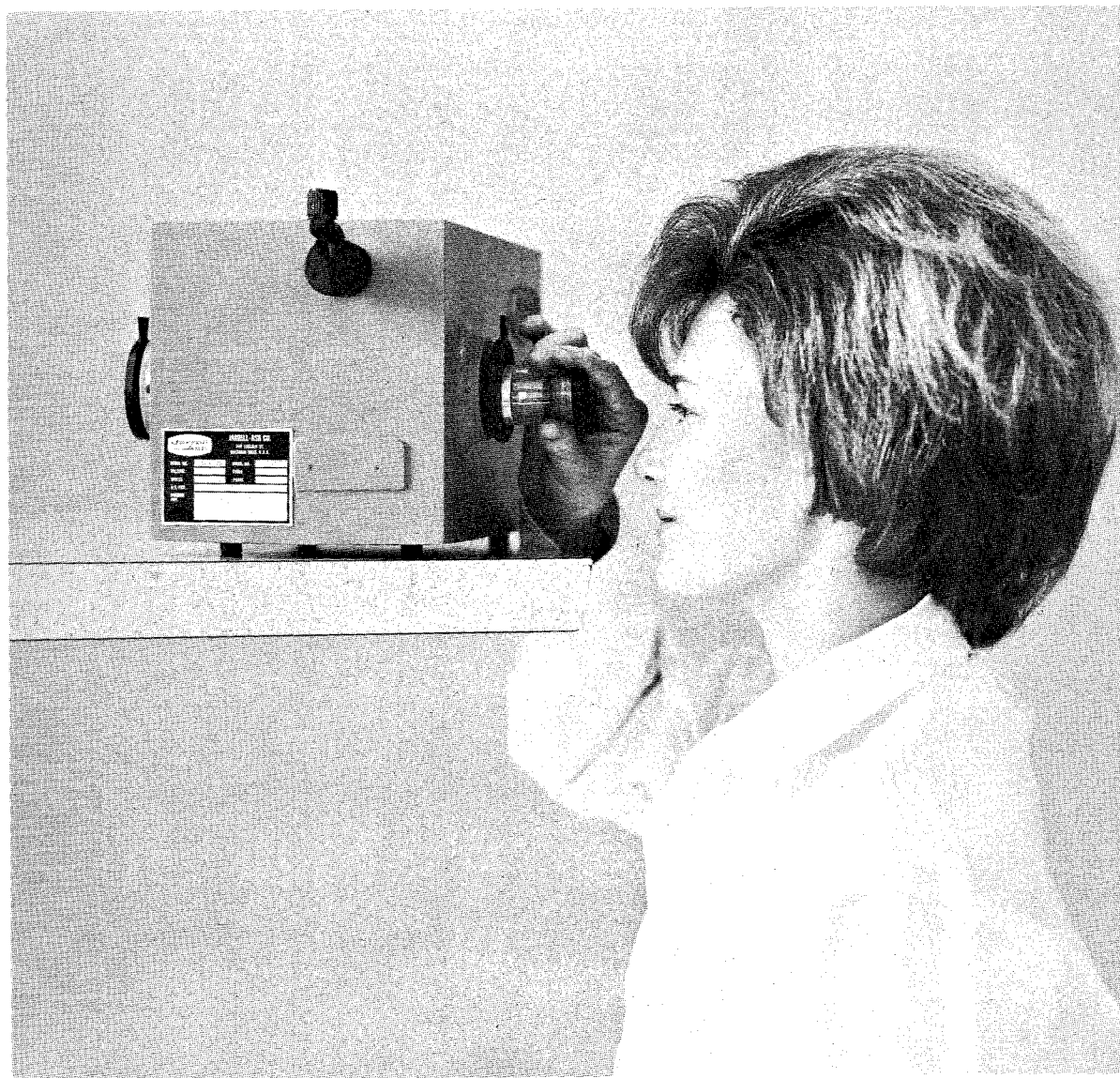


OPERATING AND SERVICE INSTRUCTIONS
FOR THE
0.25 METER EBERT MONOCHROMATOR



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MAY '67

JARRELL-ASH COMPANY • 590 LINCOLN STREET • WALTHAM, MASS.

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SECTION 1 INTRODUCTION

1-1 General Description

The 0.25 Meter Ebert Monochromator combines high aperture ratio with good resolution. It comes complete with two gratings and slits and is preadjusted and calibrated. It can be used easily by all laboratory personnel. It may be used as a monochromatic illuminator or as a spectrometer in a wide variety of applications. The unit can be used in measurements of absorption, transmission, emission, reflection, radiation, fluorescence, phosphorescence and low level luminescence of all types. It is useful as a source of monochromatic light for microscopes, photometers, and other spectrometric uses. The versatility of the Model 82-410 Series Monochromator makes it the standard monochromator for general use in physics, chemistry, biology laboratories. The instrument is suitable for use in the ultraviolet, visible and infrared.

This manual should be read and understood thoroughly prior to commencing installation, operation, and/or servicing.

1-2 Equipment Specifications

Over-all dimensions:	17.7 x 22.1 x 21.4 cm 7" x 8-3/4" x 12-1/2"
Weight:	Approximately 12 lbs. 5.44 Kilograms
✓ Focal Length:	0.25 meter
Linear Dispersion:	3.3 mμ/mm with 1180 grooves/mm grating.
Aperture Ratio (Speed): Model 82-410	f/3.6
✓ Gratings (two supplied): Model 82-410	Ruled Area: 64mm x 64mm Replicas, 1180 grooves/mm
Gratings Blazed at:	300.0 mμ and 600.0 mμ
Resolution: (half-band width at 3131 mμ)	.2 mμ with 25 micron slits .3 mμ with 75 micron slits .5 mμ with 100 micron slits
Scattered Light: *	Less than 0.3% at 300.0 mμ
Slits:	Two 100 micron slits, standard interchangeable.
Slit Arrangement:	Focusing slits in line on opposite sides of instrument.

* See Para. 2-3-12, Page 6

Calibrated Readout: Preadjusted and calibrated, three digit wavelength dial reads directly in millimicrons, 0 - 900 equivalent to 0 to 900 mμ, accuracy ± 1 mμ.

Wavelength Drive Coverage: 0 to 900 mμ.

1-3 Component Identification and Description

1-3-1 OVERALL VIEW 82-410 (Figure 1)

1. Interchangeable Slit
100 μ, standard width, others available.
2. Slit Focus
A #6-32 x 3/4" long oval tip set screw is provided in the right hand threaded hole in the slit face plate, and is used to set focus.
3. Two nylon tipped set screws are used to retain the focus tube position.
4. Wavelength Drive Knob
Hand rotated to cover 0 - 900.0 mμ.
5. Mounting holes for electric drive accessories.

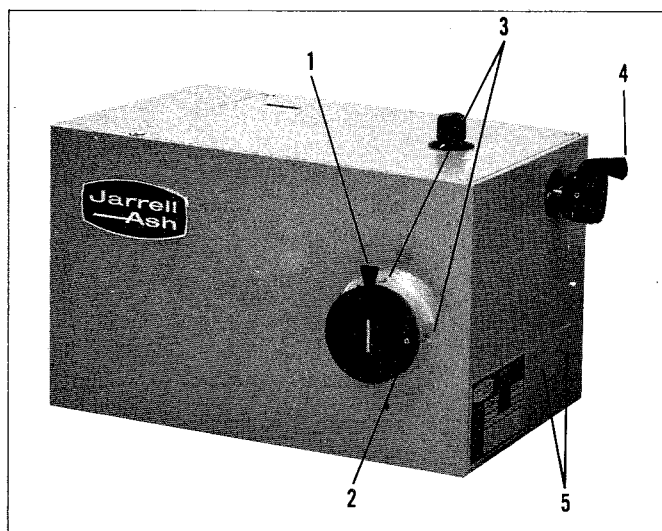


Figure 1

1-3-2 OVERALL VIEW 82-410 (Figure 2)

6. Wavelength Counter
Reads from 0 to 900, equivalent 0 to 900 mμ.
7. Grating Selector Knob
Two gratings are located back-to-back in a single grating holder. The Selector Knob places desired grating in operating position.

8. Main Compartment Cover Plate
Remove for access to the grating holder.
9. Mirror Compartment Cover Plate
Remove for access to the mirror.
10. Locking screw to maintain the 45° mirror position.

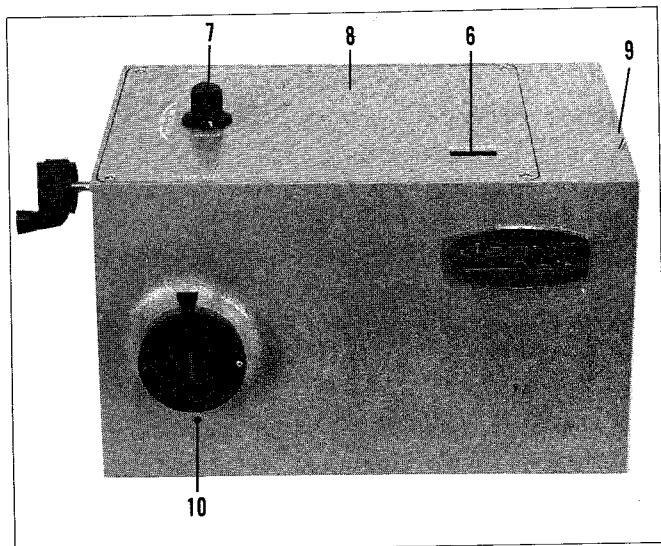


Figure 2

1-3-3 OPTICAL LAYOUT (Figure 3)

The monochromator is an Ebert optical mount. The light passes through the entrance slit (A) striking a 45° mirror (B) and is reflected to a large collimating mirror (C-1). From this mirror it is reflected to the grating (D) and dispersed back to the collimating mirror (C-2). The light beam, returning to focus, is reflected; by 45° mirror (E) out through exit slit (F). The entrance and exit slits (A,F) are in line on opposite sides of the instrument. Two gratings are mounted back-to-back at (D) and either may be selected for use by turning the external knob (7, Fig. 2).

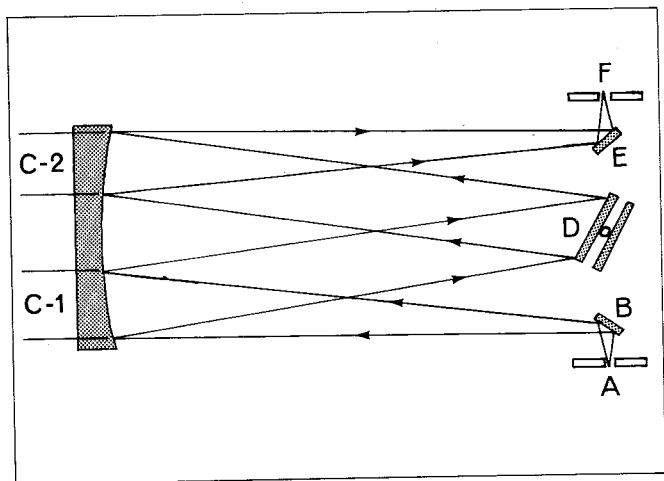


Figure 3

1-4 Auxiliary and Related Equipment

1-4-1 LIGHT SOURCES

Model Number

45-451	Deuterium Lamp and Tungsten lamp with power supply for deuterium and Tungsten lamps. For 115 volts, 60 cycles, single phase.
45-541 D	Deuterium Lamp and Tungsten lamp with power supply for deuterium and Tungsten lamps. For 115 volts, 50 cycles, single phase.
45-542	Tungsten Quartz Iodine Lamp
45-541-A-01	Deuterium Lamp.
45-542-A-01	Tungsten Lamp.
45-543	Xenon Lamp and power supply. For 115 volts, 60 cycles, single phase.
45-543-A-01	Xenon Lamp.
45-544	Mercury Lamp & Power Supply. For 115 volts, 50/60 cycles, single phase.
45-544-A-01	Mercury Lamp. For 115 volts, 50/60 cycles, single phase.
45-544-A-01	Mercury Lamp.

1-4-2 MOUNTING AND SCANNING ACCESSORIES

Model Number

82-440	Same as above, including factory alignment and calibration of two monochromators. Refer to App. A.
82-441	Double Monochromator Assembly Plate. Refer to App. A.
82-451	Gear Assembly for wavelength drive.
82-452	Motor unit for 10 mμ/min. For 115 volts, 60 cycles, single phase.
82-453	Motor unit for 10 mμ/min. For 115 volts, 50 cycles, single phase.
82-455	Motor unit for 25 mμ/min. For 115 volts, 60 cycles, single phase.
82-454	Motor unit for 25 mμ/min. For 115 volts, 50 cycles, single phase.
82-457	Motor unit for 100 mμ/min. For 115 volts, 60 cycles, single phase.
82-456	Motor unit for 100 mμ/min. For 115 volts, 50 cycles, single phase.

Model Number

82-442		Adaptor for Jarrell-Ash Accessory Bars of 10-000 series.
82-443	A	Adaptor for triangular profile optical bar.
10-014		Jarrell-Ash 100 cm bar.
10-024		Jarrell-Ash 125 cm bar.
10-034		Jarrell-Ash 150 cm bar.
10-104		Triangular profile, 50 cm optical bench.
10-114		Triangular profile, 100 cm optical bench.

1-4-3 GRATINGS AND HOLDERS

Model Number

11-043		Holder for two gratings of 69 x 69 x 6 mm blank size.
11-044		Holder for one grating of 69 x 69 x 10 mm blank size.
37-00-60-29		Grating, 1180 grooves/mm, blazed for 3000 A.
37-00-60-36		Grating, 1180 grooves/mm, blazed for 6000 A.
37-00-60-57		Grating, 590 grooves/mm, blazed for 1.2 microns.
37-00-60-72		Grating, 295 grooves/mm, blazed for 2.1 microns.
37-00-60-84		Grating, 148 grooves/mm, blazed for 5.0 microns.

1-4-4 SLITS

12-510		Slit, width 25 microns.
12-515		Slit width 50 microns.
12-525		Slit width 100 microns.
12-535		Slit width 250 microns.
12-540		Slit width 500 microns.
12-560		Slit width 1000 microns.
12-570		Slit width 2000 microns.
12-590		Circular aperture, 3mm dia.
12-591		Circular aperture, 6 mm dia.

1-4-5 POWER SUPPLIES AND AMPLIFIERS

Model Number

82-375C	High Voltage Power Supply and Amplifier. For 115 volts, 50/60 cycles.
26-780	Power Supply Amplifier for DC operation. For 110 volts, 60 cycles.

1-4-6 PHOTOMULTIPLIERS

83-021	Side Window Photomultiplier Tube Housing with wired socket.
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Photomultiplier Tube, 931 A, spectral response S-4:

17-700A	Grade A
17-700B	Grade B
17-700C	Grade C
17-700D	Grade D
17-700E	Grade E

Photomultiplier, R212, spectral response S-5:

17-724A	Grade A
17-724B	Grade B
17-724C	Grade C
17-724D	Grade D
17-724E	Grade E

Photomultiplier with quartz envelope, R106, spectral response S-19:

17-721A	Grade A
17-721B	Grade B
17-721C	Grade C
17-721D	Grade D
17-721E	Grade E

SECTION 2 PRE-OPERATIONAL CHECK

2-1 Unpacking

The 82-410 should be carefully unpacked and inspected for any visible signs of damage. The customer is responsible for filing any damage claim against the carrier. All items should be checked against the packing list so that no small parts will be discarded with the packing material.

2-2 Installation

The 82-410 is shipped completely assembled, adjusted, and calibrated. However, the grating yoke is locked in place by a red screw, which must be removed before operating the instrument.

2-2-1 Remove the main compartment cover plate.

2-2-2 Remove the Red, grating yoke shipping screw. Follow the directions on the blue card attached to the main compartment cover plate.

2-2-3 Replace the cover plate.

Note The shipping screw should be retained and replaced, whenever the instrument is to be transported to a new location.

2-3 Optical Alignment Procedure

The 82-410 has been completely aligned and calibrated at the factory, and NO further adjustments should be required. However, to insure that no damage has occurred during shipment, or that the alignment has not been disturbed, a visual check of the alignment should be made. The complete alignment procedure is outlined in the following steps, and should be followed closely to insure proper operation.

2-3-1 Remove main compartment cover plate.

2-3-2 Set a bright tungsten source at the entrance slit (100 μ). The light beam reflected from the 45° mirror (B, Fig. 3) should be centered on the rear collimating mirror (C-1, Fig. 3), which is closest to the entrance slit.

2-3-3 Then move the tungsten source to the exit slit (100 μ). The light beam reflected from the 45° mirror (E, Fig. 3) should be centered on the rear collimating mirror (C-2, Fig. 3) which is closest to the exit slit.

Note Do not adjust the 45° mirrors before checking the rest of the alignment.

2-3-4 Remove the tungsten source from the exit slit and place a mercury lamp at the entrance slit (100 μ).

2-3-5 Using the standard 1180 g/mm gratings, rotate the grating selector lever arm so that the 600.0 μ blaze grating is facing the collimating mirror. The grating

holder adjusting screw (4, Fig. 5) should come in contact with the magnetic stop (2, Fig. 5).

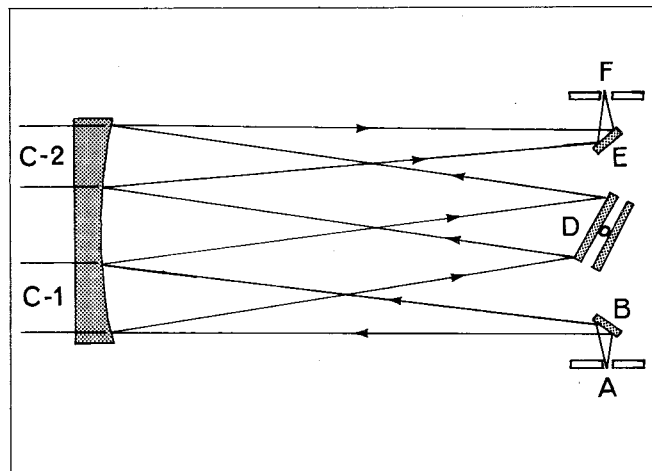


Figure 3

2-3-6 Rotate the wavelength drive until a bright green mercury line is seen visually through the exit slit (100 μ). Set the counter to 546 μ , by loosening the set screw on the small counter gear (2, Fig. 4).

2-3-7 Rotate the Grating Selector Lever Arm until the 300.0 μ blaze grating adjusting screw (3, Fig. 5) contacts the magnetic stop (1, Fig. 5). The green mercury line from the 300.0 μ blaze grating should be seen through the exit slit.

Note Extreme care must be taken to prevent any contact of the grating face, or mirror surfaces - Permanent damage will result.

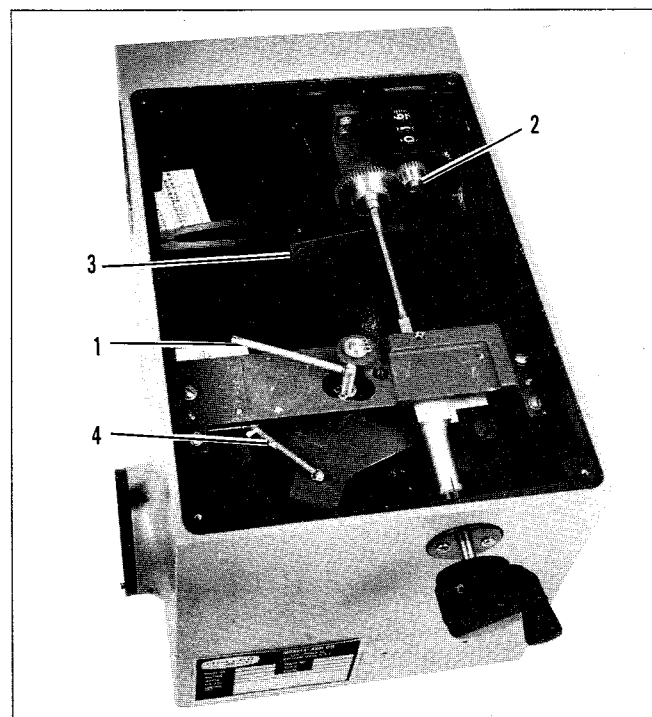


Figure 4

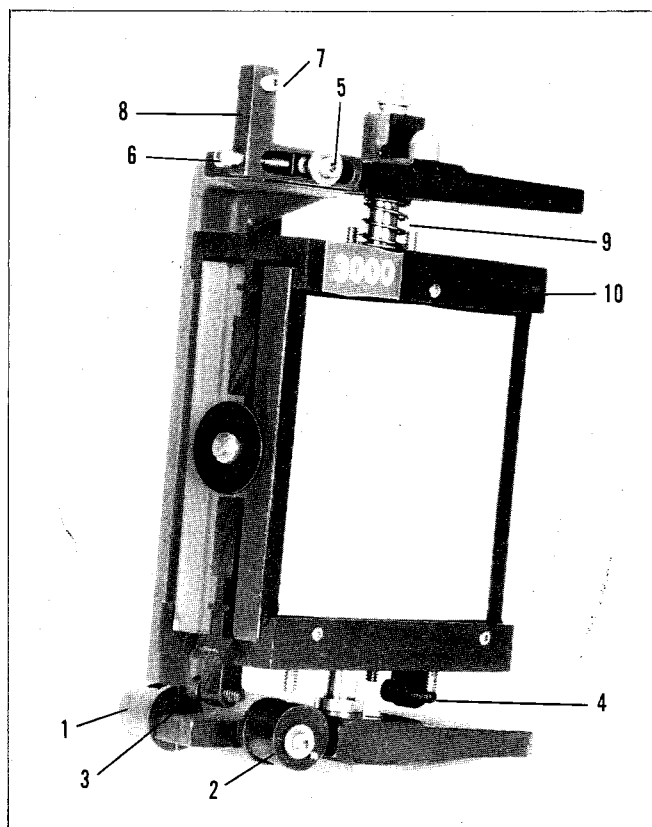


Figure 5

2-3-8 The 300.0 mμ blaze grating holder adjusting screw (3, Fig. 5) should be adjusted either in or out until both gratings can be positioned on the magnetic stops and the green mercury line seen through the exit slit. The counter should read 546.mμ at this point.

2-3-9 Loosen the two set screws (3, Fig. 1). Holding your eye as close as possible to the slit, adjust the focus tube by sliding either in or out until green illumination fills the entire grating surface. With the grating fully illuminated, slowly rotate the wavelength drive and re-adjust the focus tube slightly until proper focus is achieved. Focus is correct when the entire grating surface is illuminated and extinguishes uniformly and quickly as the wavelength drive is rotated.

Note Both the entrance and exit focus tubes should be withdrawn approximately the same distance when focus is achieved. (3mm - 5mm).

2-3-10 Position your eye about 12" from the exit slit, and slowly rotate the wavelength drive toward lower wavelengths until the 546 mμ mercury green line starts to appear in the exit slit. The illumination should come in evenly from the top and bottom of the slit. Rotate the exit slit assembly slightly until the illumination comes in evenly at the top and bottom and appears to close out in the center of the slit (See Fig. 6).

2-3-11 The focus tube should be locked in this position and not moved unless it is necessary to readjust the focus for another set of gratings.

2-3-12 Rotate the wavelength drive to approximately 300.0 mμ, and place a tungsten source at the entrance slit. A re-entry spectrum will appear at the center of the collimating mirror and may be observed at the exit slit. To eliminate the re-entry spectrum, rotate the baffle (3, Fig. 4) located below the wavelength counter, until the re-entry spectrum is visually eliminated from the C-2 collimating mirror. Do not mask out more light than is required to accomplish the above step.

Note Re-entry spectra is inherent to grating monochromators of the type, and masking is necessary to insure the lowest possible light scattering in the monochromatic spectra near 300.0 mμ. Optimum masking depends upon the length of the slit illuminated by the particular source used. The illumination should be centered vertically on the entrance slit so that only the minimum masking is required. For each source used, the mask will have to be adjusted slightly because of the various image sizes or illumination properties. When working in the visible region, the mask is not required to cut out any light.

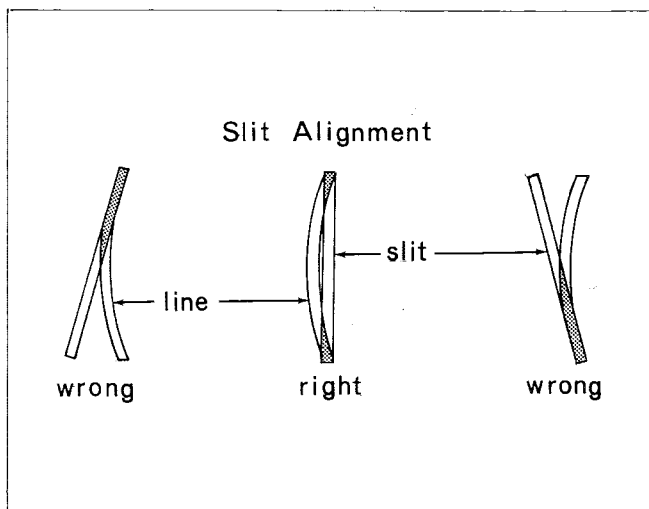


Figure 6

2-4 Wavelength Drive Calibration

The wavelength drive has been calibrated at the factory. A visual check is required to insure that the calibration has not been disturbed during shipment.

2-4-1 Place a mercury lamp at the entrance slit.

2-4-2 Locate the bright green mercury line and set the wavelength counter to 546.0 mμ.

2-4-3 Rotate the wavelength drive toward lower wavelength until the counter reads 0000.

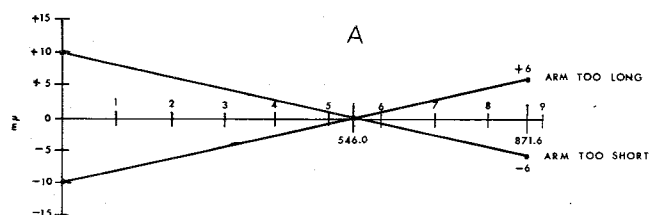
2-4-4 Locate the following mercury lines, and record the counter readings for each line.

Central Image:	0 mμ	white
	435.8 mμ	blue
	546.0 mμ	green
	871.6 mμ	blue = 2nd order
	435.8 mμ	

All readings should be taken rotating the wavelength drive in the same direction, to eliminate errors due to backlash.

2-4-5 If the counter readings obtained, for the various mercury lines, exceed the true wavelength values by more than ± 1 mμ, the wavelength drive will require some adjustment.

2-4-6 By plotting the wavelength calibration on a graph as shown in Fig. 7; one is easily able to determine which adjustment is required to properly calibrate the wavelength drive.



Sine Drive Calibration

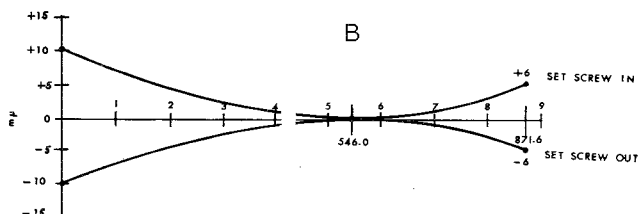


Figure 7

2-4-7 If the plot shows the error to be a curved line bending up, as shown in Fig. 7B; the set screw (7, Fig. 5) should be adjusted (1/2 turn or less) counter clockwise. The set screw (7, Fig. 5) is adjusted clockwise if the curve bends down.

2-4-8 If the plot shows the error to be a straight line going up as shown in Fig. 7A; the length of the arm (8, Fig. 5) must be shortened. Loosen cap screw (5, Fig. 5) and adjust cap screw (6, Fig. 5) counter clockwise (1/2 turn or less). Push the arm toward the pivot and tighten cap screw (5, Fig. 5). The arm (8, Fig. 5) is made longer if the plot shows the error to be a straight line going down.

Note All adjustments should be kept small. Adjustments of 1/2 turn or less on all adjusting screws are adequate.

2-4-9 Repeat Steps 2-4-2 through 2-4-8 until the calibration is complete. Calibration is complete when all readings are within ± 1 mμ.

2-4-10 The second grating requires only to be zeroed out at 546.0 mμ. Refer to Para.'s 2-3-5, 2-3-6, 2-3-7, and 2-3-8. All points should then be identical to those of the first grating.

2-5 Use of Gratings Other than 1180 groove/mm

1. All Jarrell-Ash Model 82-410 monochromators are provided with wavelength counters calibrated for 1180 groove/mm. To obtain direct wavelength readings for other gratings, use the following table:

Grating Spacing	For Counter Reading Multiply Desired Wavelength by Factor	OR For Wavelength Reading Multiply Counter Reading by Factor
1180 g/mm	1.0	1.0
590 g/mm	0.5	2.0
295 g/mm	0.25	4.0
2160 g/mm	1.83	0.5468

Note At 546.0 mμ when using a 590 g/mm grating a green line will be seen at the exit slit. This line is the 2nd order of 546.0 mμ. A 295 g/mm grating will show the 4th order green at a setting of 546.0 mμ. The order of the line will be the same as the factor (described above) at any particular setting.

2-6 Interchanging Grating Holders

Additional gratings may be mounted in separate holders (two per holder). Grating holders may easily be interchanged in the 82-410 by following the procedure listed below.

CAUTION

Extreme care must be taken to prevent any contact between the grating face and installer's fingers. This will result in permanent damage.

2-6-1 Remove the monochromators main compartment cover plate.

2-6-2 Unscrew the grating selector arm (1, Fig. 4).

2-6-3 Disconnect spring (4, Fig. 4) from grating yoke.

2-6-4 Lift entire grating yoke assembly (Fig. 5) until the bottom pivot is free of the pivot boss, move the bottom of the grating yoke to the rear of the instrument until free of all obstacles before lifting it out of the monochromator.

2-6-5 To remove the grating and holder from the yoke, grasp the dual holder firmly at the sides and push against the spring loaded pivot (9, Fig. 5) at the top of the yoke. Swing the bottom of the holder out and free of obstructions and remove from yoke. Replace a new grating and holder in the same manner. Care should be taken to ensure that grating holder will rotate freely within the grating yoke.

2-6-6 Carefully replace grating yoke assembly within the monochromator and complete the assembly by replacing the spring (4, Fig. 4) and the selector arm (1, Fig. 4).

2-6-7 Place a mercury lamp at the entrance slit. Adjust wavelength drive until readout is set at 546. Visually check the exit slit to ensure that slits are filled with green light.

2-6-8 If the green light is not visible on exit slit, adjust grating holder adjusting screws (3, 4, Fig. 5) which come in contact with the magnetic stops until green light appears for each grating. Instrument is now ready for use. Do not change counter, since this has been set up previously.

SECTION 3 OPERATION

3-1 Manual Wavelength Drive

1. Turn the wavelength drive knob to the region of interest i.e., $250 \text{ m}\mu = 2500 \text{ \AA}$.
2. Select the most efficient grating for the area of interest by use of the grating selector. Note that the selector knob will turn 180° only. Do not force this selector knob.
3. Illuminate the entrance slit with the desired source.
4. If the instrument is going to be used around $300 \text{ m}\mu$ check the setting of the re-entry spectra mask for the particular source used (Para. 2-3-12).
5. Install the desired phototube or detector at the exit slit.

3-2 Electrical Wavelength Drive

1. By use of an accessory kit, the unit can be converted for electrical scanning with a choice of drive rates: $10 \text{ m}\mu/\text{min.}$ - Catalog No. 82-452; $25 \text{ m}\mu/\text{min.}$ - Catalog No. 82-455; $100 \text{ m}\mu/\text{min.}$ Catalog No. 82-457. Each of these units contains a motor on a mounting plate, complete with drive gear, line cord, switch, and plug.
 2. Remove the crank knob on the wavelength drive shaft and attach the drive gear (Cat. No. 82-451) on the shaft.
- Replace handle. Insert knurled screws into appropriate threaded holes (3, Fig. 4). Do not screw these all the way home.
3. The keyhole slots of the motor mounting bracket fit over the knurled screw heads. Slide motor vertically upwards for full engagement into driven gear and tighten knurled headed screws.
 4. Connect line cord to a 110 V, 60 cycle outlet.
 5. The electrical drive is arranged to scan in a direction of increasing wavelength only. When the electrical drive is in operation, the manual drive may not be used.
 6. To return to starting wavelength, switch OFF motor, manually rotate wavelength drive to a shorter wavelength region then switch ON the motor drive to scan to higher wavelengths.
 7. The motor is provided with a stall clutch mechanism. If the high wavelength limit of travel is reached, the motor will stall but the switch will remain ON. It is important, to switch OFF the motor before returning the wavelength drive to a shorter wavelength setting.
 8. For a change of wavelength drive speed, exchange one motor drive unit for another. To do this, remove line cord from the electrical outlet, loosen the knurled headed screws and remove the motor drive unit by use of the keyhole slots. Replace the drive unit of the desired speed and engage the electric drive gear with the shaft gear, then tighten the knurled screws.

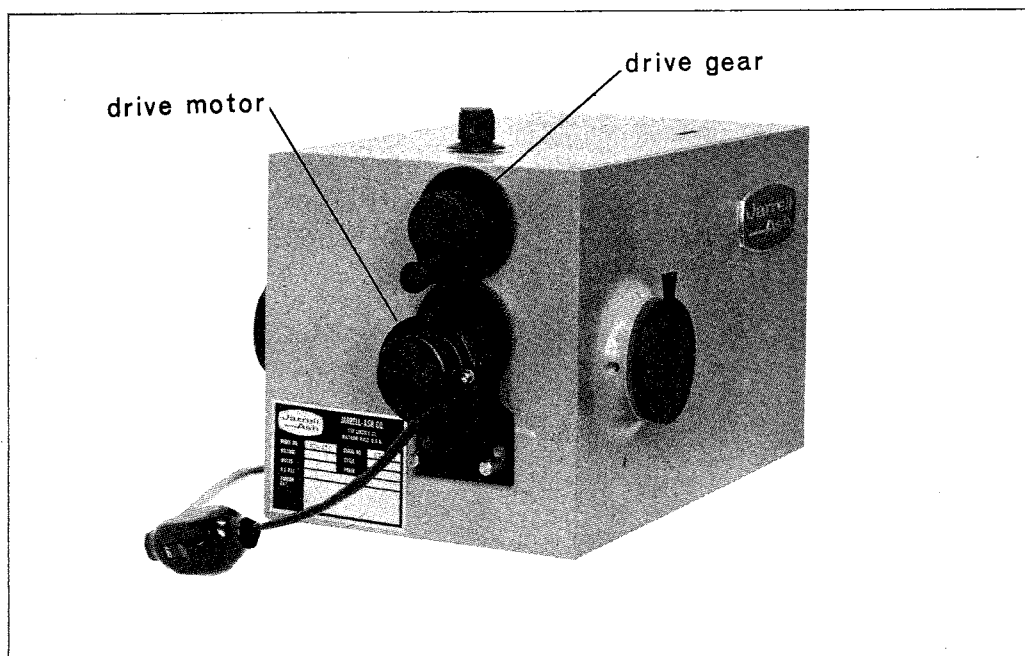


Figure 8

SECTION 4 SERVICE INSTRUCTIONS

4-1 Periodic Inspection

Periodic inspection should be performed in the following manner:

1. Check focus as described in Sec. 2, Para. 2-3-9, 2-3-10, and 2-3-11.
2. Check grating selector knob to ensure gratings are against the stops. (Refer to Sec. 2, Para. 2-3-7, and 2-3-8).
3. Check wavelength calibration either visually or photoelectrically (See Section 2-4).
4. Check wavelength drive mechanism for axial play. Play can be removed by adjusting the small nut (1, Fig. 9) until the play is eliminated and the micrometer operates smoothly. The nut (2, Fig. 9) on the flexible shaft should be jammed against the small nut (1, Fig. 9) to maintain the adjustment.
5. Once a year it is advisable to go through the optical alignment procedures as described in Sec. 2. At this time it is also advisable to check the grating drive for "skipping". With the cover removed and the wavelength readout set on 150, turn wavelength knob clockwise. While turning, notice that the grating yoke is following the micrometer arm in a smooth motion. If any "sticking" occurs, two items must be checked:
 - a. Wavelength drive mechanism as in Item 4 above.
 - b. Excess wear on face of micrometer arm, or the contact screw.

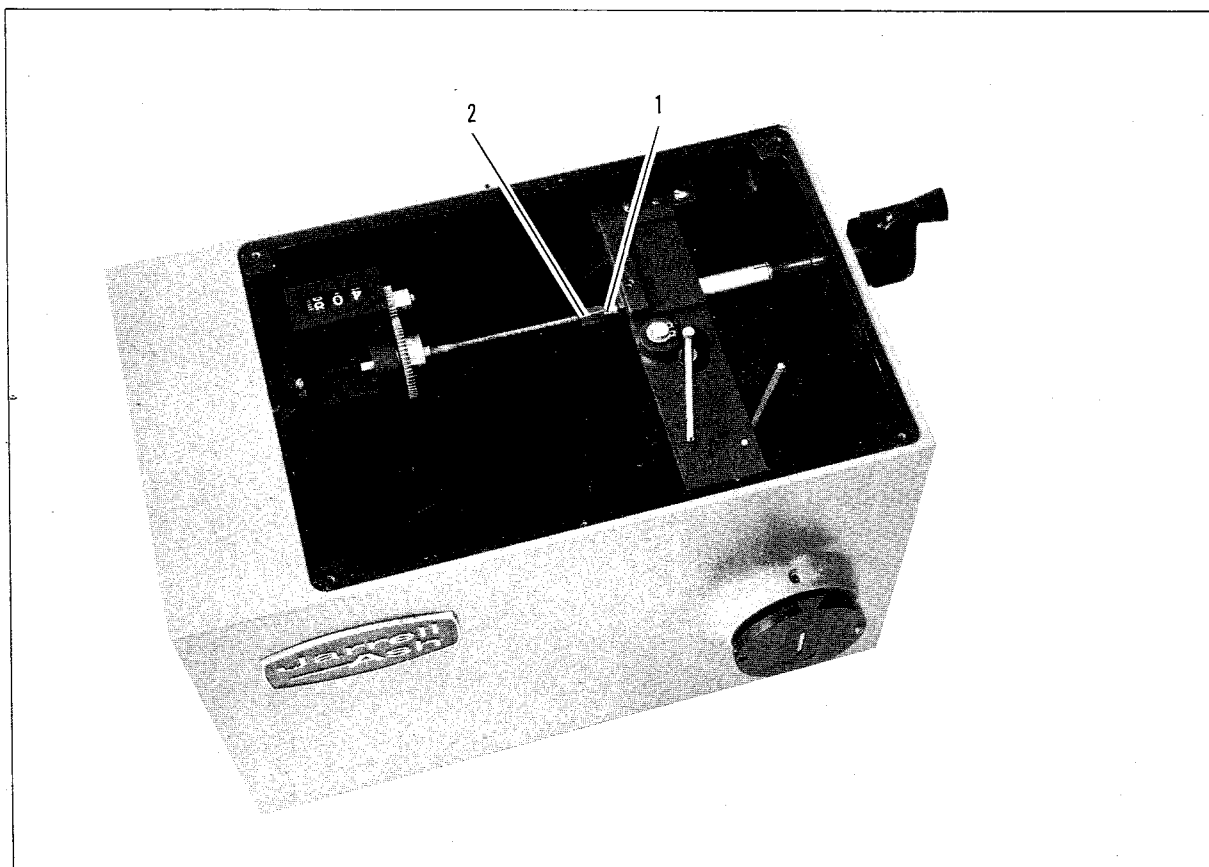


Figure 9

SECTION 5 SPARE PARTS LIST

DESCRIPTION	MFR	JACO STOCK OR PART NO.	RS*
Thumb Screws	PIC #4015	82-451-A-01	
Spur Gear		82-400-A-13 A-00-2857	1
Counter Gear		82-400-A-14 A-00-2858	1
Micrometer		82-400-A-17 B-00-2204	1
Phototube Housing Light Shield Neoprene Rubber 1/16 thick		82-400-A-45	1
Flexible Counter Shaft		82-400-A-37 82-400-A-39 82-400-A-46	1
Counter	Durant #378823-L-CL	82-400-A-014	1
Knob (crank)	Raytheon #125-6-2	82-400-A-016	1
Knob (skirted rd.)	Raytheon #70-3-2	82-400-A-017	1
Stem Bumper	Atlantic India #16	82-400-A-021	4
Grating Yoke Tension Spring SE 11/16 x 3/16 x .016 Loops	Hardware Product	82-400-A-034 12240062	1
Rotation Pin 2-3/16 Long	PIC #A8-11	82-400-C-4 29100089	1
Sine Bar 2024-T4 Alum. Rect. Bar 3/16 thick x 1 x 1-5/16		82-400-C-11	1
Sine Bar Adjusting Screw Slotted Head Set Screw	Long-Lok LP 57 x B40J8	82-400-C-04 12190018	1
Magnet	General Magnet Alinco	82-400-C-014 12430009	2
Front Surface Mirror Glass 1/4 thick x 1-1/8 x 3		82-400-D-1	2
Operational Kit		82-400-E	
Focus Tube Adjusting Screw	PIC #CS-15 (No-Mar)	82-400-H-02	1
Re-Entry Spectrum Baffle		82-400-J	

* Recommended Spare

Jarrell-Ash Company
590 Lincoln Street
Waltham, Mass. 02154

Performance Test Record
Model 82-400/410

0.25 M Ebert Monochromator

MODEL: 82-410 CUSTOMER Brown Univ. Providence RI.
SERIAL NO: 952865 CUSTOMER ORDER NO: 80414
JOB NO: R14037 DATE: 2/6/68

1. Instrument Performance

1.1 Customer's Gratings and Mirror Installed:

Mirror Serial # 101913

Grating Cat. # 885-30-20-18 Blaze 3000 grooves/mm 1180 Serial # 1827

Grating Cat. # 885-30-20-27 Blaze 6000 grooves/mm 1180 Serial # 1897

1.2 Customer slits installed, 100 microns and checked
for alignment visually ✓

1.3 Instrument focused ✓

1.4 Sine Drive Accuracy

		Grating	
		Normal	Specified
(± 10 Å tolerance)		Groove <u>1180</u> Blaze <u>3000</u>	Groove <u>1180</u> Blaze <u>6000</u>
Line	Reading	Line	Reading
4358 Å	<u>4362</u>	<u>4358</u>	<u>4360</u>
5460 Å	<u>5464</u>	<u>5460</u>	<u>5464</u>
4358 Å, II	<u>8713</u>	<u>4358 II</u>	<u>8711</u>

1.5 Sine Drive, mechanical coverage
1000 to 9000 Å ✓
100 to 900 on counter ✓

1.6 Check of alignment with second grating
visually: 5460 Å and 4358 Å, II ✓

1.7 Grating selector operation positive ✓

2. Inspection for Shipment

- 2.1 Finish and general appearance satisfactory ✓
- 2.2 Grating Holder shipping screw in position (red) ✓
- 2.3 Interior and exterior of instrument clean ✓
- 2.4 Operational kit packed with instrument ✓
- 2.5 Instruction manual packed with instrument ✓
- 2.6 Re-entry Spectrum mask in horizontal position ✓

18/10/66

80111

Approved by Optical Inspection Amptzob
Approved for Shipment by Amptzob
Final Inspector - Jarrell-Ash Company