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BRIGHTNESS METER FOR SELF-LUMINOUS DIALS

By Leon F. Curtiss

ABSTRACT

A compact, self-contained apparatus is described which can be used to determine the brightness in microlamberts of a self-luminous dial. The arrangement consists of a translucent-glass disk uniformly illuminated from the back by a flashlight bulb. An opaque stencil, cut to match the figures on the dial to be tested, is fitted to the front of the disk. The intensity of illumination and, therefore, the brightness of the face of the glass disk is controlled by a wheatstone-bridge arrangement which regulates the current through the bulb, supplied by two flashlight dry cells. A milliammeter is connected to show the out-of-balance current of the wheatstone bridge and may be calibrated directly in microlamberts. The range of the apparatus is from 1 to 50 microlamberts, which upper limit exceeds the brightness of any commercial dials now made. The device is easily portable and can be used to test dials mounted in instrument panels without dismounting them.

I. INTRODUCTION

There is a demand at the present time on the part of users and makers of self-luminous dials for some form of photometric device which can be used to test the brightness of completed dials, both immediately after manufacture or purchase and at intervals during their serviceable life. Two methods which have been followed in the past for this purpose, are somewhat unsatisfactory. One is the use of a portable photometer in which the brightness is varied by changing the distance between a calibrated lamp and a diffusing screen over which is fitted an opaque stencil pierced with figures to match the dial under test. This photometer is bulky and not very easily portable. In particular, it is not at all adapted to testing dials already installed, unless they are dismounted for purposes of test.

The second method is to prepare a self-luminous screen made by mounting a layer of luminous powder between two sheets of glass. This is fitted with an opaque stencil to match the dial to be tested. Although this arrangement is readily portable, it merely permits the observer to determine whether the dial is brighter or dimmer than the standard. Furthermore, such standards of brightness are subject to the steady deterioration of all self-luminous compounds.

The writer has approached the problem with the point of view of providing a very compact photometer in which the brightness is controlled by varying the current through the lamp at a fixed distance from the diffusing screen. In working out such an arrangement, he has followed the design as suggested by B. H. Crawford [1] in which the variation of brightness is produced by changing the current through a lamp placed in one arm of a wheatstone-bridge circuit. A milliammeter is connected to read the out-of-balance current produced by changes in the resistance of the lamp as the applied voltage is changed. This paper describes an instrument built on this principle, adapting an arrangement described previously [2] for measurement of luminous powder in the dry state to the measurement of completed dials.

II. DESCRIPTION OF INSTRUMENT

Figure 1 shows the luminous disk in elevation, and a cross-section view of the luminous disk which is used to obtain a comparison of brightness with the self-luminous dials. The disk is made up of two pieces of opal glass O, clamped to each side of a green-glass disk G, which is cut from a Corning green railway-signal roundel having a transmission of approximately 140 percent on the American Railway Scale. The opal-glass disks are each about ⅛ inch thick. Back of these glasses a flat-white diffusing reflector D is mounted. The shape of this reflector is not very important. A hemispherical surface would do very well. However, such a shape would make the depth of the cell greater than is desirable. The nature of the surface is, however, quite important. The best surface is obtained by "smoking" with burning magnesium. Care must be taken to prevent any contact with this surface after it has been prepared. A 3-cell flashlight bulb F projects through a hole in the center of the reflector D. This bulb is fitted with an opaque cap C. In this way practically uniform illumination is obtained over the whole of the glass disk, although the cell is only 2 inches deep, as indicated by the scale at the bottom of the drawing.

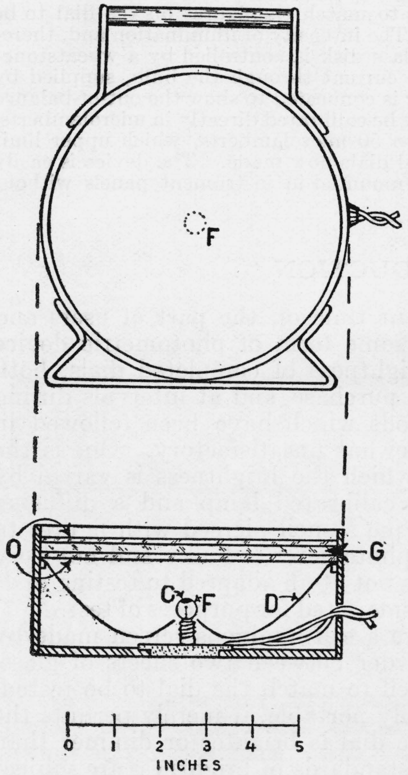

FIGURE 1.—*Luminous disk in elevation and cross section.*

The wheatstone-bridge resistors, rheostats, battery, and meter are contained in a separate small aluminum box with bakelite cover, shown in the drawing in figure 2. This box is connected with a flexible 2-wire cable to the flashlight bulb shown at F in figure 1. The wiring diagram of the complete arrangement is shown in figure 3.

[1] J. Sci. Instr., **11**, 14 (1934).

[2] J. Research NBS **13**, 203 (1934) RP702.

The values of the resistances of the various arms of the bridge are indicated. The voltage applied to the bulb, supplied by 2 flashlight cells, is controlled by the radio-type rheostats R_1 and R_2. The one of lower resistance is used when a fine adjustment of brightness is desired. Since the flashlight bulb is always operated well below its rated voltage, it can be expected to give long service with a fairly stable calibration. Unless subjected to abuse, this instrument should require recalibration only at very infrequent intervals. The milliammeter M, having a full-scale deflection of 1.5 milliamperes, is connected as shown to measure the out-of-balance current of the bridge. Its readings are, therefore, approximately proportional to the brightness of the lamp. The exact relation is of no importance since it is simpler to calibrate each instrument separately. The instrument is calibrated by observing the brightness of the luminous disk, by comparison with that of a screen of known transmission illuminated by a standard lamp, at various readings of the milliammeter. In this way the scale of the meter may be graduated directly in microlamberts.

The actual values of the resistances may vary slightly in different instruments since careful adjustment of at least one of the arms of the wheatstone bridge is required to bring the out-of-balance currents of the wheatstone bridge within the range of the milliammeter selected.

The values given in figure 3 should be convenient for making the necessary preliminary adjustments.

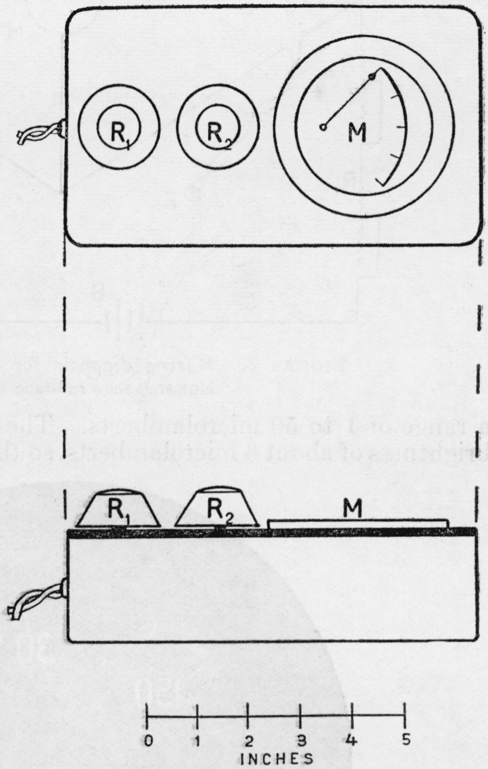

FIGURE 2.—*Top and side view of control box for luminous disk.*

To complete the instrument, a stencil cut from opaque material with characters to match those on the dial is required. This stencil is clamped to the front of the luminous disk. Such a stencil is shown in figure 4. In making measurements, the luminous disk with stencil is placed beside the dial to be tested and the brightness varied until a match is obtained. This method gives sufficient accuracy for all practical purposes. Measurements on unmounted dials may be made with the comparison dial resting on the base provided to hold it in an upright position. However, this part of the apparatus is thin and light enough so that it may be held near a dial mounted in an instrument panel so that a measurement can be obtained without removing the dial.

A photograph of a completed instrument is shown in figure 5. The total weight is about 6 pounds. As described, this instrument has

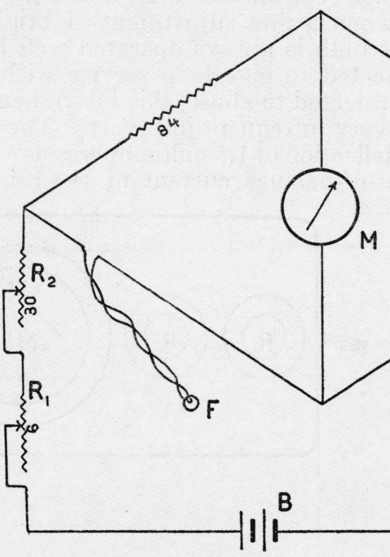

FIGURE 3.—*Wiring diagram for the brightness meter.*
Numerals show resistances in ohms.

a range of 1 to 50 microlamberts. The average luminous dial has a brightness of about 6 microlamberts, so this range is entirely adequate.

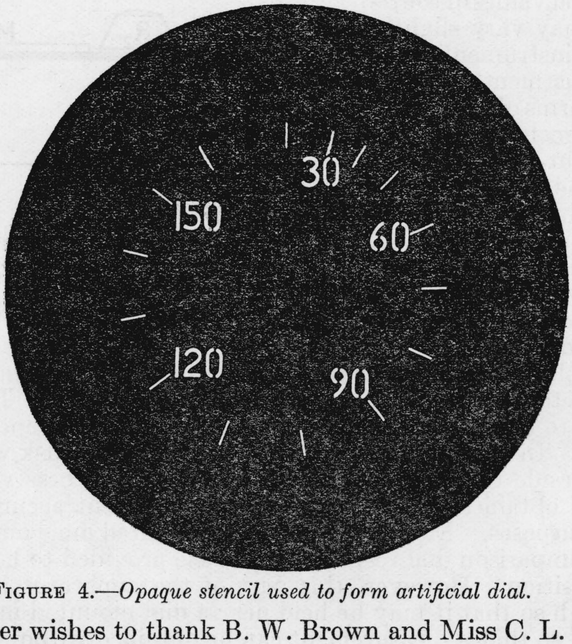

FIGURE 4.—*Opaque stencil used to form artificial dial.*

The writer wishes to thank B. W. Brown and Miss C. L. Torrey for help in designing the instrument.

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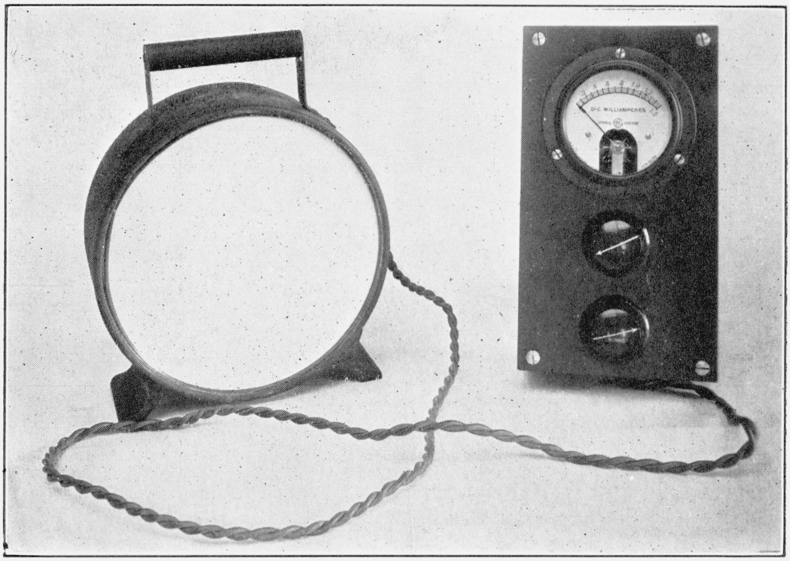

FIGURE 5.—*Completed brightness meter.*