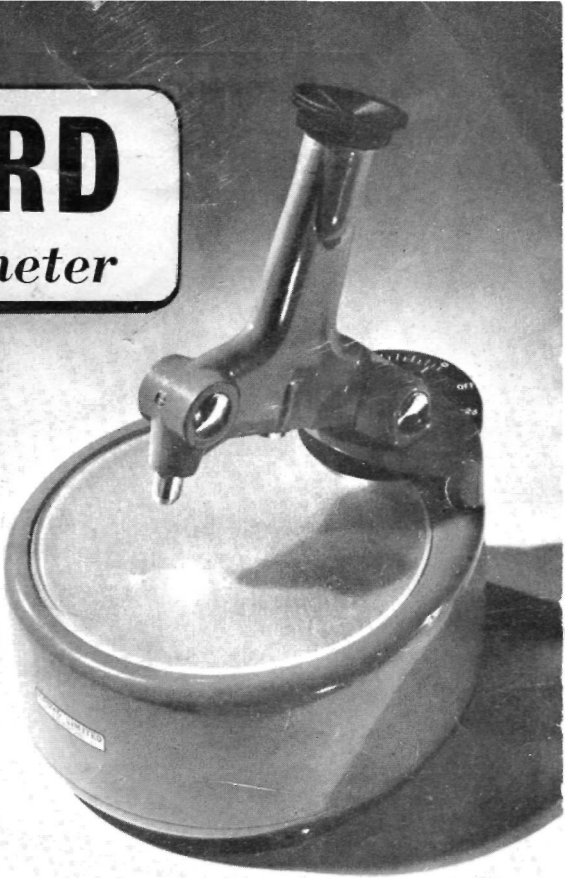
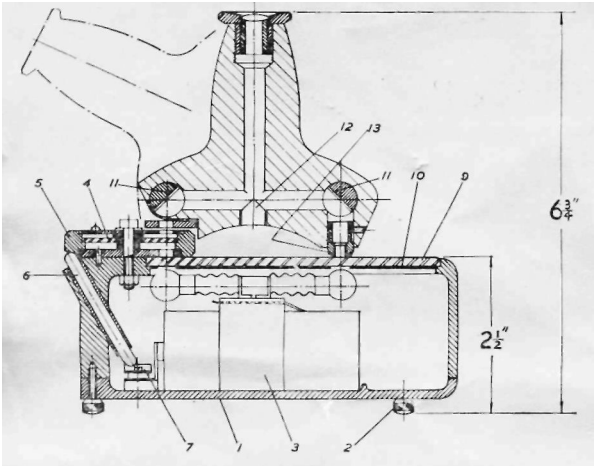
ILFORD

Densitometer

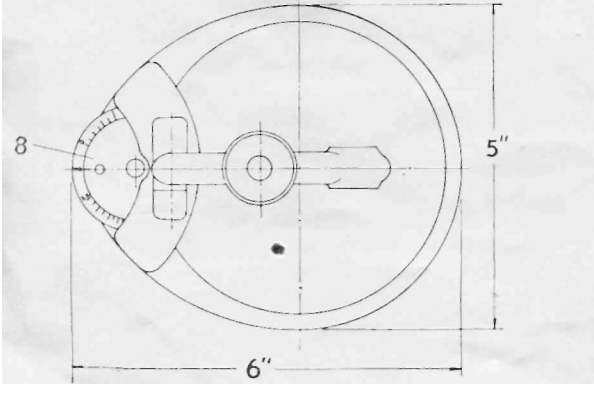


For direct readings of transmission densities

ILFORD *Densitometer*



Sectional view



Plan view

General description

This is a direct reading instrument for measuring transmission densities of ordinary photographic negatives. Visual observation of the photometric fields is employed.

Two models are available, one for battery the other for A.C. mains use. The battery model works from a No. 800 dry cell battery. The transformer model works from A.C. mains supply, 200-250 volts. Tappings are provided on the input coil for different voltages and a 6 ft. length of flex is provided. Roth models utilise a pair of coiled filament 2-5 volt 03 amp. torch bulbs (G.E.C. Catalogue Reference OS.45). Bulbs are supplied with both models and the transformer with the transformer model. A battery is not supplied with the battery model.

The arrangement of the instrument is illustrated in the diagrams opposite.

The base of the instrument (1) is held to the body by three screws (2) which provide a tripod base. The transformer or battery is held under the bridge piece (3) on which the bulbs are mounted. An annular optical wedge screen (4) is carried in a rotatable mounting (5) on which is engraved a scale of densities. By means of a cam on the edge of the wedge mounting a rod (6) operates a switch (7) when the mount is rotated slightly from the "off'* position. The index for the density scale is on a disc (8) which can be rotated to zero the scale. A glass plate *(9)* diffused on the under side provides a stage for the plate or film to be investigated. This stage has a green screen (10) below it to reduce the brightness of stray light; apertures are provided in this screen to accommodate the wedge screen and the objective nozzle (13). The eyepiece is carried in a mounting hinged to the body of the instrument above the wedge. Inclined mirrors (11) mounted in the arms of this eyepiece mounting reflect on to a white prism (12) which is viewed through the eye-piece. The objective nozzle (13) is situated at one extremity of the arm of the eyepiece mounting. This nozzle serves to limit the area of density which is observed to a circle of about 3 mm. diameter ; it slides in its support so that different thicknesses of plates and films can be accommodated. The eyepiece mounting with the objective nozzle can be swung out of position for ease of inserting the plate or film for measurements to be made.

Method of making measurements

The instrument should be used in a dimly lighted room.

Switch on the lights by turning, in clockwise manner, the black disc carrying the wedge and density scale.

Look into the eyepiece and turn the disc until the two sides of the field are matched. Zero the density scale by rotating the disc (8) to bring the index in line with the figure 0 on the scale.

The instrument is now ready for making measurements. Place the plate or film on the glass plate so that the objective nozzle corresponds with the part to be investigated. Obtain photometric balance in the eyepiece by turning the disc and record the reading. It is advisable to make at least two readings, approaching the balance point from each direction.

Adjustments

1. Insertion of battery. Remove the base by unscrewing the screws forming the feet (2) and insert the battery under the bridge piece (3) so that the end connector of the battery makes contact with the terminal provided in the insulated stop piece at the side of the switch. The other battery connector must be in contact with the bridge or base. Note that the switch operating rod is loose and must be replaced in its tubular mounting if it falls out ; the rounded end should be inserted first into the tube so as to permit the cam to work smoothly.

2. Connecting transformer for appropriate mains supply. Remove the base as described above and connect the red lead to the tapping marked with the nearest voltage number to that of the mains supply to be used. In order to prevent accidental overloading of the lamps when first connected, the instrument is sent out with the red lead connected to the 245 volt (highest available) tapping.

3. Replacement of lamps. If a lamp becomes dim or burns out, remove the base as for inserting a battery. The lamps are carried in screw holders and can be taken out in the usual way. Note that if, after renewal of a lamp, the instrument cannot be adjusted for zero the cause may be unequal brilliance of the lamps. Zero adjustment may be made possible cither by interchanging the lamps or by selecting two new ones which arc more nearly alike.

Notes on the application of density measurement to photographic printing

Density is the degree of blackening in a photographic negative or print. From its value the fraction of the incident light which will be transmitted by any selected part of a photographic image can be calculated. The calculation has been made for a range of densities between zero and 100 and the results are shown in the following table, but in using the table it is useful to remember that zero density means a transmission of 100 per cent.; a density of 2.00 means a transmission of 1 per cent., and so on.

Density	*Light transmitted by the negative (per cent.)*	*Density*	*Light transmitted by the negative (per cent.)*	*Density*	*Light transmitted by the negative (per cent.)*
0 00	100	0.35	45	0.70	20
0.05	89	0.40	40	0.75	17.8
0.10	**80**	0.45	35	0.80	15.9
0.15	71	0.50	31	0.85	14.1
0.20	63	0.55	28	0.90	12.6
0.25	56	0.60	25	0.95	11.2
0.30	50	0.65	22	1.00	10.0

For densities above 1.00 the amount of light transmitted will be given by the same table except that when the 0 before the decimal point is replaced by 1 the values in the second column must be divided by 10. When the figure before the decimal point in the density value is 2 the values must be divided by 100, and so on.

Choice of paper grade

The task of the photographer is to represent in a print the brightness tones of the scene in tones of grey which differ from one another sufficiently to give

a satisfactory picture of the original scene. It is necessary therefore, to study how best to distribute the tones of grey in the print.

The full tone range of a printing paper extends from the full while of the paper to the deepest black of which the paper is capable. The difference in density between the least dense and the most dense parts of a negative (negative density range) will determine whether or not on a given printing paper the full available tone scale can be evoked in printing or whether the negative is too contrasty and cannot be accommodated by the paper.

Printing papers are made in different contrast grades to cope with negatives of different density ranges. The grading method is approximately determined by the negative density range which will result, at a single printing exposure, in a just "off white" grey behind the heaviest negative density and a black just short of the maximum of which the paper is capable behind the lightest negative density. For example one range of papers is graded as follows :

Contrast Code	*Nominal Contrast Grade Ilford Bromide Papers*	*Negative Density Range*
1	Soft	1.50
2	Normal	1.25
3	Hard	0.95
4	Extra Hard	0.85
5	Ultra Hard	0.65

In order to choose the paper to be used for printing from a negative it is only necessary to measure the densities of the heaviest and lightest parts of the negative, to find the difference between them and to select the grade of paper which is shown in the third column to have the nearest Negative Range. This procedure will yield prints in which the whole tone range of the paper is used. If the subject is one for which it is desired to use only part of the tone range (e.g. in " High Key " or " Low Key " prints), then a softer paper than the one selected by this rule must be chosen.

Calculating time of exposure for printing by contact

As an example of another application of density values, suppose that several

negatives have been graded as suitable for printing on a given grade of paper. The lowest density of each will have been determined as part of the process of grading. From these the relative printing exposures to give just full black can be calculated very easily provided the exposure for one of the negatives is known.

Taking the printing exposure of the standard as unity, the factors for calculating the other printing exposures are given in the following table :

Difference of density between density of standard and other negatives	*Factor by which printing time of standard must be multiplied*
+ 0 5 (standard lower)	3.2
+ 0.4	2.5
+ 0.3	2.0
+ 0.2	1.6
+ 0.1	1.3
0.0	1.0
- *0.1*	0.8
- 0.2	0.6
- 0.3	0.5
- 0.4	0.4
- 0.5	0.3

These factors are of course properties of the negatives themselves and must he used together with such changes as may be introduced by changes of printing light, speed of paper, etc.

Comparison of negative contrast for colour reproduction

Separation work

Yet another application of density measurement is that of ensuring that the negative taken through each of the filters in colour separation work is developed to the same degree of contrast. A neutral grey scale must be included at the side of the subject and will be recorded along with it. The difference between the densities of the deepest and lightest parts of the grey scale as recorded on the negative is a comparative measure of the contrast achieved in the negative as a whole. This serves as a check on the uniformity in degree of development for the set of negatives.

How to deal with negatives to be used for enlarging

No precise direction can be given to cope with all the circumstances which may be encountered in enlarging. The following are the principal reasons for the complications which occur.

1. Light scatter by the negative. When light passes through a negative some of it is scattered away from the general direction of the light which forms the image. In contact printing all this scattered light is caught by the printing paper, none is lost. In printing by projection some of the scattered light is lost; the effective density of the negative is thus higher when printing by projection than when printing by contact. The amount of the loss is different for different kinds of negative material and for different ways of illuminating the negatives. It is generally greater for coarse grained negatives than for fine grained and it is greater when a condenser system is used to illuminate the negative than it is when diffuse illumination is employed.

2. Light scatter by the projection lens. This causes a degradation of contrast in the image, mainly caused by the addition of a uniform "overlay" of light on the image. The extent to which this occurs will depend on the enlarging lens and the defect should be small in a good enlarger.

These factors make it difficult to apply density measurements directly to the grading of negatives for enlarging purposes in the manner described for contact printing. It is, however, possible to derive much benefit from systematic recording of density range for negatives which are to be enlarged ; the information obtained must be linked with the record of paper grade found suitable for each negative. When a sufficient number of negatives have been handled in this way, the experience can be used to grade further negatives for the same enlarger.

The use of density measurements in estimating exposure for enlarging is subject to the same difficulties as in estimating contrast. The change of exposure with magnification is of course a complication which is common to all problems of enlargement. Nevertheless by systematically recording the data for several successfully enlarged negatives it will be found that measurement of density can be a valuable aid to precision in working.

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