ZOOMAR SEI EXPOSURE PHOTOMETER

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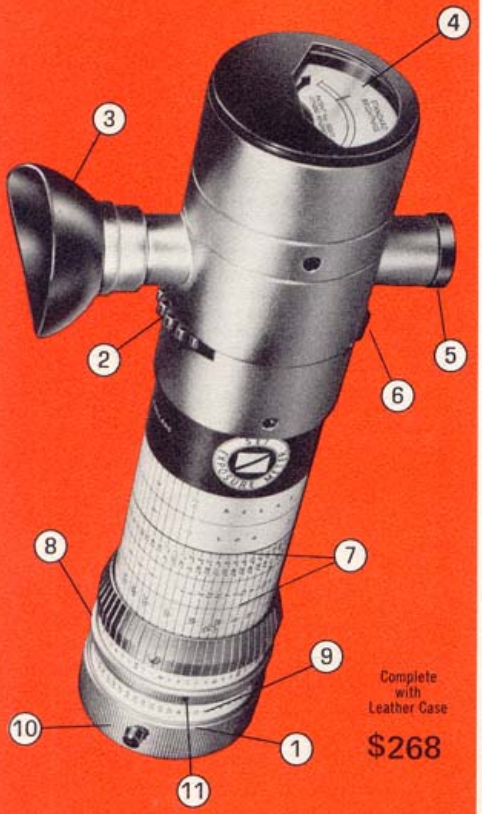

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1 Knurled adjustable ring
2 Daylight or artificial light
3 Adjustable telescope eyepiece
4 Microammeter for standardizing
5 telescope objective
6 Brightness range selector
7 Exposure time scale
8 Lens aperture scale
9 Film speed scale
10 Push button switch
11 Setting ring for shadow or keytone methods

The Ultimate In Light Measurement

- measures reflected light exactly as the camera lens receives it from its position.
- measures the object brightness regardless of background illumination.
- has a selectivity of target to allow readings on a telegraph pole 100 feet away.
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Printing
Enlarging
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Light Level and Contrast Measurement in:

Photographic studios
Motion-picture studios
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Transmission and Reflection Measurement for:

The graphic arts
Color printing processes

Projection Screen Brightness Determination and many other valuable data for illumination engineers

Ansel Adams says:

"**The S.E.I. Exposure Photometer**...I critically evaluate this new meter as an instrument that enables the photographer to measure subject brightness of small areas (acceptance angle of ½°) over a wide range of brightnesses (1 to 1,000,000). It is not a simple field instrument for ordinary work, but it will allow the photographer to refine his measurements, and to analyze the brightness of very small areas of his subject. It functions under very low values of illumination—far beyond the capacity of the standard photoelectric meter (excepting electronic meters such as the Photovolt meters Nos. 500 and 501). Perhaps the chief value of the S.E.I. meter is its ability to solve hitherto impossible problems of exposure under complex lighting—small, dark objects against bright backgrounds, and vice versa; twilight scenes including street lights; very dark areas of architectural interiors; brilliant clouds near the sun, etc. It is extremely helpful in color photography, where a critical evaluation of highlight and shadow values is of decisive importance."

Reprinted from "The Negative" by Ansel Adams, Morgan & Morgan, Inc., Publishers

ZOOMAR, INC.

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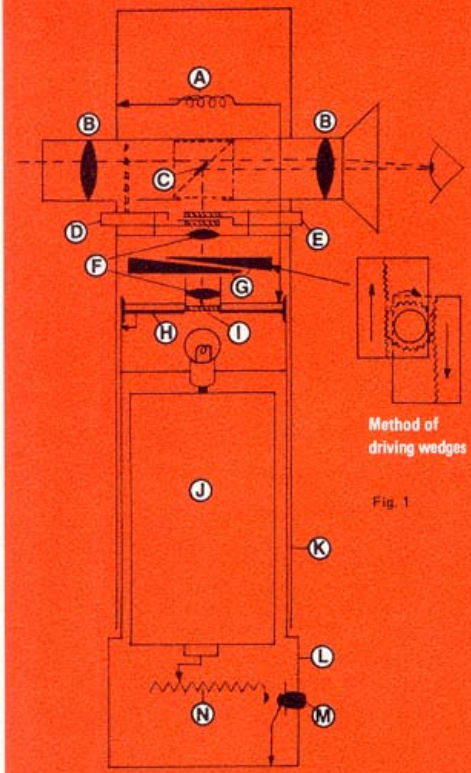
Schematic diagram



Method of driving wedges

Fig. 1

A Microammeter coil
B Telescope lenses
C Mirror spot
D Range shift disc
E Colour matching disc
F Collecting lenses
G Optical wedges
H Photo-electric cell
I Diffusing screen
J Dry battery
K Exposure, density and brightness scales
L Stop and film speed scales
M Lamp switch
N Rheostat

Principles of construction

The subject is viewed approximately full size but inverted, through a simple telescope (B). By an adaption of the Lummer-Brodhun cube, a small comparison spot (C) is superimposed on the centre of the image field, this spot subtending at the eye an angle of only ½°. The spot is diffusely illuminated by a small electric lamp via a diffusing screen (I), the lamp being fed by a dry battery (J) through a rheostat (N). The lamp also illuminates a ring-shaped photo-cell (H) which is connected to a microammeter (A). By adjusting the rheostat, the pointer of the microammeter is made to coincide with a standardising mark so that the luminous output of the lamp and consequently the brightness of the "internal reference surface" (I), are always at a constant value. The instrument is therefore self-standardising.

Situated between the lamp and the spot are two opposed photometric wedges (G). These are moved in opposition to one another by a rack and pinion mechanism operated by rotating the base (L) of the photometer. The light reaching the comparison spot can in this way be varied through an intensity range of 100 to 1. Reduction of the brightness of the subject or spot by the insertion of neutral filters attached to a range shift disc (D) provides a further increase of range up or down by factors of 100 thus giving the instrument a total range of 1,000,000 to 1.

The range shift disc has three index marks. When the white mark is central under the object lens of the telescope, the meter is on its normal range, covering the deepest significant shadows of most outdoor subjects. When the red mark is central the meter is set for subjects of very low brightness. When the blue mark is central the meter is on its high range, which mainly covers highlight or keytone methods as described later.

To make easy the comparison of brightness between spot and object a colour correcting filter is provided in disc (E) situated immediately below the telescope eye-piece. This has two positions, the index marks for which are yellow, which is used for measurements in artificial light and white for measurements in daylight. The calibration of the instrument is unaffected by the movement of this disc. Note, however, that when the subject is illuminated by artificial light, the appropriate film speed index should be used.

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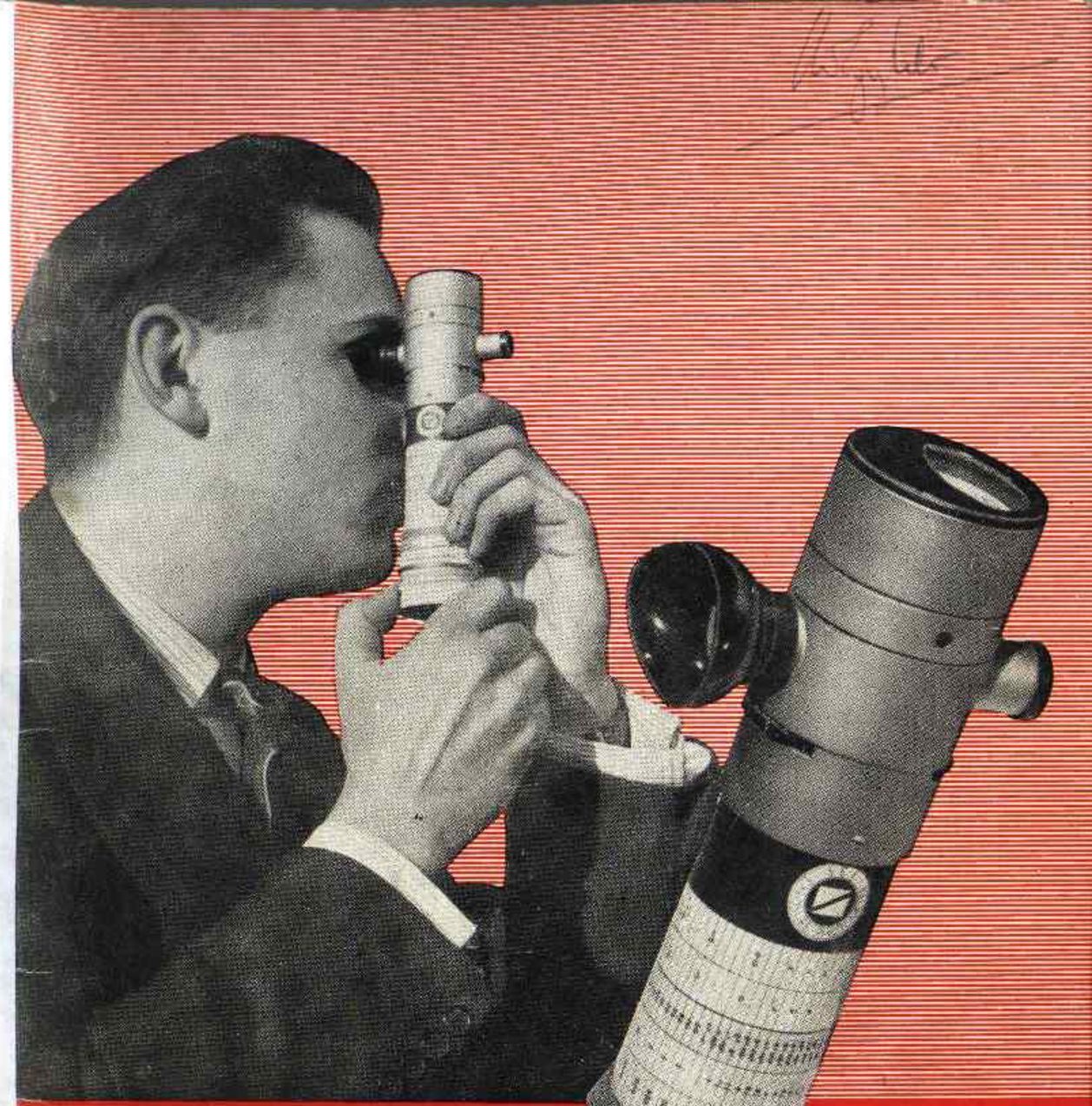

SEI

Exposure Photometer

Manufactured by SALFORD ELECTRICAL INSTRUMENTS LTD
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SEI

Exposure Photometer

A precision instrument for the determination of exposures in general photography, reversal processes, copying and enlarging, and for the accurate measurement of transmission and reflection densities, brightness and illumination levels and other factors of interest to illuminating engineers

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As efforts are constantly made to improve both designs and methods of manufacture, apparatus supplied may differ in details from the illustrations.

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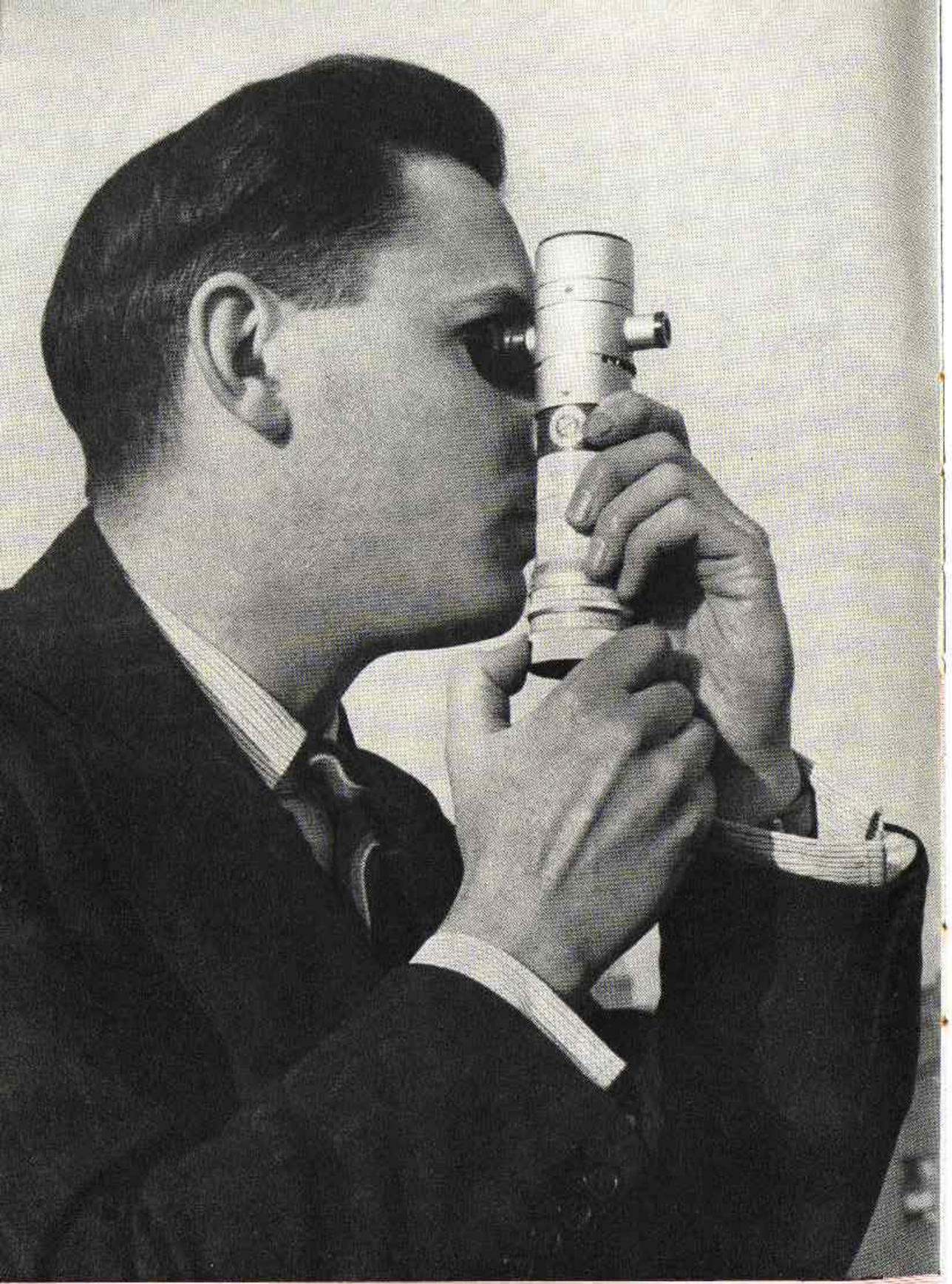


Introduction

The S.E.I. Photometer is the first commercial and practical instrument to be sold to the public which gives scientifically correct answers to the exposure problem. It is also the first exposure meter which allows full advantage to be taken of the fundamental approach upon which is based the new 'Exposure Index' Specification of the British Standards Institution No. 1380-1947, and its American contemporary, A.S.A. Specification Z38.2.1 - 1947.

It is based on the Dunn and Plant 'Photometric Exposure Meter'—first described to the Royal Photographic Society in 1945 (*Photographic Journal*, **85B**, 114-119, Nov.-Dec. 1945).

The main attribute of the *S.E.I. Photometer* is its ability to measure selectively the brightness of very small areas at a distance over a great brightness range. It is thus not only applicable to the precision exposure determination of the most 'difficult' of photographic subjects but also to the solution of many problems in illuminating engineering.

The instrument contains its own comparison lamp which is set by the user to illuminate an internal comparison surface at a predetermined brightness level, the photoelectric cell and microammeter necessary for this self-calibrating feature also being contained within the body of the photometer.

For the illuminating engineer the instrument allows of the direct measurement of *brightness* (in foot-lamberts) and incident *illumination* (in foot-candles).

For the photographer the *S.E.I Photometer* measures with precision the brightness of a small area in the subject from the camera position and thus can measure the brightness range of the subject. By eliminating guesswork it enables the photographer to predict with certainty the character of his negatives. It has many other photographic uses, e.g. in projection printing, densitometry, etc.

For normal photographic work the subject is viewed through the telescope of the instrument and a small spot in the middle of the field of view is made to coincide with that part of the scene the brightness value of which is required. The photometric setting is then made by causing the brightness of the spot to match that of the selected area. The instrument possesses two outstanding advantages over most photographic exposure meters: it can be used to measure the brightness of very small areas in the scene, the spot in the field of view subtending an angle of only $\frac{1}{2}°$, and the range of brightness which may be measured is a million to one, accommodating dark surfaces in interiors and brilliantly lighted skies.

The *S.E.I. Photometer* is simple to use and has been made so as to reduce maintenance to a minimum. In order to become familiar with the instrument the following working instructions should be studied with care, preferably with the photometer at hand.

SEI

Exposure Photometer

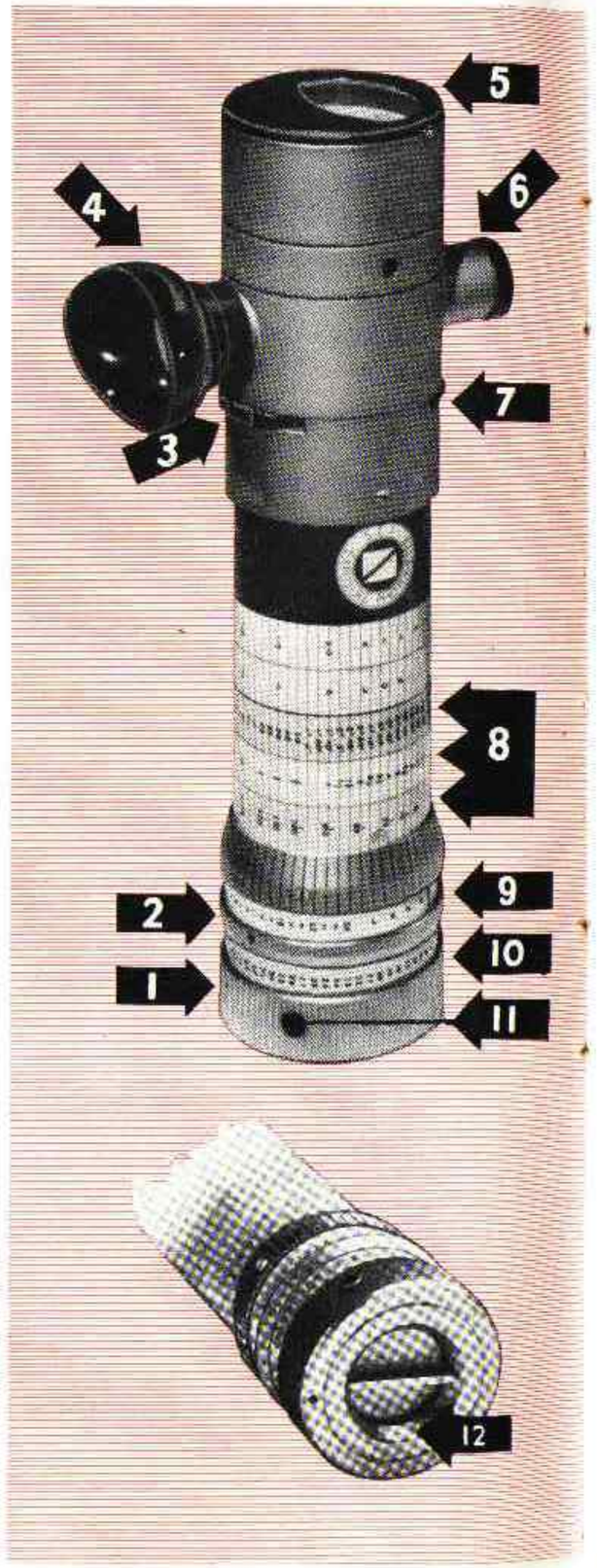


Fig. 1

KEY TO ILLUSTRATIONS

1. Operating ring
2. Setting ring for shadow or key-tone methods
3. Daylight or artificial light setting
4. Adjustable telescope eyepiece
5. Microammeter for standardising comparison lamp intensity
6. Telescope objective
7. Brightness range selector
8. Exposure time scales
9. Lens aperture scale
10. Film speed scale
11. Push button switch
12. Rheostat control

Working instructions
for estimating
camera exposures

Note: The instrument is supplied without a battery. Instructions for making it ready for use are given on page 13 under General Instructions.

TO DETERMINE CAMERA EXPOSURES FOR MAKING NEGATIVES IN GENERAL PHOTOGRAPHY.—See Fig. 1

1. Set the speed scale. For ordinary black and white *negative*-making set the *black* index mark on the narrow knurled ring (2) opposite the appropriate number on the Speed Scale (10). The meter is graduated in British Standard Logarithmic Exposure Indices. An appropriate allowance must be made for any factor known to reduce the effective film speed ; e.g. the use of certain fine grain developers, a shorter development time than that nominally recommended, stale film, working by artificial light, etc. The following conversion table will enable the appropriate exposure index to be approximately derived from other speed systems:—

Working Conversion Table between speed systems.

Relative Speed	Ilford Group	B.S.I. Ilford Scheiner	American Scheiner	DIN/10	British H & D	A.S.A. G.E. Weston	Wellcome*
		16°	11°	6°	80	3	2/3
1	A	17°	12°	7°	100	4	1/2
		18°	13°	8°	125	5	—
		19°	14°	9°	160	6	1/3
2	B	20°	15°	10°	200	8	1/4
		21°	16°	11°	250	10	—
		22°	17°	12°	320	12	1/6
4	C	23°	18°	13°	400	16	1/8
		24°	19°	14°	500	20	—
		25°	20°	15°	640	25	1/12
8	D	26°	21°	16°	800	32	1/16
		27°	22°	17°	1000	40	—
		28°	23°	18°	1250	50	1/24
16	E	29°	24°	19°	1600	64	1/32
		30°	25°	20°	2000	80	—
		31°	26°	21°	2500	100	1/48
32	F	32°	27°	22°	3200	125	1/64
		33°	28°	23°	4000	160	—
		34°	29°	24°	5000	200	1/96
64	G	35°	30°	25°	6400	250	1/128
		36°	31°	26°	8000	320	—

*Exposure factors as used in Wellcome Calculators prior to 1950.

2. Standardise the lamp intensity. Press the black switch button (11) in the broad knurled ring (1) at the bottom of the instrument. Note the position taken by the pointer of the microammeter (5) at the top. Make the pointer coincide with the standard mark by turning the recessed

rheostat control (12), which will be found at the lower end of the barrel of the instrument. Release the switch button after standardising.

It should be noted that for ordinary purposes the " standard brightness " setting accuracy need not be too great. A setting above the red mark by one tenth of an inch causes an increased exposure equivalent to about one-third of a stop, and vice-versa. The slight drift of the microammeter pointer is due to the unavoidable drop and recovery of the battery voltage and can be minimised by keeping the switch button depressed only for the short time necessary to obtain the required brightness match.

3. Set the colour-of-the-light corrector. If working by *daylight* set the knurled disc (3) which is found under the eyepiece (4) of the telescope so that the *white* index mark is immediately under the telescope. If working in *ordinary artificial light* set this disc so that the *yellow* index mark is under the telescope.

4. View the subject. From the camera position look through the telescope (4) and (6) at the scene to be photographed.

5. Focus the eyepiece to your individual eyesight by sliding it along the barrel of the telescope. The object lens (6) also may be moved outwards if necessary for close work, but for ordinary use it should not be withdrawn.

6. Orient the spot. Make the black photometric spot in the middle of the view coincide with the image of the *darkest part of the scene in which detail is required.*

7. Match the spot. Press the switch button again and try to make the spot match the part of the scene selected by turning the broad knurled ring (1).

If the spot is always too dark or too light the subject image must be darkened or brightened by turning the knurled disc (7) to the appropriate range so that the photometric spot can be matched. This knurled disc will be found to carry three coloured index marks. One of these is to be set immediately under the middle of the telescope objective as follows :—

For ***bright*** areas use the ***blue*** index mark.
For ***normal*** areas use the ***white*** index mark.
For ***dark*** areas use the ***red*** index mark.

When bright areas are viewed and the blue index mark is in use, the shield round the eyepiece of the telescope must be close to the eye. In very bright light additional shielding with the hand above the eyepiece may also be helpful.

8. Read the time of exposure on the appropriate scale (8) in relation to the f/number scale (9), taking care to select the exposure time scale of the same colour as the index mark used for the operation described in the previous paragraph. For ' 16 frames ' cine work read off the stop on scale (9) against the cine index mark on the appropriate scale (8), or against 1/50 sec. for ' 24 frames ' cameras.

Note : A small amount of general flare in the photometer objective is unavoidable. Within limits this is actually an advantage since it tends to

compensate for the effect of flare in the camera (see " The Exposure Photometer and Modern Exposure Technique "—*Photographic Journal*, **88A**, 230, 1948). *Excessive* photometer flare should be avoided by matching on a ' darkest object ' which is not too near to a very bright area or light source.

For illuminating engineering work in which it is important to keep flare to a minimum an anti-flare tube attachment is available for mounting on the objective of the photometer telescope.

TO DETERMINE CAMERA EXPOSURES FOR REVERSAL WORK (Colour or Black and White)★

9. Set the speed scale by bringing the *white* index mark on the knurled ring (2) opposite the appropriate number on the Film Speed Scale (10). (See paragraph 1 for table of equivalent speed numbers).

10. Make the necessary adjustments described in paragraphs 2 (to standardise the lamp), 3 (to set the colour-of-the-light corrector), and 5 (to focus the telescope).

11. Orient the spot. Select for measurement *the most brightly lit white object* in the scene which is facing the main light source. If no such object exists an artificial highlight should be made by placing a piece of matt white paper or card so that it is illuminated in the same manner as the subject. The card surface should be at right angles to the direction of light from the main source in order to give the maximum brightness.

12. Match the spot. Make the photometric measurement of the highlight in the same way as described for the shadow area in paragraphs 6 and 7.

13. Read the exposure as described in paragraph 8. For ' 16 frames ' cine work read off the stop on scale (9) against the cine index mark on the appropriate scale (8), or against 1/50 sec. for ' 24 frames ' cameras.

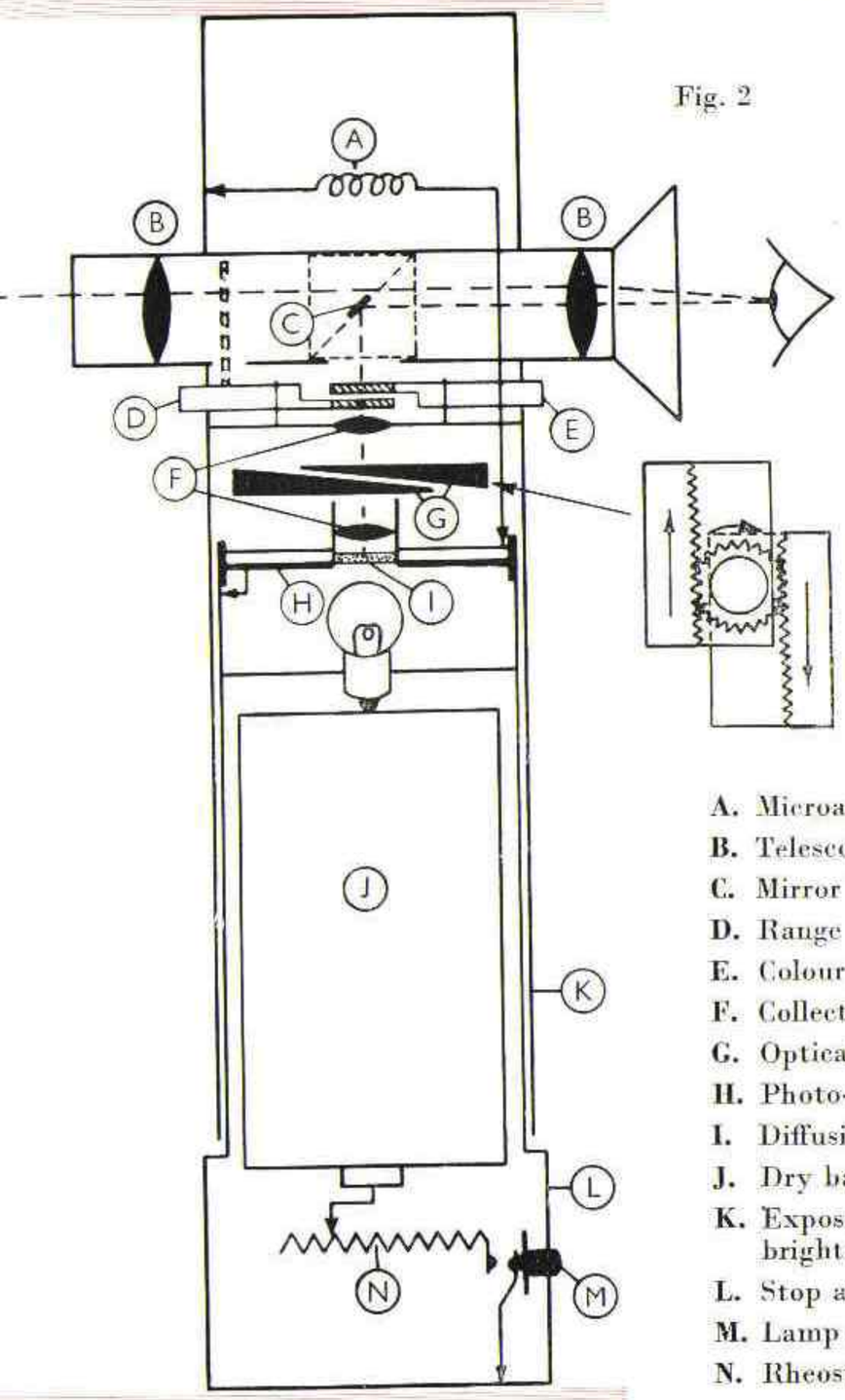
Principles of construction

The subject is viewed approximately full size, but inverted, through a simple telescope (B) (Fig. 2). By an adaptation of the Lummer-Brodhun cube, a small comparison spot (C) is superimposed on the centre of the image field, this spot subtending at the eye an angle of only $\frac{1}{2}°$. The spot is diffusely illuminated by a small electric lamp via a diffusing screen (I), the lamp being fed from a dry battery (J) through a rheostat (N).

★ *More comprehensive ' keytone ' and ' incident light ' methods of using the photometer for reversal work are described in a paper entitled " Exposure Technique for Reversal Materials "* (British Kinematography, **13**, 151, Nov. 1948). *See also 'Keytone Method' under ' Other applications ' (page 17).*

Schematic diagram

Fig. 2



Method of driving wedges

A. Microammeter coil
B. Telescope lenses
C. Mirror 'spot'
D. Range shift disc
E. Colour matching disc
F. Collecting lenses
G. Optical wedges
H. Photo-electric cell
I. Diffusing screen
J. Dry battery
K. Exposure, density and brightness scales
L. Stop and film speed scales
M. Lamp switch
N. Rheostat

The lamp also illuminates a ring-shaped photo-electric cell (H) which is connected to a microammeter (A). By adjusting the rheostat, the needle of the microammeter can be made to coincide with a standardising mark so that the luminous output of the lamp, and consequently the brightness of the 'internal reference surface' (I), are always at a constant value. The instrument is therefore self-standardising.

Situated between the lamp and the spot are two opposed photometric wedges (G). These can be moved in opposition to one another by a rack and pinion mechanism operated by rotating the base (L) of the meter. The light reaching the comparison spot can in this way be varied through an intensity range of 100 to 1. Reduction of the brightness of subject or spot by the insertion of neutral filters attached to a range shift disc (D) provides a further increase of range up or down by factors of 100 thus giving the meter a total range of 1,000,000 to 1.

The range shift disc has three index marks. When the white mark is central under the object lens of the telescope, the meter is on its normal range, covering the deepest significant shadows of most outdoor subjects. When the red mark is central the meter is ready for dealing with objects of very low brightness. When the blue mark is central the meter is on its high range, which mainly covers highlight or keytone methods as described later.

The light from the lamp is yellowish in colour when compared with daylight. A colour-correcting filter is provided to make easy the comparison of brightness between spot and object. This is attached to the notched disc (E) which is situated immediately below the eyepiece of the telescope. This disc has two index marks, a yellow and a white. The white mark is for use in daylight and the yellow for light which is deficient in blue, such as ordinary electric light. The calibration of the meter is unaffected by the movement of this disc. Note, however, that when the subject is illuminated by artificial light, the appropriate speed index should be used.

The photographic calibration of the instrument is such that when the *black* speed index mark is set against the correct B.S. exposure index for the material in use, the basic flare-free exposure relating to the subject area matched is 'pegged' at a point on the characteristic curve about two divisions (two-thirds of a stop) above the B.S. 1380 'fractional gradient' exposure index point. This 'safety factor' applies with average modern cameras, and has been found to be entirely satisfactory in practice. No additional safety factor applies to the *white* speed index mark since the exposure for reversal film must be at the correct *optimum* level, and not merely greater than a minimum value as in the making of negatives.

It may be of interest, however, to note the many advantages of keeping *negative* exposures as near to the minimum level as is practicable. These include—maximum arrest of subject movement, maximum depth of focus for a given exposure time, minimum halation, minimum loss of definition from light spread within the emulsion, minimum grain and short printing time.

Fig. 3 *above*. Fig. 4 *below*.

General instructions for use and maintenance

GENERAL

Do not use the meter with a lighted cigarette in the mouth, otherwise accidental contact may damage the scales.

The filters, wedges and other optical parts of the instrument are easily damaged by handling. For this reason the top of the instrument is completely enclosed and should not be opened.

BATTERY (see Fig. 3)

The battery to be used is a cylindrical one, size U.2. To ensure good contact choose a make without a pip on the centre brass terminal (e.g. G.E.C.). To prepare the battery for use, strip from it the insulating paper sleeve, clean both end contacting surfaces with emery cloth and smear these lightly with Vaseline.

Open the base of the photometer by holding fast the Speed and Lens Aperture scales and unscrewing the bottom of the instrument by turning the broad knurled ring (1). Insert the battery, *base first*, into the cavity. Replace the base of the instrument.

WARNING :—The battery should be inspected frequently to make sure that no chemicals are exuding from it. This happens sometimes even with a fairly fresh battery, but with age and use the battery will always tend to give this trouble, and to avoid injury to the instrument it should be replaced. If the instrument is to be stored or left out of use, the battery must be removed.

LAMP BULB (see Fig. 4)

To replace the lamp bulb unscrew the base and remove the battery. Withdraw the metal tube which lines the cavity in which the battery was situated. The bulb is mounted at the end of this tube lining. Slacken the bulb clamping screw, withdraw the locking plate and take out the bulb. Replace this by the spare special bulb supplied with the instrument. Additional spare bulbs can be obtained from Ilford Limited.

It should be noted that the lamp will rarely, if ever, actually burn out. After a very long life, however, it will eventually be found that even with a new battery more and more of the rheostat must be cut out in order to make the microammeter needle register with the red standardising mark. When this stage is reached the useful life of the lamp is ended, and it should be replaced as indicated above. Calibration accuracy is not affected as long as the microammeter needle can be set to the red mark.

Figs. 5 and 6. *The effect of brightness distribution on indicated exposure readings. The limiting brightness values occur in the bird and since the lighting remained unchanged the exposures should be the same. The area matched by the S.E.I. Photometer was the shadow between the eagle's legs*

The exposures were 2 secs. at f/5.6 on Ilford S.R. pan. plates, the latter and the prints being given identical treatment. A conventional photo-electric meter erroneously indicated 6 secs. for Fig. 5 and ½ sec. for Fig. 6 due to the misleading effect of the background brightness.

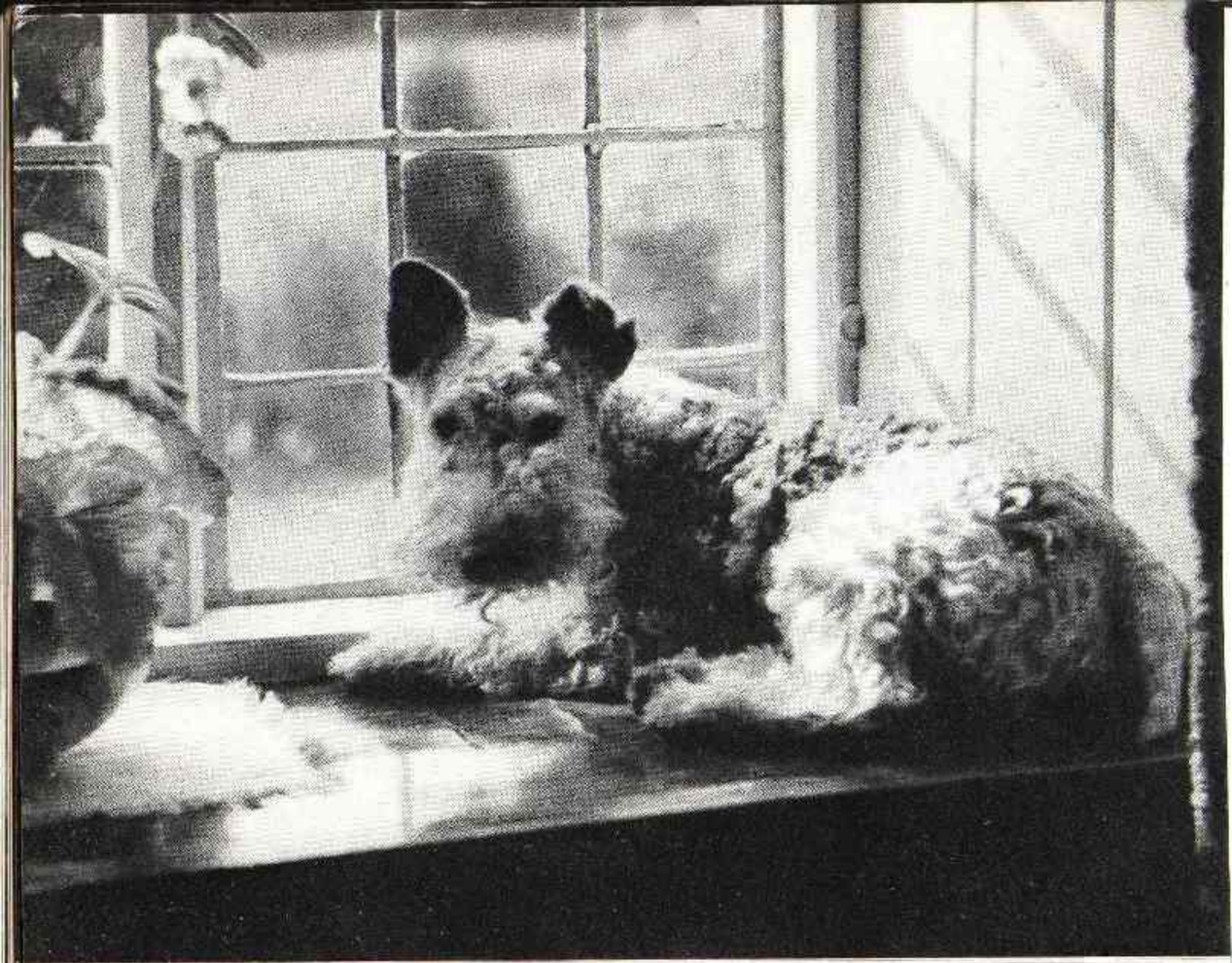


Fig. 7. *This is usually considered a most difficult type of subject. The rapidly changing reading on an ordinary photo-electric meter on moving it to or from the window will be appreciated—yet the required exposure within such limits remains unchanged. The S.E.I. Photometer gave a single definite reading of 1/25th sec. at f/5.6 on HP3 film (32°), based on the darkest shadow (see pages 7 and 8). The range was exactly 100 to 1.*

ESTIMATING EXPOSURES BY HIGHLIGHT AND KEYTONE METHODS FOR NEGATIVE WORK

There are certain classes of subject for which, even when making negatives, ' highlight ' or ' keytone ' methods are more appropriate than the normal shadow method.

Highlight method. This applies mainly to subjects of extreme contrast for which only the brighter end of the tone scale is to be printed. Examples of such subjects are shown in Figs. 8, 11 and 12.

The *white* film speed index mark is set to the exposure index number and the *brightest* significant area in the subject is matched. The exposure is then read from the appropriate scale. This method should be used only for subjects of really extreme brightness range (greater than 100 to 1) for which highlight reproduction is required at the expense of shadow gradation.

The choice of the brightest part of the subject for photometric matching would lead to a gross under-estimate of exposure if the black speed index setting were used to relate aperture with exposure time. By using the white index mark the exposure which would have been indicated is multiplied by 100. This ensures that the negative will not be over exposed and yet will record detail in the subject from its brightest part to 1/100 of this brightness.

Keytone method. This method applies in the main to special subjects, often of normal range, where the emphasis is on consistent negative density for some specific tone level in the subject—particularly where the lighting is under the complete control of the operator as in commercial portraiture, motion picture studios, etc. In such work it is usual to ' peg ' the required keytone at a particular negative density, processing in such cases usually being under close and consistent control.

The principal keytone applicable to portraiture is the diffuse highlight of the human face. The average reflection factor of a normal face is about 0.3 (30%). Obviously such a tone level should not be placed at as high an exposure level as that which would result from the uncorrected use of the white film speed index mark. It should, in fact, be placed at a point equivalent to 30% of that level.

The necessary correction to effect this adjustment is done by simply setting the *white* film speed index mark to a higher exposure index number

as indicated in the following table, depending upon the particular keytone to be matched. The corrections given are for keytones directly illuminated by the major light source.

Keytone corrections

(Applicable to the *white* film speed index mark only).

Reflectance of keytone matched%	Typical keytones	Keytone correction to basic film speed
100	Magnesium carbonate block ('Standard White') Fresh snow Sunset cloud fringes (not too near to sun)*	Nominal B.S. logarithmic exposure index number
80	White blotting paper Matt white card Clean white paint	+1°
65	Slightly weathered white paint	+2°
50	Old weathered white paint	+3°
40		+4°
30	Normal face tone (diffuse highlight)	+5°
25		+6°
20	Bronzed face tone (diffuse highlight)	+7°

* For sunsets with reversal colour film give double the indicated exposure (colour sensitivity correction).

For example, to place a normal facial highlight at its nominal relative brightness level of 30% when using a film having a B.S. exposure index of 29°, the white index should be set at 29+5=34°, the diffuse facial highlight being accordingly matched with the photometer (See Fig. 13).

Should the density level resulting from the above technique be found to be too high or too low for the particular purpose required, the setting for future exposures can, of course, be raised or lowered accordingly.

It may be of interest to note that this is the essence of the more comprehensive method recommended for reversal (monochrome and colour) work and referred to earlier in the footnote on page 9.

COPYING

The difficulties inherent in copying are due to the small latitude in exposure and to the inability of the eye to judge whether the copyboard is evenly illuminated. These difficulties are especially noticeable when process plates are used, but are easily countered with the S.E.I. Photometer.

It is essential that the emulsion speed should be accurately known and usually this entails an experimental determination.

For line work, the highlight method is used and the exposure must give adequate background density in the negative. Over exposure must be avoided however, because this leads to loss of detail in the finer lines.

As a rough guide to the order of exposure index numbers applicable to line work, 24° has been found about correct for Ilford Process Plates in ordinary 100 watt tungsten lighting when using the *white* film speed index mark and matching the white background of a black printed original. The usual allowance for camera extension must, of course, be made (i.e. the indicated exposure must be increased as the square of the ratio :— 'negative-to-lens-distance' ÷ 'lens-focal-length'). It is probable that a slightly different exposure index number may be necessary for each emulsion batch.

For continuous-tone work, normal emulsions are used and the exposures are based on the shadow method. (See Fig. 15).

PROJECTION PRINTING

The application of the photometer to the determination of exposures for enlarging (or reducing) saves much time and material once the principles are understood.

The exposure is assessed by matching a given part of the image on the easel, and to obtain consistent results it is necessary always to use a constant diffuse white surface, say a piece of clean white blotting paper, on the easel. The reading is then, in effect, a relative measure of the light which will fall on the bromide paper when this is substituted for the blotting paper. Because of this no account has to be taken of the lens aperture, degree of enlargement, size or type of illuminant or type of negative in use—*except* that any variation of negative image or light source *colour* from those used initially to determine the paper speed may cause an error. If such variations cannot be avoided an allowance must be made. The yellower the negative or light source the longer will be the exposure required.

Assuming constant colour and development conditions, the use of the photometer will, within wide limits, result in the measured image area always being reproduced in the print at a constant tone level.

There are three general methods of using a photometer for this work, (a) matching the brightest significant image tone, (b) matching the darkest significant image tone and (c) matching some specific image tone

between (a) and (b). The latter method can be used when experience is gained. A contact print from a step-wedge made on the easel in the enlarger illumination can give useful information, the resulting stepped print tone values being directly related to subsequent keytone readings of the projected images of negatives to be printed. Apart from this, it has been shown conclusively that method (a) gives a far higher percentage of successful results than method (b). (See "The Control of Photographic Printing by Measured Characteristics of the Negative" by Jones & Nelson—*J. Opt. Soc. Amer.* **32**, 558, Oct. 1942). The following working instructions are therefore based on this method:—

1. *To determine the paper speed.* Select any average full range negative which is known to give a good print on the particular grade of bromide paper under consideration.

   Find by trial the exposure required to give the best possible print from this negative on a piece of paper from the batch concerned.

   Under the same conditions match the brightest part of the image, using a piece of clean white blotting paper on the easel and switching off any safelight which might otherwise illuminate the easel and influence the reading. When matching from about one foot away the image will be sharp when the black objective end of the photometer telescope is pulled out to its limit. The 'red' range setting will usually be found appropriate, with the colour-of-the-light index set at yellow if an ordinary tungsten enlarging lamp is used.

   On the appropriate exposure-time scale find the exposure time given to the above trial print. Then the paper speed *applying to this method* will be the number on the 'film speed' scale which is found against this exposure time, the lens aperture scale being ignored.

2. *To find the printing exposure.* Set up the equipment ready to make the required print. Using a piece of clean white blotting paper on the easel match the brightest part of the image as in 1 above.

   Read off the required exposure on the appropriate exposure-time scale against the 'speed' of the paper as found under 1 above.

   Replace the blotting paper by the printing paper and proceed in the normal manner.

   For negatives of exceptionally harshly lit subjects it may occasionally be necessary to ignore small areas which have no gradation and which can be allowed to print dead black.

Determination of required paper grade. Readings can be made of the darkest as well as of the brightest part of the image and the ratio of the readings can be related to the exposure scale of the paper as can previously have been determined from a step-wedge test made by contact printing on the easel. In order to ensure complete absence of photometer flare when measuring the darkest part of the image it is advisable to place over the blotting paper a piece of black paper in which a small hole has been made and so located that the hole just uncovers the dark part of the image to be matched.

Printing control. When the relationship between image brightness and print density has been established, the photometer can be used to estimate the degree of over or under printing of portions of the image for control purposes.

Brightness and illumination measurements

For light readings generally, the small screw in the graduated tapered ring which appears opposite film speed 27° is the index mark against which the scale values are read.

Brightness. The readings can be made against this index mark on the appropriate exposure scale by taking the reciprocal of the exposure reading. This gives the brightness directly in foot-lamberts.

For accurate work the log. foot-lambert scale should be used. The scaled values (0 to 2.0) refer to the 'white' range. When on the 'blue' range read as 2.0 to 4.0 and on the 'red' range as $\bar{2}.0$ to 0.

Illumination. The surface of a block of magnesium carbonate is internationally accepted as 'standard white' and has a nominal reflectance of 100% (actually its average for the visible spectrum is 98.3%).

To measure the incident illumination place the 'standard white' surface at the required position and measure its brightness as above. Since, virtually, this surface reflects diffusely 100% of the incident light the reading in foot-lamberts is the same as the illumination in foot-candles.

Reflection factor. To determine the reflection factor of a surface, first measure the brightness of the surface concerned and then that of the 'standard white' surface when placed in the same position. The ratio of these two readings (in foot-lamberts) gives the reflection factor. If the more accurate log. foot-lambert scale is used, subtract the higher reading from the lower (resulting in a negative log. characteristic) and find the anti-log.

The following table gives the relationship between some brightness units in common use and shows where they come with respect to the three ranges on the photometer.

Approximate Relationships of Different Brightness Units

(1 foot-lambert = 0.318 candles/sq. foot = 0.00221 candles/sq. inch = 3.43 candles/sq. metre).

Photometer range	Log foot-lamberts	Foot-lamberts	Candles/sq. foot
Low (red index) ..	$\bar{2}.0$	0.01 (1/100)	0.0032 (1/314
	1.0	0.1 (1/10)	0.032 (1/31)
Normal (white index)	0	1	0.32 (1/3)
	1.0	10	3.2
High (blue index)	2.0	100	32
	3.0	1000	320
	4.0	10000	3200
Values for interpolation between any of the above, the decimal place to be adjusted as required ..	0	1	0.32
	.1	1.3	0.4
	.2	1.6	0.5
	.3	2	0.63
	.4	2.5	0.8
	.5	3.2	1.0
	.6	4	1.3
	.7	5	1.6
	.8	6.3	2.0
	.9	8	2.5
	1.0	10	3.2

Other definitions used in Illuminating Engineering will be found in B.S. 230.

Projection screen brightness. A valuable use of the photometer to the still or motion picture projectionist is in the checking *from the projector* of the screen brightness.

B.S. 1404-1947 lays down the limits for 35 mm. film projection as 8 to 16 foot-lamberts with the projector running but with no film in the gate.

For sub-standard film or lantern slide projection, where the room is often darker than the commercial cinema, experience suggests that a slightly lower figure may be permissible, but for really satisfactory projection quality, particularly for colour, the level should not be allowed to fall below 5 foot-lamberts. This applies to average films or slides.

Examples of exposure estimation

The following examples illustrate subjects in which accurate exposure estimation with the S.E.I. Exposure Photometer is straightforward, but without which varying degrees of difficulty would arise.
The examples include subjects having :—

(a) long range, requiring accurate exposure.

(b) extreme brightness distribution, requiring selective exposure.

(c) controlled illumination where control of brightness range is necessary for satisfactory results.

(d) low levels of illumination.

It will be seen that there is nothing photographically abnormal in any of the subjects illustrated, yet they defeat existing types of exposure meter. A little experience will confirm that the S.E.I. Photometer surmounts all such problems with ease and indicates exposures which are uniformly reliable and accurate.

Fig. 8 *above*. Fig. 9 *below*.

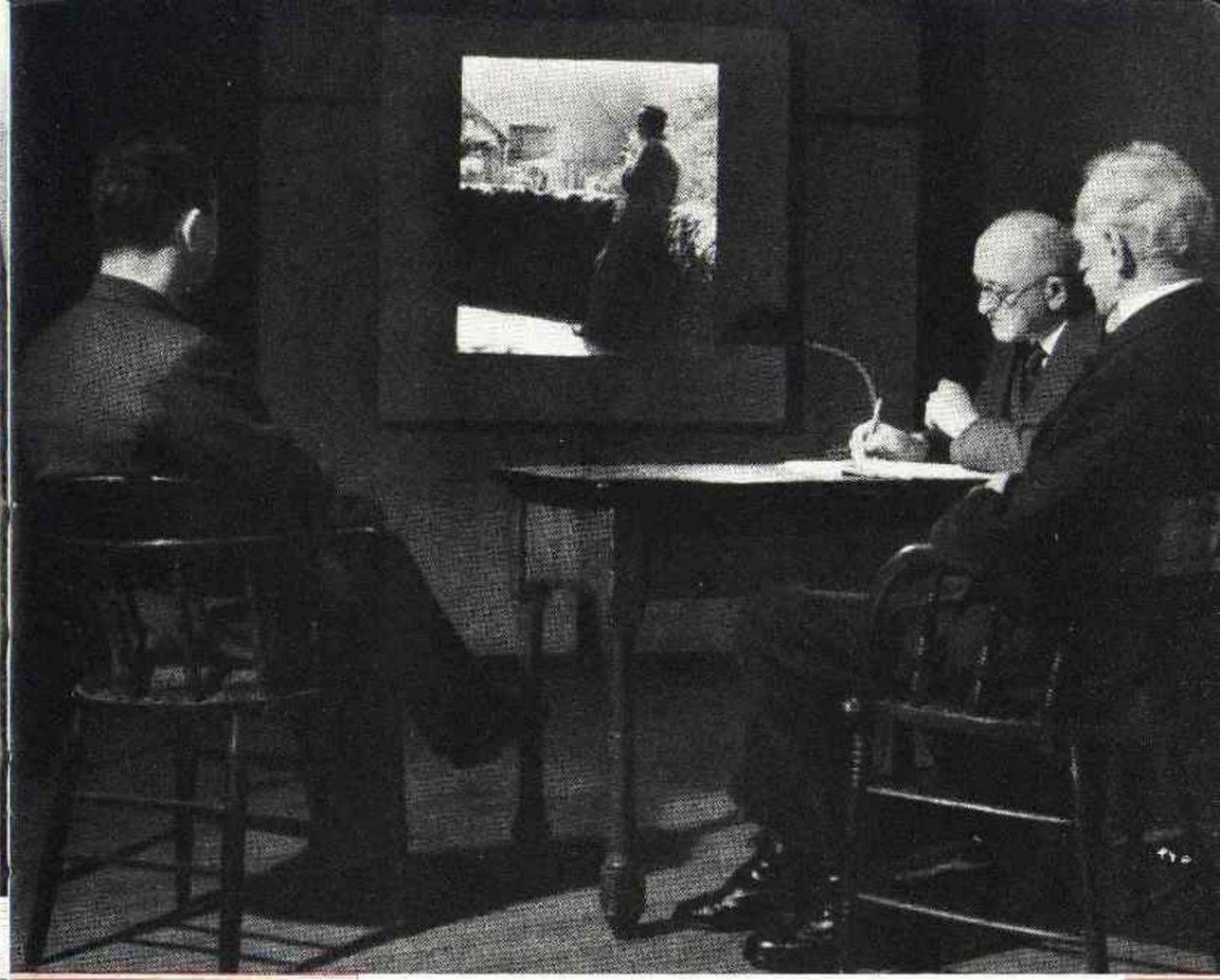


Fig. 10. *This is not a combination print but is a straightforward photograph of the judging of a lantern slide competition. The room was darkened except for a small auxiliary light used to illuminate the figures. The range measured by the S.E.I. Photometer from the highlight on the screen to the dark foreground shadows was originally over 250 to 1. The reflection range of glazed glossy paper being only 50 to 1, the projector illumination was accordingly reduced to give this ratio. The exposure of 15 seconds at f/8 on HP3 film was then determined by the shadow method as described on pages 7 and 8.*

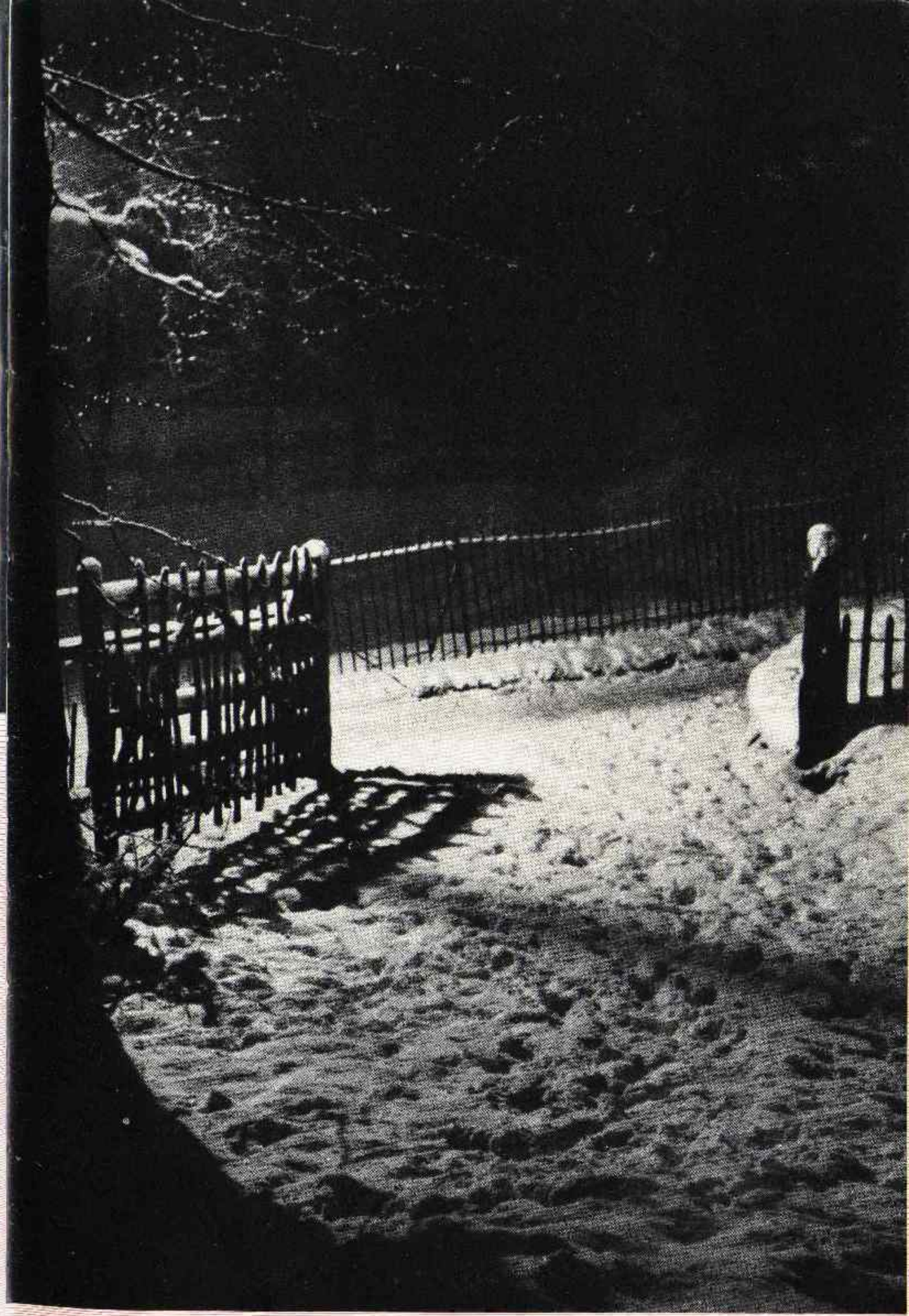
Fig. 8. *This is typically a scene where the lighter tones must be correctly reproduced but where the shadows and street lamps must be ignored owing to the extreme range. The exposure was not recorded but would be determined by the highlight method based on the gradations in the distant snow-clad mountain (see page 17).*

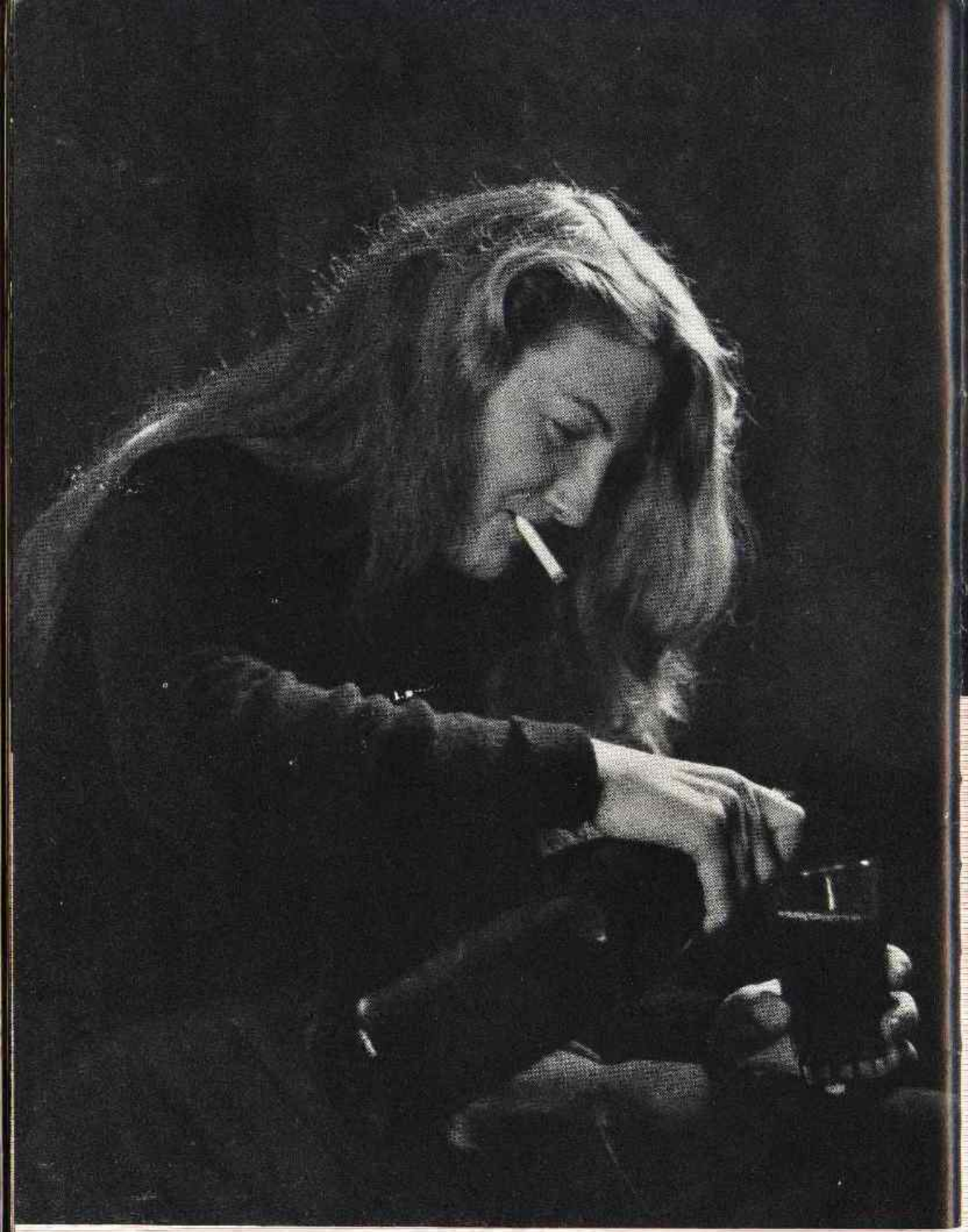
Fig. 9. *The exposure for this interior might be based on the back of one of the pews, but in view of the obviously long brightness range a check would be made on the brightest part of the near right hand pillar to ensure that the range was not excessive. If this was found to be more than about 100 to 1 the highlight method (page 17) would be used to be sure of retaining the delicate highlight gradations.*

The photometer could also have been used here from floor level to determine (by the normal shadow method) the exposures required for photographs of the mural decorations on the ceiling.

Fig. 11 (*above*). *Here is another illustration of extreme range where the highlight method was used to ensure correct reproduction of the lighter tones. The exposure was 50 secs. at f/8 on HP3 film. The dark foreground tones were deliberately ignored in the knowledge that they were well outside the film latitude* (*see page 17*).

Fig. 12 (*right*). *This snow scene was taken on a moonlight night with the additional aid of a low power street lamp. The exposure, based on the brightest area in the snow* (*see page 17*), *was 80 secs. at f/8 on HP3 film. An interesting point, which shows how the accommodation of the eye makes it a very bad judge of brightness values, is that the brightest snow in this scene was found to have the same brightness as that of a shadowed area below the keyboard of a dark rosewood piano in a normally lit lounge.*





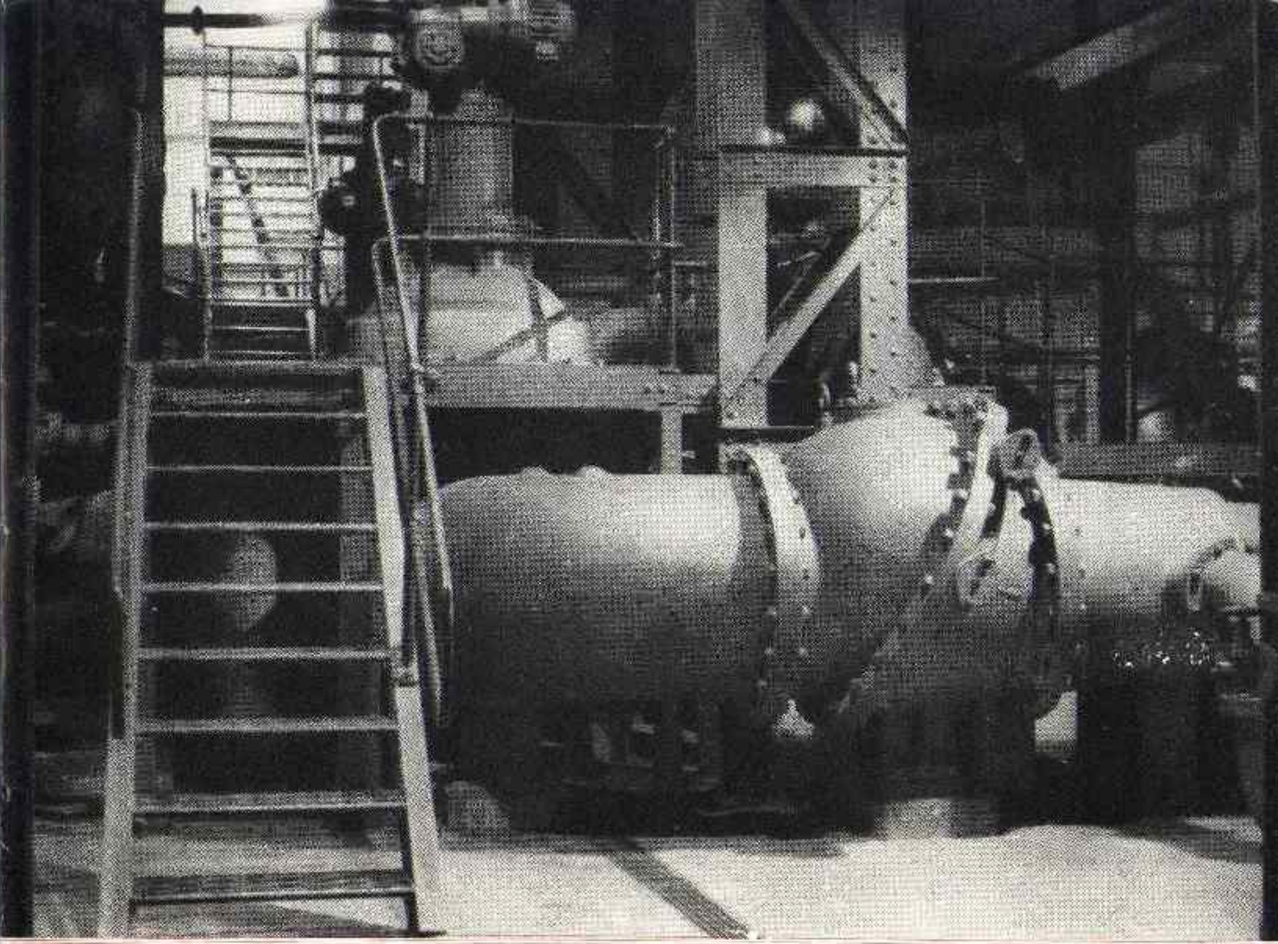
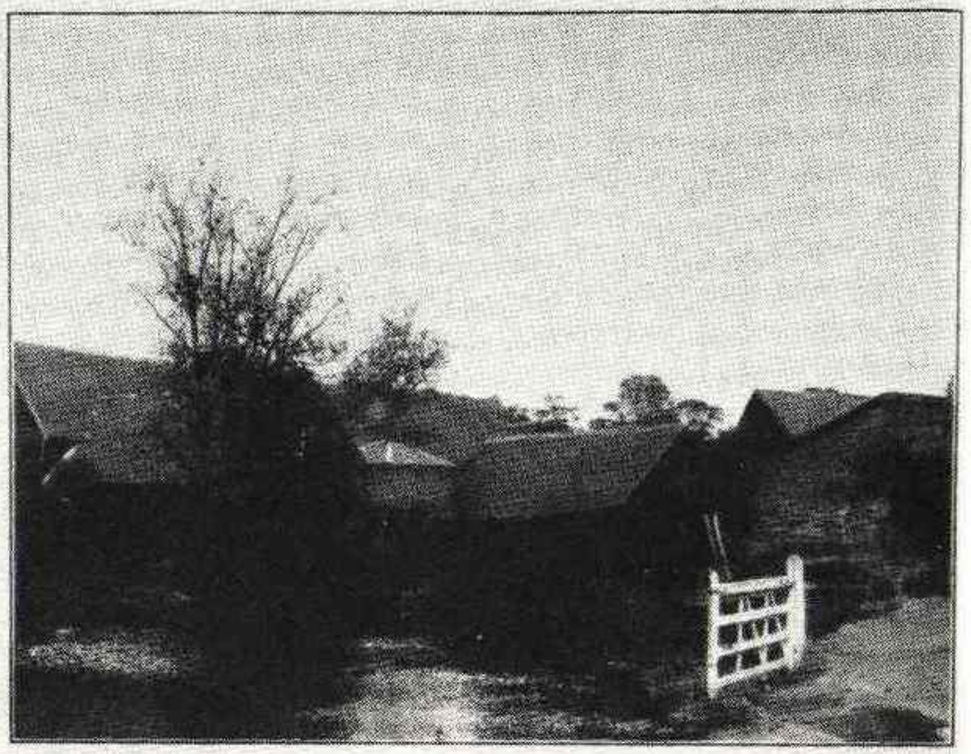
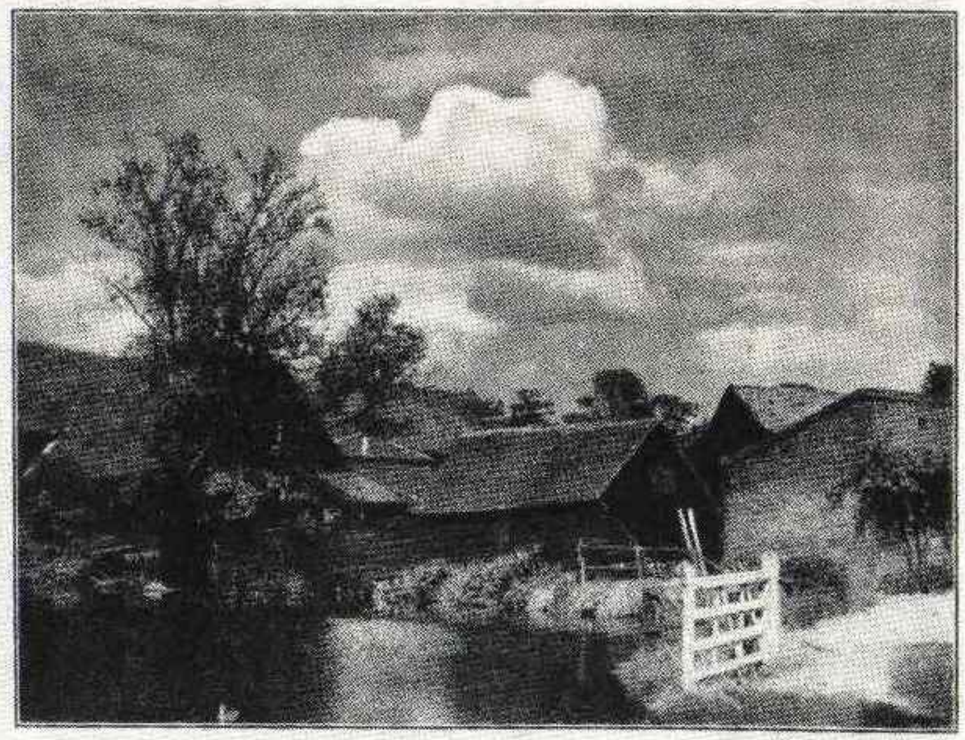


Fig. 14 (*above*). *Industrial interiors, with or without auxiliary lighting, are all well within the scope of the S.E.I. Photometer. The existing artificial lighting was used here, the exposure being 20 secs. at f/11 on HP3 film. The shadow method was used, the 'spot' being matched on the shadowed area on the left. No reading could be obtained from an ordinary photo-electric meter.* (*See normal working instructions on page 7*).

Fig. 13. *This illustrates the application of the keytone technique described on pages 17 and 18. For such 'controlled lighting' subjects the* white *film speed index mark is set to the B.S. logarithmic exposure index + 5° keytone correction for a normal face tone. The photometer spot is matched on the brightest part of the face, which results in a consistent negative face tone density at a controlled level. An identical exposure would have been indicated in this case by matching on the cigarette but using a keytone correction of + 1° instead of + 5°.*



Photographed on non-colour-sensitive material.



Photographed on Panchromatic material with a Delta Filter (Ilford Filter No. 109)

Fig. 15. *This page from 'Panchromatism', containing half-tone blocks and printed matter, was copied on an Ilford Special Rapid Plate. The exposure used for the copy negative was kept to the minimum by using the shadow method. The 'spot' was matched on the darkest part of the illustration. Daylight illumination was used, care being taken to avoid reflections. The exposure was 10 seconds at f/32* *(see page 19).*

LAMP FOR THE EXTERNAL SUPPLY ADAPTOR
(Photometer Lamp)

The external supply adaptor and lamp (Figs. 8 and 9) take the place of the normal battery container and lamp used for exposure estimation. The adaptor consists of a machined metal barrel, closed at its upper end by a disc fitted with an aperture carrying a diffusing screen. Its lower end is threaded to carry the photometer lamp holder which in turn is mounted in an auxiliary base ring to fit the body of the photometer itself. This auxiliary base ring screws into the position on the photometer body normally taken by the 'operating ring' when the photometer is used for exposure estimation, and indeed the operating ring, with its push button switch screws into an outer cavity of the auxiliary base ring in which are situated the insulated contact and other terminal for the lamp circuit.

The leads to the lamp are brought in from two plugs through a hole in the auxiliary base ring, the lamp being operated by the push-button switch in the normal way.

The plugs for the photometer lamp circuit are used to connect the lamp and button switch with a two socket connector on the top of the transformer box. The sockets are themselves connected inside the transformer with the 6-volt output terminals of the transformer.

THE ILLUMINATOR LAMP AND ITS MOUNTING

The illuminator lamp is carried on a swivelling arm inside the illuminator. Its purpose is to illuminate the opal window in the top of the illuminator which is used as the platform of the densitometer. A lead screw terminating in a knob on the upper side of the transformer box, enables the distance of the densitometer lamp from the opal window to be adjusted so that the brightness of the opal window can be fixed at a convenient level and so that the zero of the relative density scale can be made to correspond with absolute zero density. The illuminator lamp is connected in parallel with the external supply adaptor (photometer) lamp. A switch on the top of the illuminator enables this lamp to be switched off.

The lamps employed are 6-volt, 6-watt, two-pole motor car side lamp bulbs with small bayonet cap fittings, Osram Reference No. 80.

Calibration

The S.E.I. exposure photometer is sufficiently accurate for most ordinary densitometry. If, however, density values are required to be compared with those obtained on different instruments to an accuracy of better than ± 0.04, the instrument should be calibrated against densities of known values. Strips of film carrying about 15 measured densities between 0 and 4 may be purchased from Ilford Limited.

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SEI

Photometer

accessories for densitometry

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S.E.I. Photometer accessories for densitometry

The S.E.I. Exposure Photometer is described fully in the Instruction Book supplied with the instrument. The present book describes accessories which provide a means for conveniently using the S.E.I. Photometer as a densitometer for transparencies and reflection images. Negatives and prints from miniature size upwards may be accommodated.

The Densitometer Accessories comprise :—

1. Densitometer Supplementary Lens Attachment, to focus the photometer on to the negative.
2. Densitometer Illuminator, containing transformer, 6-volt lamp, opal diffuser and cradle to support the photometer.

   WARNING : This apparatus must be used only with A.C. Main Electric Supply.
3. External Supply Adaptor, to convert the photometer to mains operation.

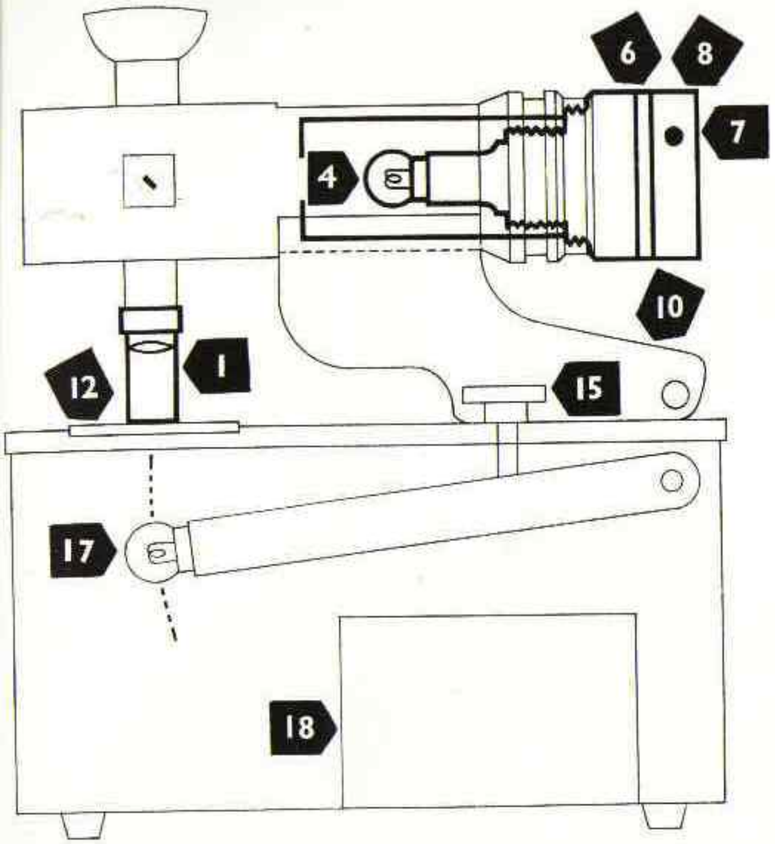
General arrangement

The general arrangement of the photometer and accessories is shown diagrammatically in Fig. 1, and their actual appearance in Fig. 2.

The photometer is mounted in a cradle on the *Illuminator* so that its telescope points at a white diffuser which forms a window in the top of the illuminator box. The diffuser is illuminated from inside the box by a small lamp whose distance from the diffuser can be varied; thus the brightness of the diffuser can be adjusted. The telescope of the photometer is provided with a *Supplementary Lens Attachment* (Fig. 7) which carries a lens of such a power that the upper side of the diffuser can be focused in the eyepiece. This lens is mounted in the upper part of a small extension tube, blackened on the inside and provided at its lower end with a diaphragm having a small circular opening through which the diffuser is viewed. The tube of the supplementary attachment is provided at its lower end with a cut-away window for use in making density measurements of reflection images (see page 7). This window is provided with a sleeve by which it can be closed.

The *External Supply Adaptor* (Fig. 8) takes the place of the normal battery container and lamp used for exposure estimation. It consists of a tube to fit inside the body of the photometer and carries a lamp to illuminate the comparison 'spot' of the photometer.

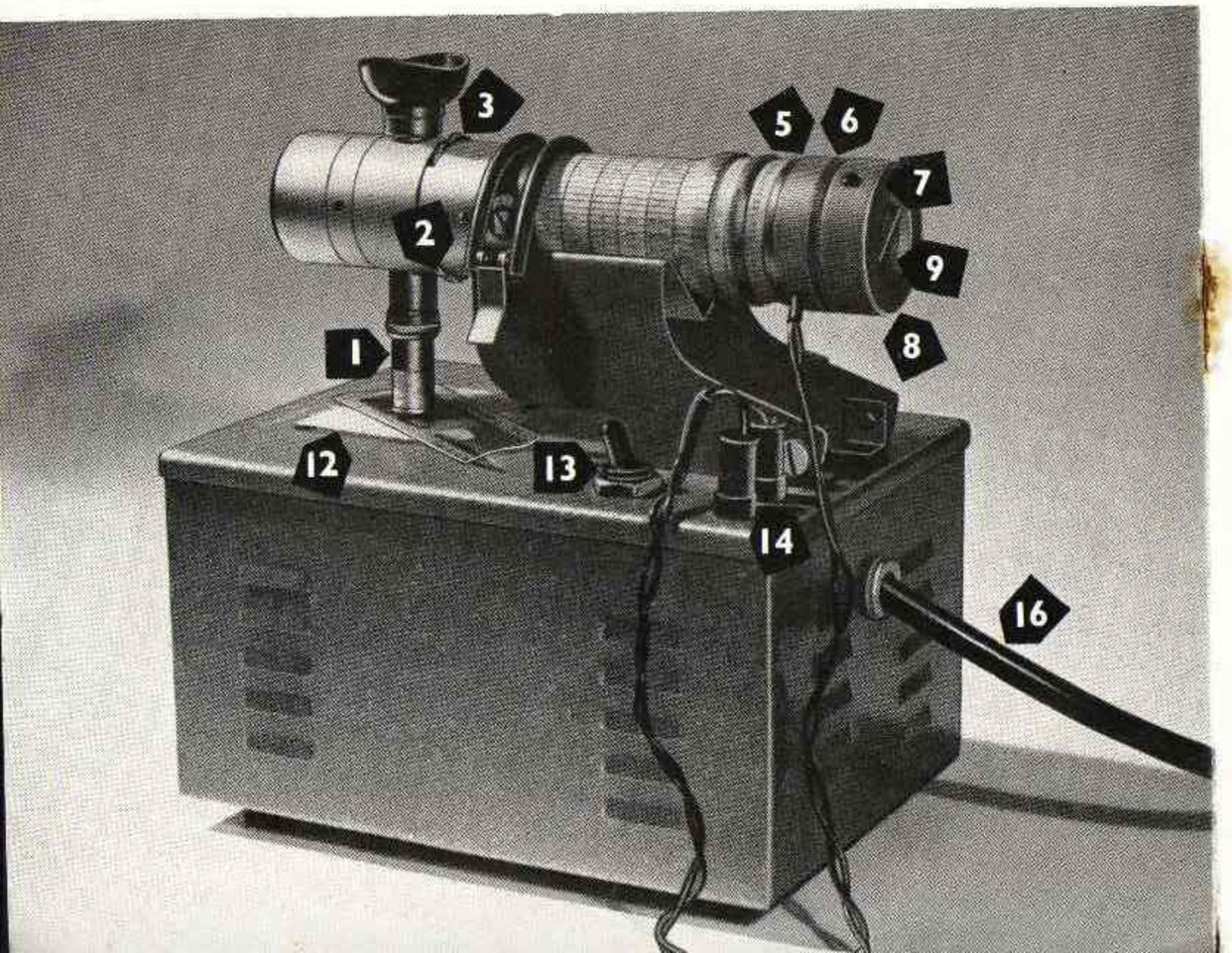
The two lamps are of the same type and wattage, 6-volt 6-watt. They are fed on parallel circuits from a small transformer which is mounted in



Figs. 1 and 2. *General arrangement*

Key to numbers :

1. *Supplementary lens attachment*
2. *Range shift disc*
3. *Colour matching disc*
4. *External supply adaptor*
5. *Base ring of external supply adaptor*
6. *Locking ring*
7. *Button switch*
8. *Operating ring*
9. *Rheostat control*
10. *Cradle*
12. *Diffuser*
13. *Switch for illuminator lamp*
14. *Plugs for photometer lamp supply*
15. *Zero adjusting screw*
16. *Mains lead*
17. *Illuminator lamp*
18. *Transformer*



the base of the illuminator. Any variations in mains voltage thus produce equal relative variations of output from the lamps; it is thus unnecessary to read and adjust the galvanometer in the photometer during the progress of densitometric work.

To set up the S.E.I. Photometer to measure densities of transparencies

1. Make sure that your electricity supply is A.C. 50 cycles/sec. Find out the nominal mains voltage. If the mains voltage is not 240 volts the connections to the illuminator transformer should be altered as described on page 9.

2. Mount and clamp the S.E.I. Photometer in the cradle of the illuminator so that the telescope points vertically downwards at about the centre of the diffuser. In this position the cradle should just occupy the scale space between the rotating end and the metal housing at the other end of the Photometer (Figs. 2 and 3).

3. Slip the supplementary lens attachment over the telescope. Note that the telescope lens itself should be pushed in as far as it will go and, for measuring the density of a transparency, the aperture in the side of the attachment must be closed by the sleeve provided (Fig. 2).

4. Set the knurled cradle stop screw so that the end of the supplementary attachment cannot accidently break the negative or diffuser window (Fig. 5).

5. Unscrew the operating ring at the end of the photometer (Fig. 2) and withdraw the battery container and lamp.

6. Insert the external supply adaptor to take the place of the battery container which you have just removed, and screw this adaptor into place (Fig. 6).

7. Screw the operating ring into the end of the adaptor, locking it with the ring provided (Fig. 2) so that the switch button is in a comfortable operating position.

8. Connect the two plugs from the adaptor to the sockets provided on the illuminator platform (Fig. 2).

9. Connect the illuminator mains lead (Fig. 2) to the supply point via a suitable earthing type (3-pin) plug.

The instrument is now ready for adjusting the zero.

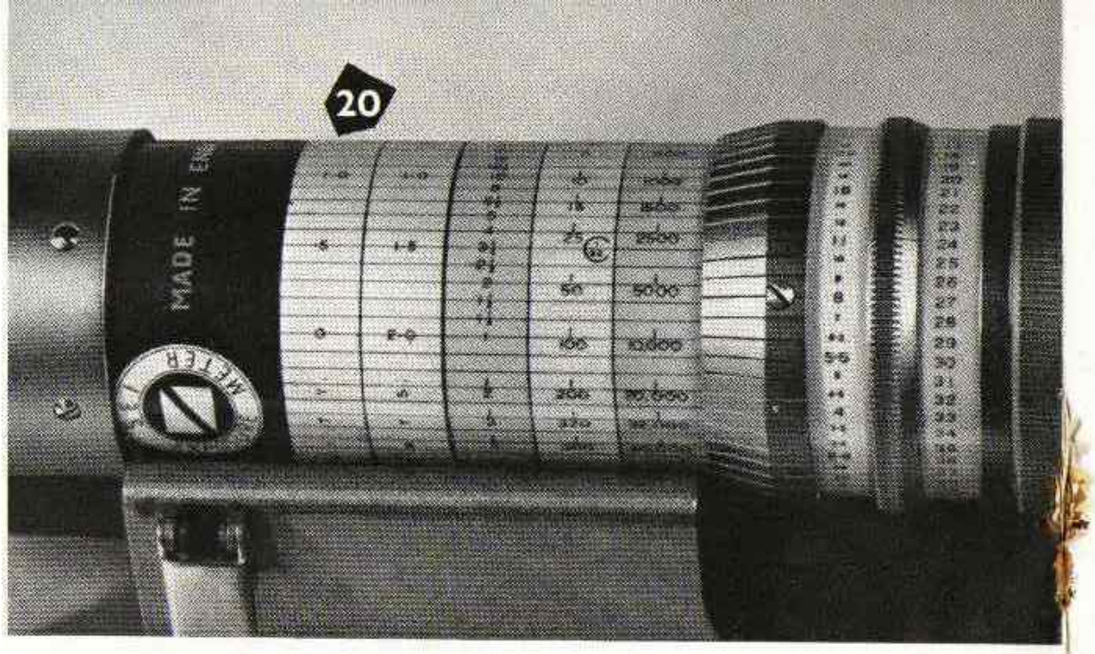
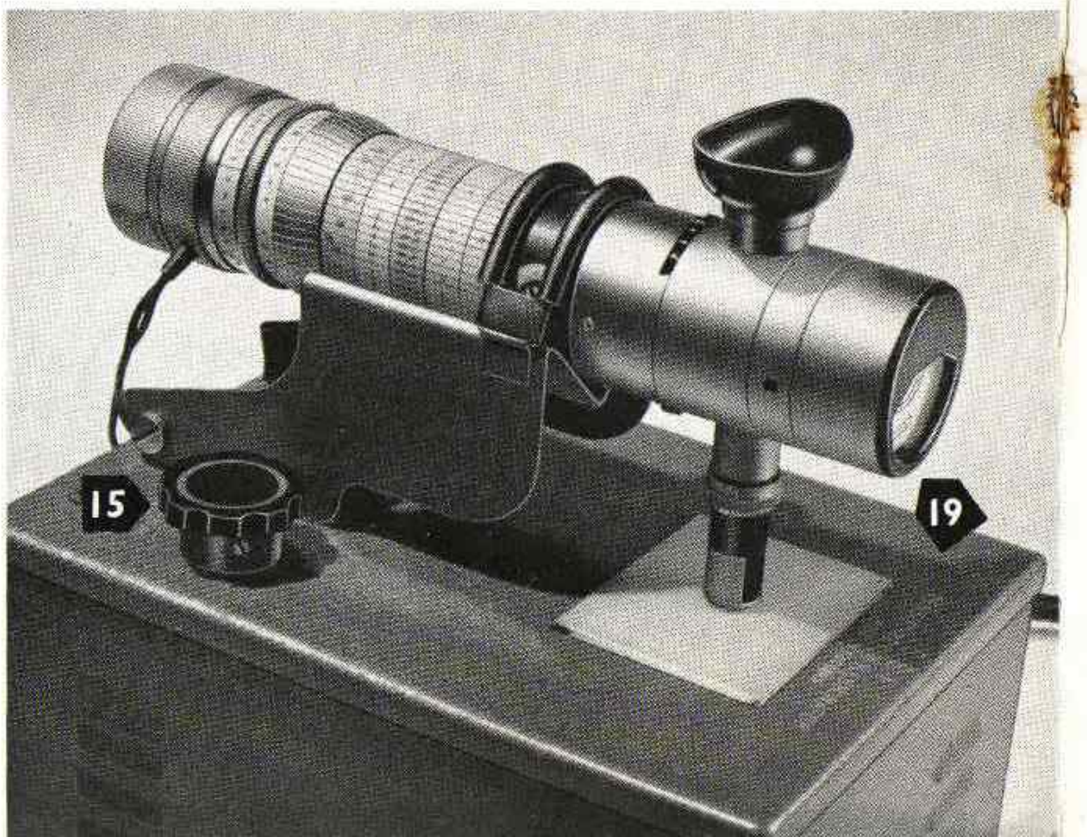


Fig. 3. *View of the Scales showing Relative Density Scale and reference mark screw. The instrument is shown recording a density value of* 0.23. *Arrow* (20) *points to Relative Density Scale*

Fig. 4. *View showing Zero Adjusting Screw* (15)



TO ADJUST THE ZERO

To enable the relative density scale of the photometer to be used as an absolute scale it is necessary to adjust the brightness of the illuminator. The procedure is as follows:—

10. Turn the operating ring of the photometer until the screw head in the graduated tapered ring corresponds with the zero of the relative density scale. This screw appears opposite 27° on the film speed scale and is in line with the reference mark of the photometer (Fig. 3).

11. Focus the eyepiece on the photometric spot.

12. Set the brightness range selector to the white index mark for densities between 0 and 2.0 (for higher densities, see 17 below), the colour-of-light corrector to the yellow index mark and the photometer rheostat control (Fig. 2) to about its mid position.

13. Look into the eyepiece, press the button switch in the operating ring and turn the densitometer zero adjusting screw (Fig. 3) until photometric balance is obtained.

Note: If the spot is yellower or whiter than the surrounding field, turn the rheostat control until colour balance has been restored. This must be done before the final zero brightness adjustment is made and should, as implied in 12 above, normally be obtained with the rheostat control at about its mid position. The needle of the photometer galvanometer (19, Fig. 4) should not be allowed to go over the end of the scale, but there is no need to use the red 'standard brightness' mark for this work.

TO MEASURE TRANSMISSION DENSITIES

14. Place the transparency, emulsion upwards, on the diffuser and arrange the part to be measured exactly under the aperture of the supplementary attachment (Fig. 2).

15. Look into the eyepiece and make any slight adjustment of the position of the negative which may be necessary to bring the image of the part to be studied over the photometric spot. The cradle stop screw may be used to assist in focusing the image of the negative, but it may sometimes be an advantage not to focus too sharply. Then press the switch button and rotate the operating ring until photometric balance is obtained.

16. Read the density from the relative density scale, using the line adjoining the screw mentioned in paragraph 10 as the reference mark.

17. For densities above 2.0, change to the 'red' range selector and proceed as above but adding 2.0 to the scale values then obtained.

Precautions to be taken in measuring transmission densities

The S.E.I. densitometer is intended to measure 'totally-diffuse densities'; that is to say, the density value should be that obtained when the image

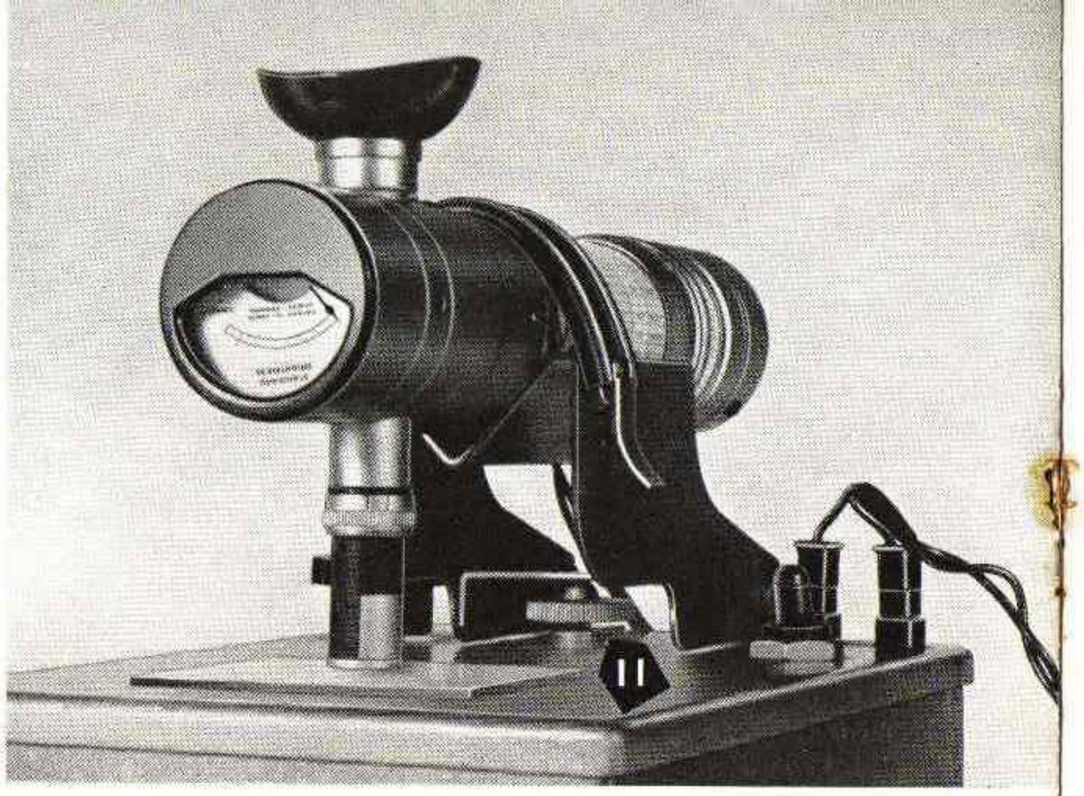
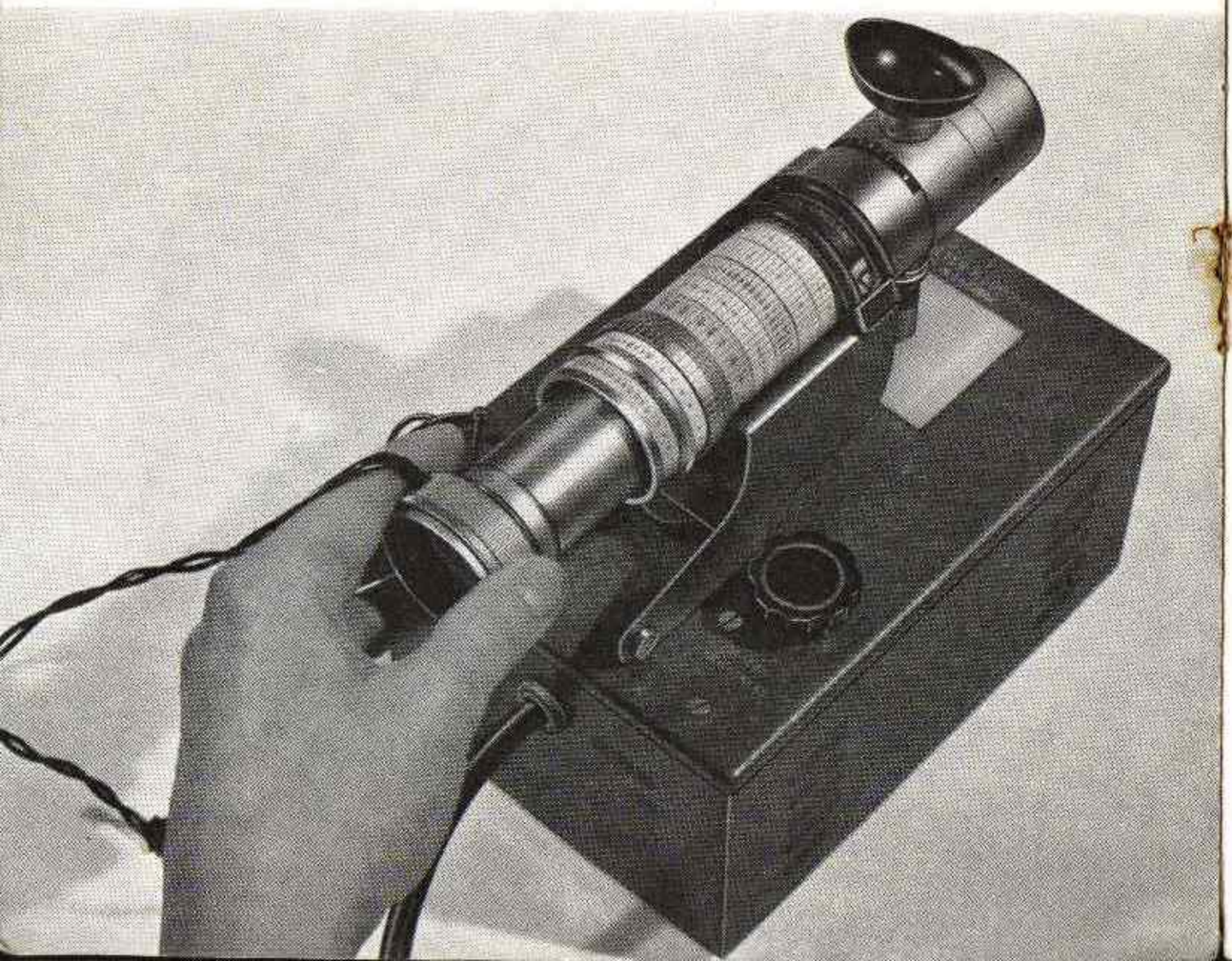


Fig. 5. *View showing Cradle Stop Screw* (11)

Fig. 6. *Inserting the External Supply Adaptor*



side of the negative is in contact with the diffusing window. If the instrument is used in a dimly lighted room and the diffuser window is masked down to a small aperture by means of a thin black mask placed under the negative and the negative itself is placed face downwards on the platform, these conditions are fulfilled. The aperture in the mask should be only sufficiently larger than the image of the photometer spot to ensure exclusion of any brighter surrounding area of negative. It has been found, however, that by placing the negative *face upwards* on the platform and the aperture of the supplementary attachment in contact with the negative, correct readings are obtained without masking provided the area to be measured covers the aperture. When these conditions are fulfilled, there is also no need to work in an inconveniently darkened room. It is for this reason that in paragraph 14 of the instructions it is advised that the negative be placed 'face upwards'.

For measuring densities which will not permit contact either with the diffuser or with the aperture, e.g. lantern slides with cover glasses, the diffuser must be masked and the room should be only dimly lighted.

The values of density obtained with this instrument from negatives which are neutral grey in colour will be directly applicable to contact printing. They will not, without further experiment, give correct printing values for negatives which are to be used for projection printing.

Measurement of reflection density

For measuring reflection densities of prints the lamp within the illuminator is switched off and the paper print to be measured is placed face up under the aperture of the supplementary attachment. The illumination must now be provided by means of an external lamp arranged so that it can shine at an angle of about 45° to the surface of the paper through the side aperture of the supplementary attachment (Fig. 7). This aperture is uncovered by turning the sleeve provided.

Although it is possible to adjust the position of the external lamp so that the white of the fixed out paper gives photometric balance when the relative density scale reads zero, it is more convenient to fix the position of the lamp relative to the photometer and obtain balance by turning the operating ring of the photometer. The photometer reading obtained with the instrument so set must be taken as the zero position and all subsequent readings must be measured from this point.

To obtain the best out of the apparatus for reflection density work, it is best to use a lamp like that used in the adaptor (6-volt 6-watt). This must be fed by a parallel circuit tapped from the same plugs as used for the adaptor.

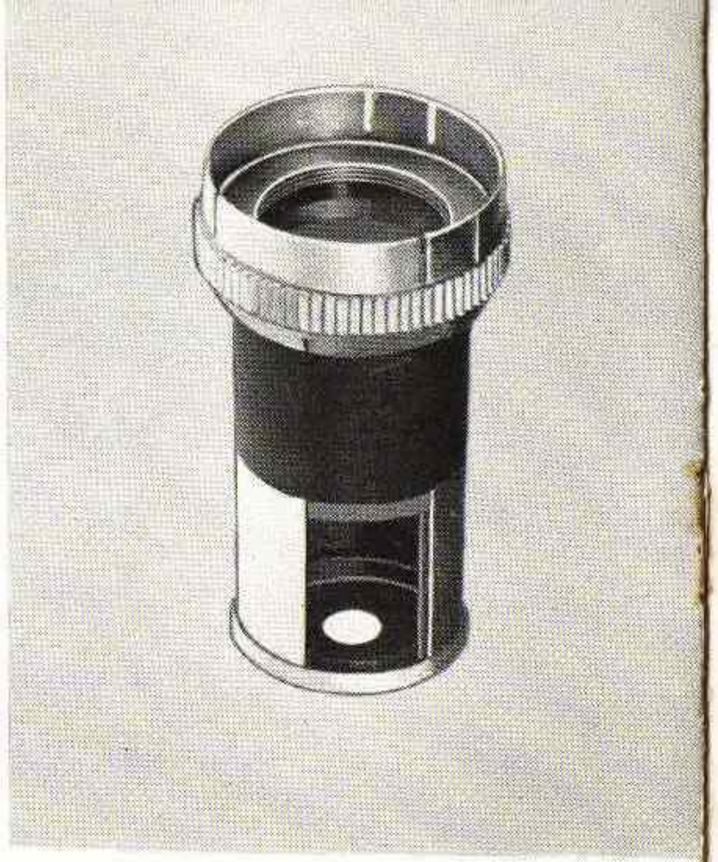
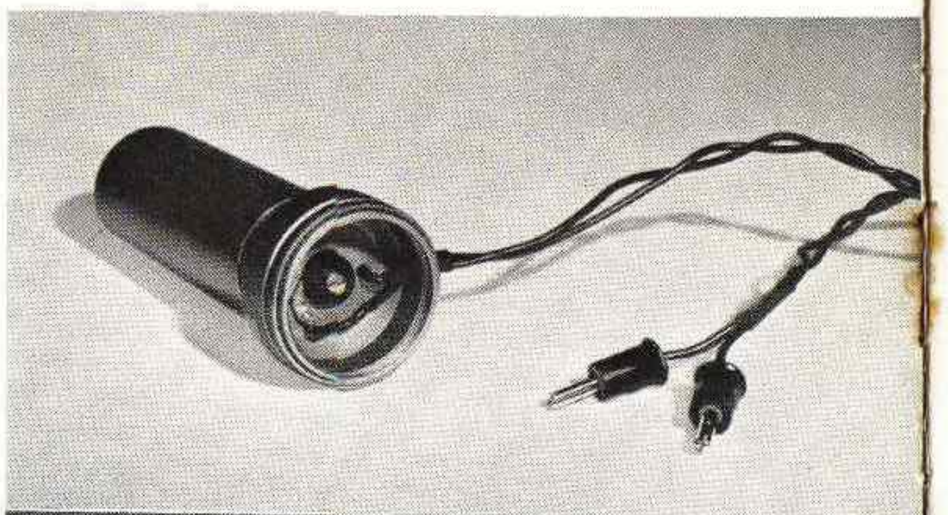


Fig. 7. *Supplementary Lens Attachment, about twice actual size, showing side window open as it would be for reflection density work*

Fig. 8. *External Supply Adaptor*

Fig. 9. *Barrel of External Supply Adaptor removed to show lamp*



Electrical connections and maintenance

Connection to A.C. mains is provided by a length of 3-core flex carrying the usual earthing wire. This flex is led through one end of the illuminator and held by a rubber fairlead ring (Fig. 2). The instrument is sent out connected for a 240 volt A.C. 50 cycle circuit. If the available voltage is other than this, the red and black wires must be moved and soldered to the appropriate connectors on the transformer panel.

TRANSFORMER PANEL

To get at the transformer panel, give a half turn anticlockwise to the slot-headed fastening clamp on the bottom of the box and lift off the top of the box. It will be necessary to push the main supply lead inwards in order to lift the lid of the box far enough to get at the transformer panel.

The instrument as supplied is wired for 240V A.C. as shown in Fig. 10.

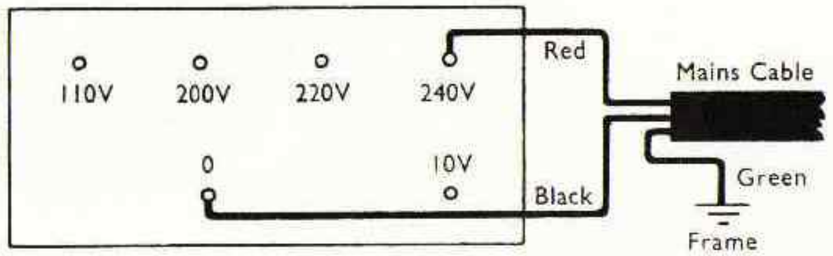


Fig. 10. Transformer panel wired for 240V A.C.

Before using the instrument on other A.C. voltages the connections of the mains lead on the panel must be altered. The connections in each case should be as shown in the following table.

A.C. supply voltage	Terminals for mains lead connections		
	Red	Black	Green
110V	110V	0V	Frame
120V	110V	10V	Frame
200V	200V	0V	Frame
210V	200V	10V	Frame
220V	220V	0V	Frame
230V	220V	10V	Frame
240V	240V	0V	Frame
250V	240V	10V	Frame

S.E.I. PHOTOMETER REPAIRS

1. Calibration must be checked even if the photometer has only had minor servicing, e.g. cleaning.

2. If more complex work be carried out, e.g. fitting new photocell, meter, wedges, or filters, then the Standard Brightness setting will definitely not coincide with that already marked on the dial of the microammeter.

3. Faults most likely to occur:-

(1)	Battery leakage(affecting battery tube, inner case, Rheostat Base and Scales).	10%
(2)	Photocell unserviceable	10%
(3)	Microammeter faulty	10%
(4)	Rheostat Base unserviceable	60%
(5)	Wedges and/or filters damaged due to age, corrosion, etc.,	30%
(6)	Scales and scale covers damaged	50%
(7)	Telescopic ring tube damaged	10%
(8)	Action of lower body siezed up	10%
(9)	Clean and recalibrate <u>only</u>	10%

This survey was conducted on 100 photometers serviced during the latter half of 1963. From this it will be seen that battery leakage and loss in photocell sensitivity caused most of the repairs to be necessary. Battery leakage is the main contributor to rheostat base failure, bloomed wedges and filters, and scale damage.

4. From this it will be seen that the spare parts which will be needed most are:-

   (1) Photocells
   (2) Scales
   (3) Scale covers
   (4) Battery tubes
   (5) Wedges
   (6) Filters
   (7) All components of Rheostat Bases
   (8) Complete Rheostat Bases

5. In addition to these important spares, it would be advisable to also stock:-

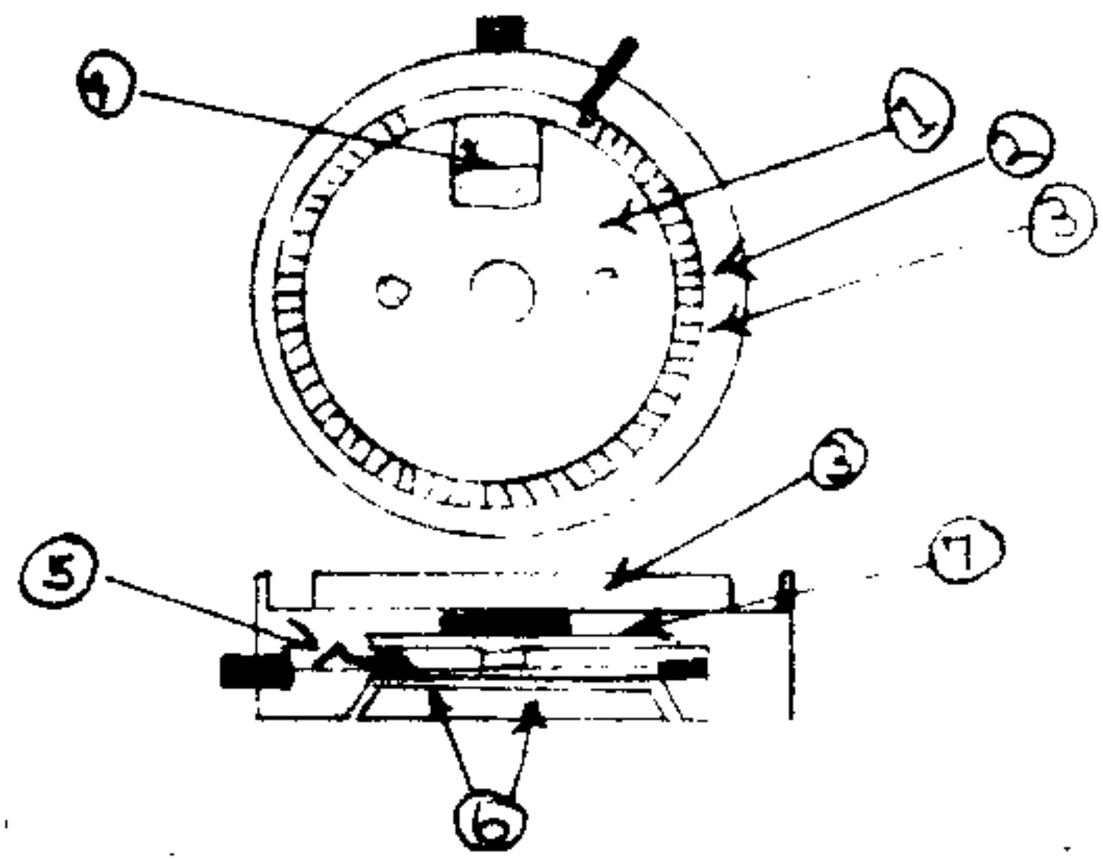
(1)	Microammeters	(9)	Diffusing screen
(2)	Tele-ring tubes	(10)	Filter discs
(3)	Eyepiece mouldings	(11)	Cursor ring
(4)	Bulb assemblies	(12)	Ratchet sleeve
(5)	Lenses	(13)	Lens aperture ring
(6)	Photocell assy.	(14)	Speed degree ring
(7)	Photocell clamp	(15)	Contact assy. 36392
(8)	Photocell contact plate	(16)	Battery insulator

6. In the absence of a service manual, here is a summary of the problems likely to be encountered when servicing the S.E.I. Photometer.

The instrument is stripped down and given a thorough examination for signs of damage and wear. From this a quotation is prepared for the customer. Very little experience is necessary for the actual estimation and, with practice, this becomes easy.

A few of the faults to look for are as follows:-

RHEOSTAT BASE ASSEMBLY

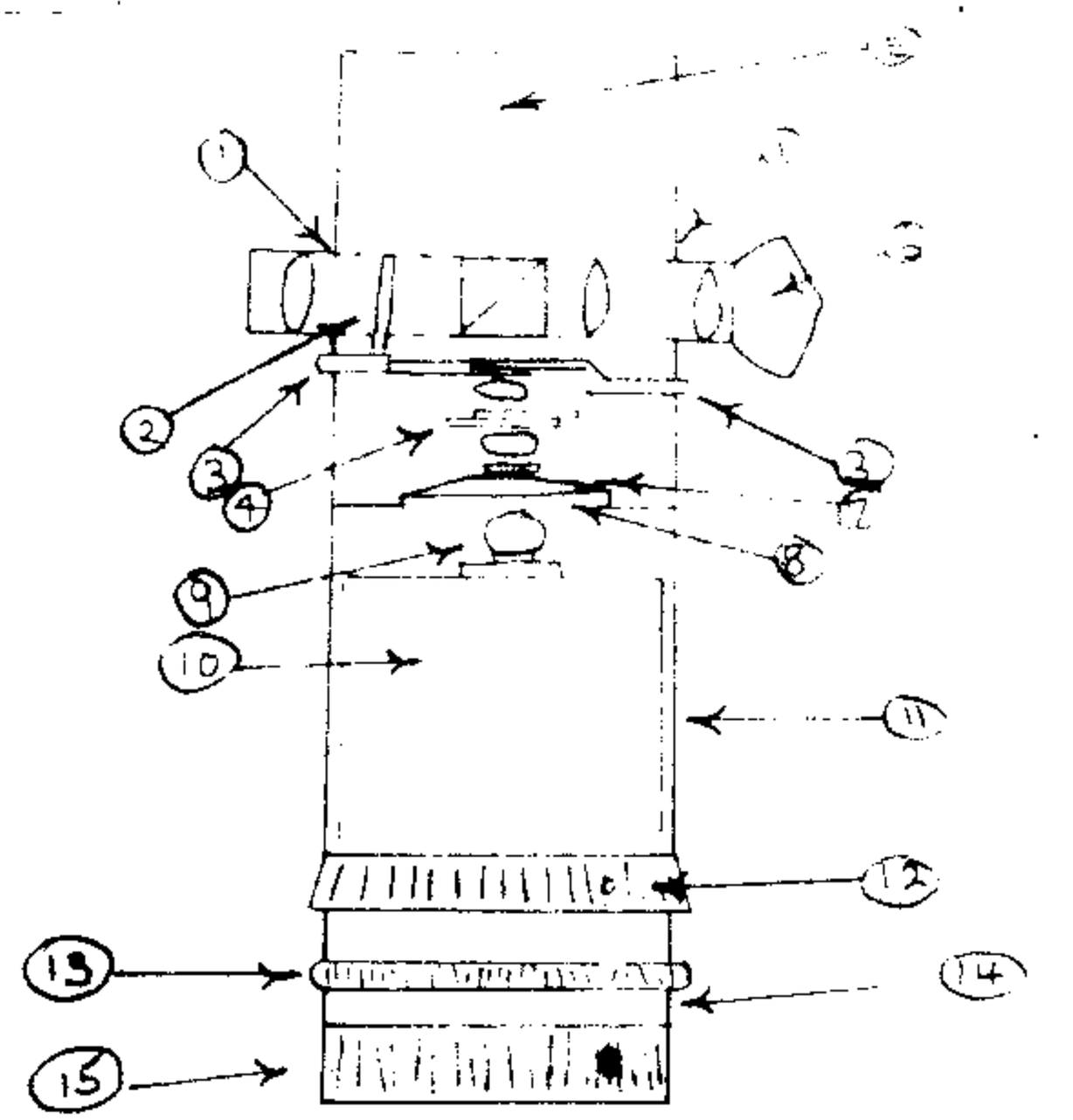


(1) Check for cracks and corrosion.
(2) Check resistance for corrosion and smoothness of track.
(3) Cup moulding should be unbroken
(4) Contact and contact carrier to be free from corrosion and be fully plated.

(5) Contact)
(6) Bottom face of contact) *
(7) Edge of wiper)

* These edges to be polished for good electrical contact.

A GUIDE TO PREPARING AN ESTIMATE



(1) Look for tubes coming loose in T.R. Tube.
(2) Check filters for scratches and blooming.
(3) Check for cracked discs.
(4) Check wedges for scratches, blooming and ageing (yellowness showing).
(5) Meter should be well balanced and be on zero. If not zeroed check springs are not hooked up.
(6) Check moulding for cracks and lenses for chipped edges.
(7) Polish contact plate.
(8) Check output of photocell.
(9) Does the bulb light?
(10) Check for corrosion and that insulation is O.K.
(11) Examine scale and cover for bad damage. Normal ageing does not require new scales.
(12) Check cursor ring for correct alignment (details later).
(13) Check for correct ratchet actions and alignment.
(14) Check for alignment.
(15) Strip rheostat base. This is almost a separate subject and will be dealt with on its own.

PREPARING AN ESTIMATE (Cont'd)

(16) Check prism for alignment on all planes, also for bubbles in cement between two halves of the cube and any fault on the silver spot.

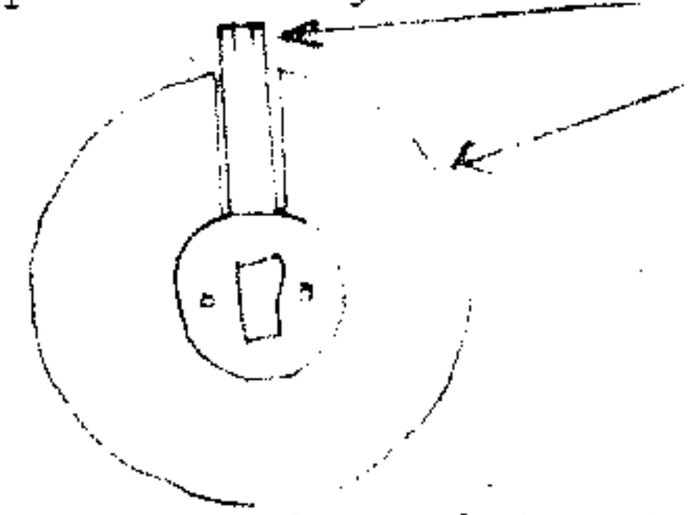
When the actual repair is being carried out, one of the major operations is the cleaning of various components. The whole of the instrument should be clean, but particular attention should be paid to parts marked thus

For the repair we will divide the Photometer into its different sections:-

(1) RHEOSTAT BASE
(2) BODY
(3) DISC HOUSING
(4) TELE-RING TUBE

(1) RHEOSTAT BASE

To get a smooth action on both the switch and the rheostat, all moving surfaces must be polished. These are the underside of the wiper assembly and contacting surfaces of sliding contact.

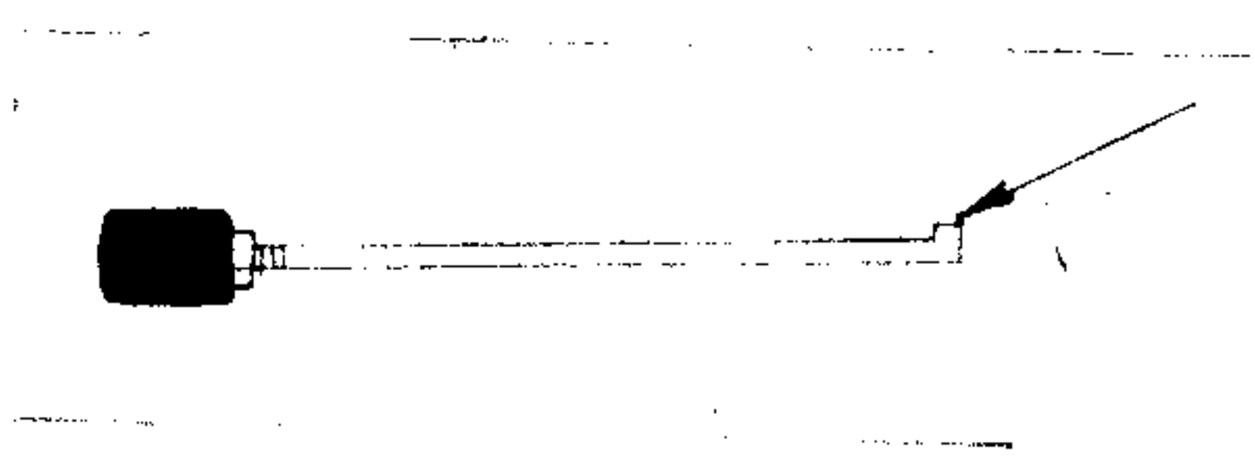


These are the points at which "flicker" is caused in the bulb, a fault which is most annoying in use, particularly during calibration.

Care must also be taken that contact is not made in any position of the wiper without the Switch Button being depressed. The most likely cause of this is one of the 10BA screws under the wiper having a burred slot or not being countersunk enough.

The insulated cover (in 2 parts) of the Sliding Switch Mechanism, if needing replacement will need to be filed to the shape of the one removed. This mainly consists of putting a chamfar on the edge under which the contact and its guide slide.

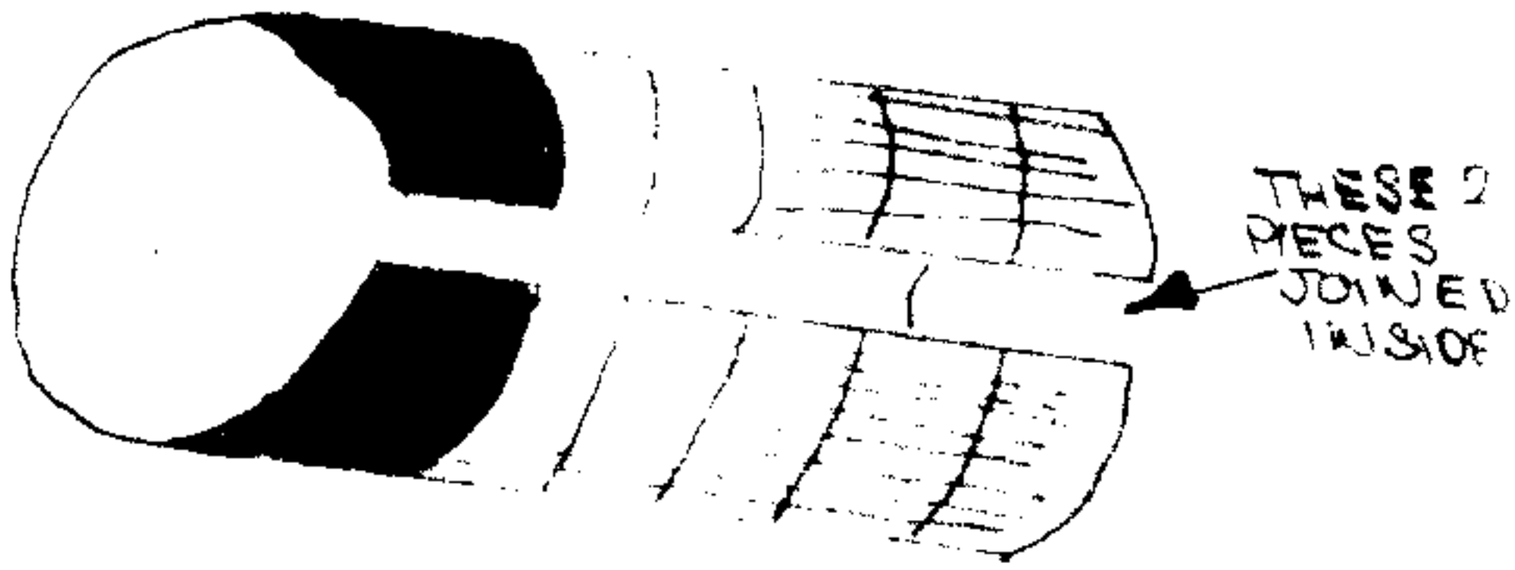
Should the Contact Carrier need replacing, then it will also need filing to fit.



The method of fixing these scales is as follows:-

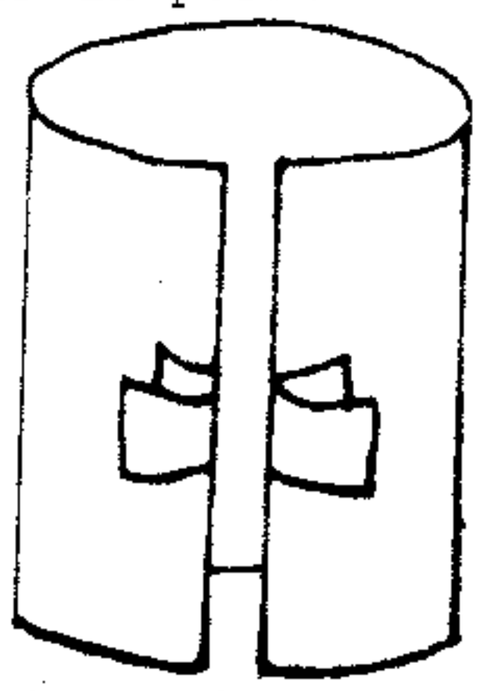
Main Scale

This is pre-shaped inside a parapex tube with adjustable internal diameter. The lines on each edge of the scale are matched up and a strip of gummed paper joins the two edges.



This tube is then slid carefully over the outer case which has been thinly coated with the Shellac solution and allowed to dry. The white line on the black edge of the scale card is positioned on the engraved line at the top of the outer case. Bake in an oven for about 10 minutes.

When the case has cooled down the cover may be put on. Wrap the acetate cover around the scale, positioning the overlap to coincide with EXPOSURE TIME - SECONDS on the join of the scale. Both the scale and the cover must of course, be very clean and free from fingerprints. With the scale cover in position a split brass tube is slid over it as shown. This is opened by pressure on the levers and so does not scratch the cover as it is slid on and off. It should be set so that the join in the acetate shows in the slot. Acetone is then applied in the tip of a screwdriver between the two surfaces of acetate. A drop of acetone is placed on the bottom layer at one end and then the top layer laid down on it and the two pressed together by running the finger nail along.



With practice this can be done so that only the one drop of acetone is necessary, this running all the way along and sealing. It is no detriment however, if it has to be sealed with several applications - moving further along the seam with each one. Care must be taken not to touch the scale cover with the acetone in any place other than between the join for the acetate will be dissolved and a new cover will be necessary.

Small Scales

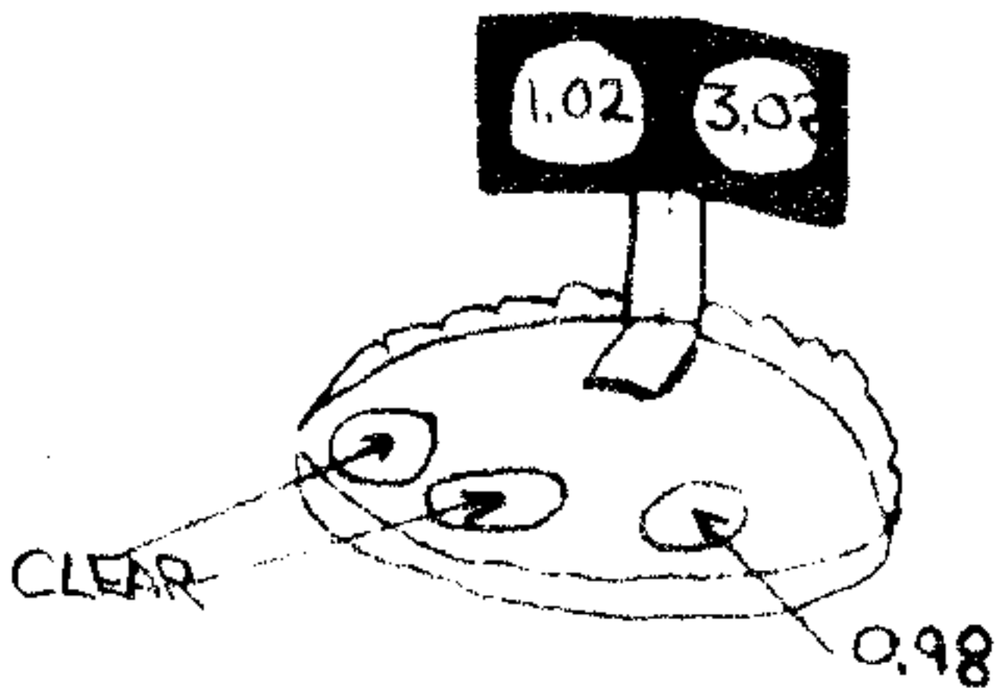
These are fitted in the same way as the main scale except that they are not made into a tube first.

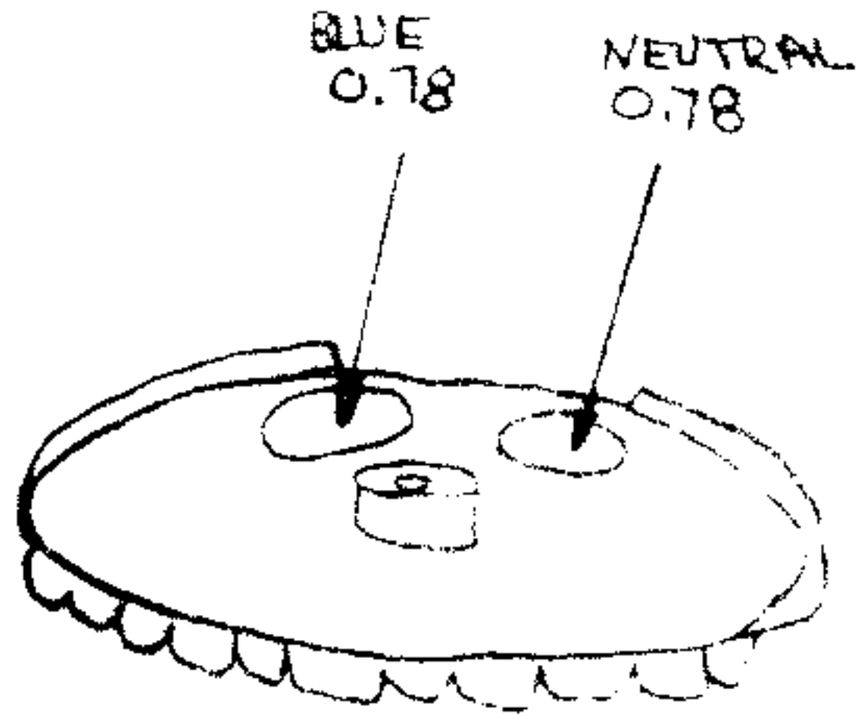
After coating the ring with Shellac and allowing to dry, the scale is wrapped around the ring, set in the correct position and the two ends held together with a gummed strip underneath. Care is necessary to ensure that there is no gap or overlap of the ends of the scale. After baking in the oven, trim the edge of the scale and clean off any excess Shellac. The cover is again secured with acetone, but this time is held in position by hand. On the Lens Aperture ring Shellac must be kept away from the spring otherwise the ratchet action may sieze up.

General

The Inner and Outer case rotation is helphed by a thin application of an adhesive lubricant - ROGOL KILOPOISE 0136.

DISC HOUSING



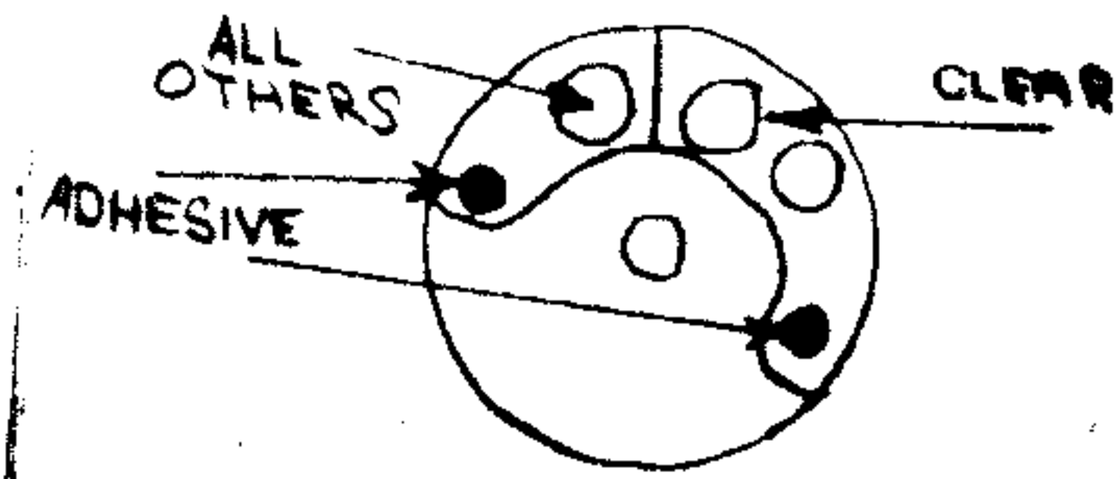


This shows the position of the range and colour matching filters in their respective discs.

The filter is held in position with a suitable adhesive (with the exception of the 1.02 and 3.02) and then the clamp is secured to the disc with a rivetted eyelet.

The 1.02 and 3.02 are simply squares of filter material clamped in the frame.

The filters that lie on the discs should be out so that the outer edge follows the shape of the disc and where the two different densities meet the cut should be radial. A A template should be made so that all filters can be cut the same. There must be no overlap and no gap between the filters.(Fig.8). The clear filter used is the same cellulose acetate as is used for scale covers. The reason for its being used is of course, that any ageing of filters that should occur will affect all these ranges equally and so conflicting readings will not be obtained when changine from one range to another - as would be the case were those two positions left empty.



The meter should be examined for free movement of the needle. Should there be anything more serious than the needle catching on the scale or foreign matter between the coil and magnet then a replacement meter should be fitted.

Care must be taken to ensure that contact betweeen photocell and meter is not lost due to a loose screw particularly the two 10BA countersunk type connecting the meter pillars to the meter.

CALIBRATION

The calibration equipment should be set to the 100 FT.LAMBERT level.

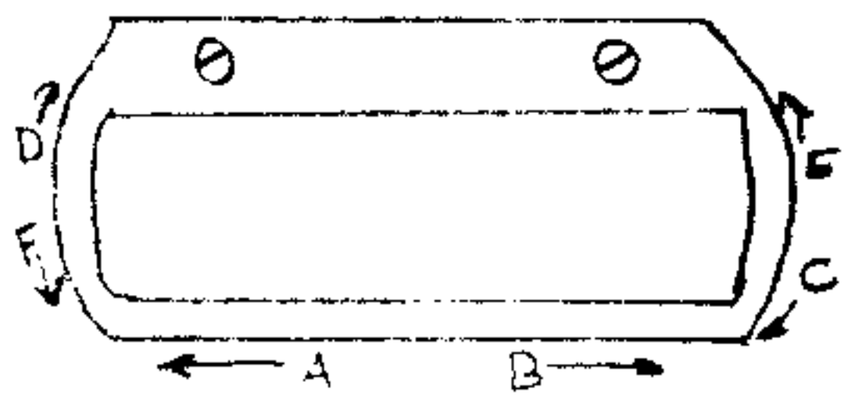
Set the Photometer Colour Matching Disc to the yellow spot and the range disc to the white spot. Turn the base of the photometer fully anti-clockwise so that the cursor screw is opposite 1/10000 on the blue scale.

Switch on and rotate the rheostat in the base of the Photometer until a match is obtained between the Calibrator and the Photometer spot. With the rheostat in the same position and the Log.2 filter in position over the front of the Calibrator a match should be obtained at the other end of the movement, i.e. with the cursor screw against 1/100 on the blue scale.

Remove the Log.2 filter from the Calibrator and set the Range disc to the Blue spot. The spot and calibrator should again match.

Return the base of the photometer to $\frac{1}{10000}$ Set the range disc to the red spot and a match should be obtained again with the Log.2 filter in position. The position of the needle is then marked with a red line.

Should a match not be obtained at any of these settings (except the first) then adjustment of the wedges is necessary. Movement in the direction of Arrow "A" will not affect the balance but will move the position of the red line up the scale. Similarly movement in the direction of Arrow "B" will bring the red line down the scale.



If a match cannot be obtained with the base clockwise on the white range, then the wedges must be moved accordingly.

(1) Should the spot be too dark then adjust as arrow "C". Adjustment in the direction of arrow "D" will not only correct the balance but will also move the red line higher. So, should this adjustment be made it may also be necessary to adjust as "B" also.

(2) Should the spot be too light than adjust as arrow "E" or "F" with the same provisions as above.

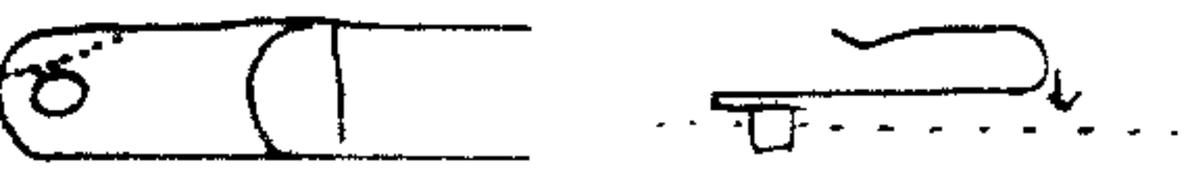
Wedges on repaired Photometers should need little or no adjustment unless replacements have been fitted.

Should it be necessary to change the disc itself - due to breakages - then certain work is necessary before the filters are fitted to it. The old disc should first be examined for any chamfers etc., that may have been filed on it. After copying these, the disc should be rubbed down on emery cloth until a click-stop motion is felt with the screw fully home. It must also be ensured that the two discs do not foul one another and should be tried in all positions. When the discs are both operating satisfactorily then the filters may be fitted.

THE FILTER MATERIAL MUST AT ALL TIMES BE HANDLED WITH TWEEZERS.

FINGERMARKS CANNOT BE REMOVED AND COMPLETELY RUIN THE MATERIAL.

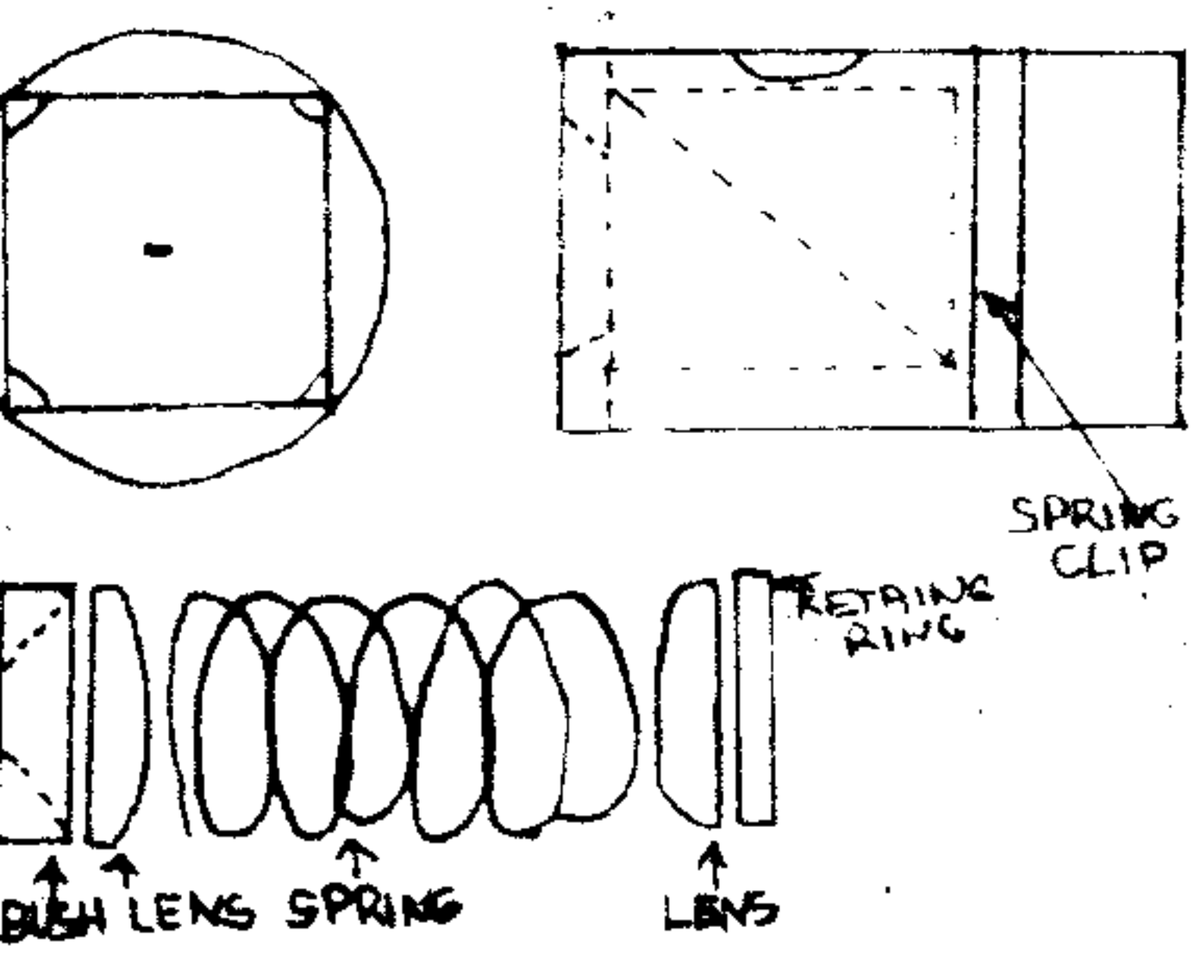
The contact on the underside of the disc housing should be shaped and filed to match the one already fitted. If it is not filed along the dotted line then a short circuit of the photocell is possible, from the contact to the outer case once the disc housing is put into position. It must also be ensured that no short is allowed in the direction of the arrow.



TELE-RING TUBE

This assemby carries two of the most important - and delicate - items in the instrument.

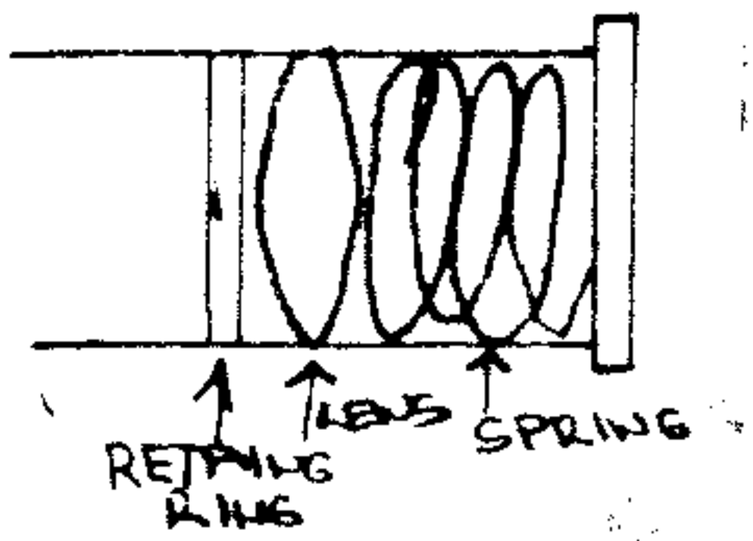
(1) Mioroammeter
(2) Prism



The prism is secured in the housing in the position shown, by a small amount of adhesive - Evostick or similar - on the four corners of the front face. The prism must be square in its housing. The three polished surfaces must be spotlessly clean.

The two eyepiece lenses (Fig.11) are mounted with their convex surfaces facing and these also must be spotlessly clean.

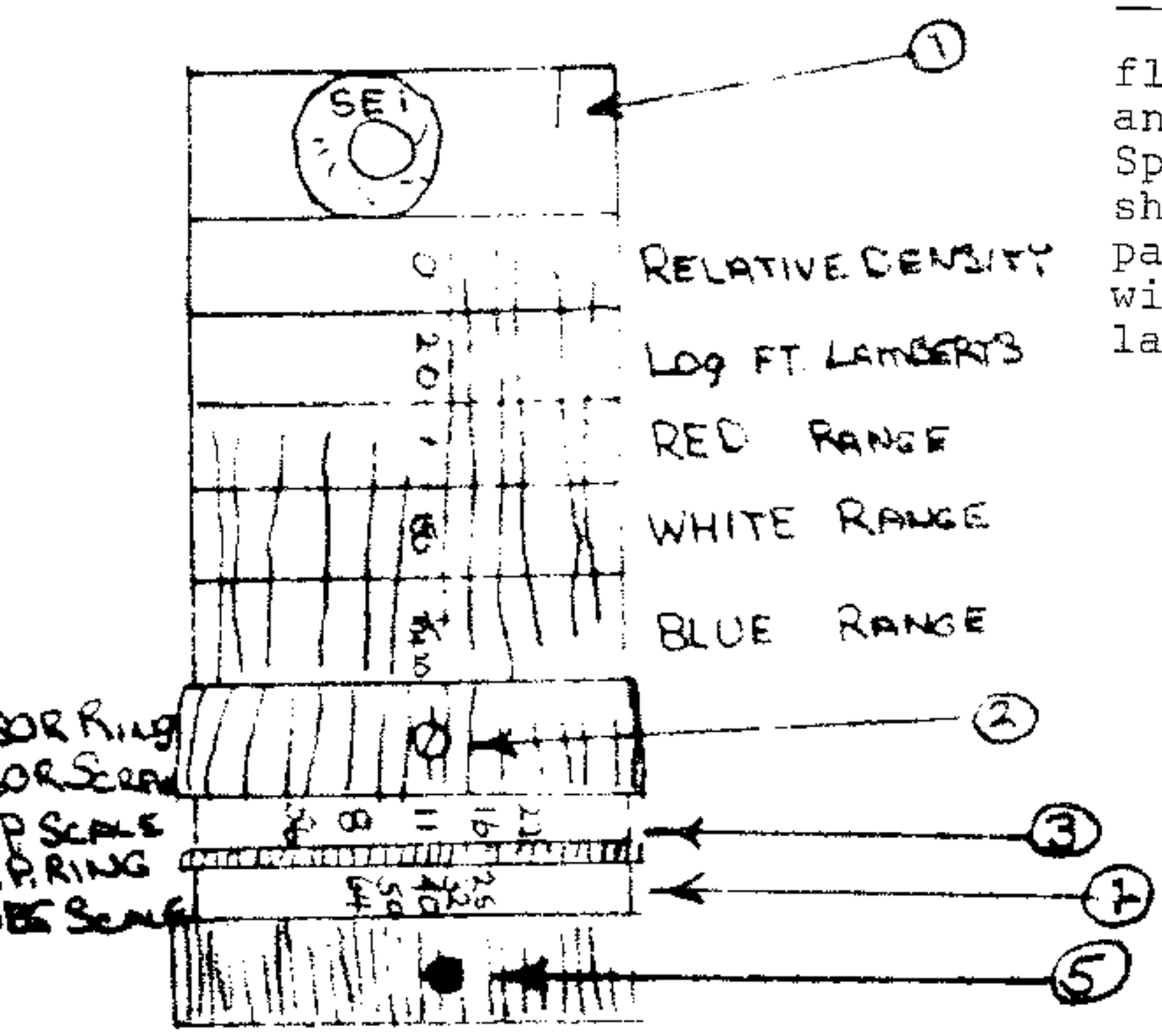
The object lens, after cleaning, should be screwed down approximately halfway, Then, with the prism and eyepiece also in position in the tele-ring tube both the silver spot and infinity should be in focus. The infinity focus can be altered by adjustment of the object lens.



The surest method of checking the completed base for correct operation is to view the mirror spot while operating the switch and rheostat, also examining the movement of the meter needle is a good test for "flicker" etc.

With the resistance "cut" - i.e. with the wiper at the lead end of the resistance - the two engraved red lines on the base and the controller should approximately coincide.

(2) MAIN BODY



SCALES

These are secured with Shellac flakes dissolved in approximately an equal quantity of Methylated Spirit (white). The consistency should be such that it can be painted on to the metal parts without being too liquid. (details later).

(1) White line on main scale to coincide exactly with engraved line on outer case.

(2) Cursor screw to line up with $\frac{1}{1000}$ on blue scale (Tolerance=$\pm$ of one line).

(3) F.11 to be set against black dot, F1.1 against white dot.

(4) Speed degree scale can be either BSI or ASA. When F.11 is not against the cursor screw the black dot should point to 40 ASA or 27 BSI.

(5) Switch button should be in line with cursor screw (in repaired instruments this will not always be so).

If a spare bulb is included in the repair, then it also will require calibration. Here the method is to calibrate to the new red line on the meter. Replace the fitted bulb with the spare and check on the white range with the base anti-clockwise. When a match is obtained the needle should coincide with the red line. It it does not then the bulb must be adjusted. If the needle does not reach the red line then the bulb should be lowered in its holder a fraction of a turn. If the needle passes the line then the bulb must be screwed up, first unscrewing the locking screw in the retaining ring.

Several adjustments will probably be necessary before the calibration is correct.