

- (21) Application No. 20453/77 (22) Filed 16 May 1977
 (31) Convention Application No. 4 836 (32) Filed 25 June 1976 in
 (33) Italy (IT)
 (44) Complete Specification published 8 Oct. 1980
 (51) INT. CL.³ G03B 27/22
 (52) Index at acceptance
 G2A 315 316 C15 C23 C3 C5 CT



(54) DEVICE FOR DETERMINING THE COLOUR
 COMPOSITION OF PRINTING LIGHT IN PHOTOGRAPHIC
 ENLARGING APPARATUSES

(71) We, DURST AG., a body corporate organised according to the laws of Italy, of Gerbergasse 58, Bozen, Italy, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

The invention relates to devices for determining the colour composition of printing light in photographic enlarging apparatus.

Prior forms of such measuring devices have a measuring probe which contains at least one photo-electric transducer, and which is introduced into the printing light ray path immediately below the objective of the enlarging apparatus during the measuring operation. The measuring probe is connected by way of an electrical lead to an evaluating apparatus containing a measuring circuit and an indicator unit. One form of measuring device is miniaturised to such an extent that the measuring probe and evaluating apparatus form one unit which can be pivoted into the path of rays immediately below the objective of the enlarging apparatus for the measuring operation.

The introduction of a measuring probe or a measuring device into the path of rays leads to rather complicated manipulation, since the objective which is covered over by the measuring probe during measuring must be free during the printing operation in order that the printing light can reach the projection surface. This disadvantage is particularly noticeable when the filter determination for which the measuring apparatus is used takes place before the printing operation for each individual original, since frequent introduction and removal of the measuring probe is then necessary.

The light which passes through the ob-

jective is influenced not only by the original which is situated in the enlarging apparatus during the measuring operation, but generally also by a variable aperture diaphragm. If each colour component of the printing light is measured on its own rather than being compared to another colour component, care must be taken to ensure that the same diaphragm value is set during each measurement. Measurements are normally carried out with the diaphragm fully open, since the maximum measuring light is then available. Measurements are normally also carried out with a fully open diaphragm in the case of measuring devices with which the relationship between individual colour components is measured, since it may be that only in this state is there sufficient light available for the photo-electric transducer arranged in the measuring probe. It therefore becomes necessary for the operator of the enlarging apparatus to adjust the objective diaphragm before and after the measuring operation, since printing is not carried out with a fully open diaphragm in most cases.

Enlarging apparatuses are known which allow prints to be made in daylight or with lighting similar to daylight, being provided for this purpose with a lightproof closed screening arrangement between the objective and the projection surface. Apparatuses of this type suffer from the disadvantage that the introduction of a measuring probe below the objective is very complicated, since the screening arrangement must be removed for this purpose and fitted again for the printing operation.

The invention provides a device for determining the colour composition of the printing beam in photographic enlarging apparatus, which comprises one or more light-sensitive receivers, and means for mixing light from the printing beam and for transmitting it to the light-sensitive

receivers, the transmitting and mixing means being capable of being introduced in use into the path of the printing beam between the original and the objective.

- 5 With such measuring devices, the measurements are independent of the diaphragm set on the objective, and the other disadvantages referred to can be reduced or avoided. Compared with previously known devices, the measuring device according to the invention offers the advantage of increased convenience of operation without necessitating higher costs, since sufficient light falls onto the measuring receivers either for the same relatively insensitive measuring receivers as in previously known devices to be used, or for, when using more sensitive measuring receivers, there to be no need for large expenditure on the measuring circuit; due to the high level of measurement signals available, the circuitry can be such that any errors which do arise in the circuitry will affect the measurements only to a negligible extent.

The measuring device also has the advantage that it can be used in daylight enlarging apparatus: all the operating members can be arranged outside the light-screening arrangement.

- 30 Advantageously, the light-transmitting and mixing means includes a light-transmitting shaft extending substantially parallel to the plane of the original, and having reflecting internal surfaces. Preferably, the light-transmitting shaft is of rectangular section, one side of the rectangle being small in length compared to the other, and the shaft being capable of insertion with the longer side parallel to the plane of the original. This enables the device to be used even with objectives of very short focal length when the space available between original and objective is restricted. Light diffusing means, for example, a plate, may be provided in the shaft in the path of the printing beam in its operative position.

- The light-transmitting shaft may be pivotally mounted such that it can be pivoted in beneath the original. The pivoting may be in response to actuation of a push control on the front of the apparatus. A separate push control may be provided for each filter measurement to be carried out, such that depression of the respective push control automatically ensures that the respective filter measurement will take place. The push controls may be spring-biased into the inoperative position.

- 60 A device for measuring the colour composition of a printing beam in photographic enlarging apparatus, will now be described, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a plan view of the measuring device;

Fig. 2 is a front view of the head of an enlarging apparatus provided with the measuring device;

Fig. 3 shows a longitudinal section through a light-transmitting and mixing shaft of the measuring device; and

Fig. 4 shows a circuit for the measuring device.

The housing 1 of the measuring device is attached by means of two screws 2 and 3, for example, to an opening on the front of the head 4 of a photographic enlarging apparatus in the space between a support 5 for the original (for example, a negative) being printed, and the objective 6 of the enlarging apparatus. The housing 1 contains a plate 7 on which a light-transmitting and mixing means, for example, a light-transmitting shaft 8 (to be described hereinafter), is pivotally arranged.

In order to measure the colour composition of the printing beam, the shaft 8 is pivoted into the path of rays of the printing beam (which issue from a light source arranged in the head 4), that is, into the position indicated by solid lines (Fig. 1), below the original 9 in the original support 5. In this position the light-transmitting shaft 8 receives the light-transmitted through the original 9, and the light is mixed inside the shaft and led to three measuring receivers 41, 42 and 43, for example, which are situated in the housing and each of which is made sensitive to one of the three primary colours red, green or blue by means of a corresponding colour filter. In the rest position, that is, when not in use, the light-transmitting shaft 8 is pivoted out of the path of rays and can for example be situated in the position indicated in the drawing by broken lines.

The pivoting movement of the light-transmitting shaft 8 is controlled by drive means which are operated from the front of the enlarging apparatus, although the drive means can be operable from elsewhere if desired. The drive means consists of a lever 11 which is pivotable about an axis of rotation 10 and is provided with a toothed arcuate rim 13 engaging in a gear-wheel 12 rigidly connected to the light-transmitting shaft 8; the lever 11 is actuated by means of two push controls 14 and 15 which are mounted on the front of the housing 1. Two push controls are provided since (as will be explained hereinafter) two measurements are made to determine the colour composition of the light. The push controls slide in corresponding guides (not shown), and each has a projection 16 or 17, respectively. The projections 16 and 17 are so arranged that they both engage with the lever 11 at approxi-

mately the same position along its length. When one of the push controls 14 or 15 is moved by the operator in the direction of the arrow G, the lever 11 rotates about its axis of rotation 10 in the direction of the arrow F and, by means of the gear-wheel connection described, causes the light-transmitting shaft 8 to rotate in a clockwise direction about its axis of rotation 8a (Fig. 3).

The light-transmitting shaft 8 can thus be pivoted into the path of the printing rays, where its end position is determined by means of a stop 18. The return of the light-transmitting shaft 8 to its rest position is brought about by means of a spring 19 (for example) which engages with the lever 11 and is tensioned during the pivoting movement. Thus, the light-transmitting shaft 8 is only pivoted into the path of rays when the operator applies pressure to one of the push controls 14 or 15. When the controls are released, the light-transmitting shaft returns automatically to the rest position and thus moves out of the printing beam. Due to the positioning of the projections 16 and 17 close to each other, the force that has to be exerted on the two push controls 14 and 15 is approximately the same.

The light-transmitting shaft 8 is preferably rectangular in cross-section, and its height is small in relation to the length of the side running parallel to the plane of the original. Due to this flat shape, the light-transmitting shaft 8 can be used in enlarging apparatus fitted with a short focal length objective (when the space between the original 9 and the objective 6 will be restricted).

The light-transmitting shaft 8 can be produced from sheet-metal having a mirror surface on the inside (for example), and having, on the side facing the original, a light-collecting aperture containing diffusing means, for example a diffusing plate 20. The latter preferably corresponds in area to that of the original 9 (defined by the dash/dotted lines), so that practically all the light passing through the original can enter the light-transmitting shaft 8 when the latter is in its pivoted-in end position. In order to increase the light absorption through the diffusing plate 20 and/or to reduce reflection, the surface of the plate that faces the original is preferably roughened or constructed in a saw-tooth shape. At the end which is situated over the measuring receivers in the pivoted-in position (Fig. 3), the light-transmitting shaft 8 has a light outlet aperture which is so shaped that the transmitted light is guided onto the measuring receivers.

Due to the fact that the light is diffused by means of the diffusing plate 20 at the

entry of the light-transmitting shaft 8 and is also intensively mixed in the latter by multiple reflection, measuring light of the same colour composition reaches each filter in front of the individual measuring receivers so that measuring errors due to uneven colour distribution in the original do not occur. The amount of measuring light fed to each measuring receiver can be controlled by means of suitable diaphragms, such as screws 24, 25 and 26 received in corresponding threaded holes 21, 22 and 23 respectively. This makes it possible to calibrate the measuring device in a manner which will be briefly summarised herein-after.

Fig. 4 shows a possible circuitry arrangement 40 for the evaluation of the measurement signals. The measuring receivers are in the form of three photo-resistors 41, 42 and 43. The photo-resistor 41 is sensitive to red, for example, the photoresistor 42 to green, and the photoresistor 43 to blue (primary colours), and the sensitisation for each of these primary colours is achieved by means of colour filters as already mentioned which are arranged in front of the photoresistors. The circuit operates by comparing the ratios of the intensities of the green component and the red component, and of the blue component and the red component. Two measurements are thus made, and a changeover switch 46 is provided to enable each to be made. The use of circuitry for comparing colour components is described and claimed in the Complete Specification of the Applicants Patent Application No. 39587/75 (Serial No. 1521272).

The changeover switch 46 is coupled to the means for pivoting the light-transmitting shaft 8 into its operative position. As will be explained hereinafter, the changeover switch 46 is switched by the push controls 14 and 15.

The photoresistor 41 and either one of the photoresistors 42 or 43 are arranged in two adjacent branches of a resistance measuring bridge, which is completed by fixed resistors 44 and 45 in the other two branches. By means of the changeover switch 46, either the photoresistor 42 or the photoresistor 43 can be switched into the measuring circuit. The measuring bridge is supplied across one diagonal by a voltage source 47. The measurement signal is picked off across the second diagonal and fed to a differential amplifier 48 which has its output connected in a known manner to two lamps, for example, two light-emitting diodes 49 and 50, connected in parallel with the voltage source. Resistors 51 and 52 serve to limit the current in the current circuit of each of these light-emitting diodes. When the measuring

bridge is detuned, only one of the two light-emitting diodes 49 or 50 lights up, depending on the direction of detuning, while both light-emitting diodes light up with equal intensity when the bridge is balanced. When the photo-resistor 42 is connected to the measuring bridge by means of the changeover switch 46, the ratio of the primary colours red and green in the printing beam is measured, whereas in the second position of the changeover switch, in which the photo-resistor 43 is connected, the ratio of the primary colours red and blue is measured.

The measuring bridge is tuned, that is, balanced, first during the calibration of the measuring apparatus. This is done by adjusting the quantity of light which meets the photo-resistors, that is, by adjusting the screws 24,25 and 26. The bridge is also balanced during the actual measurements for determining the colour composition, by suitably altering the colour composition of the printing light by means of colour filters; this is preferably achieved by using as the printing light source a so-called colour mixing head 27 in which the primary colour proportions of the printing light emitted can be continuously varied. The variation is produced by introducing filters in the subtractive colours yellow, blue/green (cyan) and purple (magenta) by varying amounts into a beam of white light emitted by a light source. The depth of introduction of the individual filters determines the colour density of the printing light in the colour in question. The individual colour filters are moved by means of setting members 28,29 and 30 respectively; the corresponding filter position is indicated on corresponding scales 31,32 and 33.

It is not necessary in most cases for the blue/green filter to be introduced into the path of rays, or for its position to be altered with respect to a previous printing situation, and so the balancing operation is generally confined to altering the depth of introduction of the yellow and purple filters. For this reason, separate actuating controls, that is, the push controls 14 and 15, are associated with each of these filter colours.

For example, the push control 14 might be associated with the filter colour yellow and the push control 15 with the filter colour purple. One of the two push controls, for example, the push control 14, has the changeover switch 46 associated with it in such a manner that the contact position of the switch depends on the position of the push control. Thus, either the photo-resistor 42 or the photo-resistor 43 is switched into the measuring circuit, depending on which push control is actuated. For example, the switching contact of the

changeover switch 46 could be in the position shown in the drawing, in the rest position of the push control 14. In this position, the blue-sensitive photo-resistor 43 is connected, but on actuation of the push control 14 in the direction of the arrow G, the switching contact of the changeover switch 46 switches into its second position and connects the green-sensitive photo-resistor 42.

As a result of this arrangement, when the push control 14 is actuated the ratio of the primary colour components red and green is measured, which ratio can be influenced by means of the purple filter in the colour mixing head 27, and when the push control 15 is actuated, the push control 14 then being in the rest position, the ratio of the primary colour components red and blue is measured, which ratio can be influenced by means of the yellow filter in the colour mixing head 27.

In order to ensure that measurement cannot take place until the light-transmitting shaft 8 is fully pivoted into its end position beneath the original, it is of advantage to provide an end switch actuated by the light-transmitting shaft 8 when it reaches its end position. An end switch of this type is shown in Fig. 4 by the reference number 53. In its normal position the switch 53 interrupts the current supply to the measuring bridge and is closed when the pivoted-in end position of the light-transmitting shaft 8 is reached, but opens again automatically when the light-transmitting shaft leaves its end position again. The changeover switch 46 and the end switch 53 are shown only in Fig. 4 and not in the other Figures, but the association of the switches with the corresponding mechanical parts presents no problems.

The two light-emitting diodes 49 and 50 are mounted visibly on the front of the housing 1. All components relating to the measuring circuit are arranged inside the housing 1. The colour filtering of the printing light needed for the printing operation is determined in the following manner.

First the push control 14 is actuated, whereupon the changeover switch 46 is switched over and the photo-resistor 42 is connected in the measuring circuit. As described above, the light-transmitting shaft 8 is simultaneously pivoted into the printing beam beneath the original 9. When the end position is reached, the end switch 53 is switched over by means of the light-transmitting shaft 8 and the current circuit is closed, whereupon the measuring circuit is switched on. Generally only one light-emitting diode lights up, indicating that the measuring bridge is out of balance and a filter value other than the one just set is necessary for a correct print. The position

of the purple filter in the colour mixing head 27 is then altered by actuation of the appropriate setting member until both luminous diodes are of equal brightness.

5 After balancing, the push control 14 is released. Thereupon the light-transmitting shaft 8 returns to its rest position, the end switch 53 opens interrupts the current circuit, and the contact of the changeover
10 switch 46 returns to its initial position, disconnecting the photo-resistor 42 from the measuring circuit and connecting the photo-resistor 43. The second push control 15 is then actuated. Since the latter has no
15 effective connection with the changeover switch 46, the photo-resistor 43 remains connected to the measuring circuit and the rest of the operation takes place in the manner just described. In this case the
20 ratio of the primary colours red and blue is measured, with the measuring bridge being tuned by suitable adjustment of the yellow filter by means of the corresponding setting member. After these two tuning
25 operations, a colour filtering of the printing light corresponding to correct colour balance for the subsequent printing is obtained. It is necessary also to alter the position of the blue/green filter in the
30 colour mixing head 27 only when the measuring bridge cannot be balanced by means of the two tuning operations described above is.

As stated above, the measuring operation
35 is preceded by a calibration operation during which a print with satisfactory colour balance is produced in a known manner from an original with an even colour distribution by means of test
40 exposures. When these filter values for a satisfactory print have been experimentally determined, the original used for the test print is introduced into the original support 5. Then the two push controls 14 and 15
45 are actuated in the manner already described, and the measuring bridge is balanced in each case, but as compared with the procedure described previously, the bridge is balanced not by further adjustment of the colour filters but by adjustment
50 of the screws 24,25 and 26. The latter are moved in front of the individual photo-resistors 41,42 and 43 to control the light incident thereon, to such an extent that the measuring bridge is balanced for both of
55 the positions of the contact of the changeover switch 46. The position of the screws 24,25 and 26 determined during calibration need then only be altered if originals with different characteristic colour distributions
60 are being printed, or if printing paper is used which has different characteristics from those of the paper used during calibration.

65 The balancing of the measuring bridge

can be achieved not only by way of a colour mixing head but also by any means with which the colour composition of the printing light can be altered. Thus, measurement of the necessary colour composition can be carried out with the printing light unaltered during the measuring operation, if corresponding adjustable resistors, for example, potentiometers, are arranged in those bridge branches where
70 fixed resistors 44 and 45 are used in the arrangement described. In this case, the actual potentiometer position at which the bridge equilibrium is reached provides a measurement for the filter values required.
75 The calibration values may be stored by means of corresponding potentiometers in the measuring bridge.

It is not necessary for the light-transmitting and mixing means, like the
80 light-transmitting shaft 8 shown in the drawing, to receive light from almost the whole of the original. To obtain usable results it is sufficient to measure an important section of the image, which generally lies in the centre of an original. As a result, the measuring device described may also be used for originals of different
85 formats. The projection of the light collecting aperture of the light-transmitting and mixing means in the plane of the original preferably corresponds to a smaller format than the maximum that can be printed with the enlarging apparatus.

If desired, the two push controls 14 and 15 may be replaced by a single push control. In this case, the changeover switch may be operated separately. Alternatively, if a different measuring circuit is provided
90 in which separate measurements are made on all three components, it may be desirable to provide three push controls.

WHAT WE CLAIM IS:

1. A device for determining the colour composition of the printing beam in photographic enlarging apparatus, which comprises one or more light-sensitive receivers, and means for mixing light from the printing beam and for transmitting it to the light-sensitive receivers, the transmitting
110 and mixing means being capable of being introduced in use into the path of the printing beam between the original and the objective.

2. A device as claimed in claim 1, wherein there is provided light diffusing means associated with the light entry region of the light transmitting and mixing means.

3. A device as claimed in claim 1 or claim 2, wherein the light-transmitting and mixing means includes a light-transmitting shaft extending substantially parallel to the plane of the original and having reflecting internal surfaces.

4. A device as claimed in claim 3, where-
125 130

in the light-transmitting shaft is of rectangular section, one side of the rectangle being small in length compared to the other, and the shaft being capable of insertion with the longer side parallel to the plane of the original.

5. A device as claimed in claim 4, wherein there is provided light diffusing means in the path of the printing beam, in the light-transmitting shaft.

6. A device as claimed in claim 5, wherein the light diffusing means is in the form of a plate.

7. A device as claimed in claim 6, wherein the diffusing plate has a roughened or saw-tooth shaped surface.

8. A device as claimed in any one of claims 3 to 7, wherein the path of light from the light-exit region of the light transmitting shaft to the light sensitive receivers is in a direction transverse to the plane of the original.

9. A device as claimed in any one of claims 1 to 8, wherein the light-sensitive receivers are so arranged that the light exit region of the light-transmitting and mixing means is situated immediately adjacent them at least when in operation the light-transmitting and mixing means is in the path of the printing beam.

10. A device as claimed in any one of claims 1 to 9, wherein the light-transmitting and mixing means and other parts of the device are mounted on a housing which can be inserted in an opening in the enlarging apparatus.

11. A device as claimed in any one of claims 1 to 10, wherein in use at least a part of the light-transmitting and mixing means can be moved into and out of the path of the printing beam while other parts of the device remain stationary with respect to the enlarging apparatus.

12. A device as claimed in claim 11, wherein that part of the light transmitting and mixing means is resiliently biased into an inoperative position out of the path of the printing beam.

13. A device as claimed in claim 11 or claim 12, wherein that part of the light-transmitting and mixing means is pivotally mounted such that it can be pivoted into the path of the printing beam.

14. A device as claimed in any one of claims 11 to 13, wherein the light-transmitting and mixing means can be introduced into the path of the printing beam by means of a control which can be actuated from the front of the apparatus.

15. A device as claimed in claim 14 when dependent upon claim 13, wherein the control is a push control and is in operative association with a lever which is pivotable about an axis and carries a first toothed arcuate portion engaging a second

toothed arcuate portion rigidly connected to that part of the light-transmitting and mixing means.

16. A device as claimed in claim 15, wherein the first toothed arcuate portion is an end portion of the lever.

17. A device as claimed in claim 15 or claim 16, wherein the second toothed arcuate portion is the rim portion of a gear-wheel.

18. A device as claimed in any one of claims 14 to 17, wherein there is provided more than one control for moving the light-transmitting and mixing means into the path of the printing beam, each control being associated with a different measuring operation.

19. A device as claimed in claim 18, wherein there is provided circuitry for separately comparing one primary colour component with each of the other two primary colour components, and there are two controls so associated with the circuitry that actuation of each control ensures that a different comparison is made.

20. A device as claimed in claim 19, wherein there are at least two light-sensitive receivers, and the circuitry includes a changeover switch for connecting in circuit a different one of two of the light-sensitive receivers, the changeover switch being connected to one of the controls.

21. A device as claimed in any one of claims 1 to 20, wherein there are three light-sensitive receivers which are photo-resistors, and each of which is sensitised to a different one of the three primary colours.

22. A device as claimed in claim 21, wherein there is provided a resistance measuring bridge, one photo-resistor being associated with one branch, and either one of the other two photo-resistors being capable of being associated with a branch adjacent thereto, resistors with fixed or variable resistance value being associated with the other two branches.

23. A device as claimed in claim 21 or claim 22, wherein there is provided an end switch which is actuated by the light-transmitting and mixing means when the light-transmitting and mixing means reaches its operative position, the end switch being so connected to a voltage source that the source is only switched on when the light-transmitting and mixing means is in the operative position.

24. A device as claimed in any one of claims 1 to 23, wherein circuitry for evaluation of the signals from the light-sensitive receivers is contained in a housing of the device.

25. A device as claimed in any one of claims 1 to 24, wherein the light-transmitting and mixing means can be

introduced into its operative position by means of drive means actuable from the front of the enlarging apparatus.

26. A device for determining the colour composition of the printing beam in photographic enlarging apparatus substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

27. Photographic enlarging apparatus 10 having a device as claimed in any one of claims 1 to 26.

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Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1980.
Published at the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

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COMPLETE SPECIFICATION

2 SHEETS

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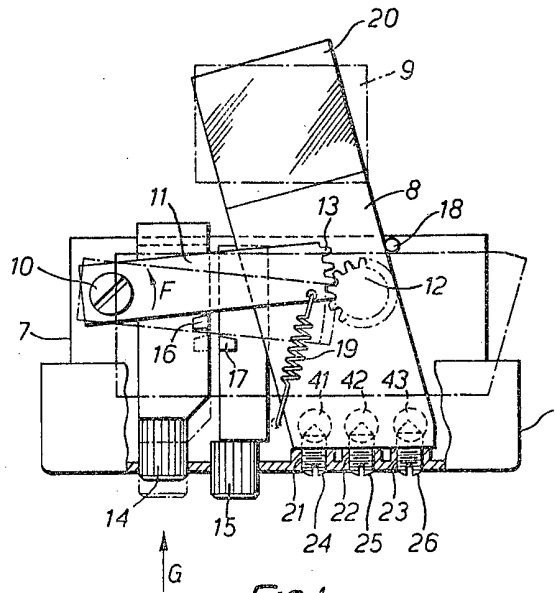


FIG. 1.

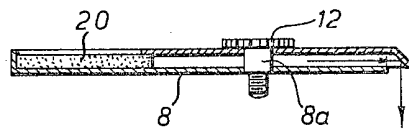


FIG. 3.

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COMPLETE SPECIFICATION

2 SHEETS

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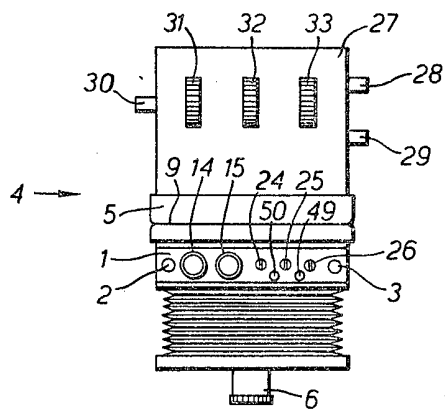


FIG. 2.

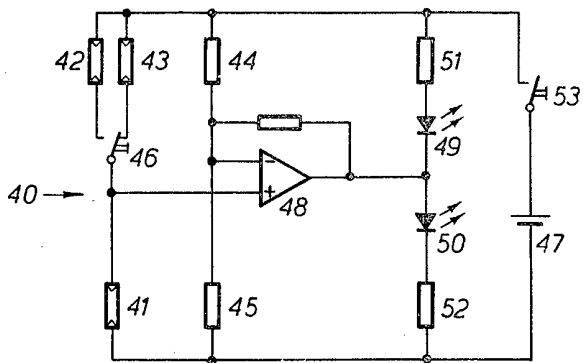


FIG. 4.