THR 1000 MONOCHROMATOR

Instruction manual

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Instruction manual

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CONTENTS

INTRODUCTION

The T.H.R. 1000 high resolution monochromator is a state of the art instrument combining precision and ease of use.

This instrument owes its flexibility to its ability to be inserted into a wide variety of instrumental configurations.

The outstanding performances of the T.H.R. 1000 result from the optical, mechanical and electronic qualities of its components.

Jobin-Yvon optics have been proven by the test of time. Generations of research by company engineers is continuing today.

The conventionally ruled or holographic gratings installed in the instrument are manufactured by Jobin-Yvon. They have specially low stray light levels and aberrations are corrected to a considerable extent.

The gratings are only one element of the system, however, and they are associated with optics of the same quality (wave surface of the mirrors for example).

The high quality mechanics and the exceptional quality of the slits of the instrument complete the apparatus.

Constitutive elements satisfy the same quality standards as the components of the other monochromators of the H.R. 1500 - T.H.R. line.

Finally, the electronics enable the monochromator to be integrated in all computer controlled systems. It can be piloted by all computers currently on the market and can furnish parameter measurements to all existing data processing systems.

Numerous accessories enable the user to install configurations which are specific to the problem under study, to free him from the constraint of detail and to free his time for other research.

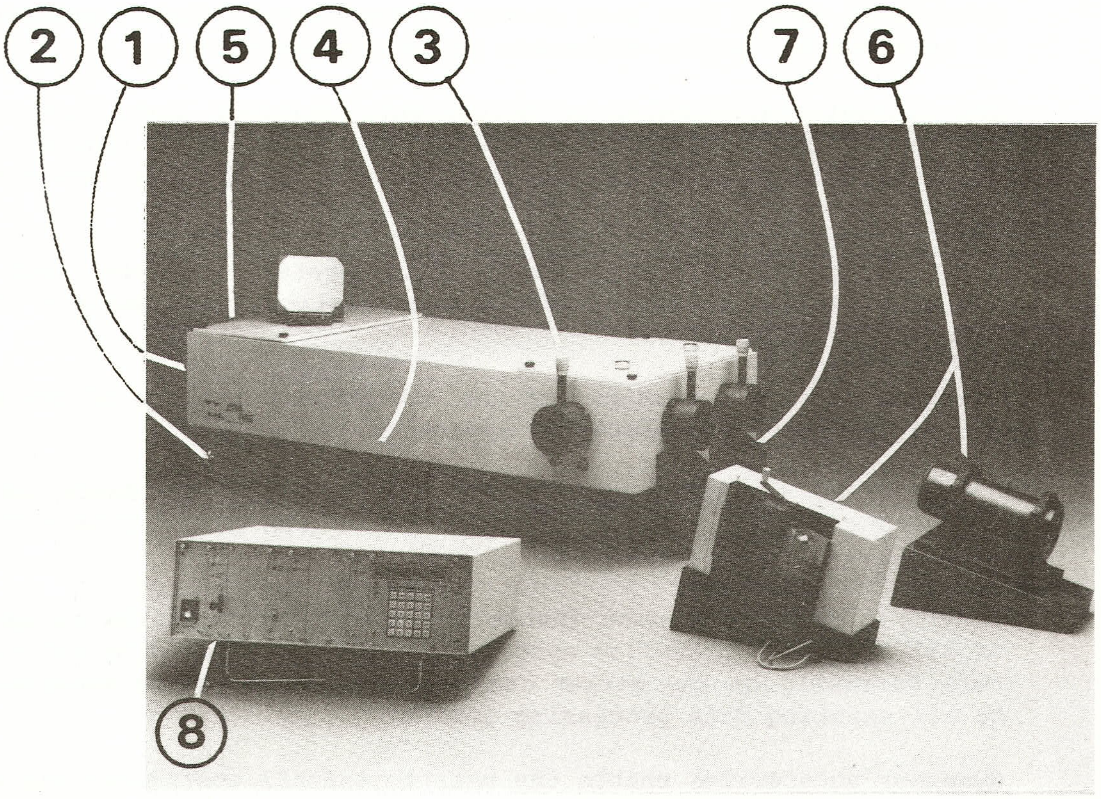


FIG. 1

I PRINCIPLE AND SYSTEM FEATURES

1.1. Principle

The T.H.R. 1000 is a Czerny-Turner configured monochromator with a 1 meter focal length. It can be optionally mounted as a spectrograph.

The low inherent deviation confers high performance on the instrument in terms of final resolution.

Large grating sizes enable high throughput to be obtained.

Constantly increasing possibilities of computer control and processing can be used to pilot all or a part of the instrument and its accessories, via powerful modular electronics.

A broad range of accessories enables a wide range of configurations to be obtained, responding to the majority of user needs.

1.2. System features (See Figure 1)

The instrument chassis is a cast parallelepiped (1), containing all the elements composing the monochromator. The plastic housing (2) is part of the instrument and also protects it from dust.

In the standard version, the slits (3) are equipped with straight lips. They are identical and changing from an axial to a lateral configuration is thus simplified.

When the slits are equipped with curved lips, the entry and exit slit units are differentiated, according to the configuration to be used.

The wavelength counter (4) can be placed on either side of the instrument, on the side opposite the power connections and the nitrogen flush.

Hatches (5) lead to easy access to the collimators, to slit switching (axial/lateral) if need be, and to the grating.

Accessories of the line of medium and large monochromators (6) are attached with a special fixation pin (7).

The instrument is equipped with leveling feet, for height adjustment.

Manual control of the wavelength drive motor is built into the instrument (8). Access to powerful internal scanning functions is easily obtained by an external computer, via a specific interface board.

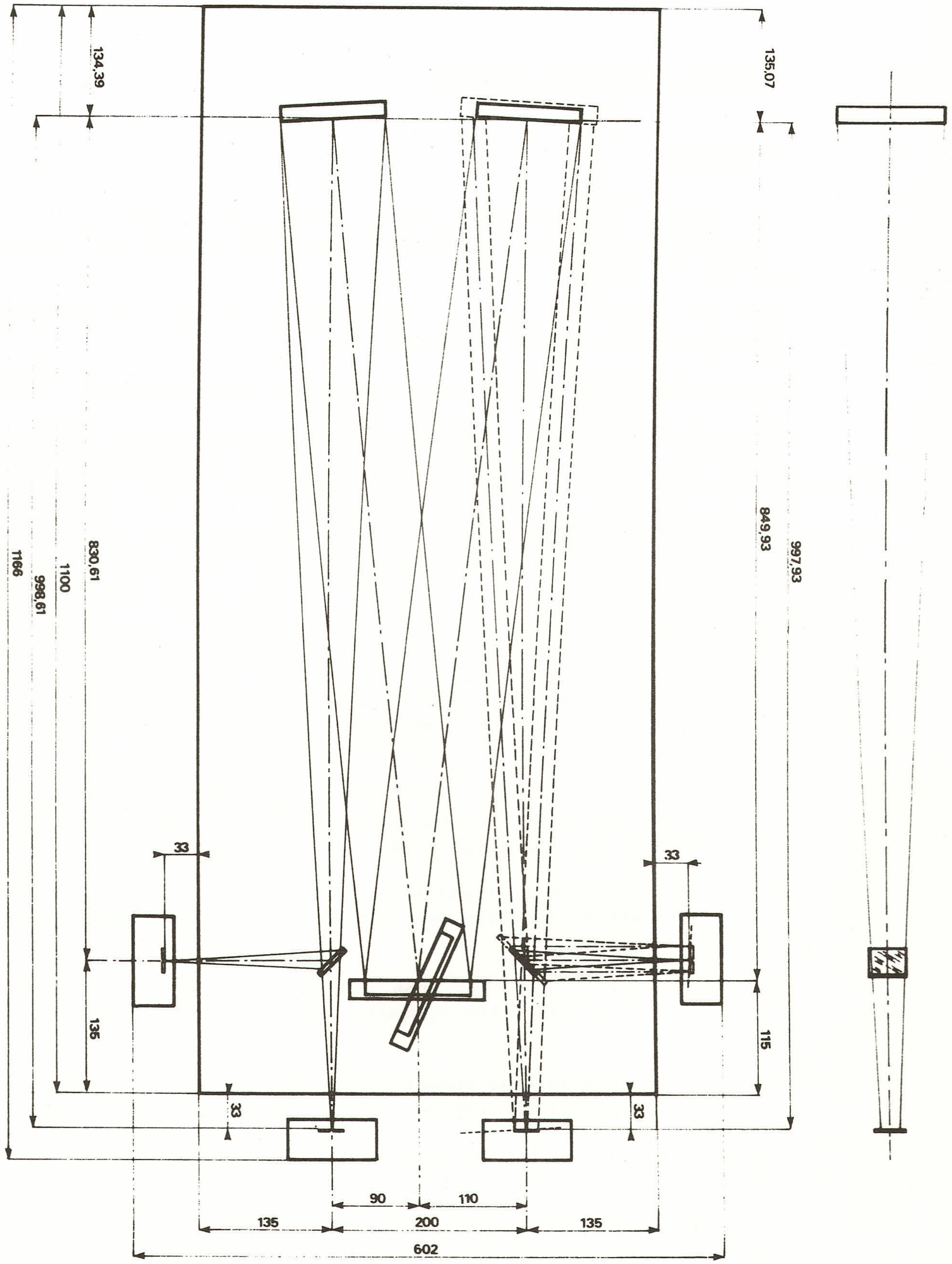


FIG.2 - OPTICAL DIAGRAM

1.3. Specifications

Configuration	Asymmetric Czerny-Turner (see optical diagram, figure 2)
Focal length	1000 mm
Aperture	f/8.4 or f/7.5, according to version
Geometric spread per bandwidth unit	0.0015 Sr/Å
Grating	Flat, interchangeable - M and S versions standard 110 x 110 mm, useful 102 x 102 mm optional 120 x 140 mm, useful 110 x 136 mm - MSL versions standard 120 x 140 mm, useful 110 x 136 mm
Spectral range	- Mechanical : order zero at 1500 nm with a 1200 gr/mm grating - Useful : 165 nm at 50 u with interchangeable gratings
Entry/exit	Axial and/or lateral
Slits	Straight in standard version, curved as option. Symmetrical opening adjustable from 0 to 3 mm. Height adjustable in steps: 1, 2, 5, 10 and 20 mm.
Dispersion	About 8 Å/mm at 500 nm with a 1200 gr/mm grating
Band width at half-height	0.08 Å with a 1200 gr/mm grating (110 x 110 mm) at 5640 Å and 2 mm high, 5-10 um wide slits.
Display	Direct readout with a 1200 gr/mm grating (option: with 1800 gr/mm grating) on mechanical counter. 1 division = 0.2 Å.
Precision	± 0.5 Å from 0 to 15,000 Å with a 1200 gr/mm grating

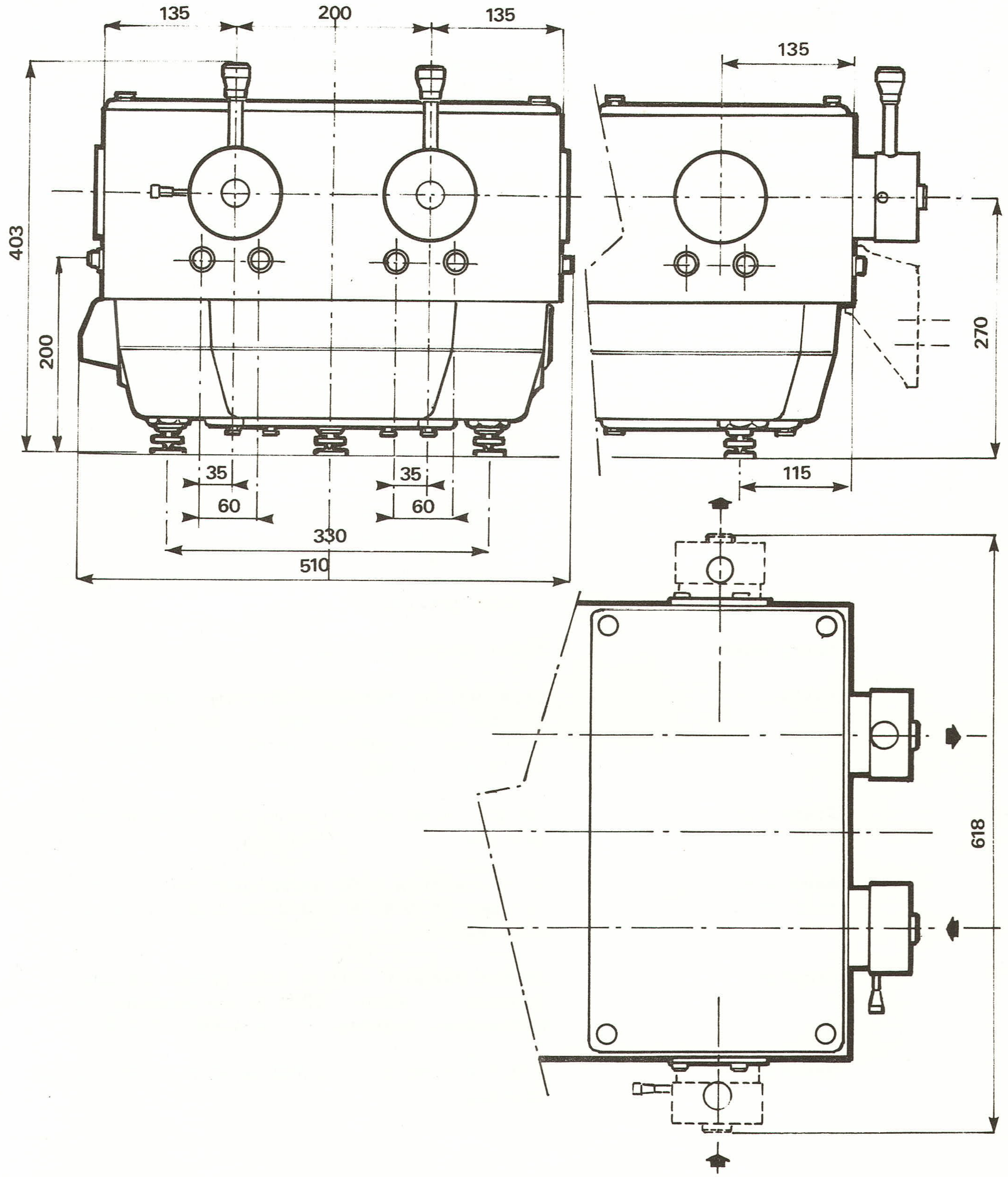


FIG. 3 bis

Scanning	- <u>Stepping motor</u>: 0.02 Å per step with a 1200 gr/mm grating in full step (0.01 Å in half step) - <u>Maximum speed</u>: 4000 Å/min with 0.01 Å half step operation and acceleration ramp.
Repeatability	±0.2 Å with a 1200 gr/mm grating with the instrument in thermal equilibrium in a temperature controlled room at ±1°C.
Stray light	Less than 10^{-5} at 10 Å from the 5145 Å laser line with 20 µm wide, 2 mm high slits (with a 1200 gr/mm grating).
Spectrograph	Length of the spectrum: 25 mm, or about 200 to 500 nm with a 1200 gr/mm grating

Nitrogen flush available on the standard version.

Overall size	1225 x 602 x 405 mm (see figure 3)
Standard control	(Spectralink equipped with the motor control board): 440 x 140 x 305 mm

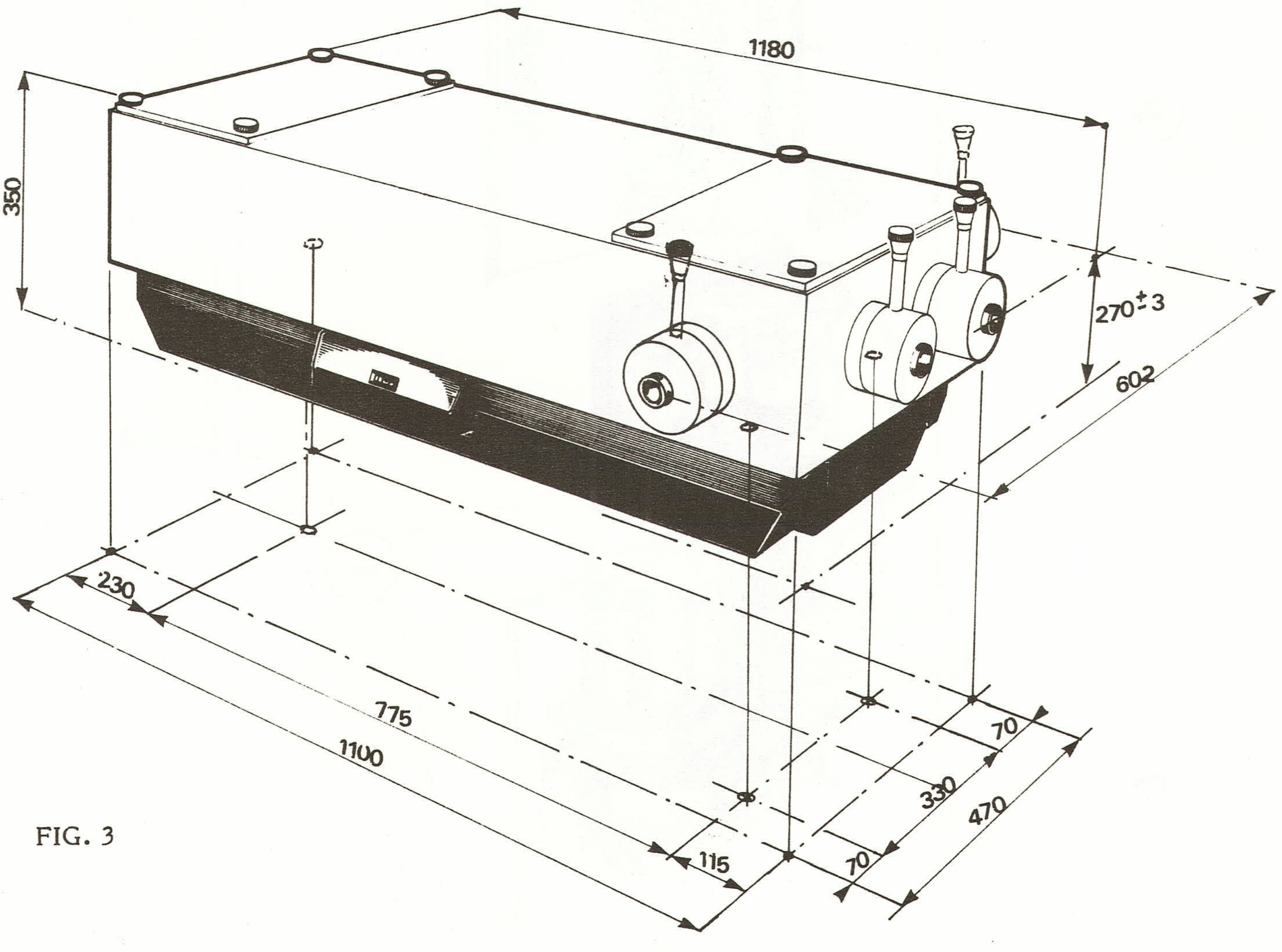


FIG. 3

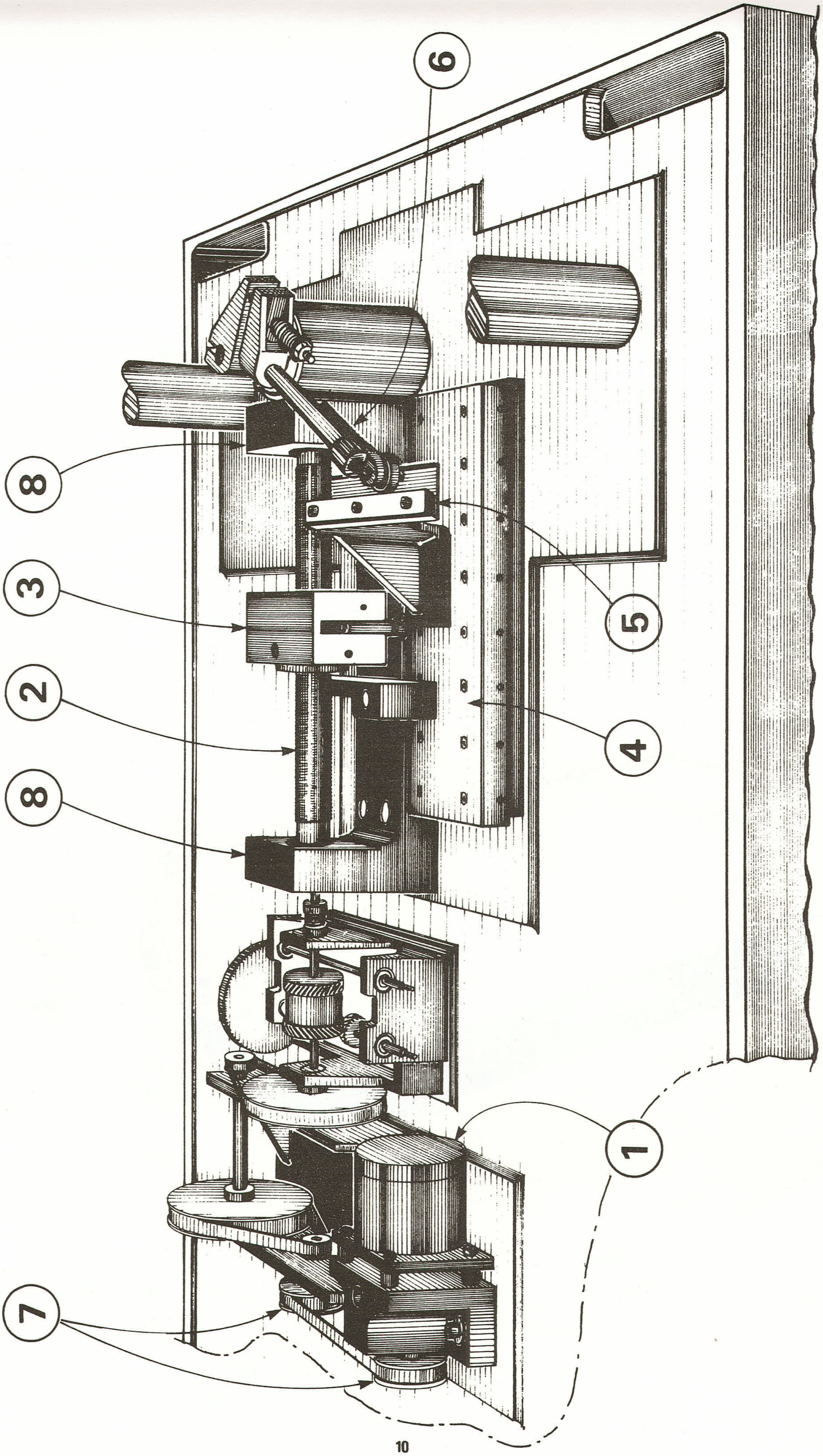


FIG. 4

II DESCRIPTION

2.1. Chassis

The chassis of the T.H.R. 1000 accepts all the component elements of the monochromator, i.e., slits, brackets of the collimators, the grating pivot and the wavelength drive system.

The function of the plastic housing is dust protection. It is attached to the feet of the instrument with the easily removed nuts. The height of the leveling feet is adjustable manually.

2.2. Grating drive mechanism (see figure 4)

Grating drive is controlled as follows. A stepping motor (1), drives the screw (2). A slide block (3) moves along the screw. The block moves the slider (4) bearing the sine bar (5). The grating arm (6) pushes against the sine bar.

The ratio between the motor and the screw can be modified by changing the motor gears (7). The gear-belt-interaxis system is such that an integer step can be obtained, regardless of the grating in place. This leads to extreme ease of use. In addition, in some cases, a smaller or larger step can be chosen, depending on planned use, e.g. a resolution of 0.005 or 0.01 Å per motor step with a 1200, 2400 or 3600 gr/mm grating.

End of travel switches (8) protect the screw and slide bar from damage in the case of malfunction of electronic motor control.

Note: it is recommended not to uncouple the grating arm from the sine bar. If this must be done, avoid harsh contact between the arm and the bar when installing to avoid damage.

2.3. Slit units (see figure 5)

The slit holders of the straight lipped slits are identical, regardless of their position (entry/exit, axial/lateral). When several slits are adjusted in the factory, only the position (left or right) of the height limit may vary for questions of ease of use. The special case of the optional curves slits requires their place to be taken into account.

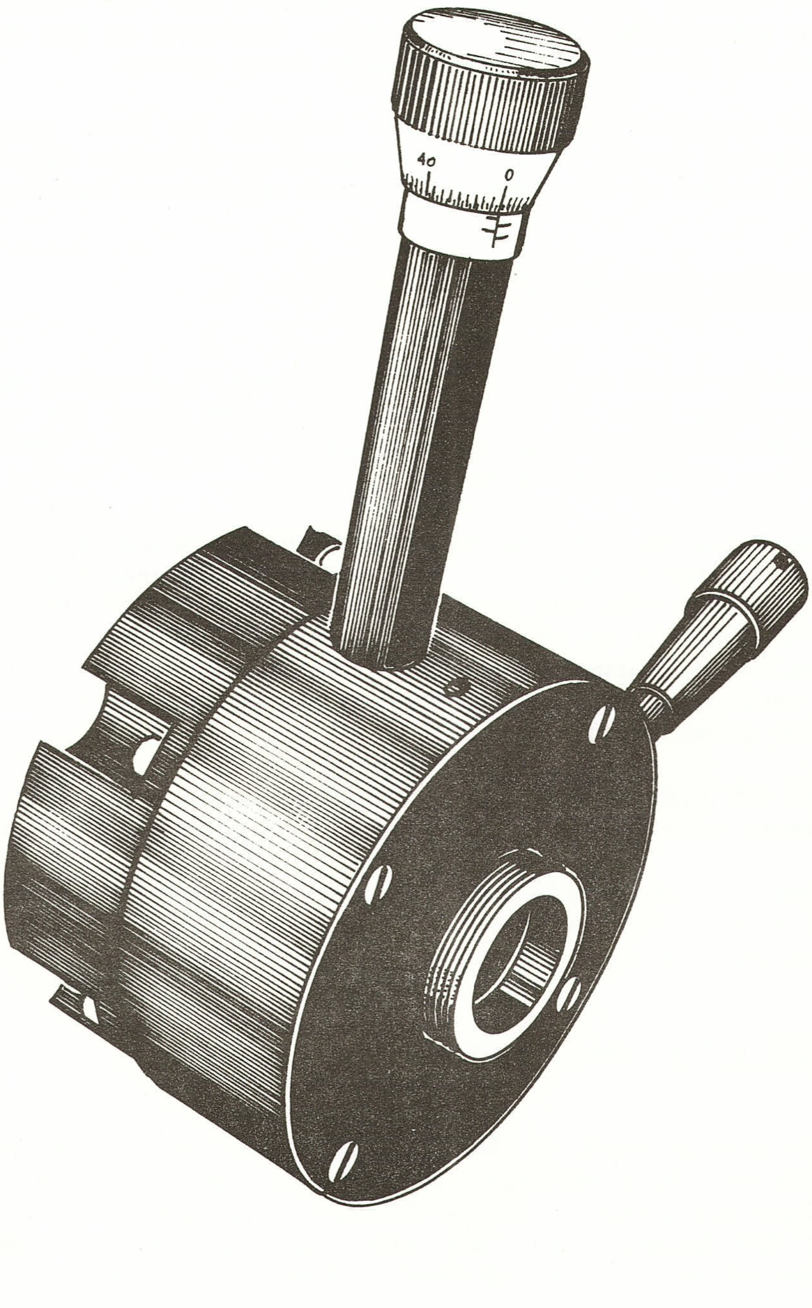


FIG. 5

Slitwidths are continuously adjustable from 0 to 3 mm. Opening is symmetric and resolution of the movement is on the order of 0.5 to 1 µm. Height is adjustable in steps at 1, 2, 5, 10 and 20 mm, thereby enabling the instrument to be used in high resolution (1 mm height) or high luminosity (20 mm height) configurations.

The positions of the aperture diaphragms is such that when a thin slit is used, only the useful maximum aperture of the monochromator can be covered (110 x 140 mm entry collimator).

Each slit holder is equipped with a threaded part for the adaptation of different accessories, e.g. gas tight plate, catathermic screen, single filter holder or filter turret (see Accessories and Options).

2.4. Housings

The lower plastic housing is composed of several parts. The main shell is used for dust protection and has an access hatch below the grating pivot. This is used whenever it is necessary to adjust the grating arm without dismounting the entire housing. The two small lateral housings are part of the connection plate and the counter-plate. They may be installed on either side of the instrument.

2.5. Control console

The standard version of the T.H.R. 1000 includes a basic version Spectralink type control rack. It contains a general power supply for subsequent connection to all available functional modules (high voltage power supply for photomultiplier, acquisition, etc.). The motor module (MDR module) enables the position of the monochromator to be set manually. Via the CPU module, or the interface board and an external computer, built in scanning functions can be accessed (scan and return speeds, number of cycles, starting and ending wavelengths, etc.) (see the Spectralink manual supplied with the instrument).

2.6. Grating mounts

The gratings are systematically delivered in preadjusted holders, leading to a practically operational interchangeability between instruments. It is extremely simple to install them in the monochromator. Any small adjustments needed by a holder preadjusted on another instrument (case of grating control installed after delivery of the apparatus) are easily corrected.

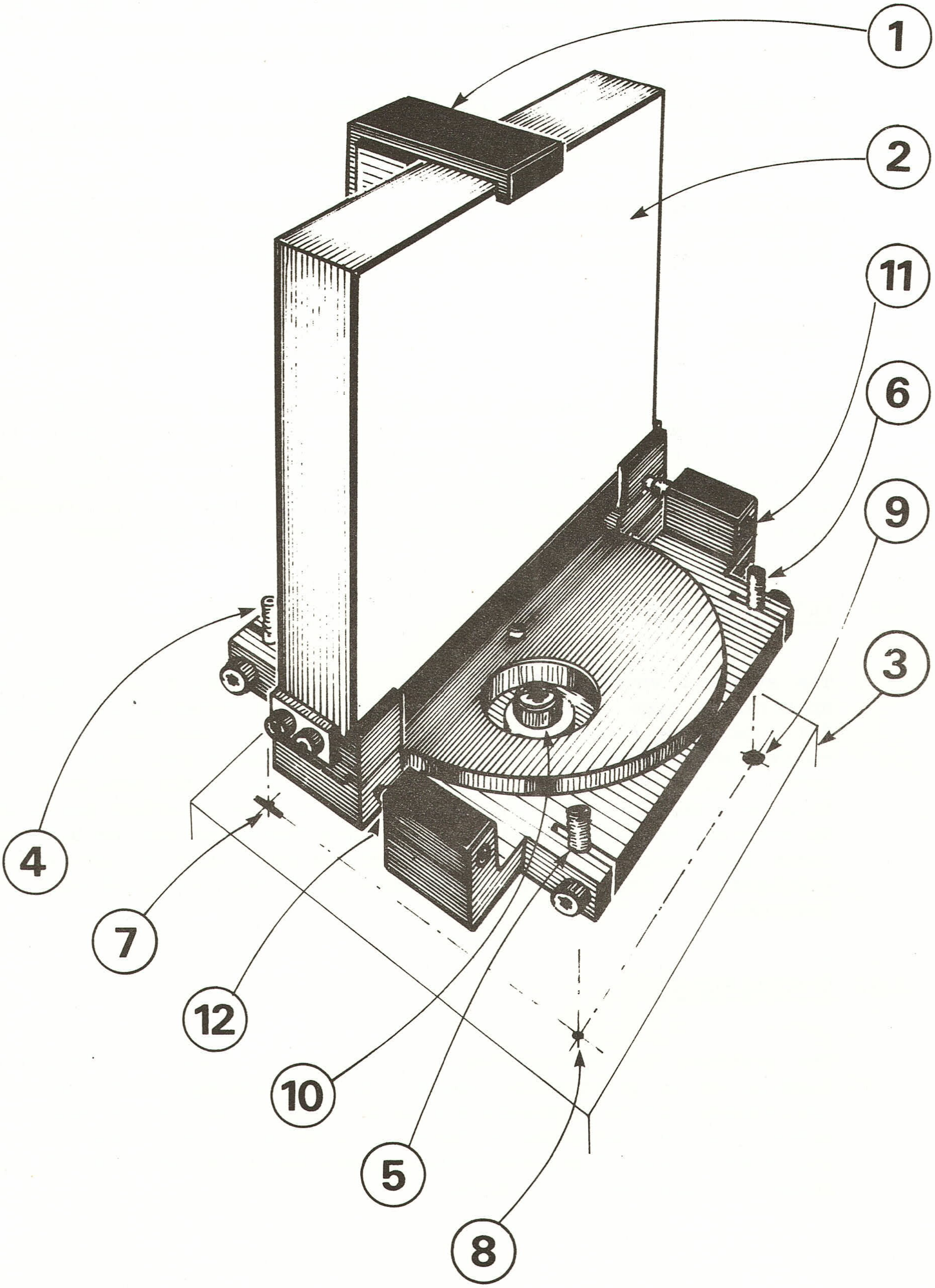


FIG. 6

2.6.1. <u>Installing a grating in its mount</u> (see figure 6)

Take the holder (1) with its grating (2) and place it on the support (3). Make sure that the screws (4) (5) (6) coincide with the Rayleigh mount (7) (8) (9). Place the screw (10) in its lodging with the spring and washer. Tighten the screw completely and then loose one turn. Verify that the grating holder is properly installed by tilting it slightly to one side (rotation around the axis corresponding to the point (9) and line (7) adjustments).

2.6.2 <u>Possible adjustments</u>

Gratings are systematically delivered in factory adjusted holders. It is thus recommended not to touch the Rayleigh mount screws (4) (5) (6) and the orientation screw (11).

If a grating is ordered separately from the monochromator, it may be necessary to precisely adjust the orientation of the grating on its support platform. Place the grating in the zero order (mechanical counter at 0). Illuminate the entry slit with a broad range source, e.g.. a spectral lamp and adjust screw (11) so that the resulting signal is maximum.

III INSTALLATION, START-UP

3.1. Standard supply package

It includes

- the monochromator with or without its slits
- a Spectralink type control panel in the basic version
- a special 5 mm Allen wrench for installing the grating
- a 3 mm Allen wrench for adjusting the grating (if necessary)
- an instruction manual

The grating supplied depends on the customer's request and is a function of the spectral range to be employed.

3.2. Installation site

3.2.1. Useful surface (see Figure 3 and Figure 3bis)

About 4 m^2
Ambient temperature = 20 ± 1°C
Avoid corrosive atmospheres and vibrations

Comment: In order to obtain optimal conditions of resolution, temperature changes in the room should not exceed 1°C.

3.2.2. External supplies

Electrical
- mains 115/220 volts, 50/60 Hz
- single phase with ground
- power: 100 VA
- regulation: ± 10%

Gas
- dry nitrogen gas (rectified) for use below 200 nm.

3.3. Connections

3.3.1. Gas

If used, connect the nitrogen tube (inner diameter 7 mm) to the corresponding inlet.

3.3.2. Electrical

Connect the cable between the console and the monochromator, then connect the mains cord.

3.4. Start-up operations

First, the monochromator drive mechanism must be released. Refer to the diagram on the grating access hatch.

VERY IMPORTANT: If electrical connections are made before the grating is released, serious damage may result.

This will void certain clauses in the guarantee.

3.4.1. Operations to carry out

Installing the grating + support

Remove the grating access hatch. First remove the lateral slit switching knob if the instrument is so equipped.

Install the grating in its holder (see paragraph 2.6.1.) and carry out any necessary adjustments (see paragraph 2.6.2).

Install the access hatch and the switching knob if necessary.

3.4.2. Verification tests

Use a low pressure mercury (Hg) lamp.

. Verification of calibration

Whenever possible, this is done with a 1200 gr/mm grating. In the opposite case, use the grating with the highest groove density. In the first and second order, use the 2536.5, 3131.8, 4358.3 and 5460.7 Å lines, covering the spectral range from 2500 to 10,000 Å.

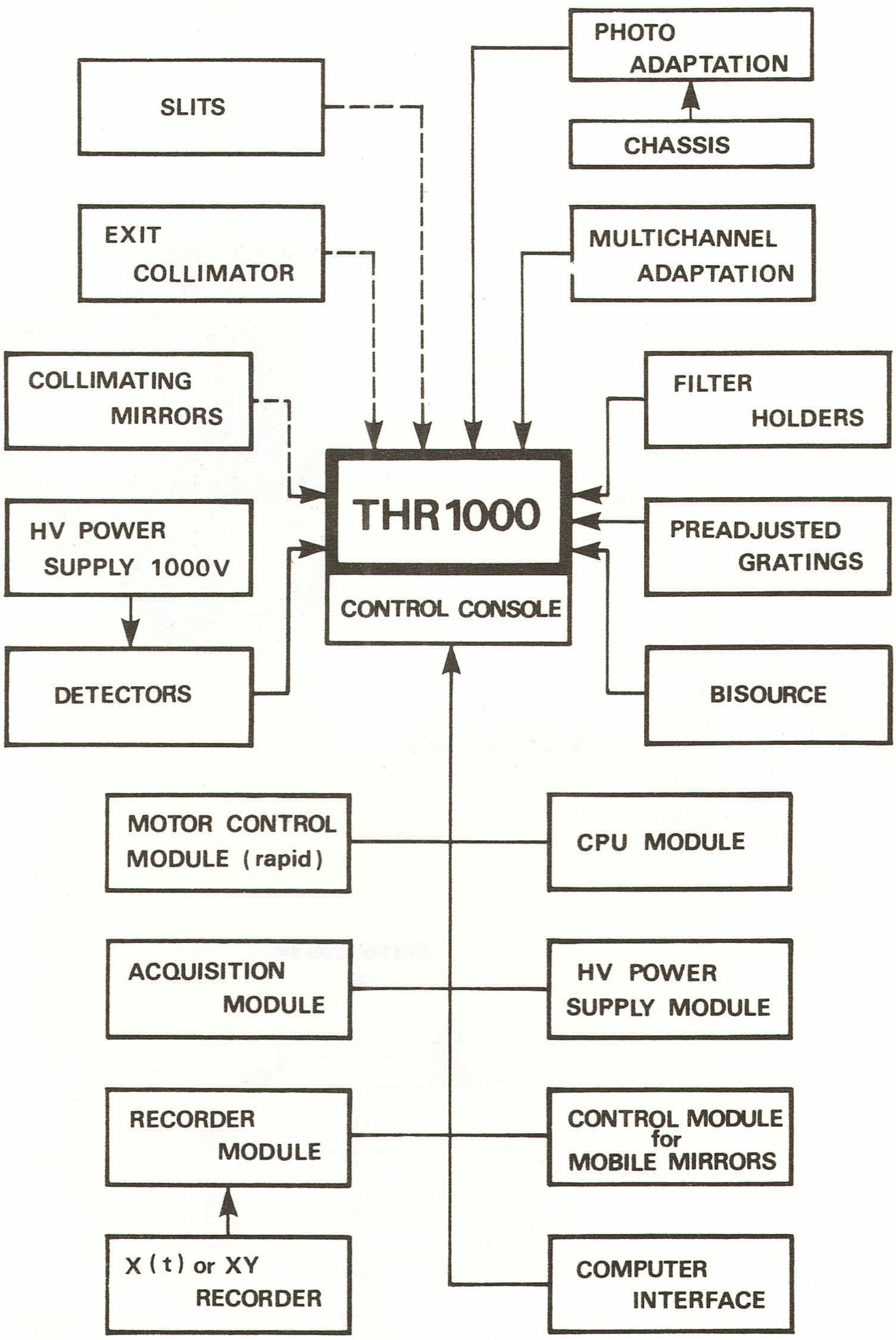
. Verification of resolution

This procedure may be carried out with the 1200 gr/mm grating with the 5460.7 Å mercury (Hg) line, with wide (5-10 µm) and high (2 mm) slits (see specifications).

Recordings performed in the factory in optimal conditions are supplied with the instrument. They are practically the best resolution obtainable with that particular instrument.

IV ACCESSORIES AND OPTIONS

4.1. Block diagram



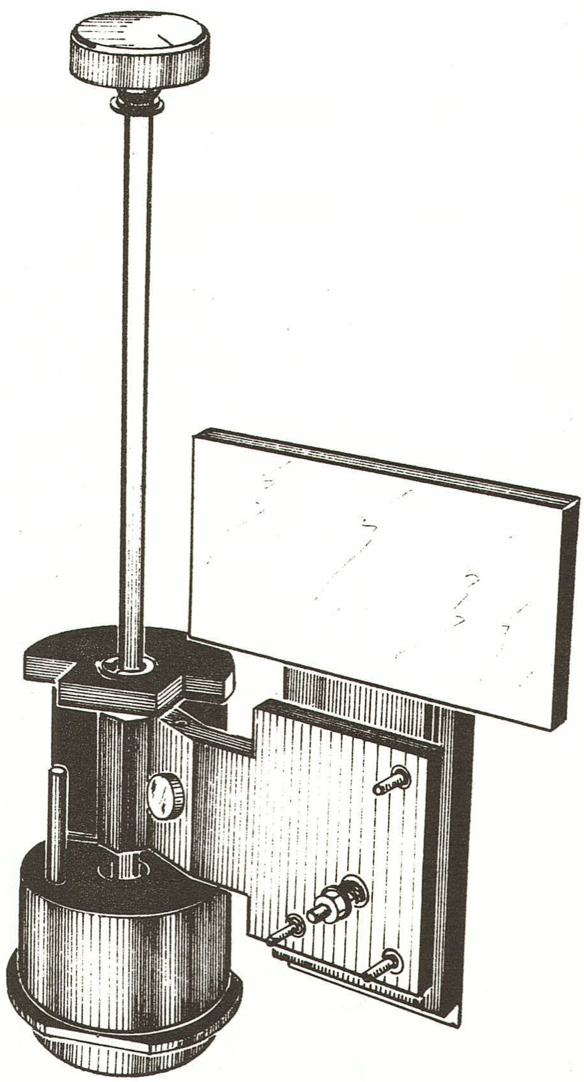


FIG. 7

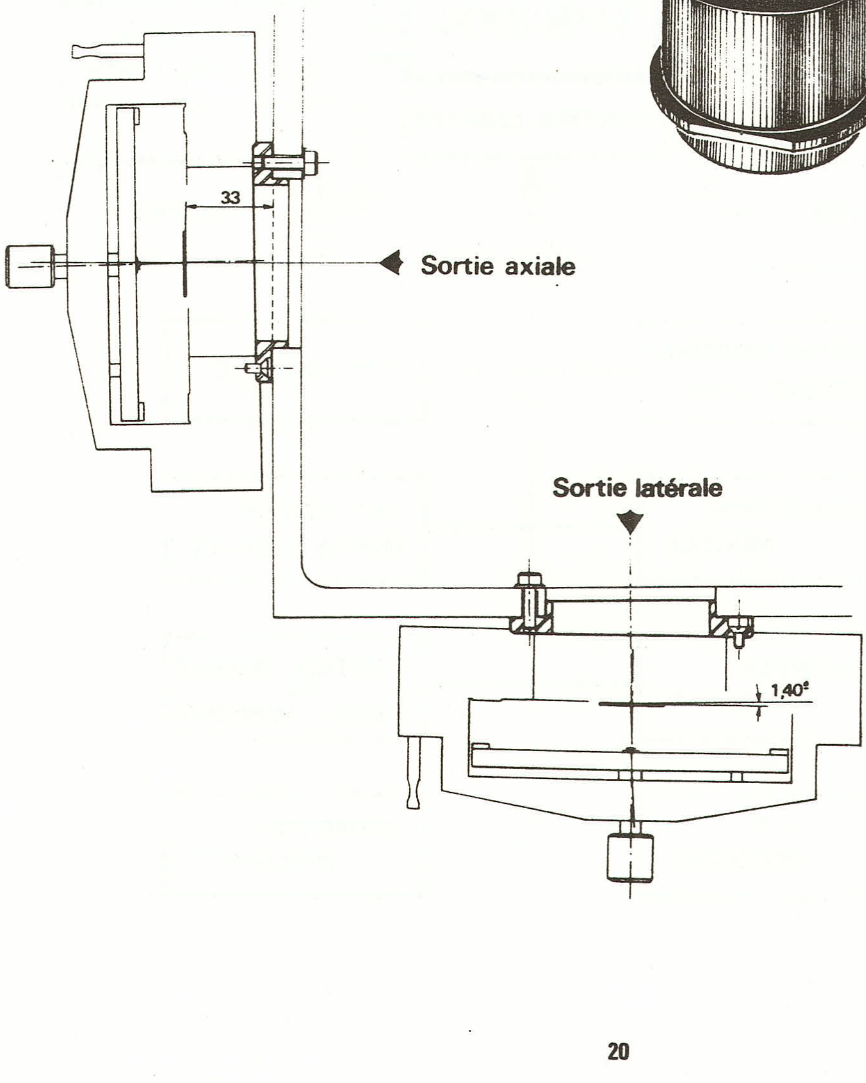


FIG 8

4.2. Slits

The slits may be equipped with straight or curved lips (option when ordering).

NOTE: DO NOT FORGET THAT THE CURVED LIP SLITS ARE NOT COMPLETELY INTERCHANGEABLE IN TERMS OF THEIR ENTRY/EXIT AND AXIAL/LATERAL POSITIONS.

They are equipped with an entry orifice used to attach a plate (suprasil for gas tightness and transmission when flushing with nitrogen) or a catathermic screen (see figures 7 and 8).

4.3. Output collimator on slide

This option, available when ordering, is used to compensate slight differences in focusing and thus resolution, as a function of ambient conditions of temperature and pressure. The adjustment vernier is located at the rear of the instrument (see overall view). One vernier division is equal to 0.05 mm of exit collimator travel.

4.4. Commutation mirrors (see figure 7)

The two versions are specific to entry and exit with either manual or motorized control. In the latter case, the Spectralink MCC board is used for control.

4.5. Preadjusted gratings

The preadjusted gratings are in reality the grating + mount. Any final adjustment that may be necessary is carried out as per paragraph 2.6.2.

4.6. Photo accessory (see figure 8)

This accessory is mounted in the place of an exit slit (axial or lateral) and enables a 9 x 12 photographic plate or a Polaroid camera body to be installed.

The full light spectral field covered is 200 Å with a 1200 gr/mm grating.

Switching from axial to lateral (and vice versa) output is done simply by rotating the intermediate adaptation plate 180° (see figure 9).

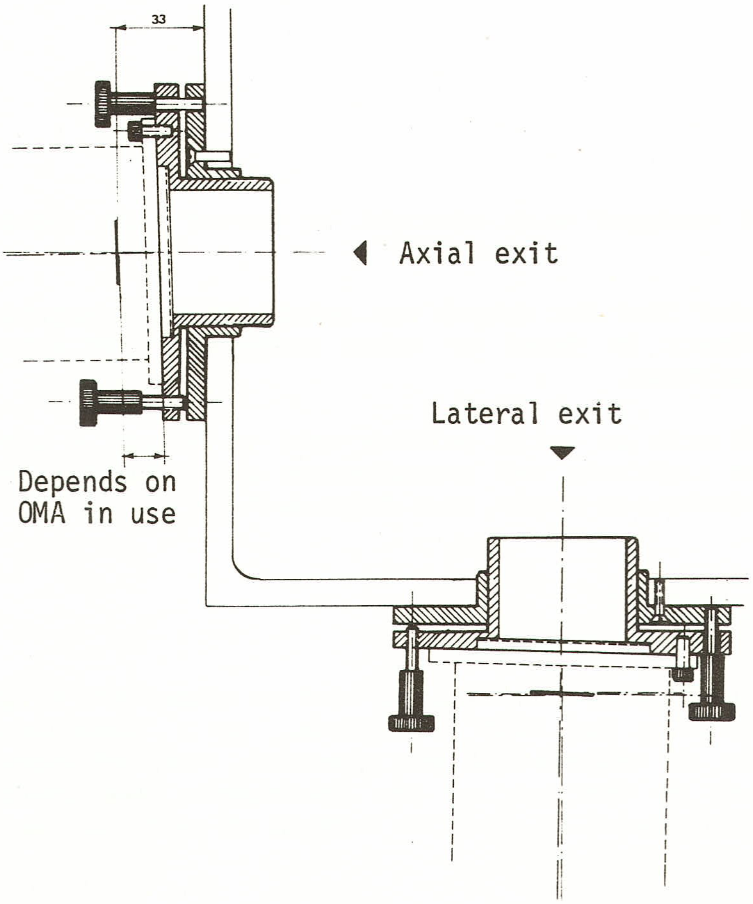


FIG. 9

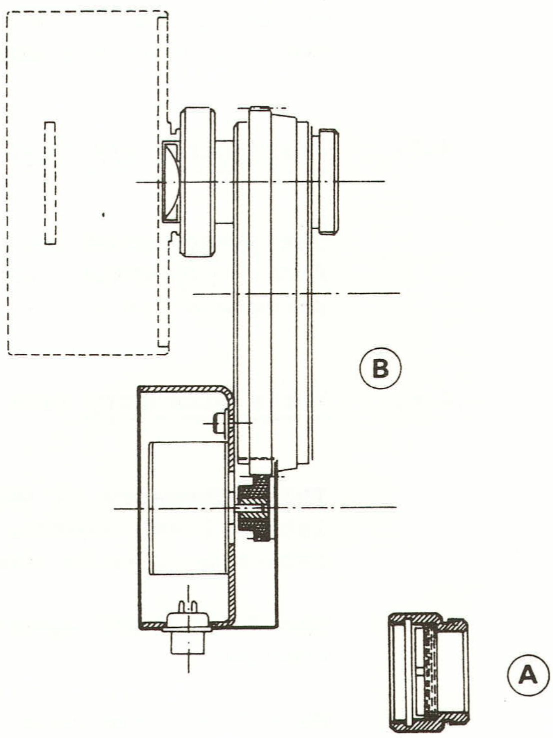


FIG. 10

4.7. Multichannel mount (see figure 9)

Same type of setup as the photo accessory (see figure 10).

The length of the spectrum is the same and enables 25 mm to be covered, i.e. the width of most multichannel detectors.

Focal length adjustment enables the detector to be optimally positioned, and is done simply at the exterior via a screw and check screw (A).

4.8. Filter holders (see figure 10)

Single or multiple filter holders accept standard 25 mm (1") diameter filters, maximum thickness 3 mm.

4.8.1. Single mount (A)

This holder screws directly onto a slit, leaving the thread available for fixation of another accessory if desired (see figure 10).

4.8.2. Filter wheel (B)

Up to six standard filters can be installed in this accessory. Control is manual in the standard version and may be optionally motorized. In the latter case, the Spectralink MCC board assumes piloting (only with programmed control via the interface).

When used on the exit side, a lens may be installed between the slit and the accessory so as to properly cover the sensitive surface of the detector, which is farther away from the slit.

4.9. High voltage power supply

This accessory is designed to power standard photomultipliers and is continuously adjustable from 0 to 1000 V.

Stability:	5.10^{-4}
Regulation range:	150 to 1000 V
Polarity:	negative
Maximum current:	500 µA.

4.10. Recorder

The single channel potentiometric recorder has the following characteristics:

- Floating input
- Multirange from 1 mV to 5 V
- Multispeed from 15 to 600 mm/min
- Zero offset: ± full scale
- Response time 0.3 s
- Pen lift and paper feed controlled by starting and stopping monochromator scanning.

4.11. Bisource

This accessory is composed of an adaptation pin and a bisource lamphouse in which the following combinations can be adapted:

- 37 W deuterium source or spectral lamp (Philips 90 W)

- 70 W Globar source or tungsten lamp

A 125 or 10 Hz modulator can be easily installed on this accessory.

4.12. Detectors

These detectors are housings wired for end window photomultipliers, 2" diameter (QB EMI 9789) or 1 1/8" (Hamamatsu R 376). These detectors are fitted on the same support or with a housing wired for 1P 28, R 446, etc. type photomultipliers. This housing is attached with the adaptor.

4.13. Spectralink modules

See the Spectralink instruction manual, delivered with the instrument.

V. MAINTENANCE

5.1. Periodic maintenance

The following operations may be performed periodically:

5.1.1. Verification of wavelength calibration

5.1.2. Verification of resolution

Verify collimator focal length if it is equipped with a slide.

5.1.3. Complete verification of control function

5.2. Troubleshooting

Symptom	Probable cause	Remedy
Power indicator not lit (Spectralink)	Connections	Check mains cord connection
	Fuses	Change the fuse(s)
	Indicator bulb	Change the bulb
	Power supply	Contact Jobin-Yvon or its representative
	Defective connection	Check the connection of the cable
No wavelength scanning	Electronics	Contact Jobin-Yvon or its representative
Wavelength calibration incorrect	Instrument damaged	Contact Jobin-Yvon or its representative
Other	Not determined	Contact Jobin-Yvon or its representative

VI APPENDIX

6.1. Resolvance - luminosity of a monochromator

6.1.1. Monochromator instrument function

Let us suppose that the monochromator is illuminated with a strictly monochromatic radiation. The recording obtained when the spectrum is scanned represents the monochromator instrument function. It presents a non-nil width because of diffraction phenomena, of non-nil slitwidths and of possible aberrations.

Let λo be the monochromatic wavelength of the radiation, the entity illuminating the entry slit. The curve recorded is spread around λo to a varying degree. Let $A(\lambda - \lambda o)$ be the function represented by this curve.

$A(\lambda)$ is the monochromator instrument function.

It is the same thing to suppose that the monochromator adjustment is fixed (at λo) and to imagine that the monochromatic wavelength varies uniformly. The function recorded is again $A(\lambda - \lambda o)$.

6.1.2. Relations among recorded spectrum, real spectrum and instrument function

Let $M(\lambda)$ be the true spectrum of the source
Let $F(\lambda)$ be the spectrum recorded
Let $A(\lambda)$ be instrument function.

The recorded function $F(\lambda)$ is the convolution product of the source function by the monochromator instrument function.

$F = L * A$

It is clear that $F(\lambda)$ is progressively closer to $L(\lambda)$ as instrument function is narrower.

6.1.3. Factors affect the instrument function

Various factors affect the form of the monochromator instrument function:

- Slitwidths
- Diffraction phenomena
- Aberrations.

Each of these factors may be characterized by a special instrument function, obtained by ignoring the effect of the other parameters.

Overall instrument function $A(\lambda)$ is related to the special functions $A_1(\lambda)$, $A_2(\lambda)$, $A_3(\lambda)$, etc. by the relationship:

$A(\lambda) = A_1(\lambda), A_2(\lambda), A_3(\lambda)$, etc.

Resolvance and luminosity

Given: the spectral interval resolved, i.e. the minimum interval which separates 2 radiations in order that they be recorded separately by the monochromator.

Resolvance $R = \lambda / \Delta\lambda$

In general, we consider that the spectral interval resolved is equal to the width at half-height of the instrument function.

The luminosity of a monochromator is the luminous flux obtained at monochromator exit.

We will see the relations between resolvance and luminosity below.

a) Influence of the slits

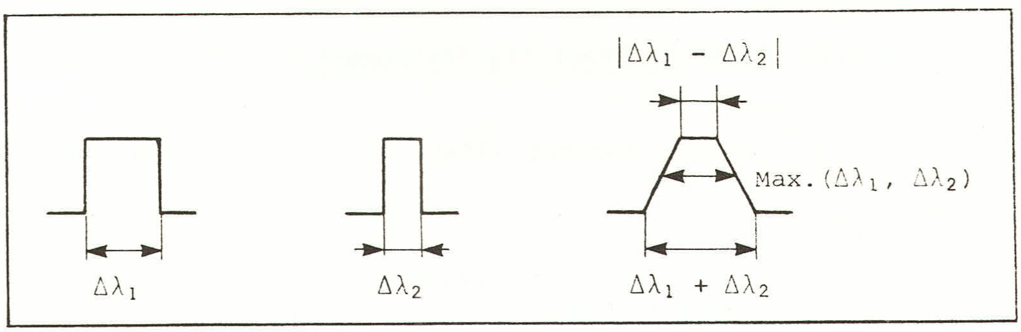
Let ΔW_1 be the width of the entry slit
Let D_1 be dispersion (nm/mm) in the plane of the entry slit

$\Delta\lambda_1 = D_1 \times \Delta W_1$

Let ΔW_2, D_2, $\Delta\lambda_2$ be the same parameters for the exit slit.

$\Delta\lambda_2 = D_2 \times \Delta W_2$

The monochromator instrument function is the convolution of the two slit functions



This is a trapezoid if $\Delta\lambda_1$ is different from $\Delta\lambda_2$
It is a triangle if $\Delta\lambda_1 = \Delta\lambda_2$. In this case, width is equal to the exit slitwidth.
In this case, we have the greatest luminance for a given resolvance.
The width at half-height is called the bandwidth.

b) Influence of diffraction:

If both slits are infinitely thin and if aberrations are negligible, instrument function is the conventional curve representing the diffraction figure.

c) Influence of aberrations:

The slits are infinitely thin and the aberration spot is large in comparison to the diffraction spot.

We observe here (in comparison to the above case):

- a broadening of the instrument function (spherical aberration effect), constant throughout the spectrum,

- an asymmetry of the curve (coma effect). This defect varies with wavelength. It is possible to correct it for a given wavelength.

d) Other factors:

Other factors may participate in the modification and broadening of the instrument function:

- quality of the optical components
- quality of the slits
- quality of instrument adjustment.

6.1.4. Calculation of monochromator luminosity

Resolvance - luminosity relation

Let L_λ be the spectral luminance of the source (in the case of a continuous spectrum) at the wavelength λ.
Let L be source luminance (in the case of a line).
Let h_{app} be the apparent height of the lowest of slits observed from the grating
Let S_g be the useful grating surface
Let N be the number of grooves/mm on the grating
Let T_λ be monochromator transmission at the wavelength λ (T_λ includes the reflective powers of the different mirrors and grating efficiency).

We suppose that the slits are wide in comparison to the diffraction and aberration spots.

$\Delta\lambda_1$ and $\Delta\lambda_2$ were defined in paragraph 6.1.3.

a) Case of a continuous spectrum:

The source spectrum is very broad in comparison to the instrument function:

$$\Phi = h_{app} \; L_\lambda \; S_g \; N \; T_\lambda \; \Delta\lambda_1 \; \Delta\lambda_2$$

Flux is proportional:

- to apparent slit height
- to the grating surface
- to slitwidths $\Delta\lambda_1$ and $\Delta\lambda_2$

  For a given resolvance, flux is maximal when $\Delta\lambda_1 = \Delta\lambda_2$. In this case, flux is proportional to the square of the bandwidth. If we double entry and exit slitwidths, flux is multiplied by 4.

- to source luminance and monochromator transmission.

We see that the aperture number of the monochromator is not a factor.

In this case, the product luminosity x $(\text{resolvance})^2$ is constant for a given monochromator.

b) Case of a line spectrum:

The instrument function is broad in comparison to the width of the line illuminating the entry slit.

$$\Phi = h_{app} \cdot L \cdot S_g \cdot N \cdot T_\lambda \; \min\,(\Delta\lambda_1 \cdot \Delta\lambda_2)$$

Flux is proportional:

- to apparent slit height
- to the grating surface
- to the width of the narrowest slit $\Delta\lambda_1$ or $\Delta\lambda_2$

If we double the widths of the entry and exit slits, flux is multiplied by 2.

- to source luminance and monochromator transmission.

In this case, the product luminosity x resolvance is constant for a given monochromator.

6.1.5. Resolution

In general, resolution is the best resolvance that can be obtained with a monochromator equipped with a given grating. In no case can it surpass the theoretical resolution of the grating.

The spectral interval resolved is proportional to slitwidths and so we will have the best resolvance with very narrow slits. In practice, nothing is gained by using slits narrower than the diffraction spot or the aberration spot.

- if the quality of the entry slit image is limited by diffraction, monochromator resolution will be on the order of the theoretical resolution of the grating. It will be obtained with slitwidths equal to the width of the diffraction spot. In general, we obtain practical resolutions on the order of 0.7 to 0.8 of theoretical resolution.

  In this case, resolution will decrease if we reduce the illuminated width of the grating.

- if the quality of the entry slit image is limited by aberrations, resolution will be very different from theoretical resolution. This depends on the degree of aberrations. In this case, if we reduce the illuminated width of the grating, we will decrease aberrations and increase resolution.

6.1.6. Slit curvature

It is shown that the image of a straight slit is curved. The curvature of this image varies with wavelength.

The effect of this phenomenon is to broaden the instrument function when very large slit heights are used.

In this case, resolvance and resolution are less than with small slit heights.

If we use curved entry and exit slits, with appropriately chosen radius, the image of the entry slit will be formed exactly on the exit slit (Fastie slits). In this case, resolution with relatively high slits is practically as good as that obtained with low slit heights.

Reference: Bousquet, Instrumental Spectroscopy, Dunod.

6.2. Stray light of a monochromator

Sources of stray light in a monochromator are:

- diffusion by optical components: mirrors, grating, etc.

  Even with the best polishing techniques, mirror surfaces are not perfect. The diffusion of the best holographic gratings cannot be less than that of the mirrors.

- incorrect monochromator illumination.

  It is important that the mask on the light source lens coincides with the monochromator lens. Similarly, on the detection side it may be useful to have the monochromator lens coincide with the lens of the exit optical system.

Variation of stray light with slit width and height

We suppose that diffusion follows the Lambert law, and that the entry and exit slits are changed simultaneously.

. Single monochromator with a continuous spectral source

- Variation as a function of slitwidths

The output signal is proportional to the square of slitwidths. It is proportional to slitwidths and the bandwidth is also proportional to slitwidth.

The signal arising from stray light is proportional to the square of slitwidth. It is proportional to the entry slitwidth which controls the flux entering the instrument and is proportional to the exit slitwidth which control the transmission of stray light.

The level of stray light thus does not vary with slitwidth.

- Variation as a function of slit heights

The output signal is proportional to slit heights. The signal arising from stray light is proportional to the square of slit heights. It is proportional to the height of the entry slit which controls the flux entering the instrument and is proportional to the height of the exit slit which controls the transmission of stray light.

The level of stray light thus varies linearly with slit heights.

. Single monochromator with a line spectrum

- Variation as a function of slitwidths.

The output signal is proportional to slitwidths. The signal arising from stray light is proportional to the square of slit widths. It is proportional to the entry slitwidth which controls the flux entering the instrument and is proportional to the exit slitwidth which controls the transmission of stray light. The level of stray light is thus proportional to slitwidths.

- Variation as a function of slit heights.

The output signal is proportional to slit heights. The signal arising from stray light is proportional to the square of slit heights for the same reasons as above.

The level of stray light is thus proportional to slit heights.

. Double monochromator

We suppose that the heights and widths of all slits are adapted.

Light diffused by the first monochromator is transmitted to the second. It is rediffused by the optical components of the second monochromator.

The stray light level is thus considerably reduced by the use of a double monochromator.

Stray light energy received by the exit slit is proportional to the energy diffused by the first monochromator and to the solid angle with which the slit is observed from the diffusing surface, thus the height and width of the slits.

- Continuous spectrum source

The light diffused by the first monochromator is proportional to slit height. The stray light level thus varies with the slitwidths and with the square of slit heights.

- Line spectrum

The light diffused by the first monochromator is proportional to the height and width of the slits. The stray light level thus varies with the square of slitwidths and with the height of slit heights.

The above results show that it is very important to correctly choose slit height and width if we wish to obtain the greatest stray light rejection possible.

It is important to follow the indications given in the Utilization section.

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