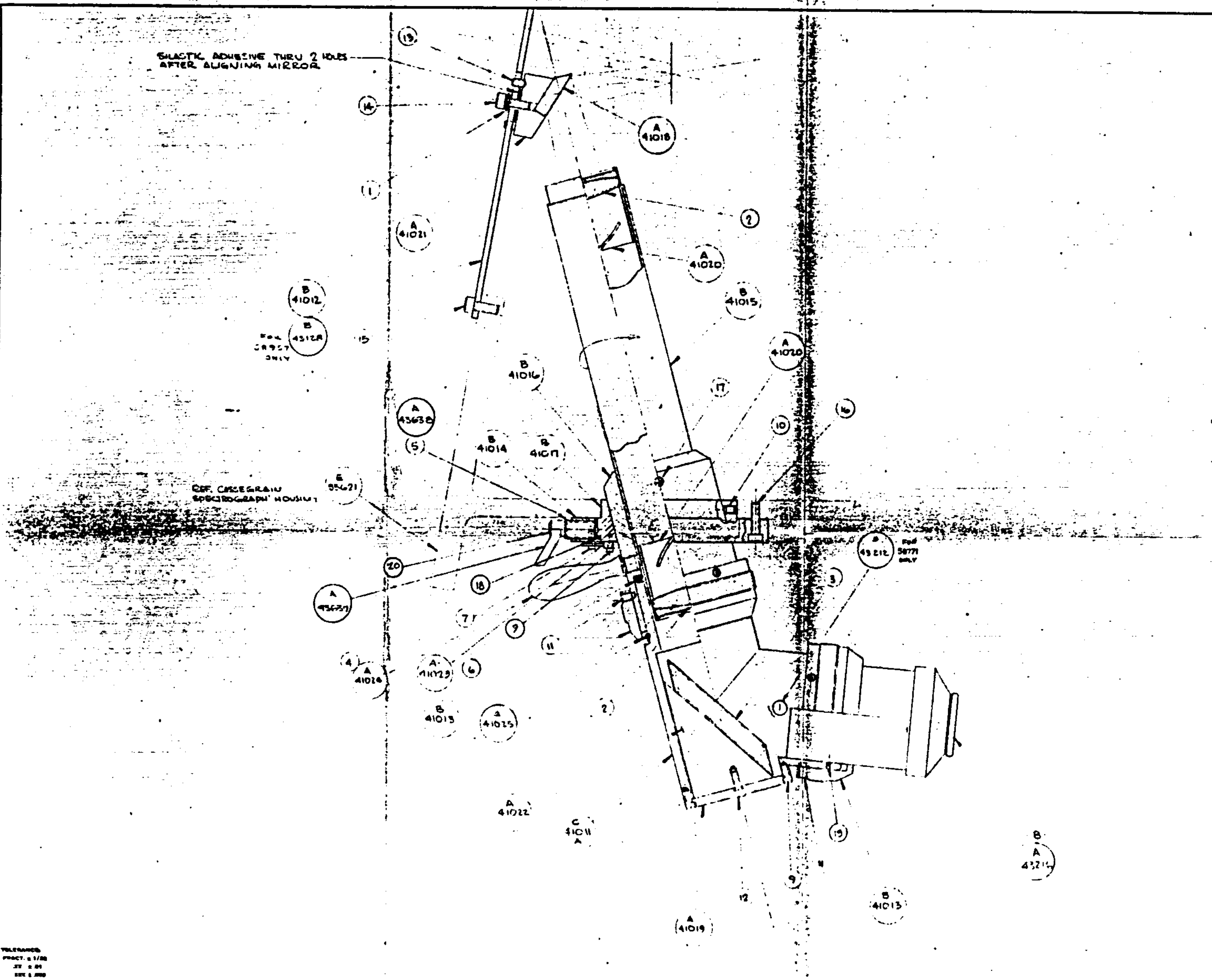
DR	EC
CK	WH
AP	
P.E.M.	

E-40144 NEXT ASSEM.
59007, [illegible], 58770 JOB NO.

BOLLER & CHIVENS
A DIVISION OF THE FERRO-ENAMEL CORPORATION

SUB-ASSEMBLY
FILTER-MIRROR
[illegible]

SCALE FULL SHEET 5 OF 5 C-41036



	ITEM	PART Nº OR SIZE	DESCRIPTION OR VENDOR	REQ
	1	80375-016	ASSOC. SPRING-BELLEVILLE WASHER	3
	2	10.0245	ROLYN – ACHROMATIC LENS 105mm FL 30mm DIA	1
	3	*30,261	EDMUND – FRONT SURFACE ELLIPTICAL MIRROR	1
A-41024	4	HS-24	DIXO TOOL SUPPLY – HANDLE	1
A-43630	5	BH-55	VLIER – BALL PLUNGER	1
	6	S 332	PARKER – O-RING	1
	7	1/8 DIA × 3/8 LG	STANDARD STEEL DOWEL	2
A-42[illegible]	8	180.A.14.00	CLAVE – EYE PIECE 45mm F.L.	1
	9	2-56 × 1/4	SOC. HD. CAP SCREW	6
	10	8-32 × 1/4	SOC. SET SCR. CONE PT.	3
	11	8-32 × 1/4	SOC. SET SCR. HALF-DOG	6
	12	6-32 × 3/8	SOC. HD. CAP SCR.	1
	13	8-32 × 1/4	SOC. SET SCREW OVAL PT	3
	14	10-32 × 1/2	SOC. HD. CAP SCREW	1
	15	10-24 × 1/2	SOC. HD. CAP SCREW	4
	16	10-24 × 3/8	SOC. HD. CAP SCREW	4
	17	S5-14 (4-20)	PIC-NO-MAR SET SCR. SOCKET	3
	18	*22 M1	TEFLON SLEEVE 3" LONG	1
	19	[illegible]	[illegible]	
	20	8-32 × 1/2	BUTTON HD. SCREW	1

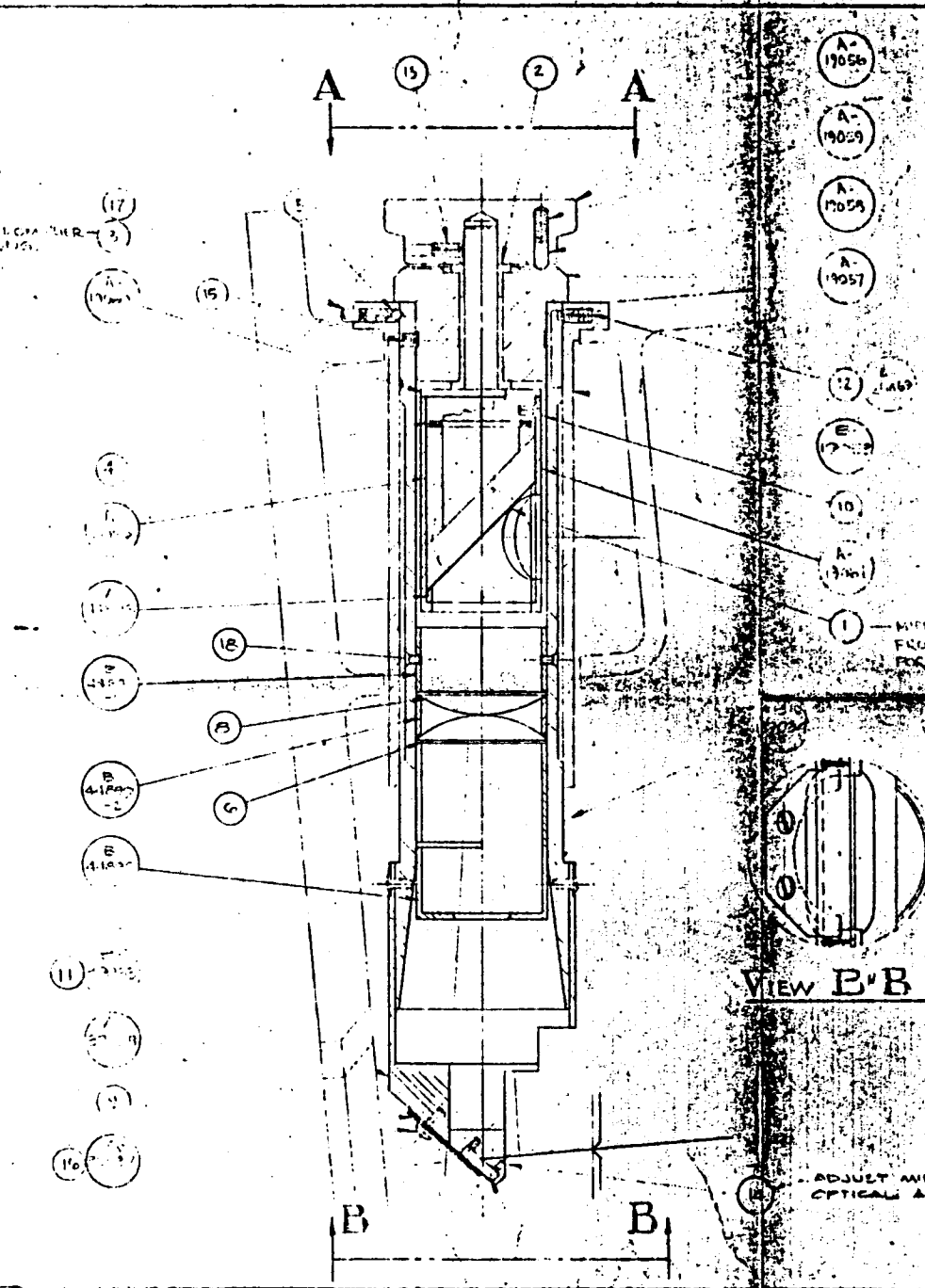
AS BUILT FEB 21/75

AS BUILT 7/11/75

5[illegible]

BOLLER & CHIVENS

D-[illegible]

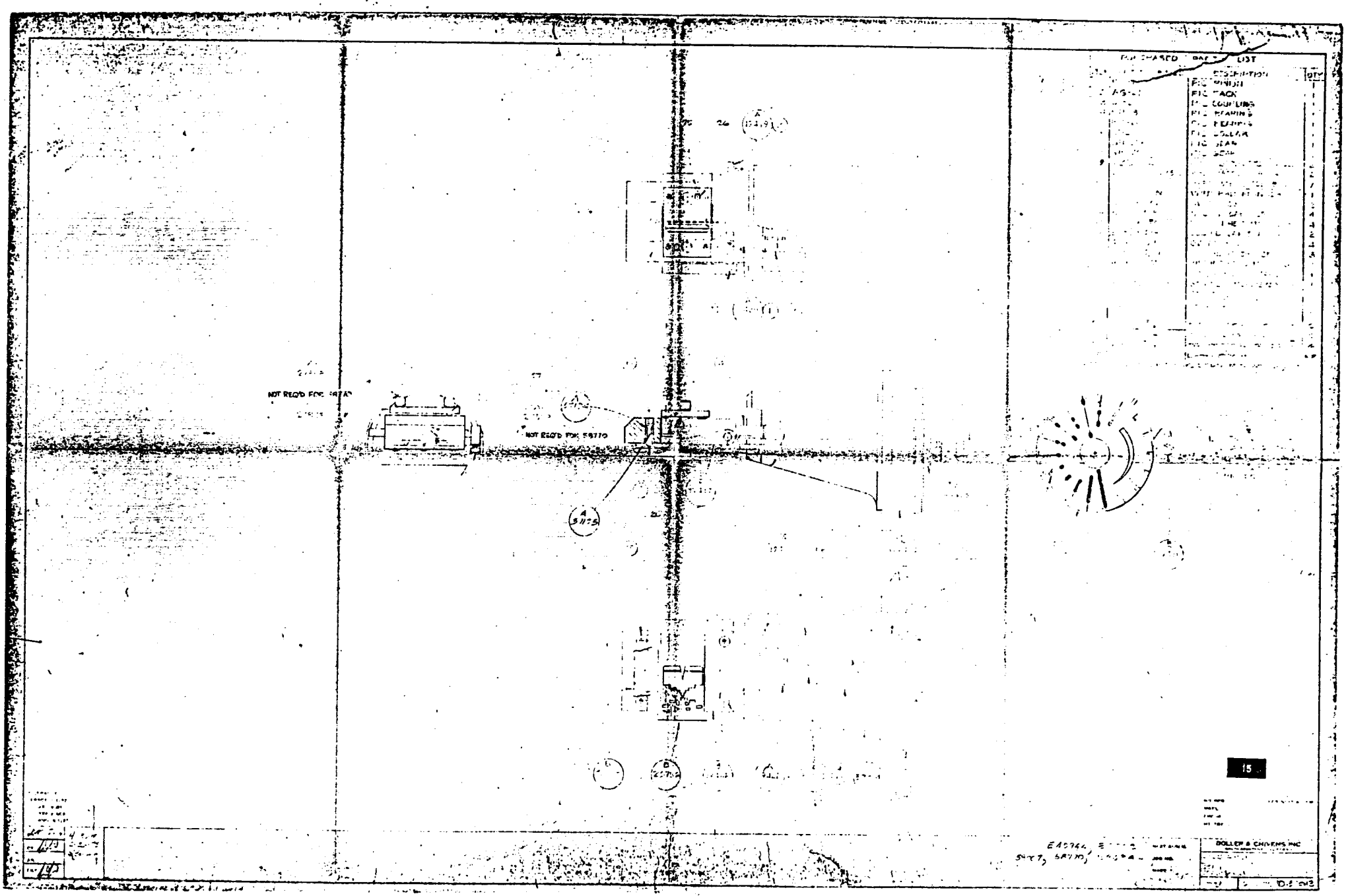


VIEW B"B

VIEW A"A

BOLLER & CHIVENS INC.

14

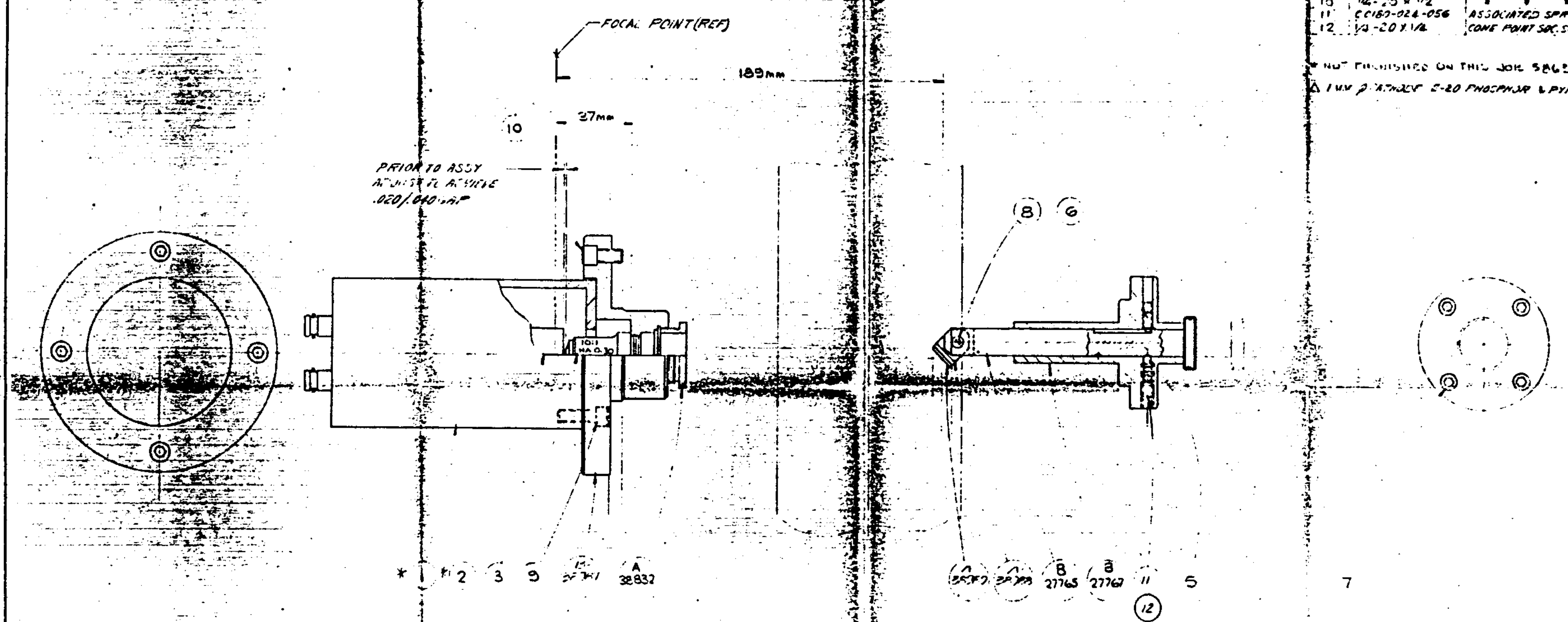

PURCHASED PART LIST
NOT REQ'D FOR 59770
15

PURCHASED PARTS LIST

ITEM	PART NO OR SIZE	DESCRIPTION	NO REQ
* 1	1135	SSR INST. CHANNELTRON TUBE H53	1
Δ 2	7500-520T	BENDIX CHANNELTRON TUBE	1
3	80.5055	RULYN ACHRO. OBJ. 10x 0.3NA	1
4			1
5	AK-5	PIC ST ST BALL	1
6	10-24 x 3/8	HALF DOG PT. SOCKET SET SCR	1
7	10-24 x 1/2	SOC. HEAD CAP SCREW	4
8	6-32 x 1/2	" " " "	1
9	1/4-20 x 1/2	" " " "	3
10	1/4-20 x 1/2	" " " "	4
11	CC180-024-056	ASSOCIATED SPRING	1
12	1/4-20 x 1/4	CONE POINT SOC. SET SCREW	1

* NOT FURNISHED ON THIS JOB 58624, 58770, 51007

Δ 1 MM ... CATHODE P-20 PHOSPHOR & PYREX WINDOW

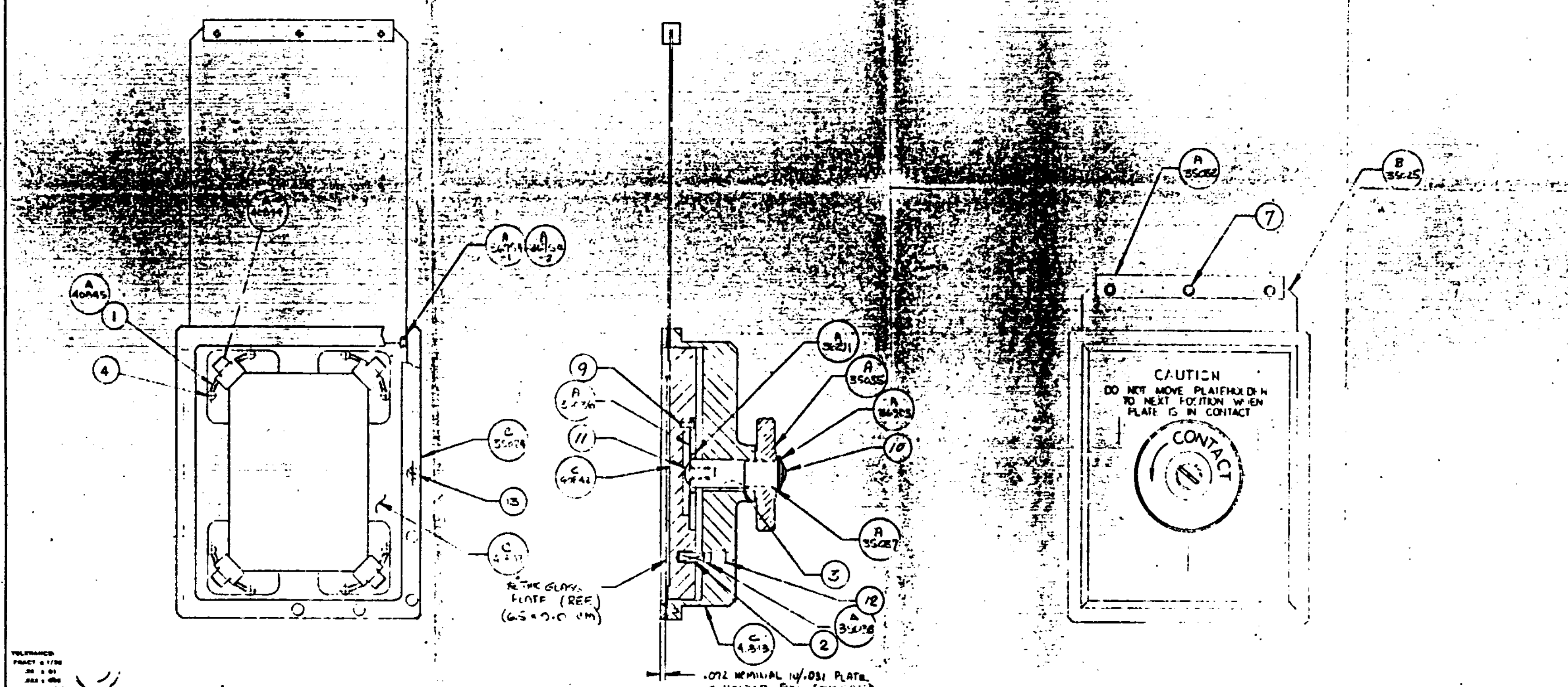


NOTE:
COVER PLATE B-39770 REPLACES ITEMS #1 & #2 WHEN THEY ARE NOT SUPPLIED

16

BOLLER & CHIVENS
38922

	IT	P/N	SIZE	MFR DESCRIPTION	QTY
A-40645	1	#203-B	5/32 O.D. .024 [illegible]	CENTURY SPRING, EXTENSION	4
	2	C.180 - 018 - C7KM (.0600 - GRN 154)		A.S.C. [illegible] COMPRESSION SPRING	3
	3	1/8" x 1/2"		WOODRUFF KEY	1
	4	2-56 x 3/16		SOCKET HD CAP SCREW	6
	5				
	6				
	7	#2-56 x 1/4 LG		SOC HD CAP SCR	3
	8				
	9	#4-40 x 1/4 LG		BUTTON HD SOC SCR	3
	10	#10-32 x 1/4 LG		82° OVAL HD SCR	1
	11	#10-32 x 3/8 LG		BUTTON HD SOC SCR	1
	12	1/4-20 x 1 1/4 LG		FLT PT SOC SET SCR	3
	13	#4-40 x 3/16 LG		FLT HD SCR	13
	14				
	15				



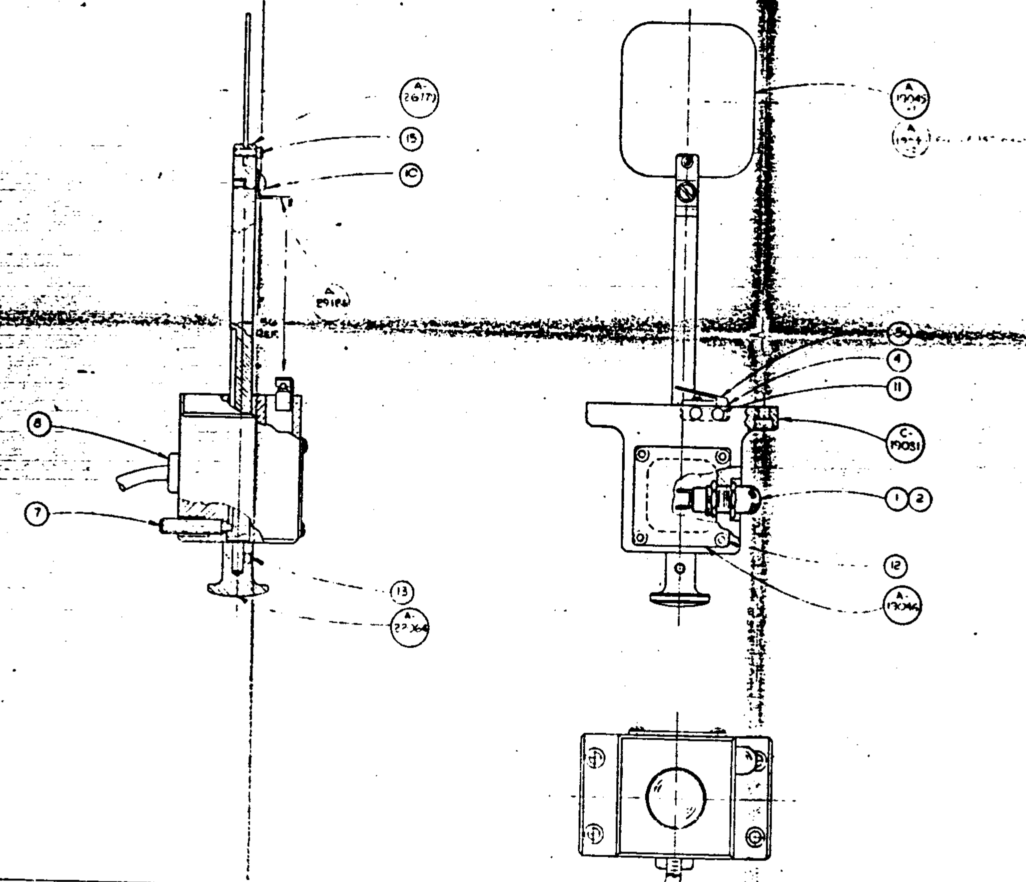
17

BOLLER & CHIVENS

D41640 58770

PURCHASED PARTS LIST

ITEM	PART NO. OR SIZE	DESCRIPTION	REQ'D
1	NE [illegible]	DIALCO LAMP	1
2	137-[illegible] OBI-[illegible]	DIALCO LAMP MOUNT	1
3	[illegible]	DEUTSCH CABLE CONNECTOR	1
4	[illegible]SMI	MICROSWITCH (HONEYWELL, FREEPORT, ILL.)	1
5	JS-2	ACTUATOR BRACKET	1
6			
7	[illegible]-50N	VLIER SPRING PLUNGER	1
8	[illegible]-15 I	HEYCO STRAIN RELIEF BUSHING	1
9			
10	[illegible]	[illegible]	1
11	NO. 2-56 × [illegible]	FLAT HD. MACHINE SCREW	2
12	NO. 4-40 × 1/4 [illegible]	BUTTON HD. SCREW	4
13	NO. 8-[illegible] × 3/16 LG.	CUP POINT SET SCREW	1
14			
15	NO. 4-40 × 7/16 LG.	SOC. HD. CAP SCREW	1
16			
17			



TOLERANCE

18

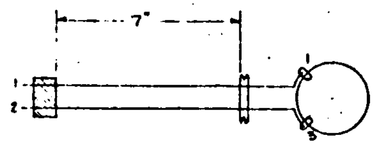
BOLLER & CHIVENS

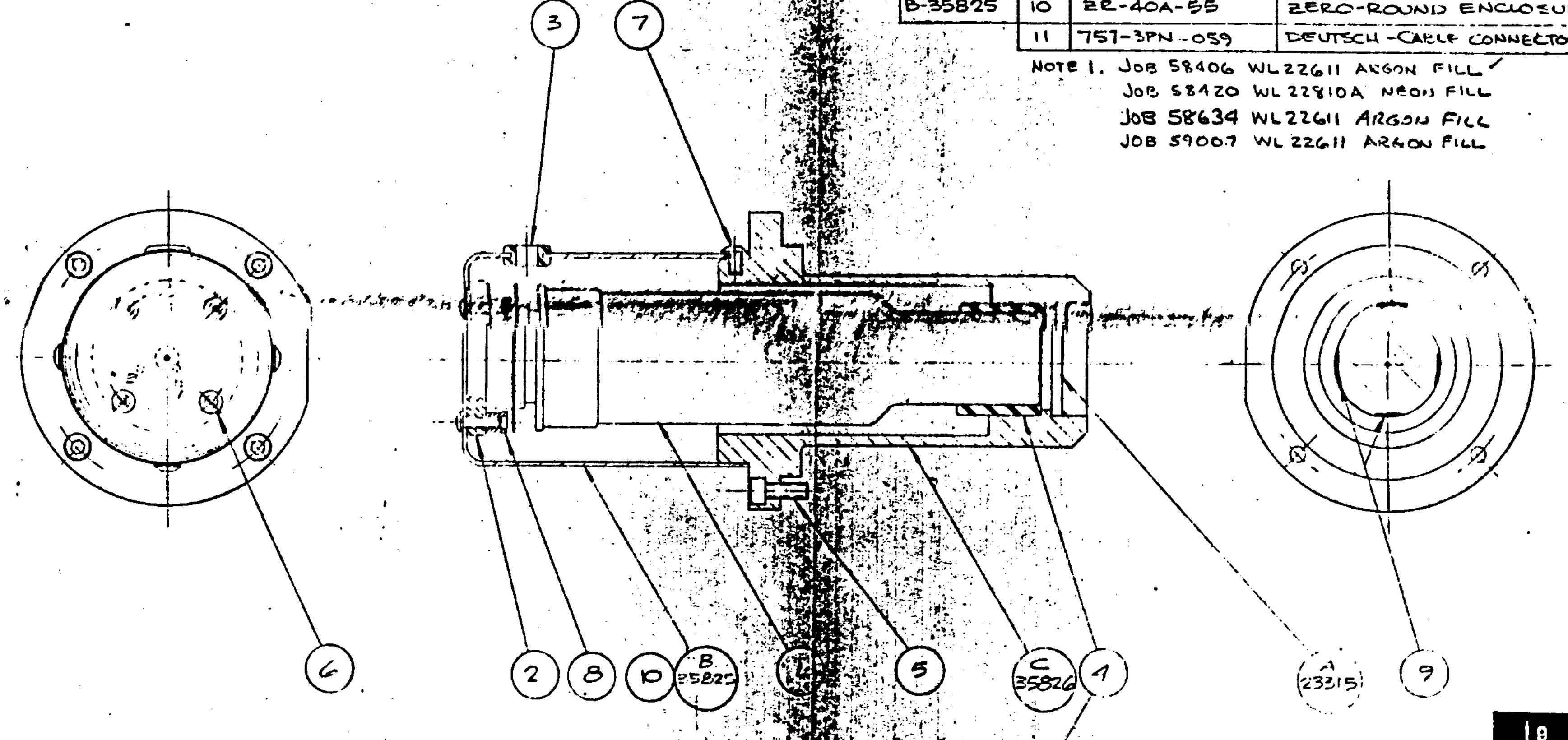
59007, [illegible] 59407

PURCHASE PARTS LIST

ITEM	PART Nº or SIZE	DESCRIPTION	QTY
1	SEE NOTE 1	WESTINGHOUSE HOLLOW CATHODE TUBE	1
2	Nº XS-8	POMONA ELECTRONIC OCTAL SOC.	1
3	Nº 5	RUBBERCRAFT GROMMET	1
4	$3\frac{17}{32} \times 1" \times \frac{1}{8}$	SILICONE RUBBER	1
5	$10\text{-}24 \times \frac{1}{2}$	SOC HD CAP SCR	4
6	$6\text{-}32 \times \frac{7}{16}$	SOC BUTTON HD SCR	4
7	$8\text{-}32 \times \frac{1}{4}$	SOC BUTTON HD SCR	4
8	6-32	ALLENUT	4
9	RTV 102	G.E. SILICONE ADHESIVE	A/R
10	ZR-40A-55	ZERO-ROUND ENCLOSURE (B-35825)	1
11	757-3PN-059	DEUTSCH - CABLE CONNECTOR	1

NOTE 1. JOB 58406 WL22611 ARGON FILL
JOB 58420 WL22810A NEON FILL
JOB 58634 WL22611 ARGON FILL
JOB 59007 WL22611 ARGON FILL





WRAP AROUND AND CEMENT TO C35826 @ ASSY

C-35824 A

18

NO. REQ - ONE PER NEXT ASSEM.
MAT'L -
FINISH -
HT. TRT. -

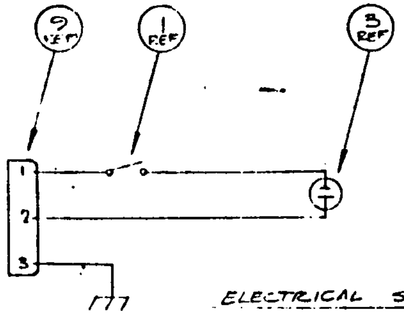
TOLERANCE:
FRACT. ± 1/32
.XX ± .01
.XXX ± .005
ANG. ± 1/2°

DR. [illegible]	AS BUILT 9-14-71 C.J.
CK. M. HEIL...	[illegible]
AP. [illegible]	'A' REV 4/17/73 JSL
P.E. N. HEIL...	AS BUILT 11/1/73 JSL

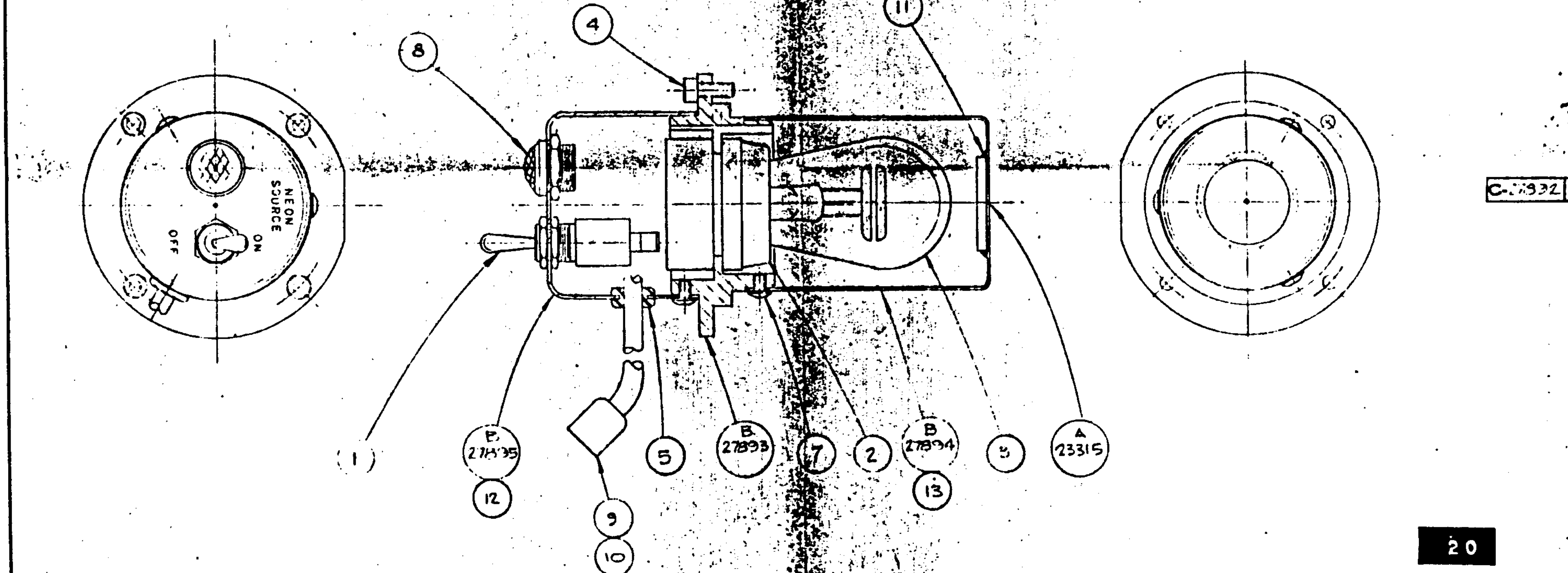
E-38922
59007, 58771, 58634
NEXT ASSEM.
58-107 JOB NO.

BOLLER & CHIVENS
A DIVISION OF THE PERKIN-ELMER CORPORATION
TUBE ASSEMBLY
HOLLOW CATHODE TUBE
[illegible]
SCALE 1/1 DATE [illegible] C-35824 A

		PURCHASED PARTS LIST		
	ITEM	PT. NO. OR SIZE	DESCRIPTION	REQ
	1	8391K7	CUTLER HAMMER TOGGLE SWITCH	1
	2	#400	BRYANT MED BASE LAMP SOCKET	1
	3	NE-40	GE NEON LAMP	1
	4	#10 24 × 1/2	SOC HD CAP SCR	4
	5	#5	RUBBERCRAFT GROMMET	1
	6			
	7	#8 32 × 1/4	SOC BUTTON HD SCR	6
	8	514-2512-0435-302	DIALCO LENS CAP ASSY	1
	9	757-3-6PII-059	DEUTSCH - CABLE CONNECTOR	1
	10	1250	ALPHA CABLE	A/C
	11	RTV 102	G.E. SILICONE ADHESIVE	A/C
B-27895	12	ZR-40A-32	ZERO MFG — ROUND ENCLOSURE	1
B-27894	13	ZTR-37A-52	" " " "	1



ELECTRICAL SCHEMATIC



20

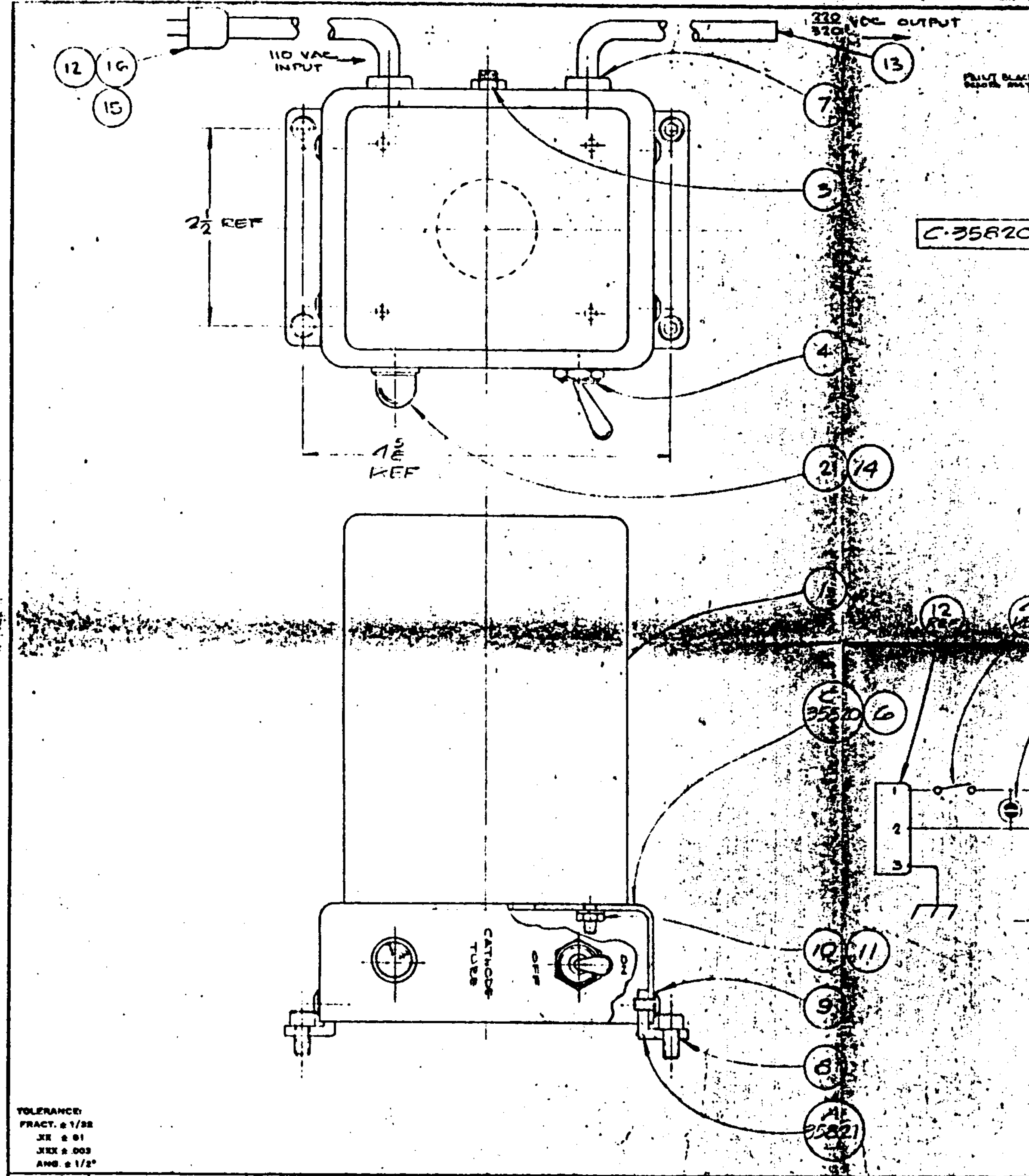
NO. REQ. — 1 PER NEXT ASSEM.
MAT'L —
FINISH —
HT. TRT. —

TOLERANCE:
FRACT. ± 1/32
.XX ± .01
.XXX ± .005
ANG. ± 1/2°

DR. MF	A ... ITEM	AS BUILT	B REV. REDRAWN	
CH.	ITEM 8 WAS NEW...	9-14-71	4/17/73 JSK	
AP.	...	CJ	AS BUILT 7/17/75 JSK	
FILE	B - REV. ... RED GND. JJS. 6-11-72			

E-40944 E-38922 E26477 E28107 — PER NEXT ASSEM.
59007 58770 58634 58407 9829 9891 JOB NO.

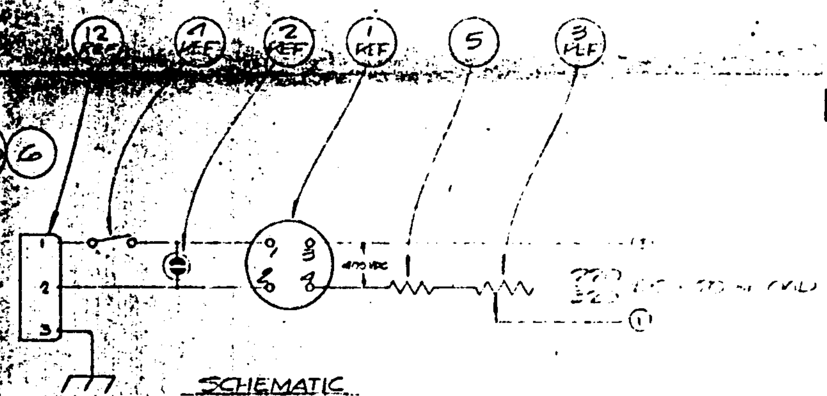
BOLLER & CHIVENS
A DIVISION OF THE PERKIN-ELMER CORPORATION
SUB ASSEMBLY NEON LAMP SOURCE
CASSEGRAIN SPECTROGRAPH
C-27932 B



PURCHASE PARTS LIST

ITEM	PART Nº or SIZE	DESCRIPTION	QTY
1	HV-400	[illegible] POWER SUPPLY	1
2	131-8836-0931-552	DIALCO INDICATOR LIGHT	1
3	CLU 5021	OHMITE TRIM POT. (2W 5000Ω)	1
4	8391K7	CUTLER HAMMER TOGGLE SWITCH	1
5	1756	OHMITE RESISTOR (12W 11K)	1
6	Z56-67 × 1½	ZERO CAN 3¼ × 1½ × 1½	1
7	SR-6W-1	HEYMAN STRAIN RELIEF	1
8	10-24 × ⅝	SOC HD CAP SCR	4
9	6-32 × ¼	BUTTON HD CAP SCR	4
10	6-32 HD	HEX NUT	4
11	Nº 6	LOCKWASHER	4
12	757-3PN-059	DEUTSCH-CABLE CONNECTOR	1
13	1250	ALPHA CABLE	A/R
14	C7A(NE20)	NEON LAMP	1
15	1451	ALPHA CABLE	A/R
16	SR6P-4	HEYMAN STRAIN RELIEF	1

C-35820



SCHEMATIC

C-35812 C

21

TOLERANCE:
FRACT. ± 1/32
.XX ± .01
.XXX ± .003
ANG. ± 1/2°

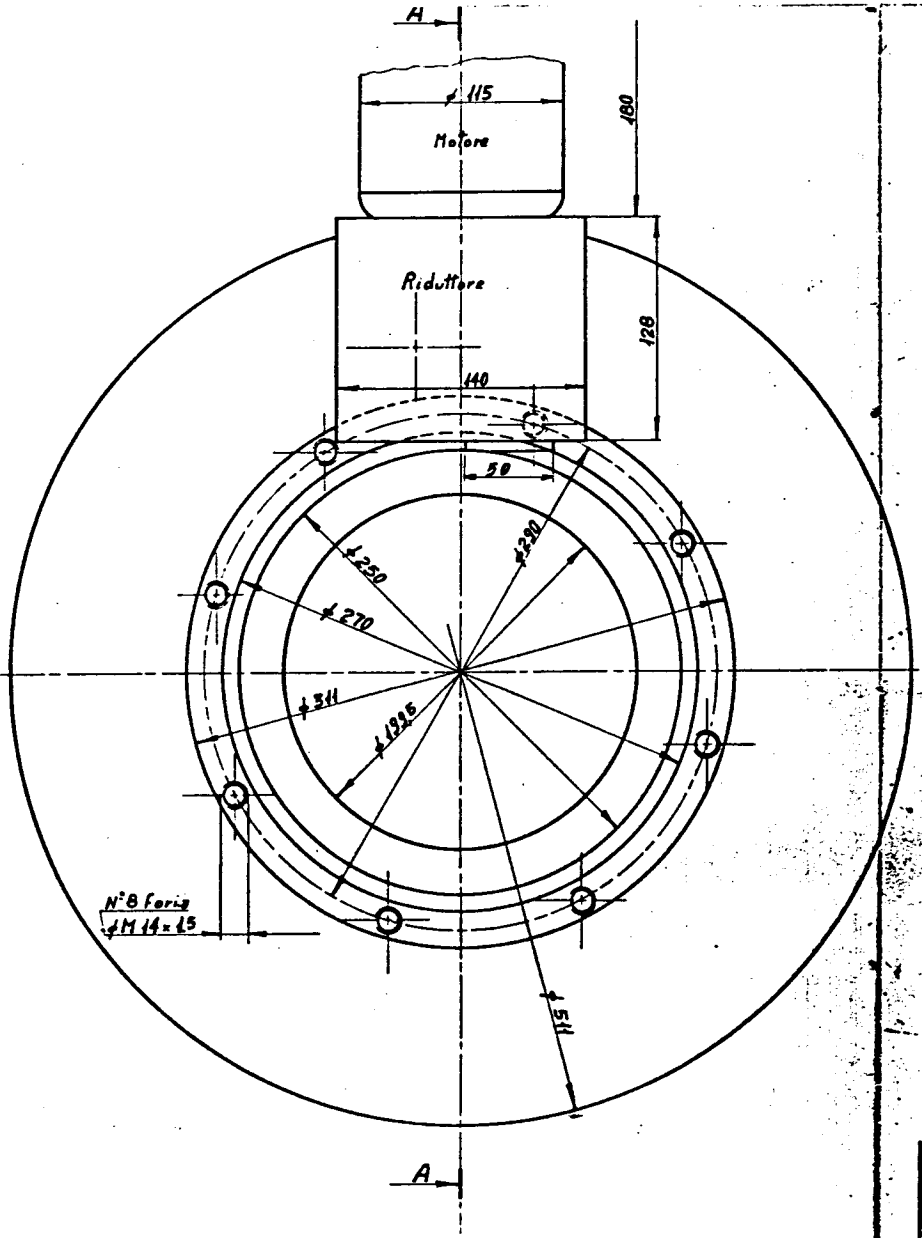
AS BUILT 6-21-74 R.C.
AS BUILT 7/17/75 JSK

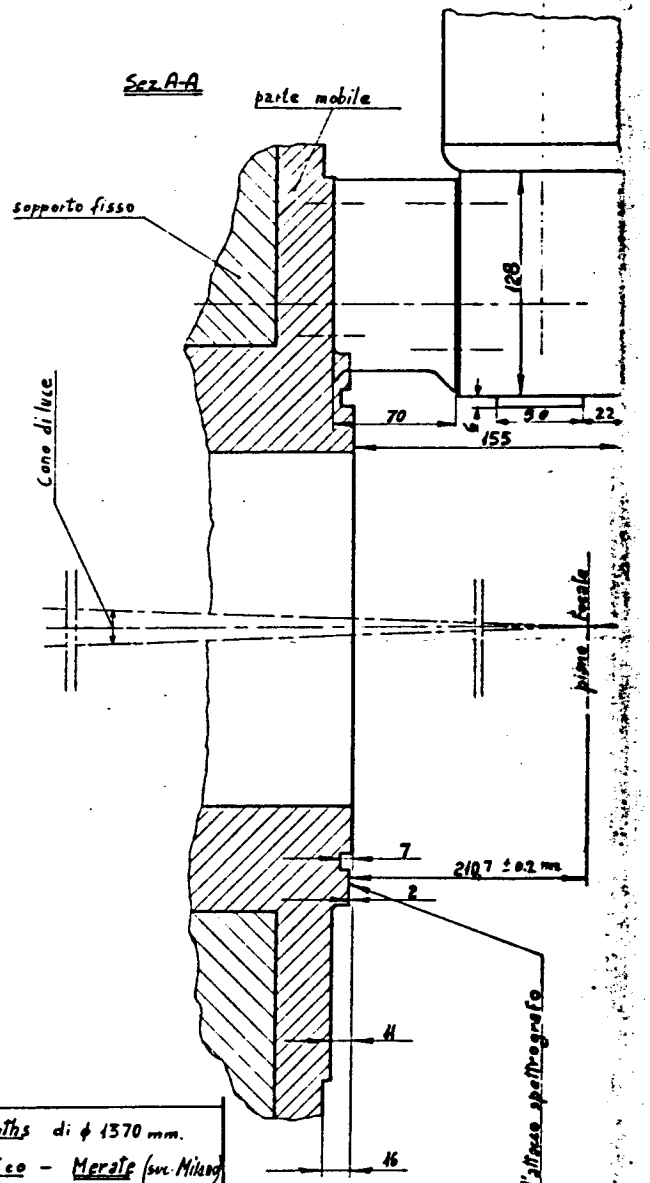
59007 58771 E-38922 58674

NEXT ASSEM. 58407 JOB NO.

NO. REQ - ONE PER NEXT ASSEM.
MAT'L -
FINISH -
HT. TRT. -

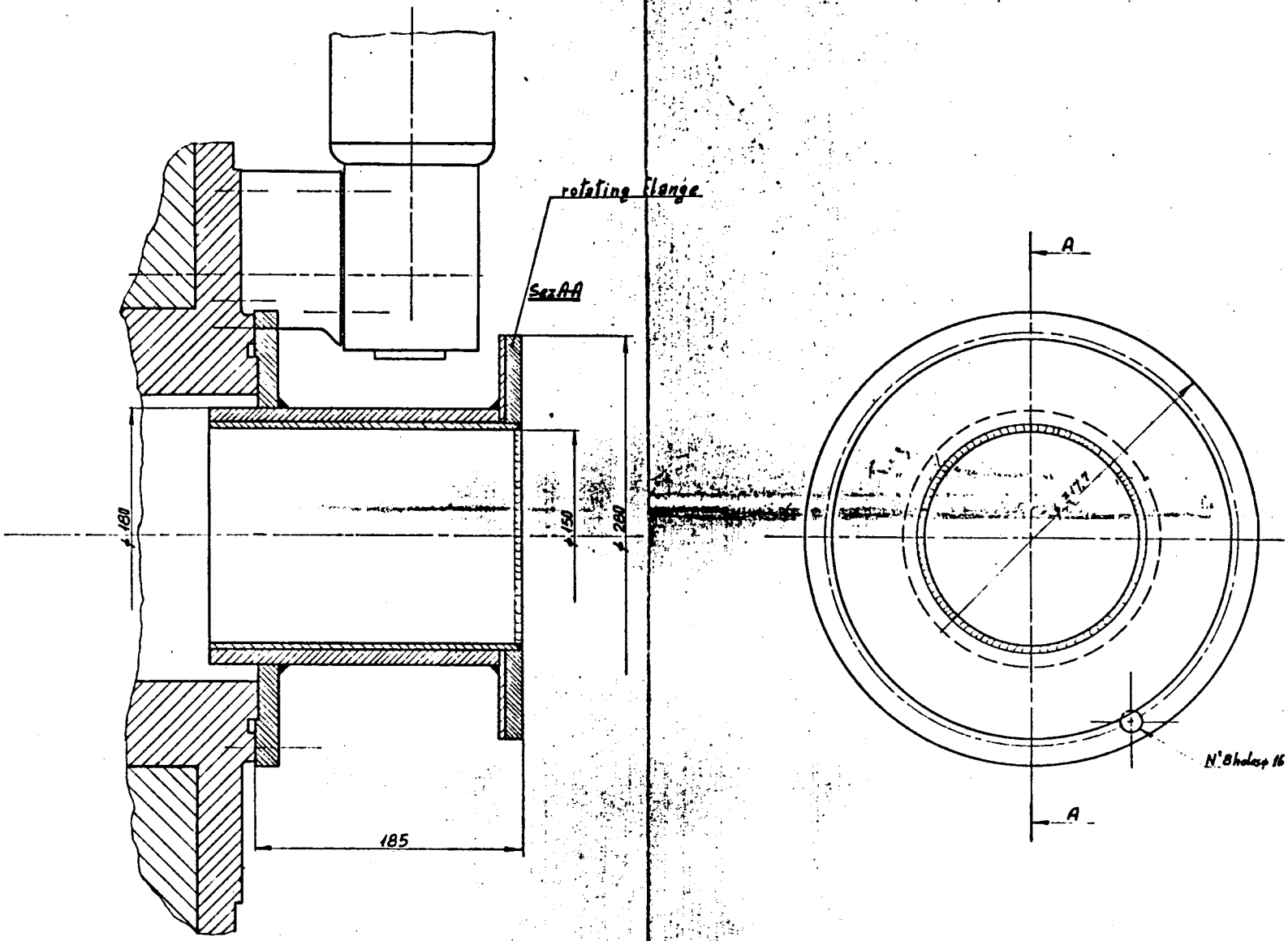
BOLLER & CHIVENS
SUB ASSEMBLY
C-35812 C





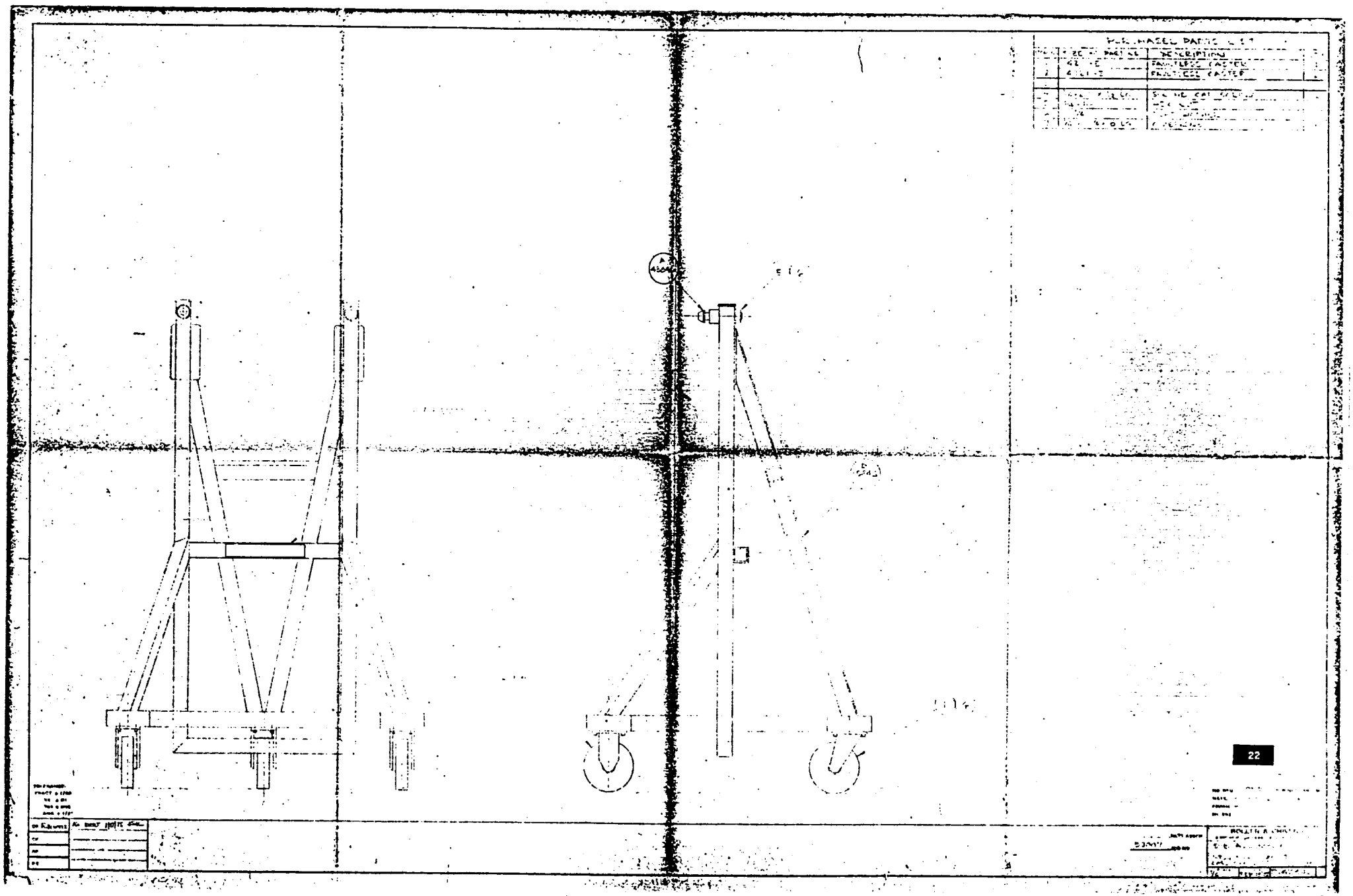
23

Telescopio Riflettore Ruths di φ 1370 mm. - Osservatorio Astronomico - Merate (Sez. Milano)		
Oggetto: Flangia d'attacco x spettrografo		Scala 1:2
Designer: Contis S.	Data: 26/11/74	



24

Telescopio Riflettore Ruths di φ 1370 mm. - Osservatorio Astronomico - Milano - (sezz Merate) -	
Object: Adapter Flange for spectrograph	Scale 1:2
Date: 23/4/73	



22