Instructions

for the use of

HILGER & WATTS

ST. PANCRAS WAY
CAMDEN ROAD
LONDON NW1
ENGLAND

BZ126

INSTRUCTION MANUAL

for the

INSTALLATION, OPERATION and MAINTENANCE

of the

PHOTO-ELECTRIC MICROPTIC AUTO-COLLIMATOR

T43

Issue 1.

Addendum to T43 and T44 Instructions

For best performance we recommend that the power supply is via a Constant Voltage Transformer with low harmonic distortion. (FF220 Constant Voltage Transformer, Output 240V, 50 cycles, Input 190-260V).

C O N T E N T S

WATTS PHOTO-ELECTRIC MICROPTIC AUTO-COLLIMATOR

TA3

INTRODUCTION

Many engineering measuring problems of straightness, flatness, angular rotation and small linear displacements demanding the highest order of accuracy are today solved by the use of the Watts Microptic Auto-Collimator.

The photo-electric version of this instrument has been introduced to offer increased speed and reliability of making observations. These advantages are achieved in view of the following features:

Sensitivity

Extreme sensitivity of the electronic setting enables a reduction to be made in the number of observations necessary for a given accuracy. A single observations can be relied on to 0.1 second.

Reduced Operator Fatigue

Ensures consistent setting accuracy over long periods, The use of electronics do not require the operator to make exacting settings through the eyepiece of the instrument.

Special Application

The instrument can be located in positions where it is not possible to view the micrometer drum when fiducial settings are required. Hence a two man operation can be achieved by one operator.

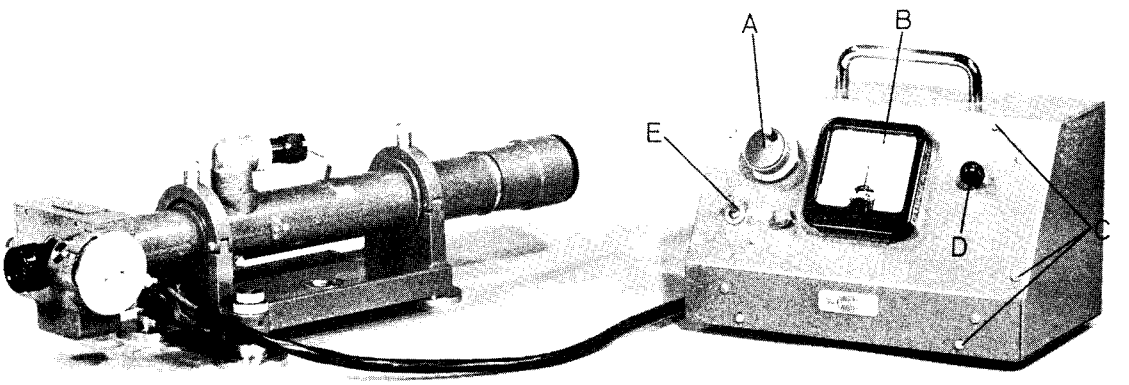


FIG. 1

A. SENSITIVITY CONTROL
B. INDICATING METER
C. SIX CHASSIS SECURING SCREWS
D. VIBRATOR AMPLITUDE
E. ON-OFF SWITCH

TA. 3

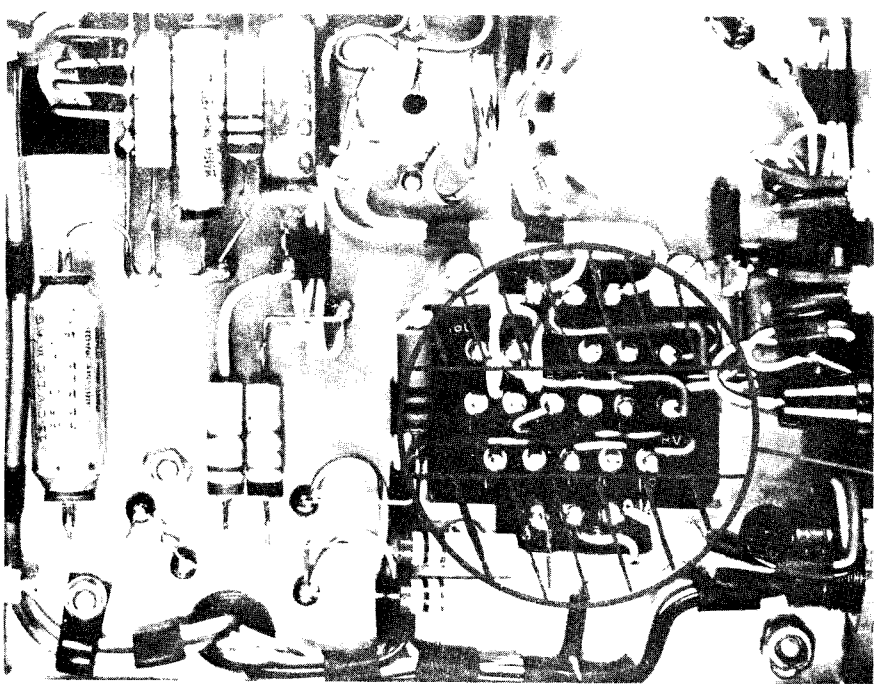


FIG. 2

TRANSFORMER TERMINAL BLOCK

DESCRIPTION

The Photo-electric Microptic Auto-collimator comprises a telescope and base unit similar to the all-optical instrument but is fitted with a micrometer eyepiece embodying a photo-electric detector. A special lamp house incorporating a pre-focus holder and an electrical display unit are also provided. Fig.1.

Photo-electric Detector

The photo-electric detector consists of a vibrating slit with associated Hilger Schwarz photo-conductive cell. The vibrator unit is integral with the micrometer reticule slide, the photocell being fixed to the micrometer box casing. The return image of the target wire is reflected by a 45° semi-reflector via the vibrating slit and focused on the photocell. When the vibrator slit is positioned, by rotation of the micrometer screw, so as to oscillate symmetrically about the reflected image of the target wire the meter needle of the display unit will read zero. Errors from the symmetrical setting of the oscillating slit to the left or right of the image are indicated by corresponding deflections of the meter needle from zero.

Illumination

Illumination is by a 3.6V 0.5A pre-focus bulb. The use of which ensures correct positioning of the filament on replacement.

Display Unit

The display unit contains an amplifier with associated electronic equipment and an indicating meter. The unit is mains operated and

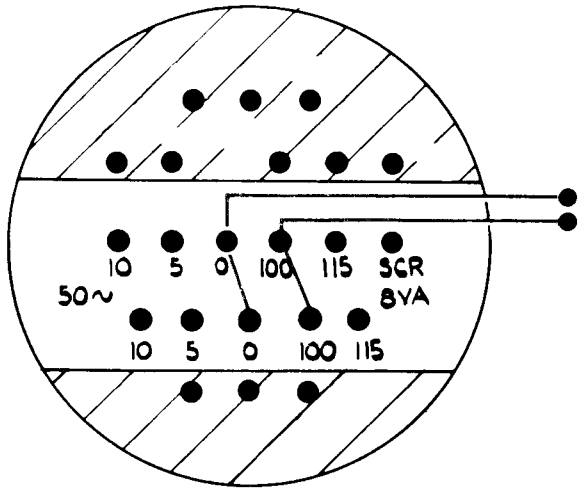
provides a power supply to the vibrator, amplifier and lamp, a bias voltage to the photocell and a reference signal to the discriminator circuit. The controls of the unit have been confined to a minimum - an on-off switch, sensitivity control and vibrator amplitude adjustment (Fig.1 refers).

Operation

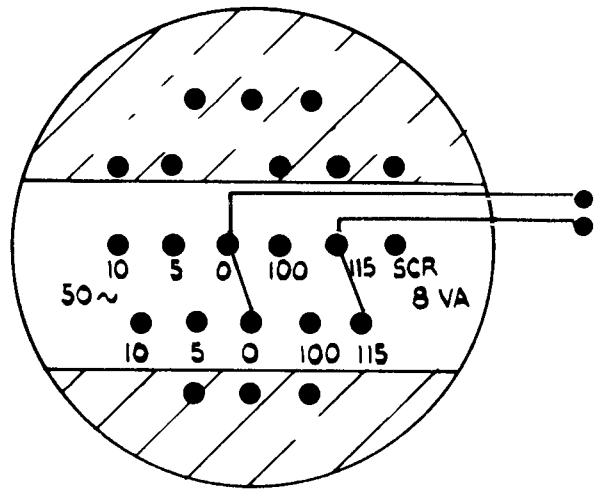
The instrument retains its eyepiece through which can be seen the normal field of view, for the purpose of setting up, or for normal visual use when required. The symmetrical positioning of the twin setting lines about the return image of the target wire is additionally indicated photo-electrically by the needle of the meter pointing to the central zero of a clearly marked scale.

The sensitivity of the meter can be adjusted to a sufficiently high value so that the exact setting of the meter needle to zero is unnecessary, i.e. errors in the micrometer setting from this cause being smaller than can be read on the micrometer drum.

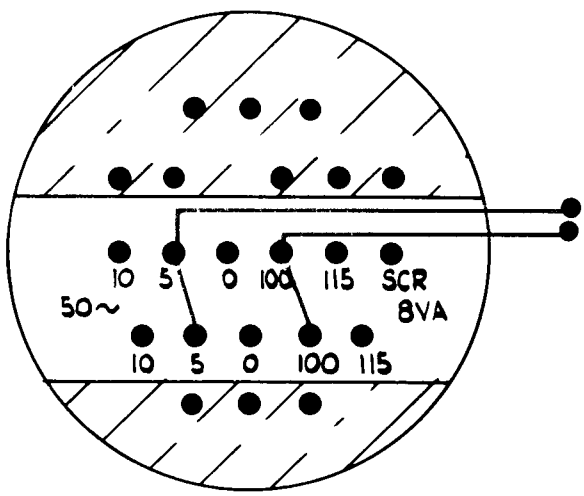
In general, the method of use is identical with that of the all-optical microptic auto-collimator, with the exception that it is unnecessary to observe through the eyepiece when making exact settings on the return image of the auto-collimator target wire. In other words the settings are made by bringing the indicating meter needle to a central mark and taking the reading from the micrometer drum of the instrument in the normal way.



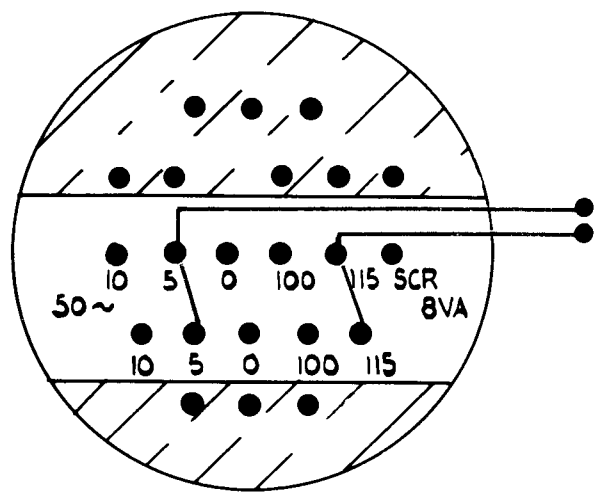
100 VOLTS



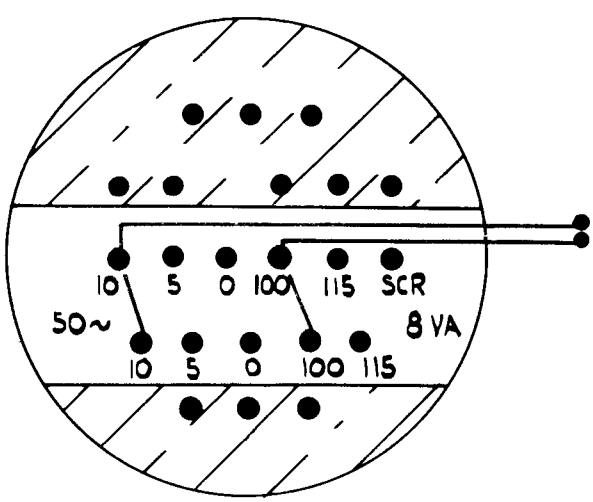
115 VOLTS



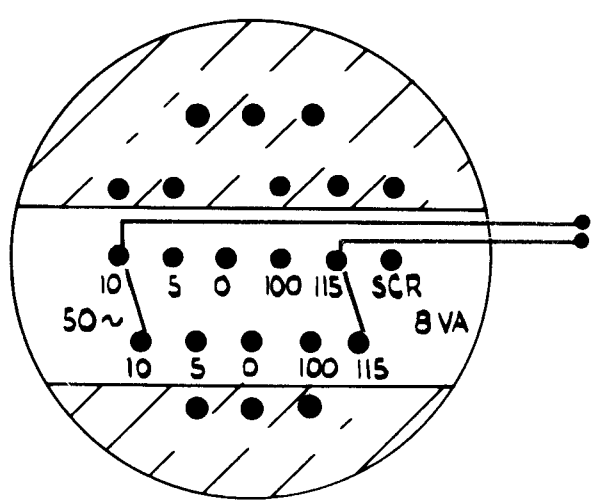
105 VOLTS



120 VOLTS

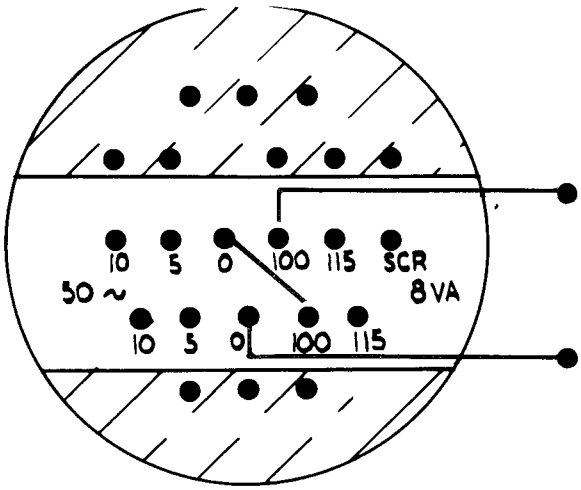


110 VOLTS

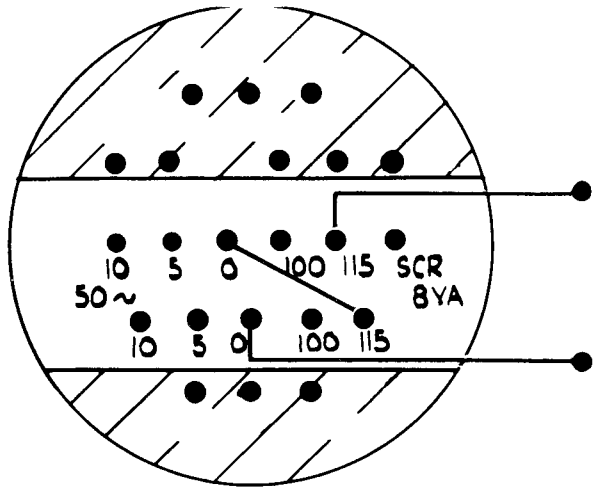


125 VOLTS

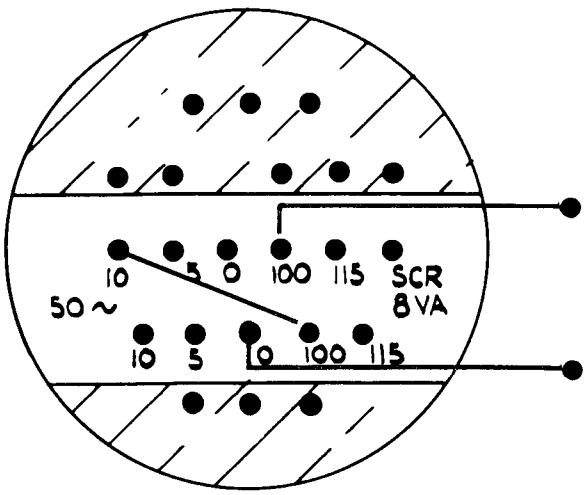
FIG 3



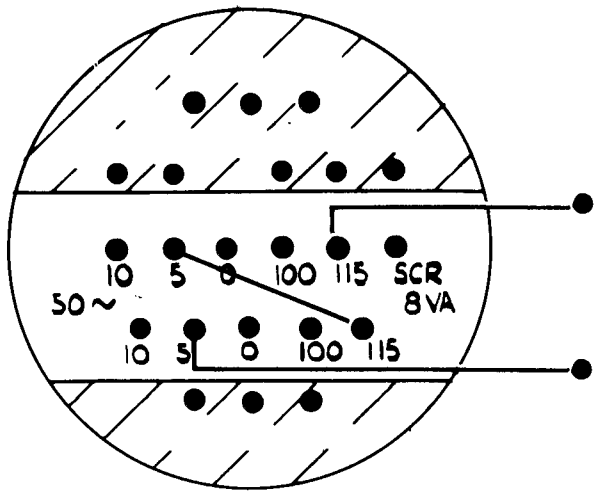
200 VOLTS



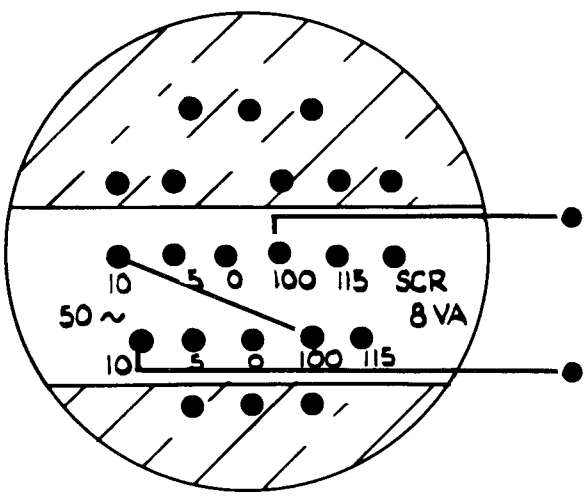
230 VOLTS



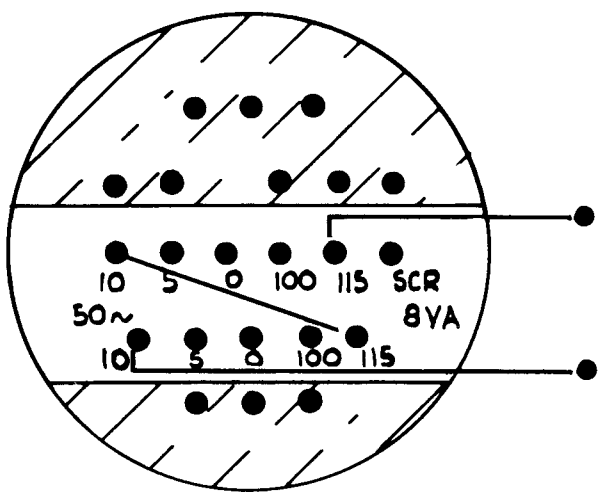
210 VOLTS



240 VOLTS



220 VOLTS



250 VOLTS

FIG 4

INSTRUCTIONS FOR USE

1. Examine display (amplifier) unit to ensure that the connections from the mains to the transformer are wired to suit the power supply; remove the six chassis securing screws from the front of the unit (see Fig.1) and pull out the chassis from its metal case. Mounted on the underside of the chassis will be seen the terminal block of the transformer (see Fig.2). This should be wired in accordance with the appropriate diagram shown in Figs. 3 and 4 to match the power supply voltage.

2. On the free end of the power supply cable connect a suitable plug, preferably one having an earth terminal (three pin):- Red to line, black to neutral and green to earth. Should a three pin outlet not be available the earth lead should be isolated. The unit will function perfectly satisfactorily under normal conditions without being earthed. However, should abnormal conditions be encountered, where the oscillation of the meter needle becomes annoying due to interference, it will be necessary to earth the unit, and an earthing terminal is provided at the rear of the chassis cover just above the mains input plug.

For best performance it is recommended that the power supply is via a Constant Voltage Transformer - (FF220 Constant Voltage Transformer, Output 240V, 50 cycles, Input 190-260V) - with low harmonic distortion.

3. The collimator should now be connected to the display unit. (On

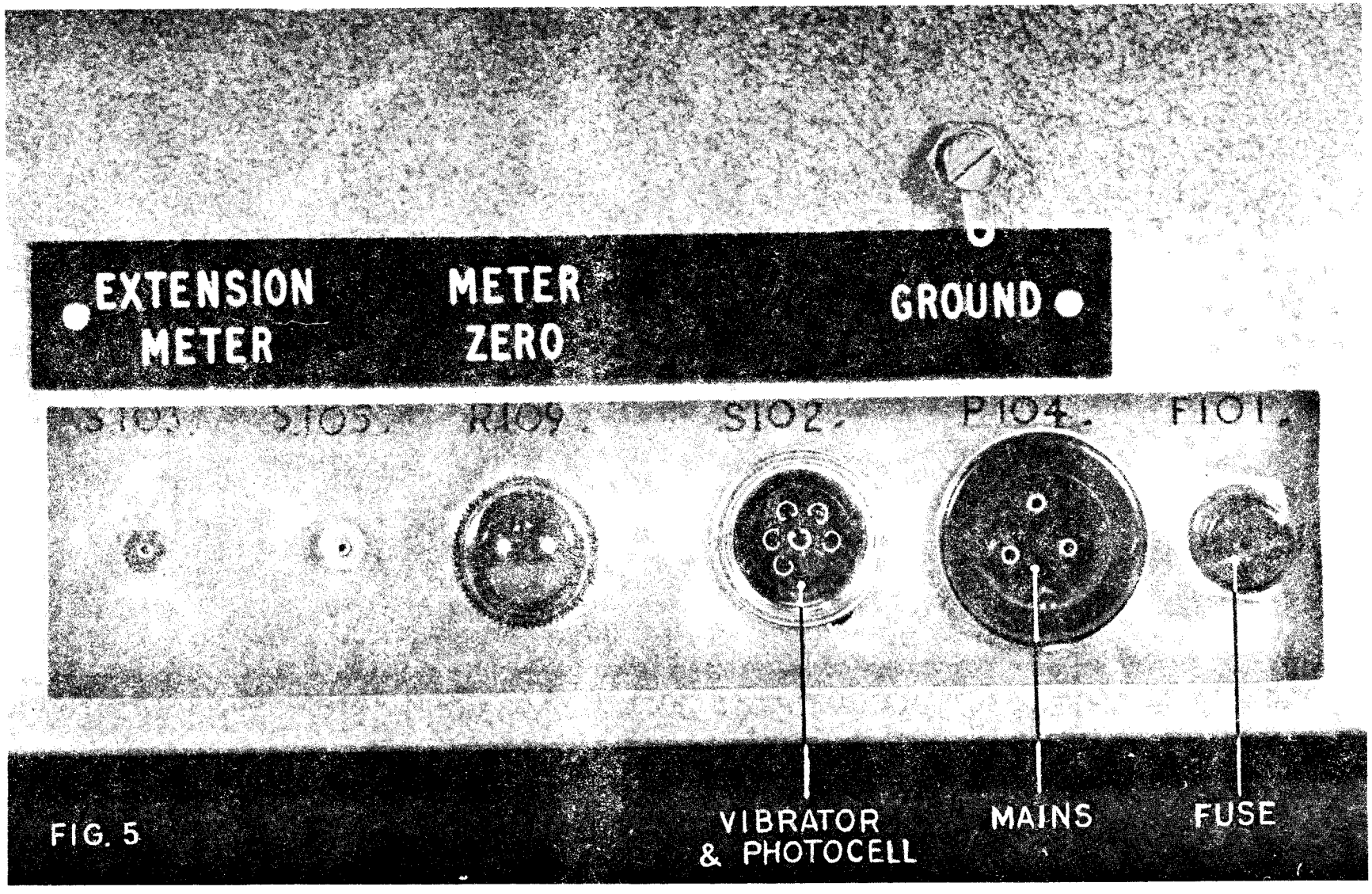

EXTENSION METER
METER ZERO
GROUND
S103
S105
R109
S102
P104
F101
VIBRATOR & PHOTOCELL
MAINS
FUSE

FIG. 5

delivery the collimator leads will be permanently attached to the collimator, a 6-way Tuchel plug with screwed securing ring being provided to lock into the appropriate output socket at the rear of the display unit (see Fig.5).

Extension Meter

Two sockets, S103 and S105, are provided on the rear panel of the Display Unit so that an extension meter may be used. A suitable meter for mounting at the breech end of the instrument is available under Cat. No. TA 29 but any microammeter reading 25-0-25 of convenient size may be used.

The leads should be connected as follows:-

Red - S105

Black - S103

but these may be reversed, if necessary, to co-ordinate the sense of the extension meter with that of the Display Unit.

4. Switch on the unit.

5. Set up the Auto-collimator in the same manner as the all-optical instrument. (See publication CT 47/2 attached).

6. Allow equipment to stabilise for 10-15 minutes from switching on (4 above).

7. Method of making a setting using indicator meter:-

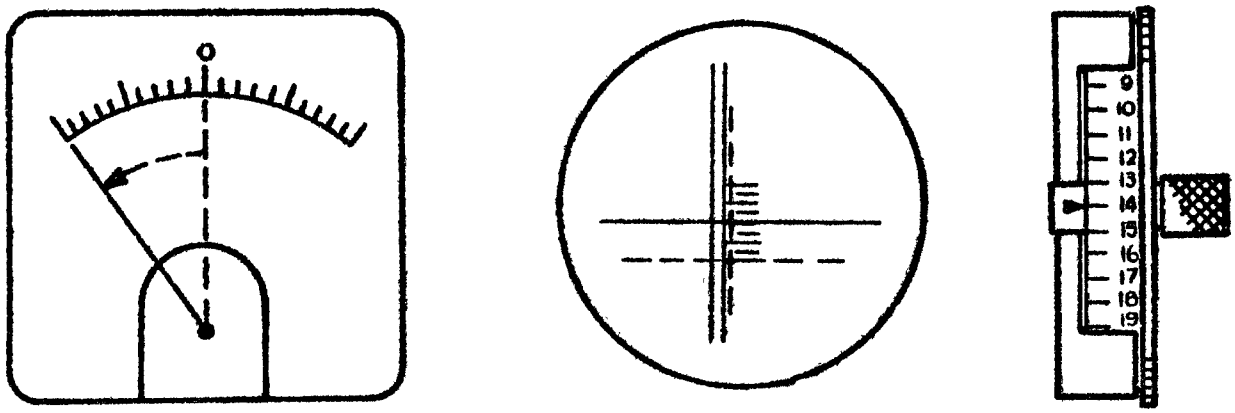


FIG 6

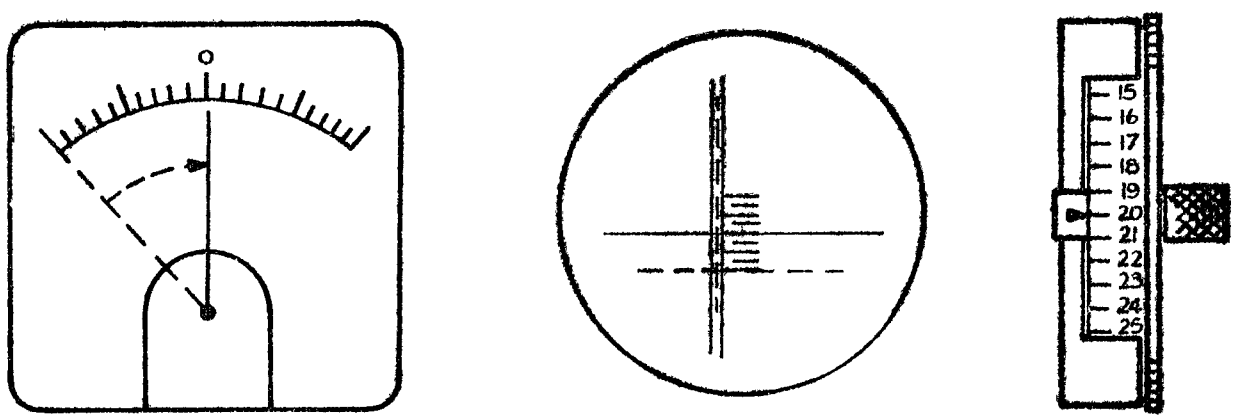


FIG 7

Position reticule twin setting lines to the left of the reflected target wire image. Rotate the micrometer drum in a clockwise direction (increasing drum reading) until the meter needle is deflected counter-clockwise (right to left) Fig.6. Continue rotation of the drum until the needle reverses its direction of travel and begins to move in a clockwise direction (left to right). When the needle reaches the central 'zero' line on the scale a null setting is indicated, Fig.7.

It should be noted that the photo-electric setting may not exactly coincide with the visual setting.

If the clockwise rotation of the micrometer drum is continued the needle will continue to deflect to the right, Fig.8, until a reversal point is reached when it will return to its unbiased zero, Fig.9.

8. Adjust the sensitivity control until full scale deflection is obtained when approaching the target wire return image, as in 7 above. A standard deviation of repetition of $\pm$0.04 sec. can be achieved under good atmospheric conditions at this setting.

9. If atmospheric disturbance is excessive, the condition can be improved by interposing a piece of cardboard tubing between the objective lens of the auto-collimator and the reflector.

10. Before proceeding with the test move the reticule setting lines clear of target images. With a piece of card placed in front of the

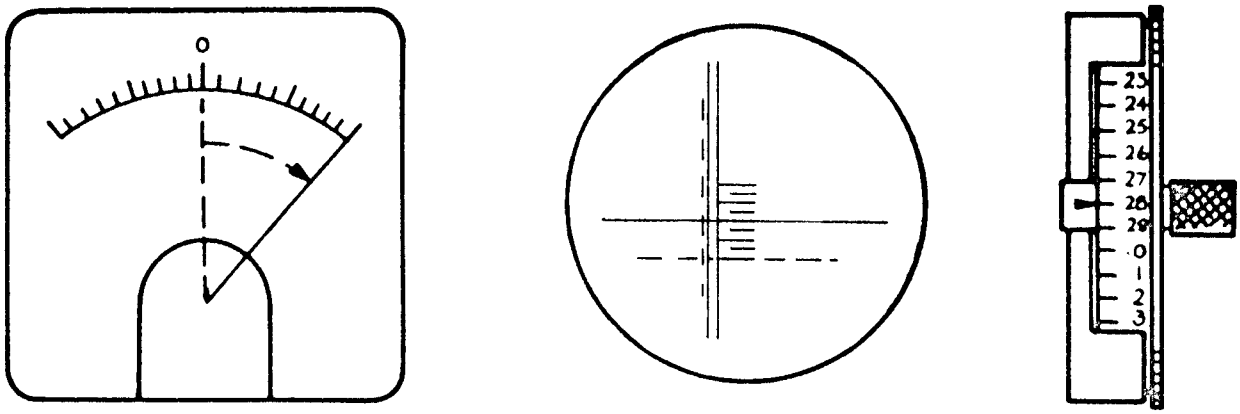


FIG 8

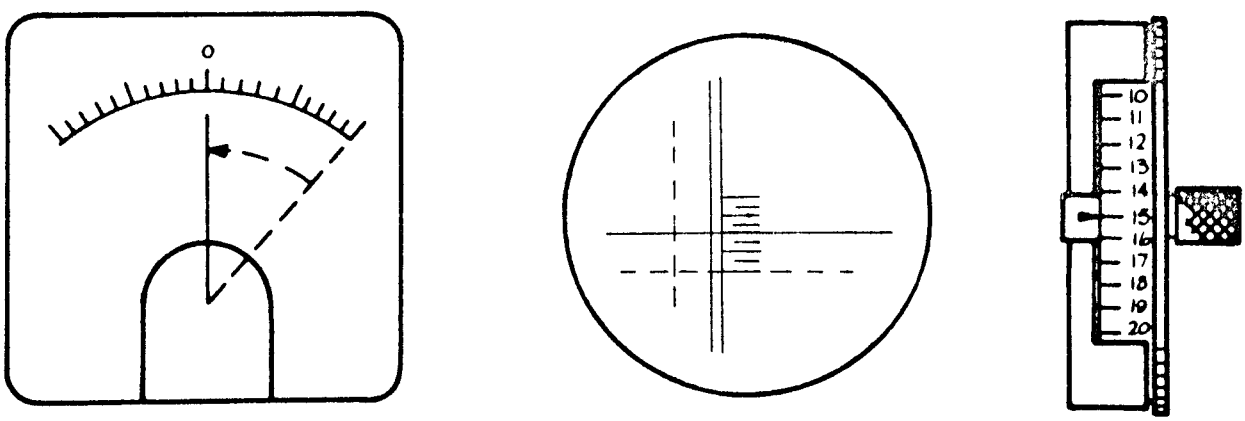


FIG 9

objective lens of the auto-collimator, the meter needle should settle on the central zero. If the needle does not settle to zero the cap of the pre-set adjuster marked Meter Zero at the rear of the Display Unit should be removed, and the adjusting screw rotated so that the meter needle reads zero.

NOTE: It will not be necessary to carry out this test on each occasion the instrument is used, but it is advisable to check zero adjustment from time to time.

11. Replace Pre-set adjuster cap.

The instrument is now set up ready for use. It will be found convenient when first using the photo-electric detector to find the line visually by very approximately setting the twin lines about the return image of the target wire. For this reason the instrument is supplied with reticule twin lines and the photo-electric detector set in approximate agreement with one another, but ON NO ACCOUNT SHOULD VISUAL SETTINGS BE MIXED WITH PHOTO-ELECTRIC SETTINGS. When large displacements more than one turn of drum, are encountered, the number of turns can be conveniently read from the external dial counter.

GENERAL

SENSITIVITY

The sensitivity should be adjusted prior to each test as the size and type of reflector will largely govern the amount of return light and hence the sensitivity.

The sensitivity over a period of several hours is liable to vary slightly but this variation will not significantly affect the null setting. It is, however, advisable not to re-adjust the sensitivity during a set of readings.

The sensitivity of the meter reading can be adjusted by trial so that the divisions on the meter scale represent a definite angular value, (as read from micrometer drum), thus enabling a small range of angular errors to be read directly from the meter. This feature is useful when the instrument is located in a position where it is not possible to view the micrometer drum, or in cases where the lower accuracy over a limited range is acceptable.

Working Distance

The photo-electric system functions to the best advantage within a working distance of 0 - 10 feet (between the objective lens of the auto-collimator and the reflector) covering a range of 10 minutes of arc. The reflector used should preferably be of greater diameter than the aperture of the objective lens.

The maximum working distance for setting by means of the photo-electric system is 30 feet.

When working at distances between 10 - 30 feet care must be taken to set up the auto-collimator so that the return image of the target wire is in the centre of the reduced diameter of the illuminated patch, and that a range of measurement not exceeding, say ±1 min. of arc be used.

Use with Polygons

This application is ideally suited for the photo-electric setting system. To achieve the best accuracy from a standard glass or steel polygon having 0.5 inch diameter peripheral reflecting faces the following special care should be taken:

1. The polygon should be centred to the axis of rotation of the inner bore (of its mount in the case of glass polygons) within 0.001 in. T.I.R.
2. The auto-collimator should be directed at the central area of each reflecting face to within approximately 0.05 in.

Also see Publication BZ.125 for full details of methods of use for precision polygons.

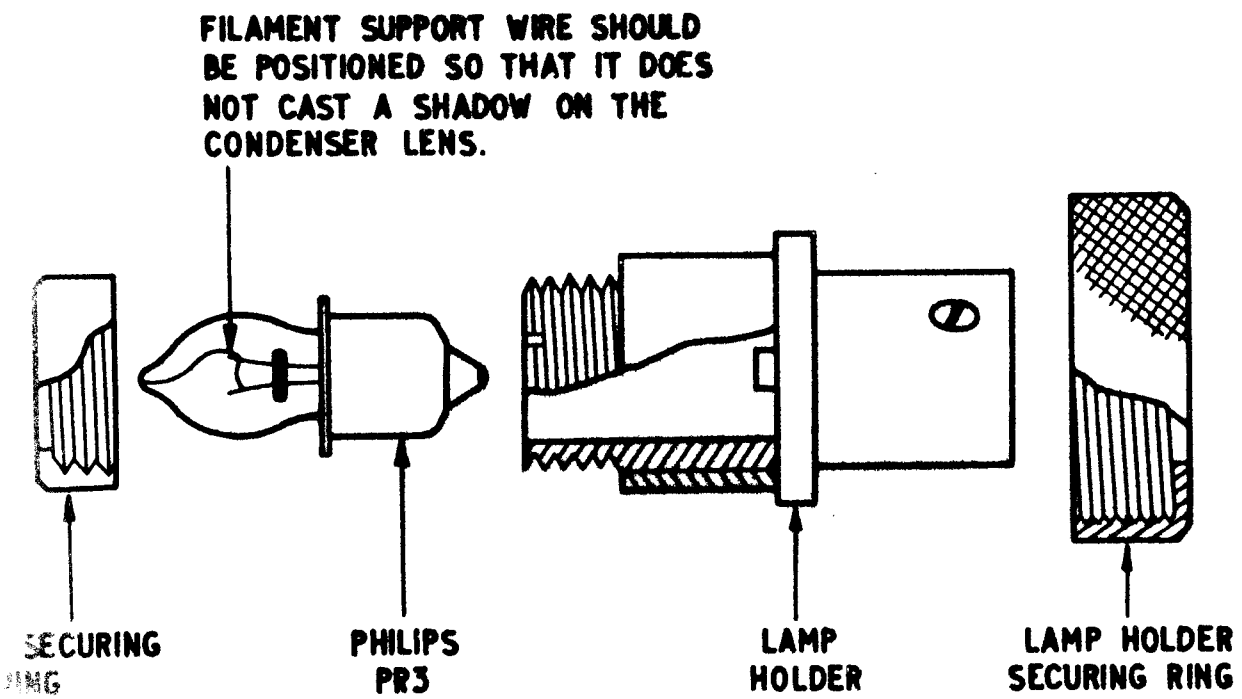

FILAMENT SUPPORT WIRE SHOULD BE POSITIONED SO THAT IT DOES NOT CAST A SHADOW ON THE CONDENSER LENS.
SECURING RING
PHILIPS PR3
LAMP HOLDER
LAMP HOLDER SECURING RING

FIG 10

CARE AND MAINTENANCE

Auto-Collimator

Base. The steel base should be cleaned and coated with rust preventative when the instrument is not in use.

Optics. The outer surfaces of the objective lens and eyepiece lens should be cleaned when necessary, very carefully, by using a silica free tissue - such as used for spectacle cleaning.

Lamp. If the sensitivity of the instrument appears to be reduced unduly examine the lamp by unscrewing lamp holder securing ring and withdrawing holder, Fig.10. if the lamp surface is internally blackened the lamp should be replaced. To fit the replacement reverse this procedure. Return lamp holder to lamp house, taking care to rotate holder so that filament support wire of the lamp does not cast a shadow on condenser lens, (in other words rotate lamp to obtain maximum illumination) and secure.

NOTE: Lamps are under run to increase their useful life.

Display Unit

If red pilot lamp fails to light unscrew dome and replace bulb. If the lamp is not at fault check fuse. If blown, replace. (500 m.a. only). Check also plug connections at each end of mains lead.

Adjustment of Vibrator Amplitude

This adjustment is preset by the manufacturer, however, should it become mal-adjusted the following procedure should be carried out.

To set Vibrator Amplitude

Remove the cap from the vibrator control screw, which is located on the front panel of the Display Unit, and insert a screwdriver into its slot. Then turn the screw, normally in a counter-clockwise direction, until the minimum amplitude is reached (i.e. the screw is against its stop). Now increase the amplitude, by turning the screw in the opposite direction, to approximately one-third of its range.

Turn the sensitivity control knob, on the front of the Display Unit, in a counter-clockwise direction until it reaches its stop, at which point it is at minimum sensitivity. Now increase the sensitivity by turning the knob in a clockwise direction, to approximately one third of its range.

Sight the Auto-collimator on to a reflector and set the twin setting lines to straddle the return image of the target wires, then by slowly rotating the micrometer screw of the Auto-collimator to and fro the meter needle on the Display Unit will be caused to deflect. Re-adjust the sensitivity control so that the needle deflection is no more than five divisions either side of the zero.

Turn the micrometer screw of the Auto-collimator until the meter needle on the Display Unit reaches the end of its swing in either direction, then slowly increase the vibrator amplitude until the needle reaches its maximum deflection.

NOTE: If when the vibrator amplitude is being increased the needle on the Display Unit reaches the end of the scale before maximum amplitude is determined, the sensitivity control should be decreased slightly. It should also be noted that as the vibrator amplitude is taken past its maximum setting, the needle on the Display Unit gradually returns to zero, indicating a decrease in sensitivity.

Replace the vibrator control screw cap.

If failure persists return unit to agent or manufacturer.

WC/EW
Nov.'63.

Publication No. BZ.126.

A P P E N D I X I

SPECIFICATION

TELESCOPE	Object Glass Aperture	1.375 in (35 mm)
MICROMETER	1 revolution of the drum equals 1 sub-division of the drum equals (Drum divided into 300 equal black and white divisions, therefore 1 division equals 0.1 second).	30 second of arc. 0.2 second of arc.
POWER SUPPLY	Mains	200 to 250 volt 50 c/s or 60 c/s or 100 to 125 volt 60 c/s or 50 c/s
	Fuse	500 mA
WARM UP TIME		30 seconds
STABILISING TIME		15 minutes
MEASURING RANGE		10 minutes of arc
WORKING DISTANCE	Visual	up to 50 feet (15 m)
	Photo-electric	up to 30 feet (9 m)
REPETITION OF SETTING		within 0.05 sec.of arc.
ACCURACY OVER TOTAL MEASURING RANGE		2 seconds of arc.
LAMP	Pre-focus 3.6V 0.5A (Philips PR3)	

DIMENSIONS OF AUTO-COLLIMATOR

Flat base	8 x 3½ in. (203 x 89 mm)
Overall length	18.3/4 in. (476 mm)
Overall width	5½ in. (140 mm)
Overall height	5.1/4 in. (134 mm)
Weight	17.1/4 lb. (7.8 kg)
Weight of instrument with case	25½ lb. (11.5 kg)
Overall size of case=	21 x 8 x 7 in. (533 x 200 x 178 mm)

DIMENSIONS OF AMPLIFIER

Length	10 in. (254 mm)
Width	6 in. (155 mm)
Height	7.3/4 in. (200 mm)
Weight	10 lb. (4.5 kg)

PACKING SHIPPING WEIGHT FOR AUTO-COLLIMATOR AND AMPLIFIER 70 lb. (31.9 kg) app

A P P E N D I X II

REPLACEMENT PARTS

Display Unit

	Pilot Lamp	Philips Ltd.,	L.E.S.E5 5 mm tubular bulb 6.3V
	Fuse (Power line)	Belling Lee Ltd.	L.754/Yellow
*	Valve (Double Triode)	Mullard Ltd.	E.88.CC
*	Voltage Reference tube	"	85.A.2.

* Note the American equivalents are:

E.88.CC = 6922) Obtainable from:
)
85.A.2 = OG.3) Amperex Electronic Corporation,
230 Duffy Avenue,
Hicksville.
L.I.
New York, N.Y.

Auto-Collimator

	Lamp	Phillips Ltd.	PR3

It is unlikely that any other part will require replacement under normal use. However, should it be necessary to replace a part not listed above please contact Hilger and Watts Ltd. or their Agents.