

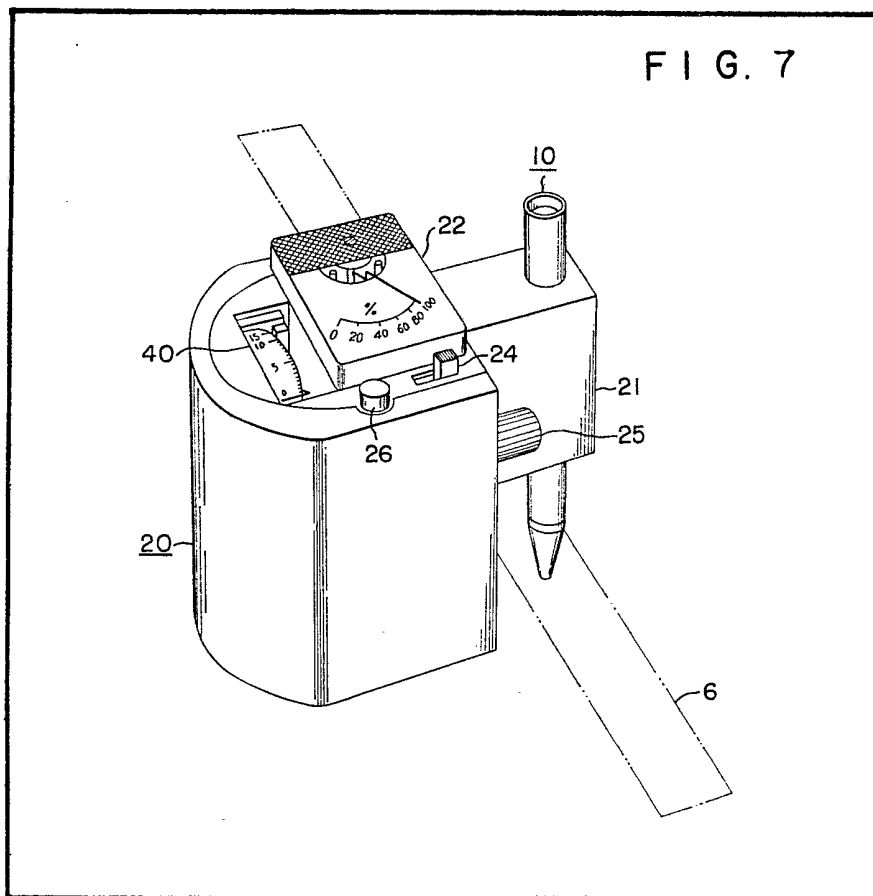
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T3 T4 T8
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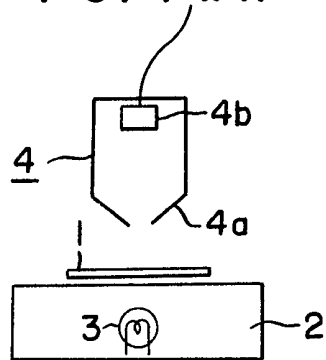
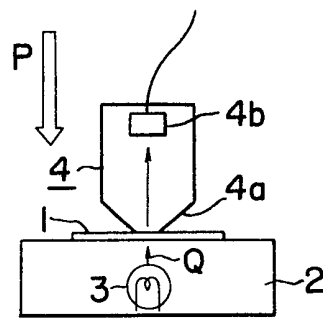
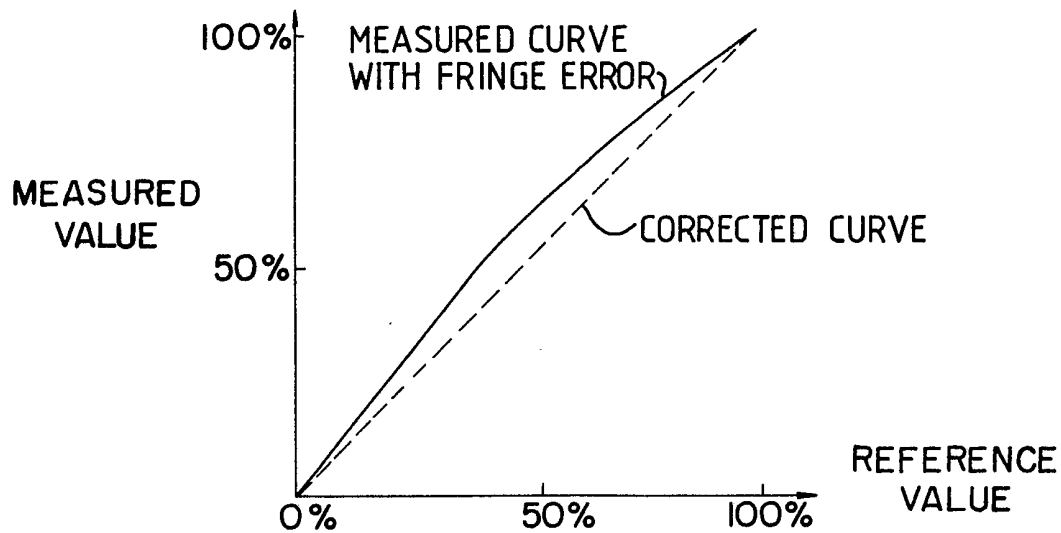
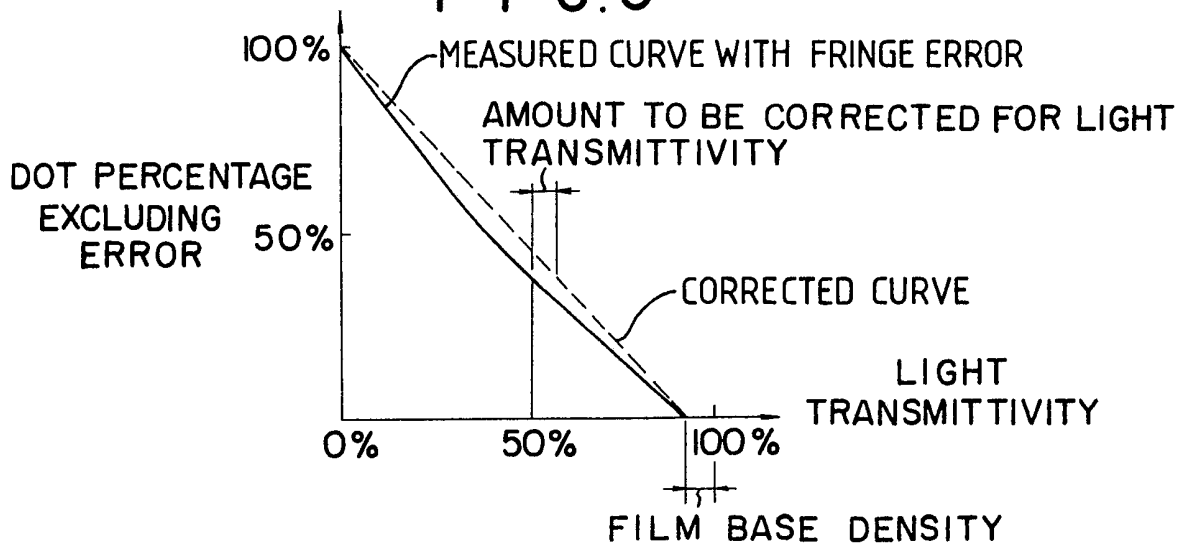
(54) **Dot percentage measuring device**

(57) In a printing process in which tones are produced by dots of various sizes, the "dot percentage" is one of the important factors which determine the quality of the printed matter, and accordingly it is essential to control the dot percentage throughout the printing process from makeup to printing. A dot percentage measuring device comprises a body 20 and a light receiving cylinder 10 mounted on a supporting arm 21 which is cantilevered from the device body 20.

The body 20 carries electrical display meter 22. Internally, light transmitted through the test piece 6 is directed to a photoelectric converter in the body 20 and the electrical output of the converter is displayed on the meter 22. The light passed through the test piece represents the dot percentage. A correction circuit to correct for the non-linear relationship between light transmittivity and dot percentage is also disclosed. The device may also include means for subtracting a first light signal from a later second signal, to indicate a change in dot percentage at 40.



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(PRIOR ART)
FIG. 1(A)(PRIOR ART)
FIG. 1(B)**FIG. 2****FIG. 3**

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FIG. 4

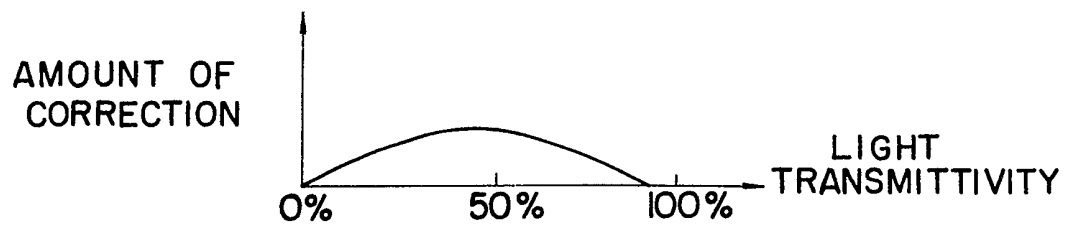


FIG. 5

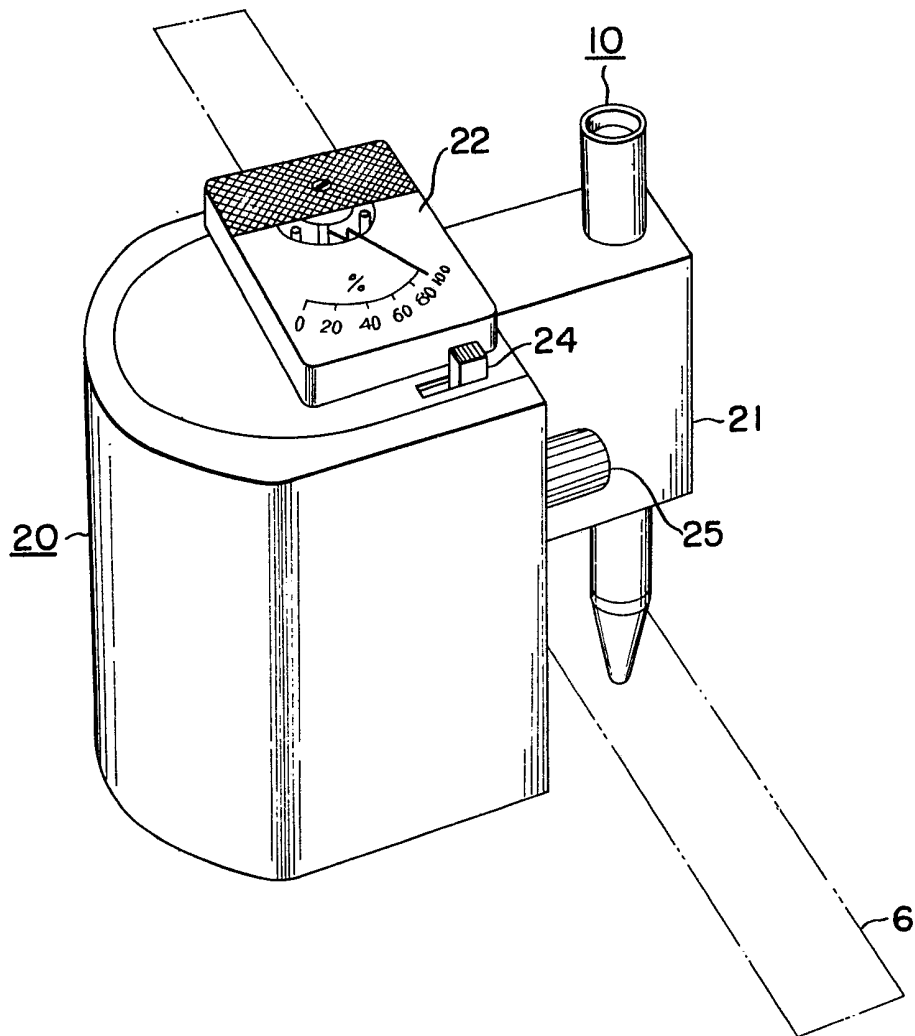


FIG. 6

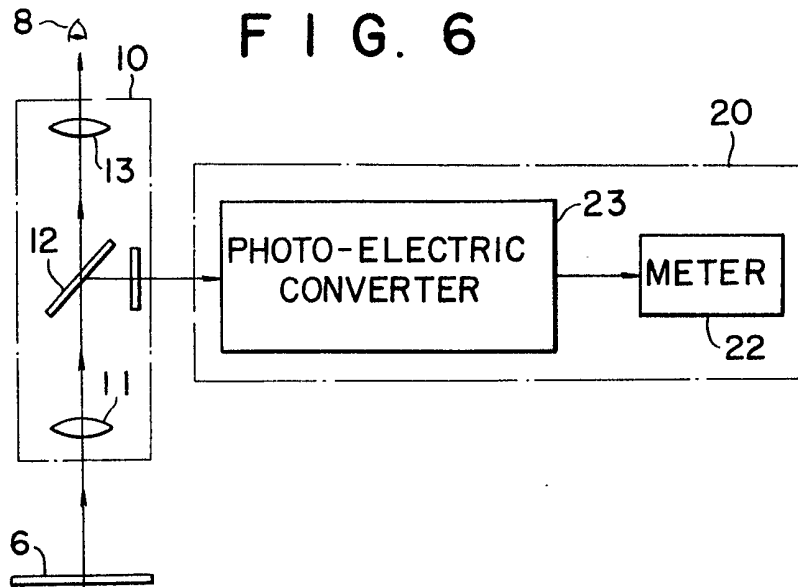
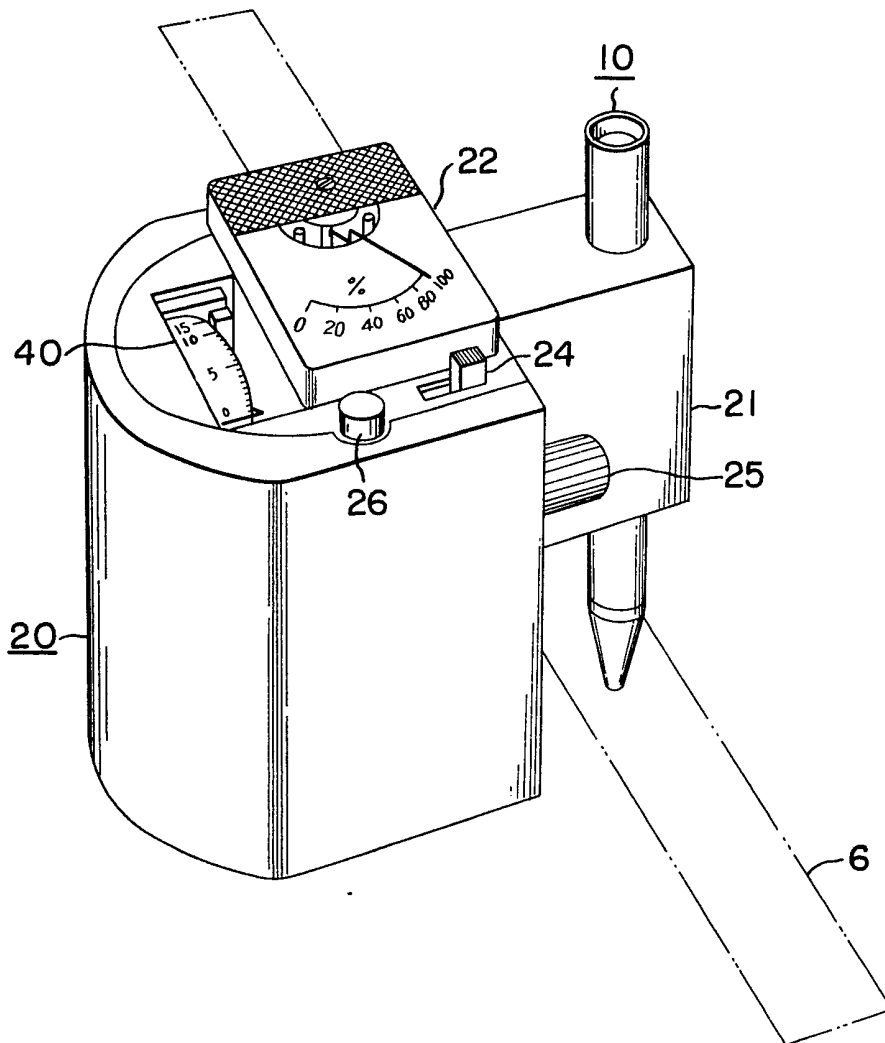


FIG. 7



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FIG. 8

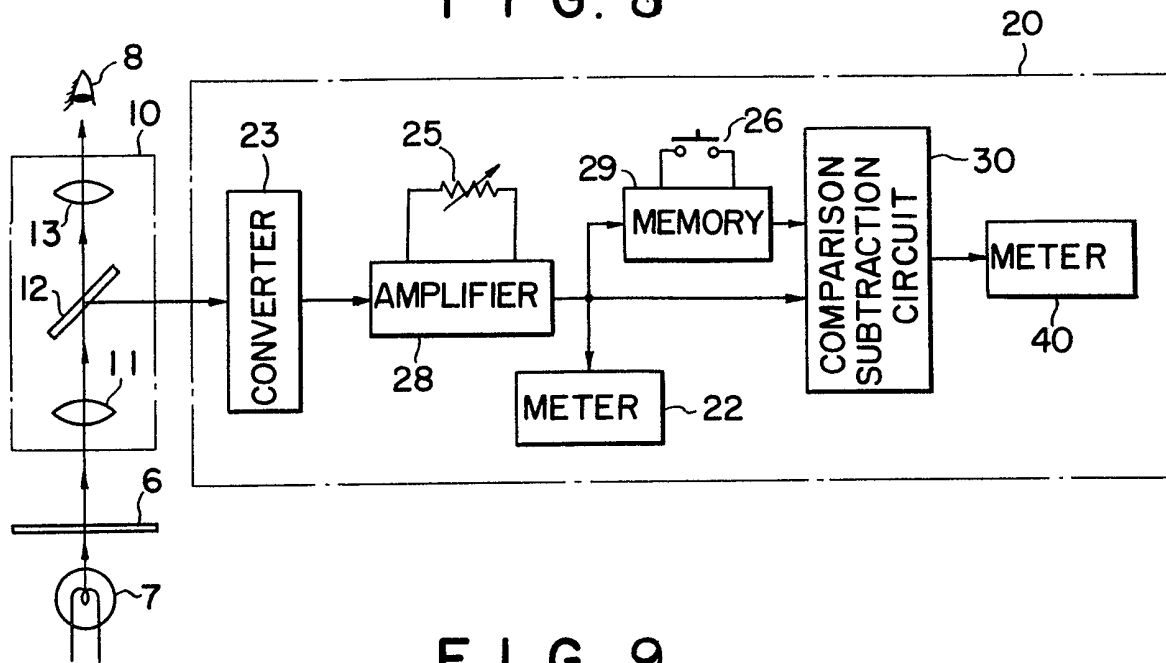


FIG. 9

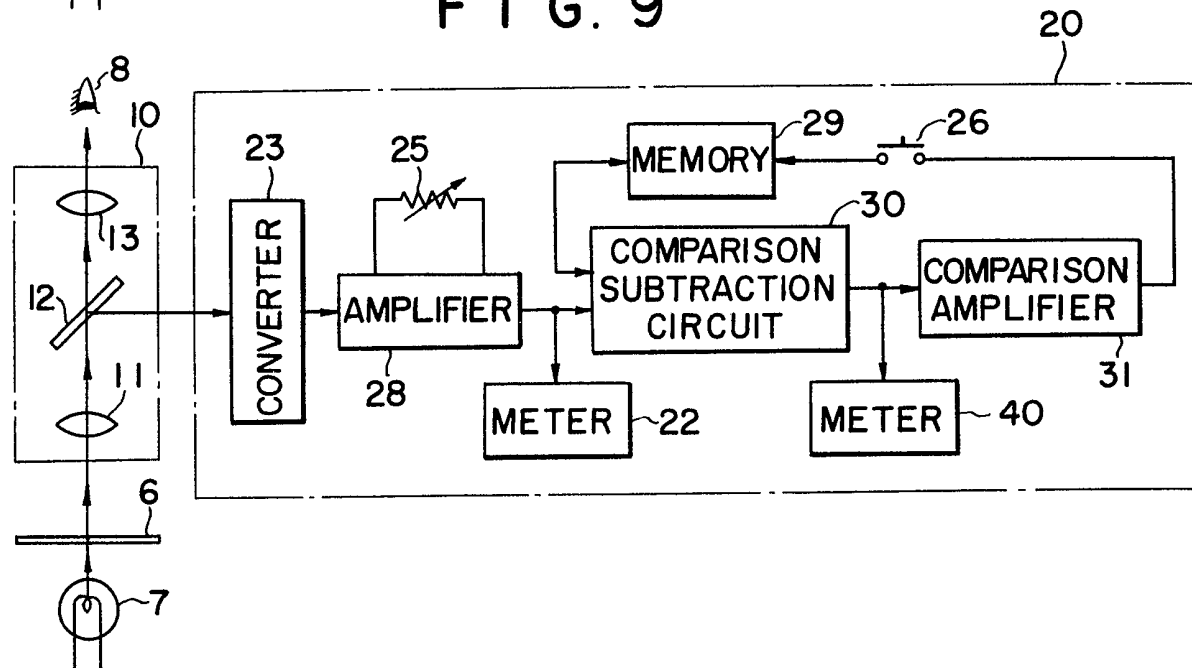


FIG. 10

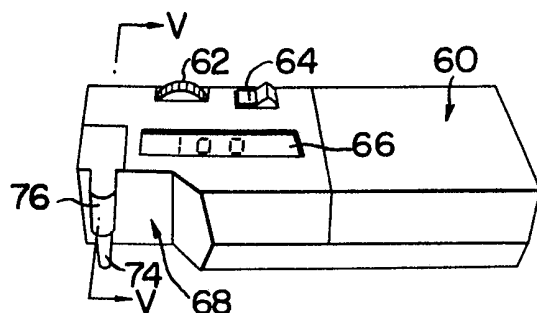


FIG. 11

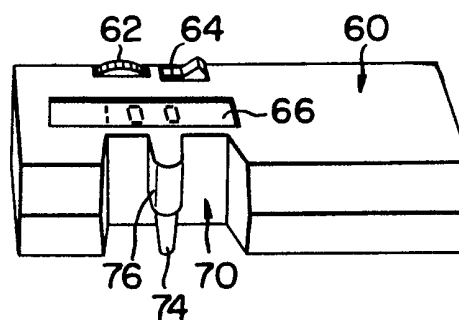


FIG. 12

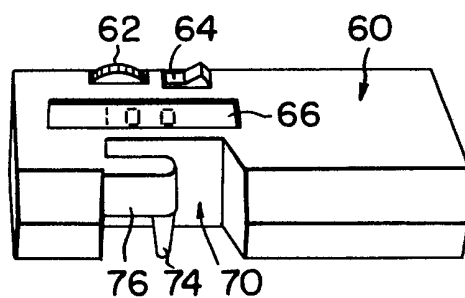
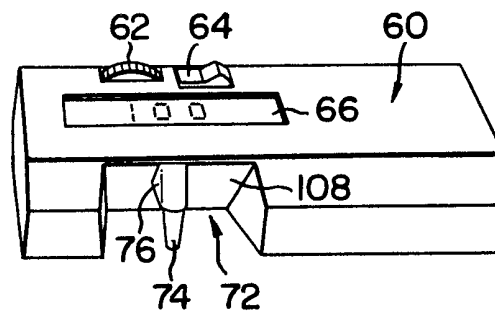
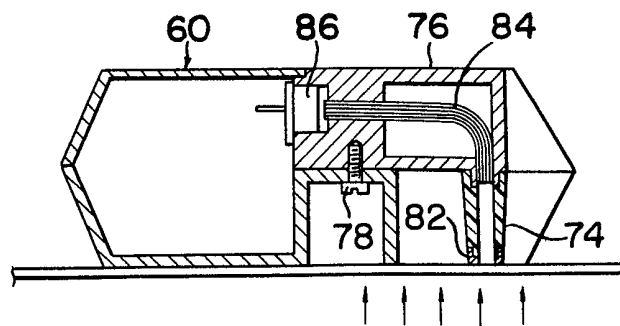


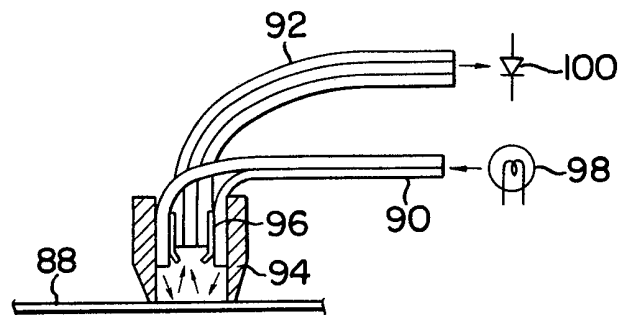
FIG. 13



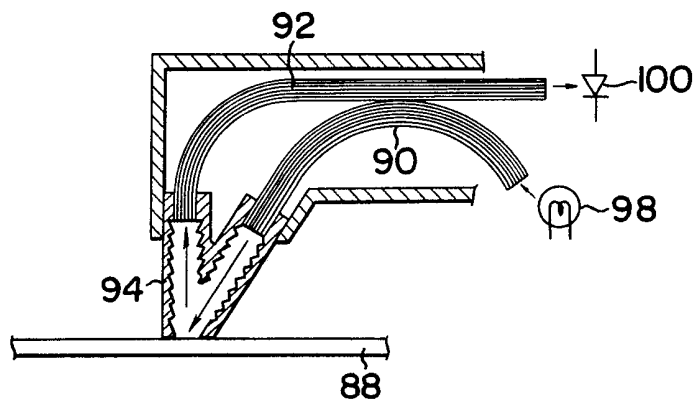
F I G. 14



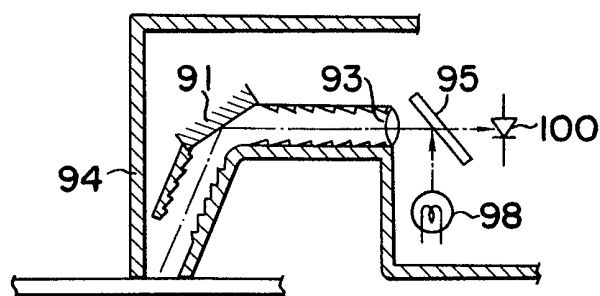
F I G. 15 (A)



F I G. 15 (B)



F I G. 15 (C)



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FIG. 16

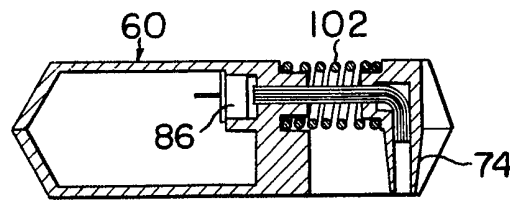


FIG. 17

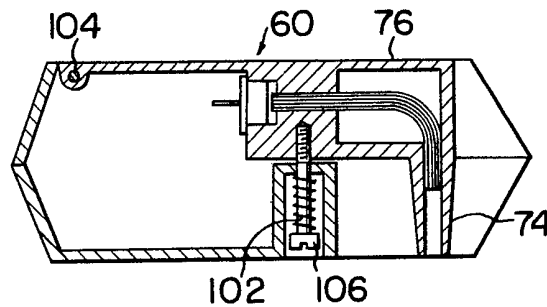
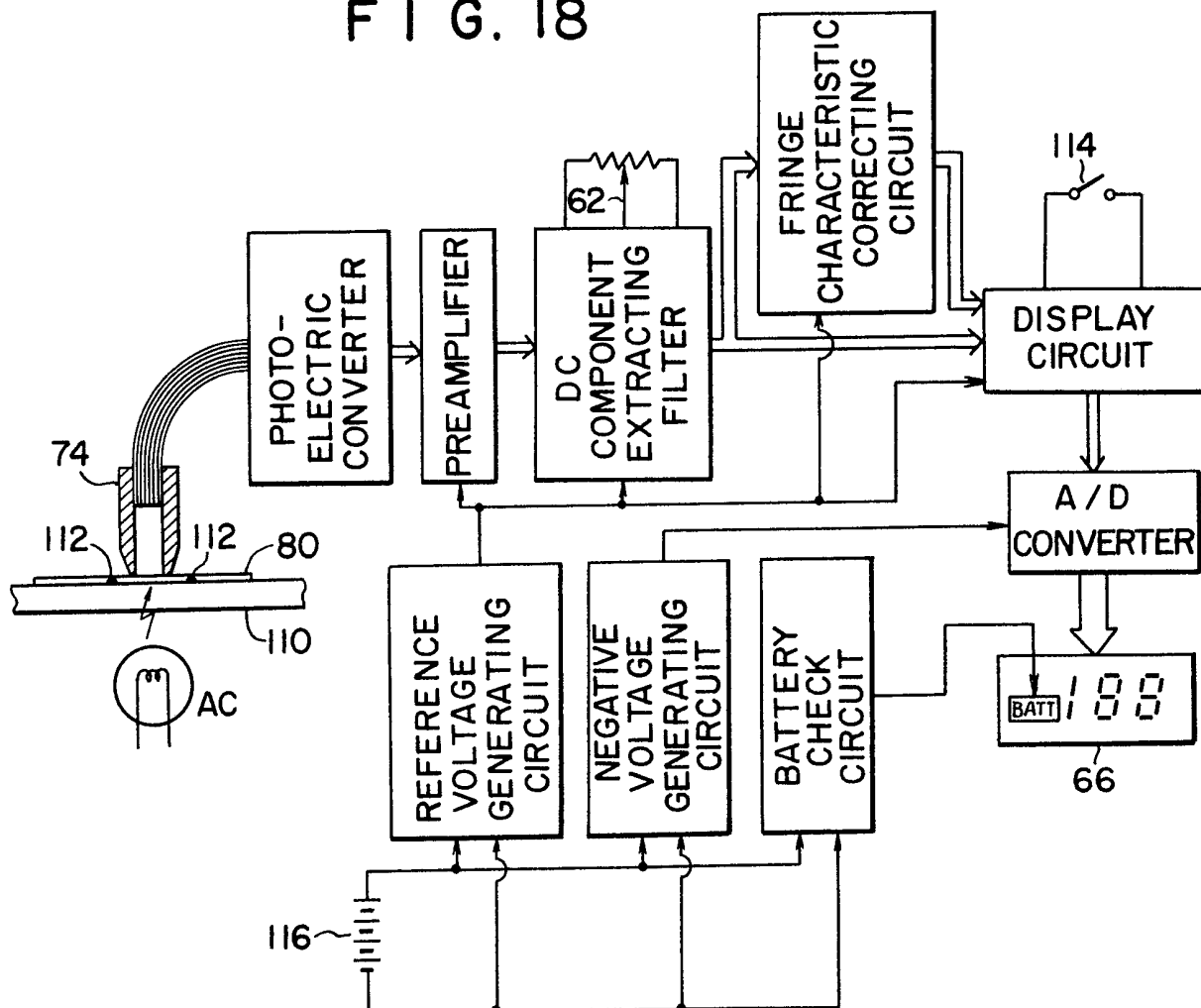


FIG. 18



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FIG. 20

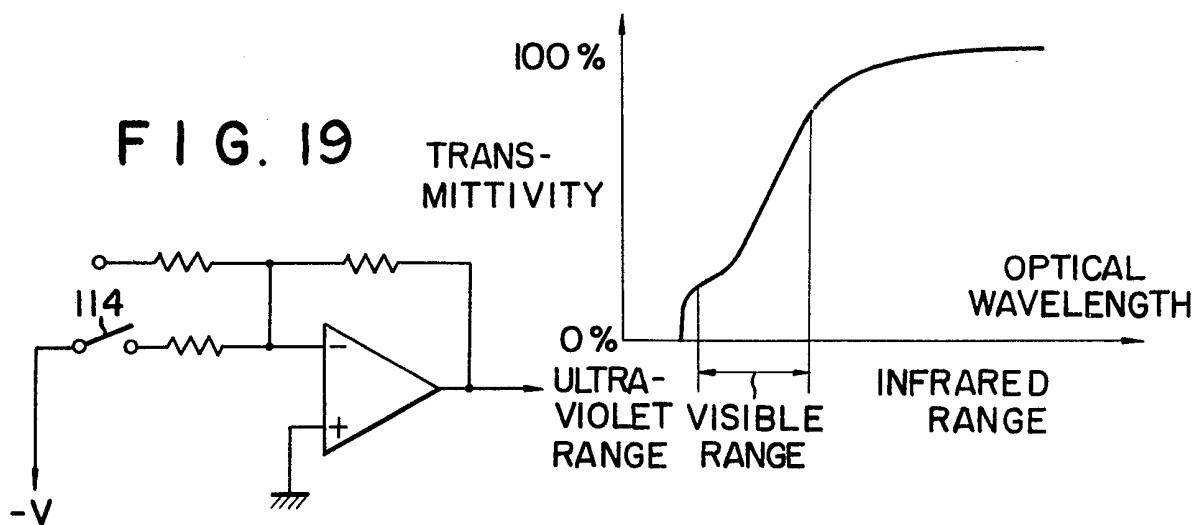


FIG. 21

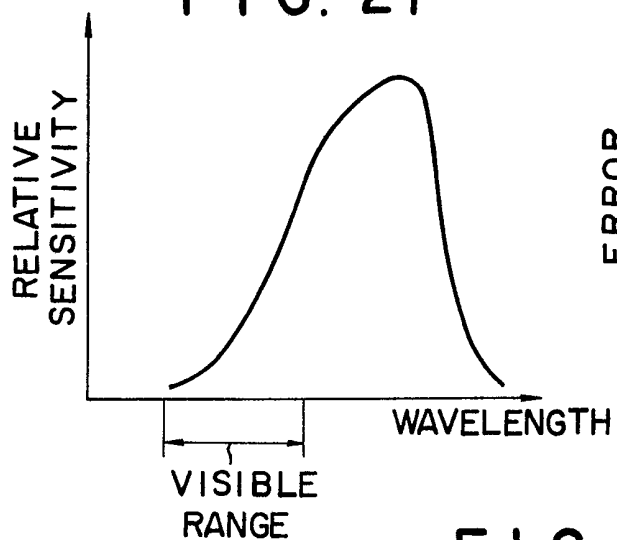


FIG. 22

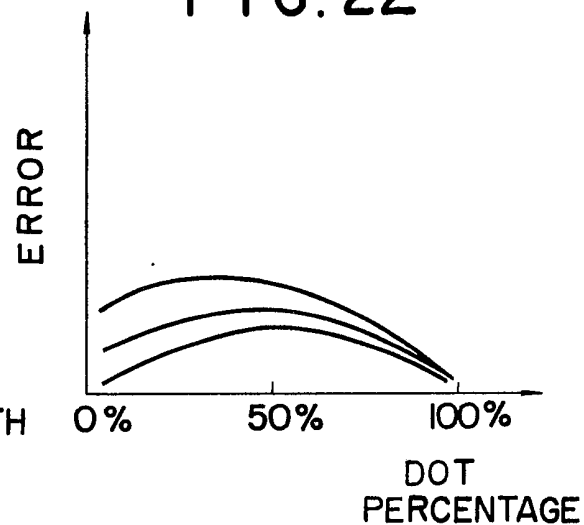
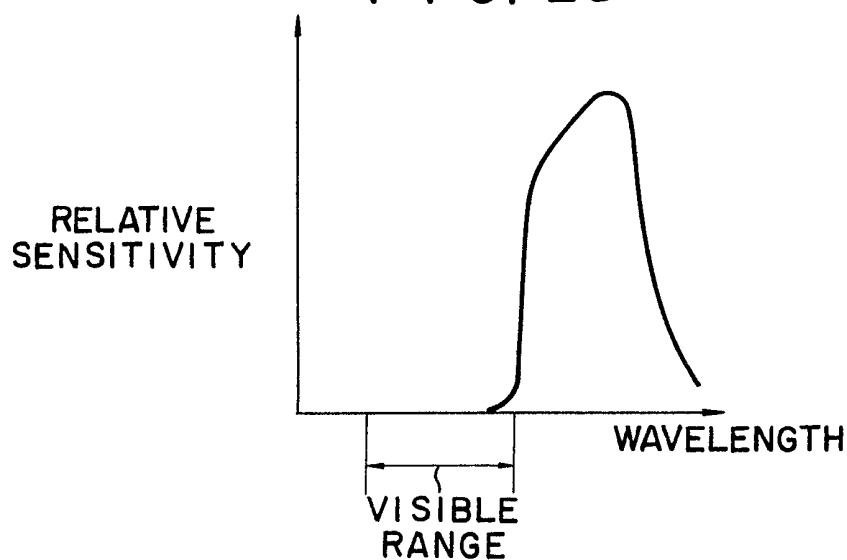


FIG. 23



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FIG. 24

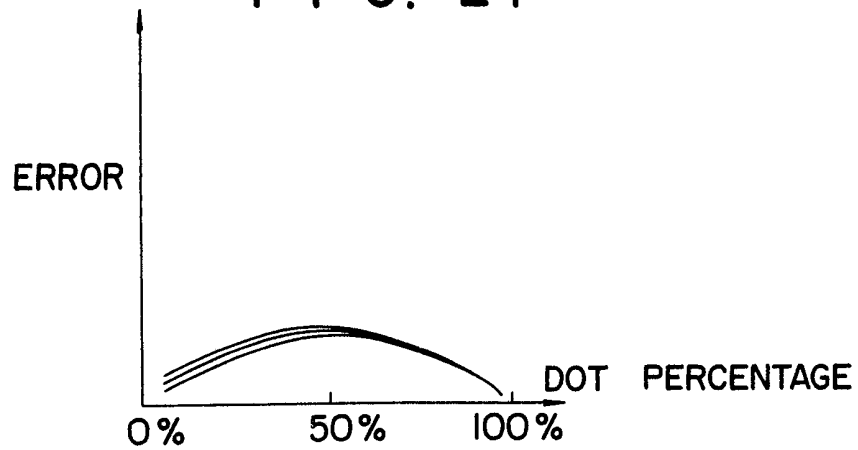


FIG. 25

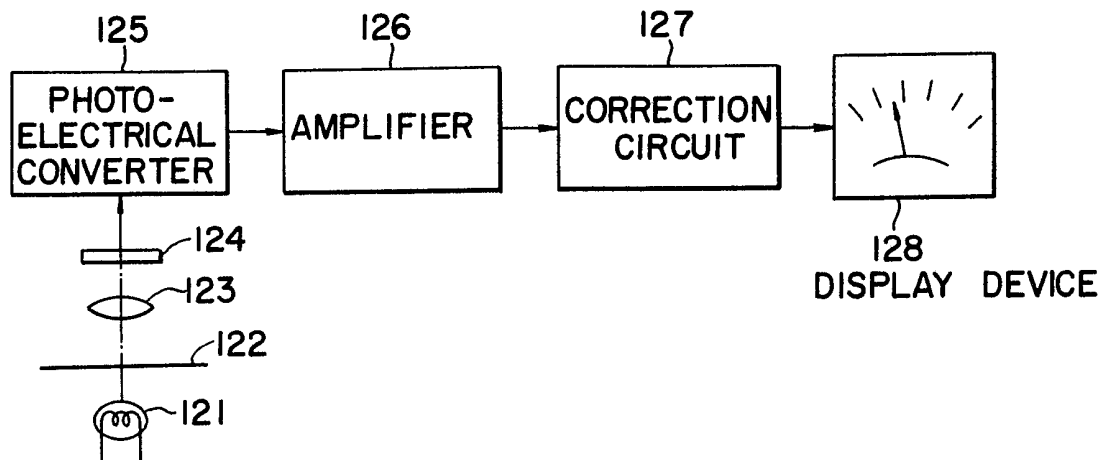
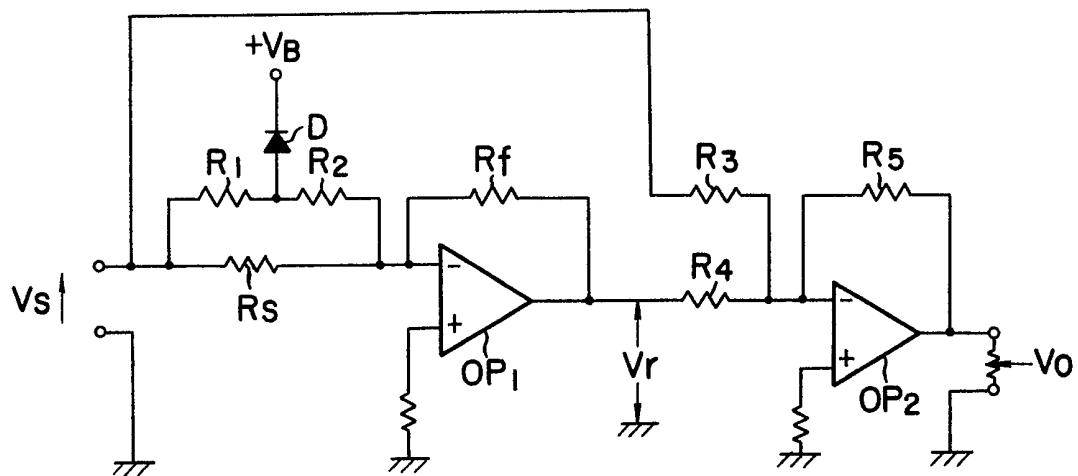


FIG. 26



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FIG. 27

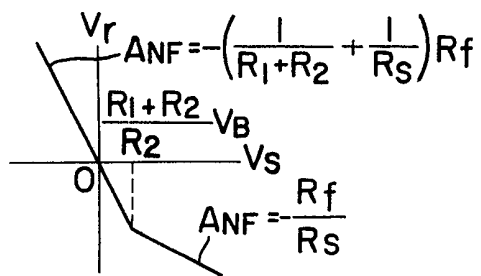


FIG. 28

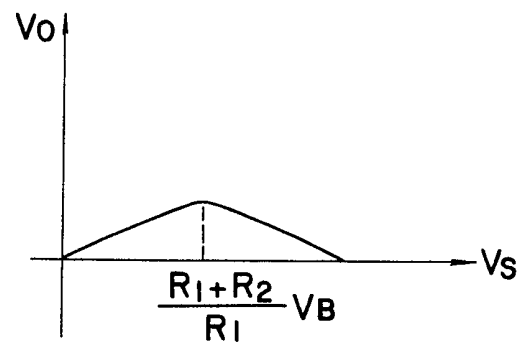


FIG. 29

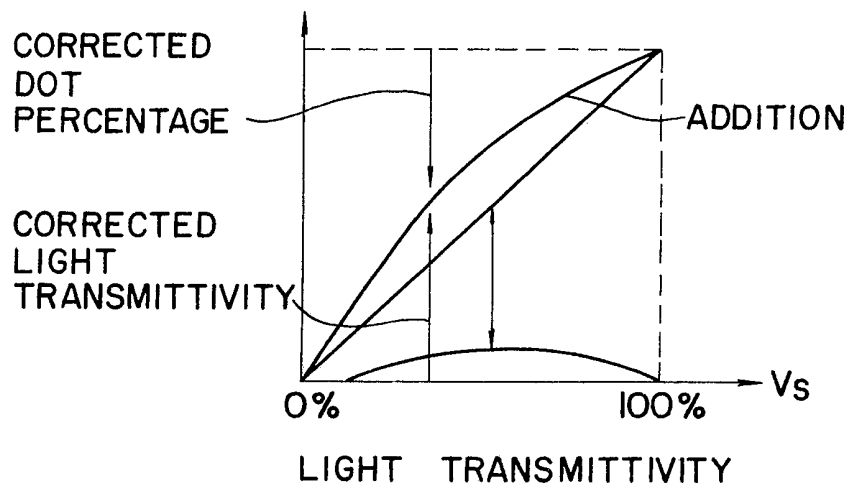
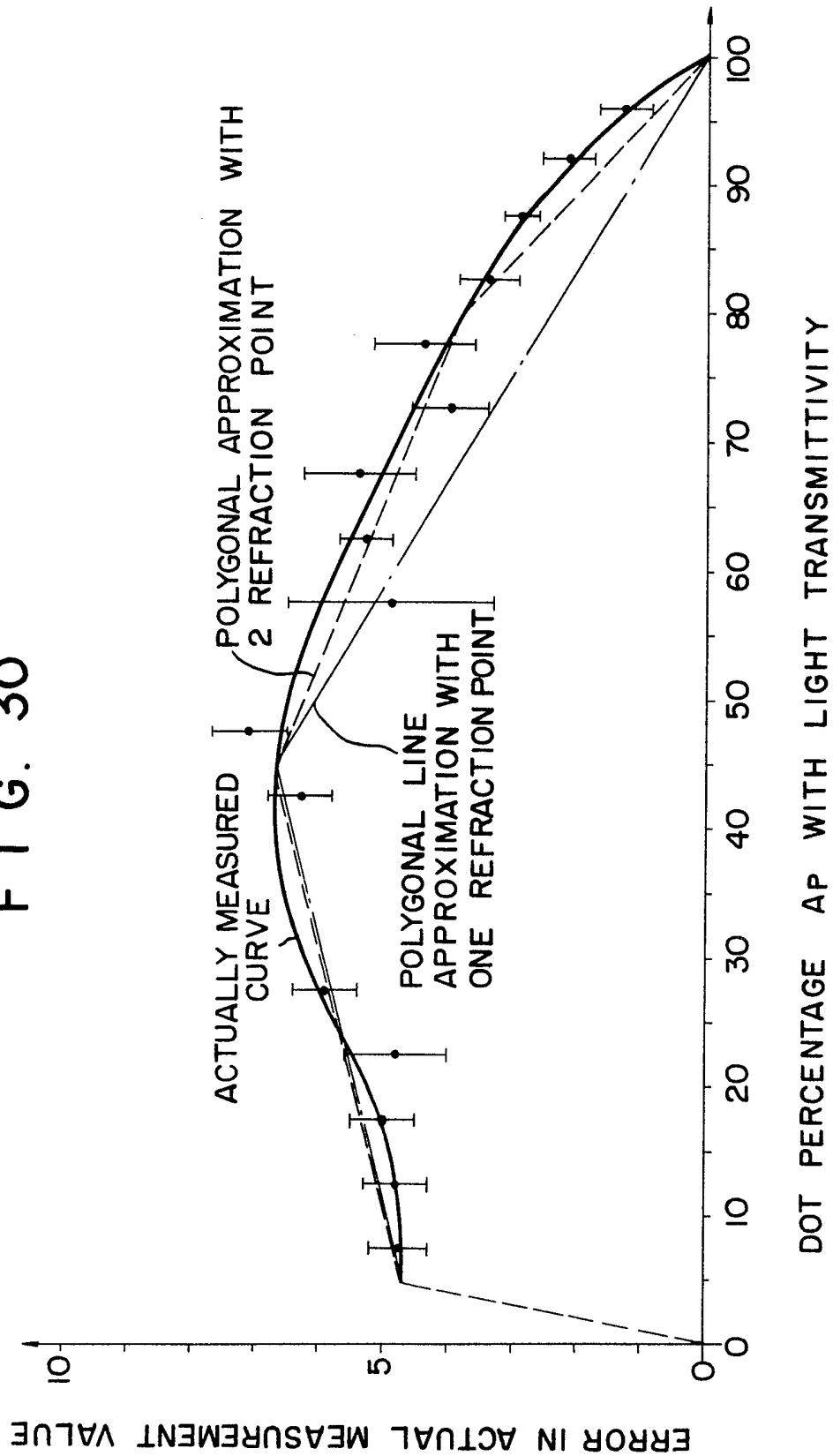
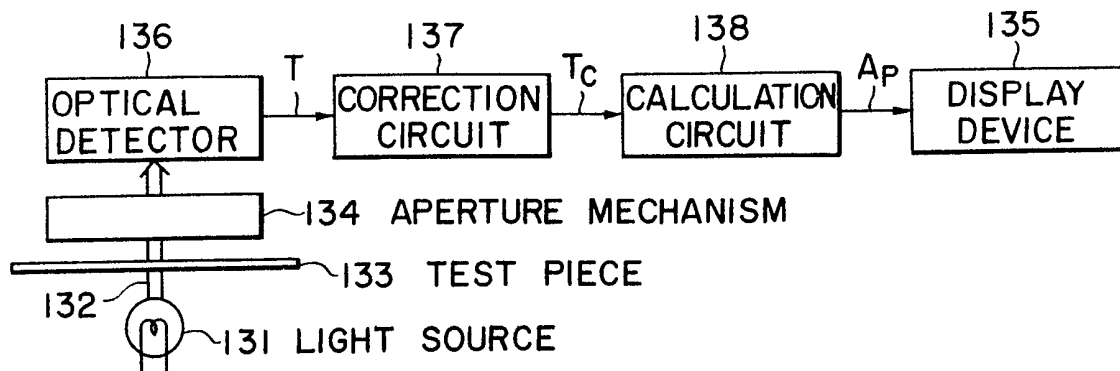


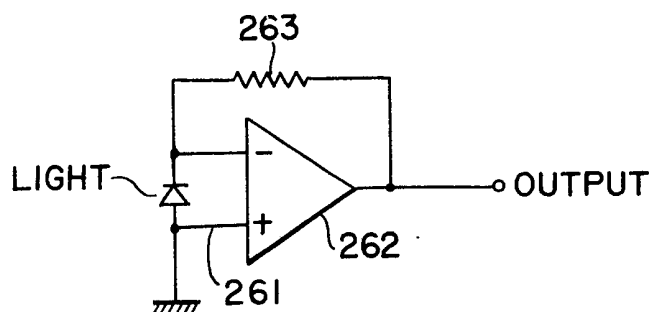
FIG. 30



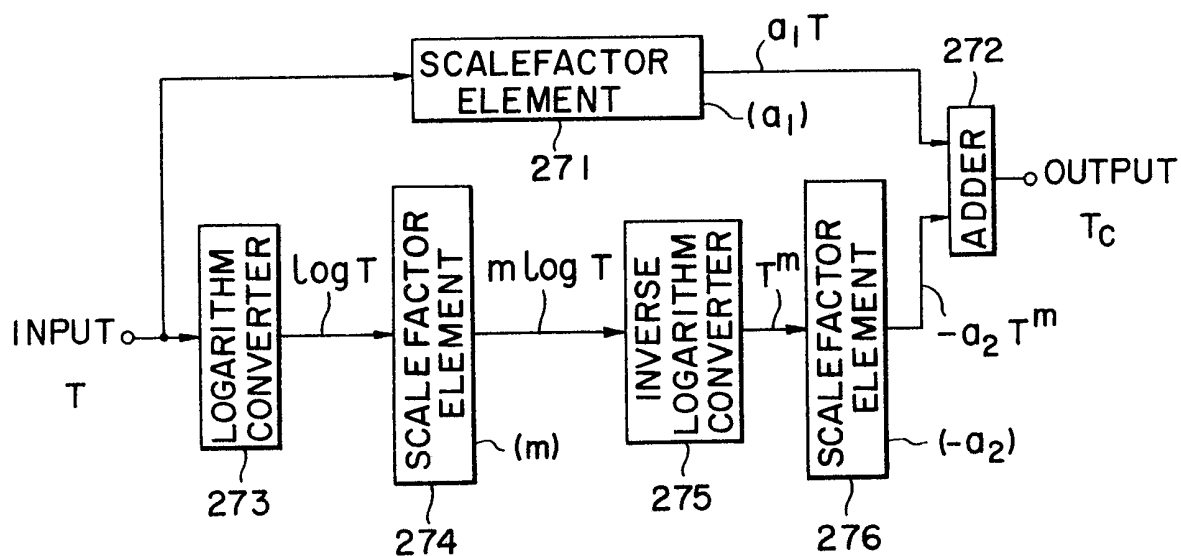
F I G. 31



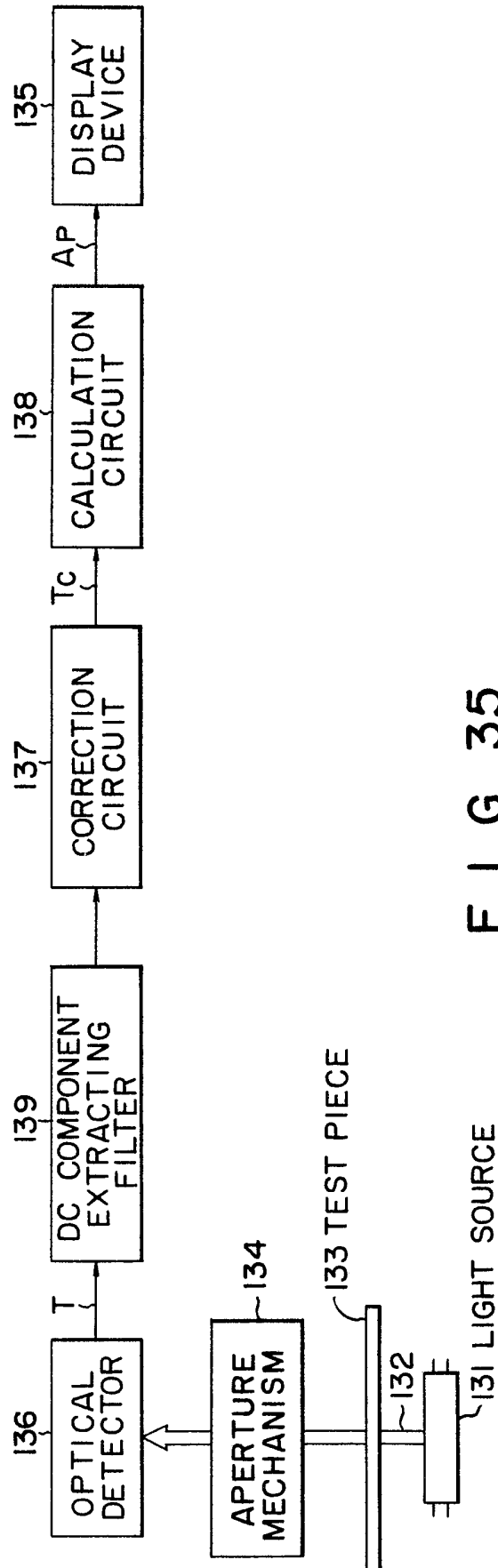
F I G. 32



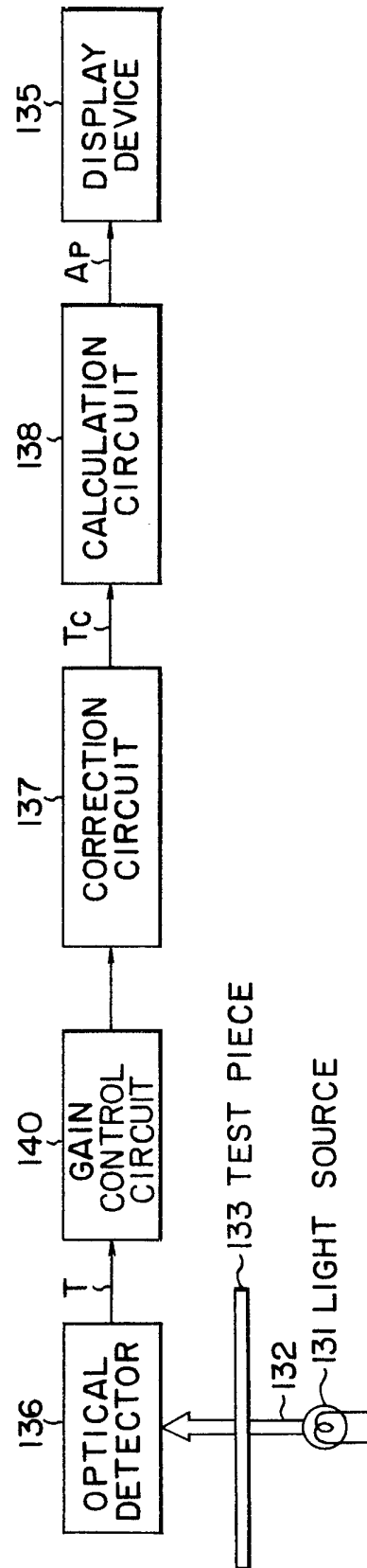
F I G. 33



F I G. 34



F I G. 35



F I G. 36

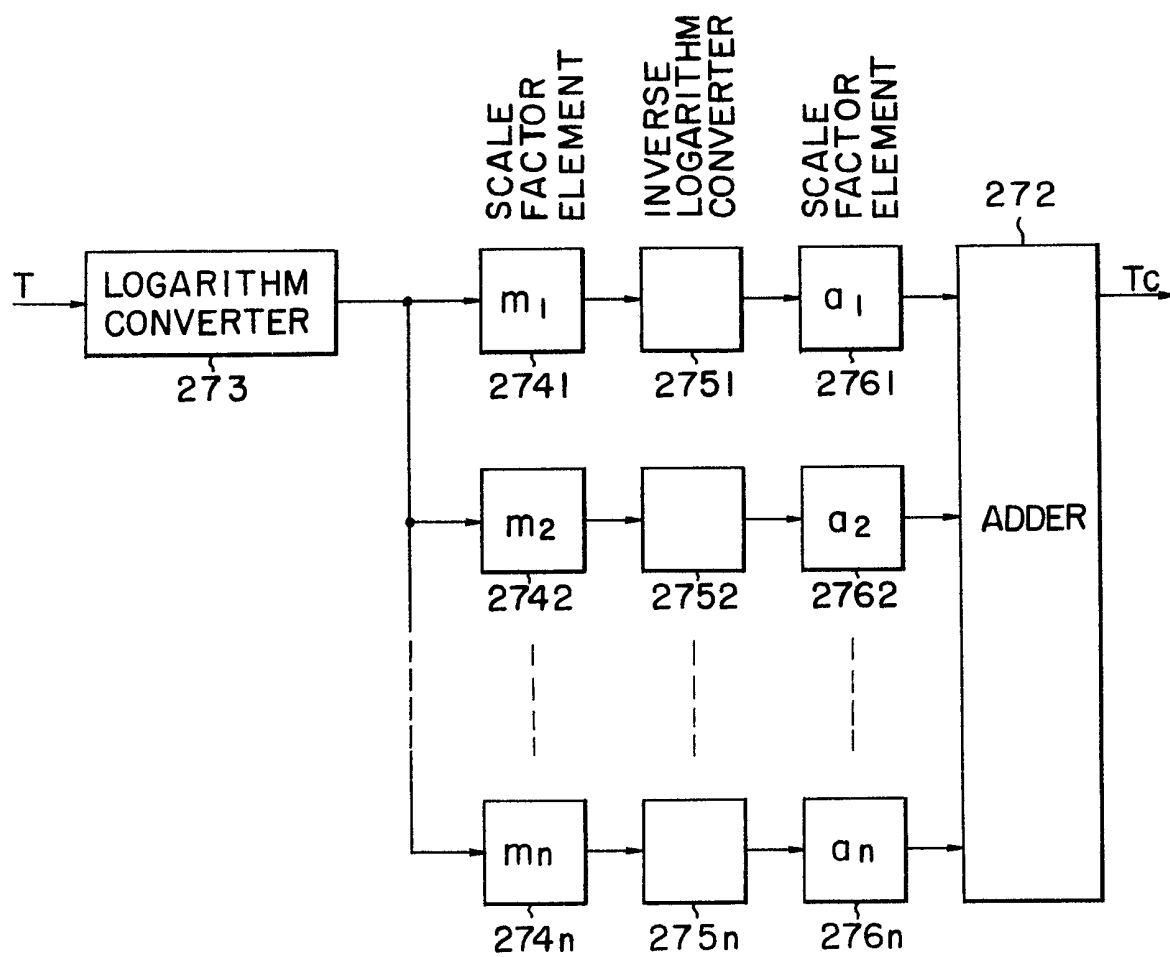
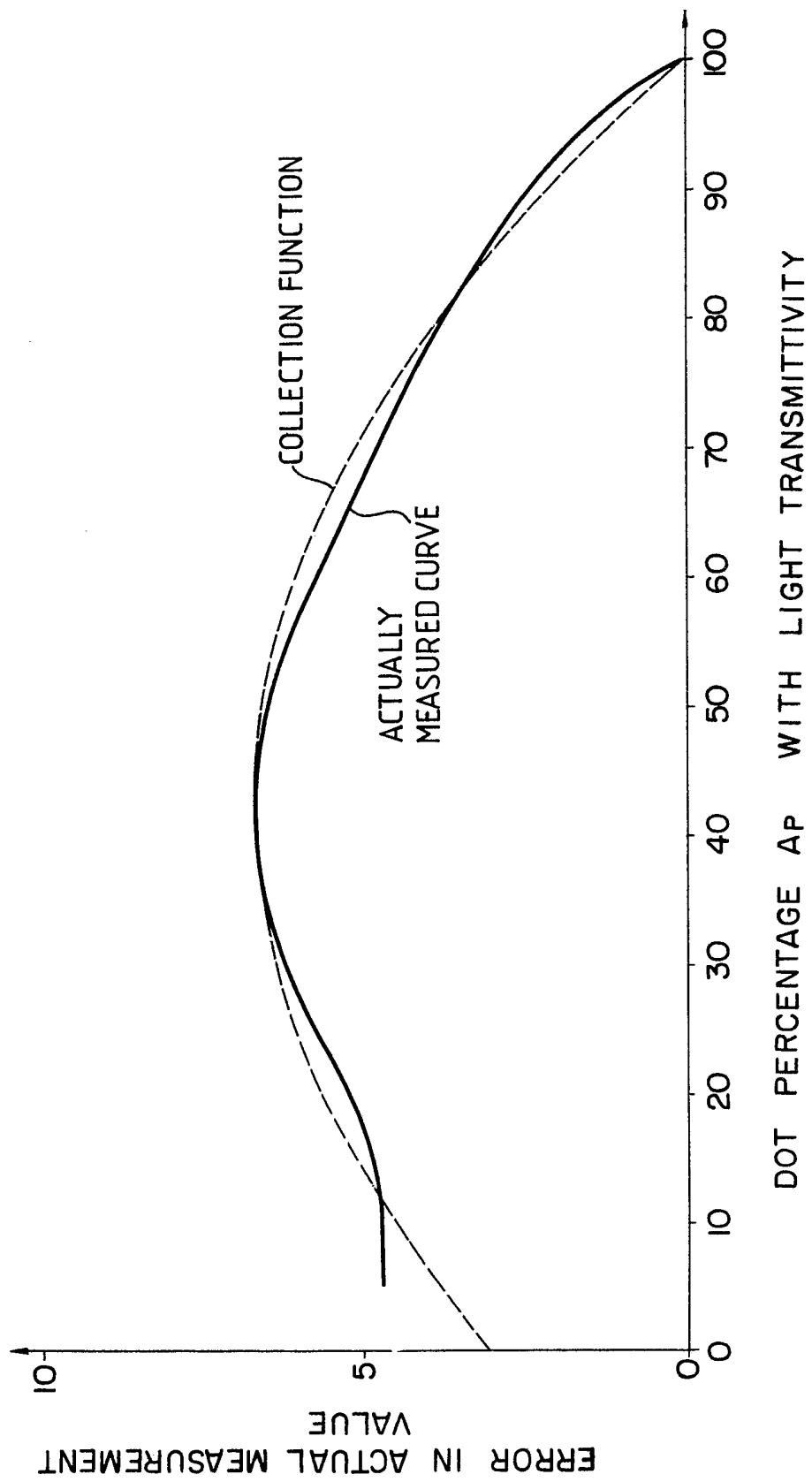
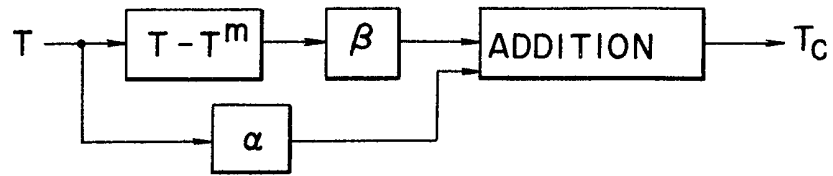


FIG. 37



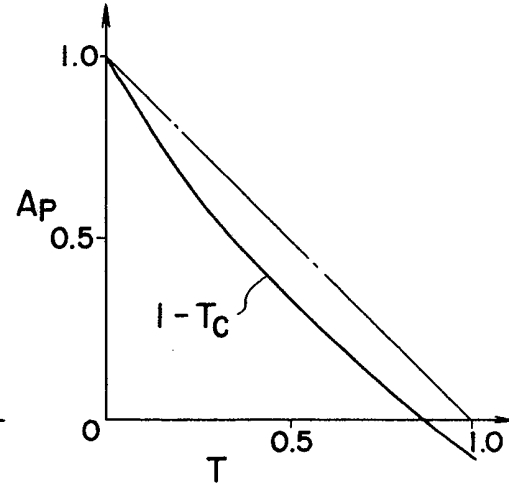
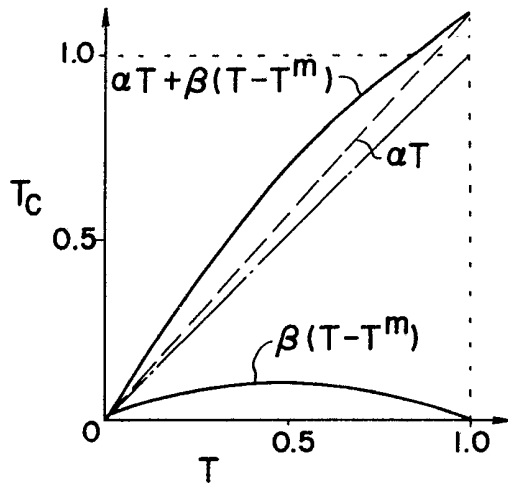
F I G. 38



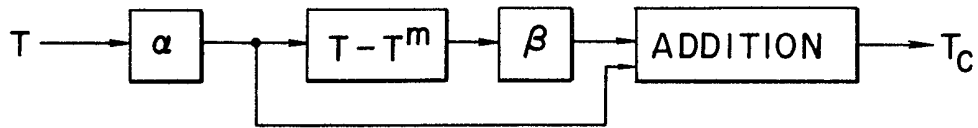
F I G. 39

(A)

(B)



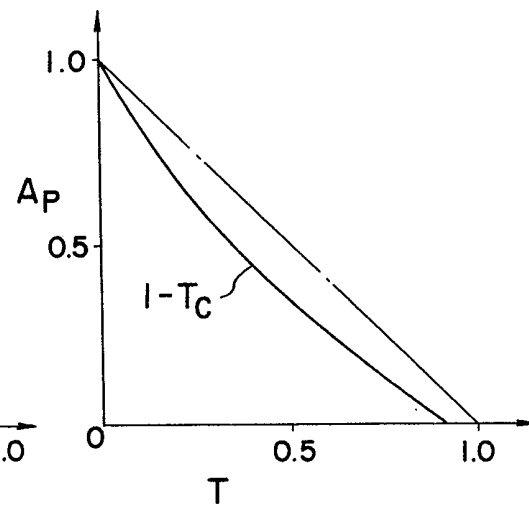
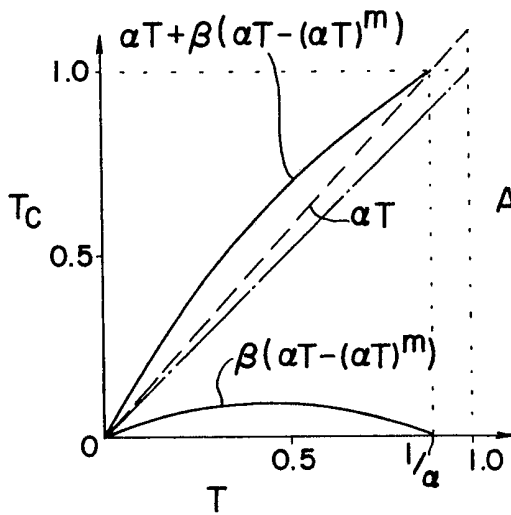
F I G. 40



F I G. 41

(A)

(B)



SPECIFICATION

Facade unit

This invention relates to dot percentage measuring devices.

5 The shading of a continuous tone copy such as a photograph is expressed by using dots different in size in printing. In this method, the continuous tone copy is photographed through a screen or a contact screen to obtain a film called a screen
10 negative or a screen positive in which the shading of the copy is expressed by dots different in size, and a printing plate is formed from this film.

A term "dot percentage" as used herein is a percentage of the total area of dots with respect
15 to a unitary area in such a screen positive or a screen negative or a dot-printed matter. Accordingly, the value of dot percentage will greatly affect the tone and gradation of a printed matter.

20 When an obtained dot percentage is different from a predetermined one, it may be corrected by subjecting the screen positive or the screen negative to "reduction" which is one of the methods of correcting a dot percentage. In the
25 reduction, the photographed film is washed with a so-called "reducer" to reduce the density of the picture. In the case of a dot-printed matter, a portion around a dot, which is low in density and is called "a fringe", on the film becomes
30 transparent by the reduction process; that is, the dot percentage is decreased to correct the values of the printed matter. Thus, in printing with dots, the dot percentage is one of the important factors which determined the quality of a printed matter,
35 and accordingly it is essential to control the dot percentage throughout the printing process from makeup to printing.

In an off-set retouch process, it is necessary to measure dot percentages after reduction has
40 been carried out, and to ensure the configurations of dots, especially whether the dots are deformed or not.

In the case where the dot area becomes considerably smaller by excessive reduction or where measurement result indicates smaller dots,
45 it is necessary that the dots are photographed again and are compared with the previous ones. Heretofore, dots are, in general, evaluated by visual inspection. However, the visual inspection
50 is disadvantageous in that it involves personal errors and therefore it is necessary to provide a skilled person for the visual inspection. Since halftone-photographed dots are soft dots including fringes, the inspector will read the size
55 of dots including fringes through his sense of sight, and accordingly the size of dots thus read is larger than the real size of dots.

Furthermore, although the data actually required in reduction process is not the absolute
60 value of dot percentage, but the amount of reduction representative of the difference between the dot percentage before reduction and that after reduction, no device for indicating the

amount of reduction has been provided in the art
65 yet.

A conventional dot percentage measuring device of this type is shown in the part (a) of Fig. 1. A light emitting section 3 is provided inside a measuring table 2 on which an object 1 to be
70 measured such as a film is placed, and a light receiving section 4 is movably provided above the measuring table 2 in such a manner that it can confront the light emitting section 3. The light receiving section 4 is made up of a cylindrical
75 head 4a which is open at one end, and a light receiving element 4b such as a photo-electric conversion element. In measuring a dot percentage with this conventional measuring device, the object 1 to be measured is placed on
80 the measuring table 2, and a portion to be measured of the object 1 is positioned at the measuring section of the device (or on the line connecting the light emitting section 3 and the light receiving section 4). Then, the light receiving
85 section 4 is lowered in the direction of the heavy arrow P to confront the light emitting section 3 as shown in the part (B) of Fig. 1, so that the upper opening edge of the head 4a is in close contact with the portion to be measured of the object 1.
90 Under the conditions that the external light is shielded, the light emitting section 3 emits predetermined light to irradiate the lower surface of the object 1 in the direction of the shorter arrow Q shown in the part (B) of Fig. 1 so that the
95 light receiving element 4b in the light receiving section 4 receives light passed through the object 1, and the dot percentage of density of the object 1 is displayed by a display section (not shown) connected electrically to the light receiving
100 element 4b.

However, the conventional measuring device is disadvantageous in the following points: The construction of the measuring device is intricate because the device is so designed that the light
105 receiving section is movable towards the light emitting section as was described above. The operation of the measuring device is intricate and accordingly troublesome because positioning the measurement portion of the object 1 must be carried out before measurement and the upper
110 opening edge of the head 4a must be brought into close contact with the measurement portion of the object 1. Therefore, in the case where a dot percentage of density measured should be
115 corrected by reduction, it is necessary to carry out the following steps: After the object 1 is removed from the measuring table 2 and is subjected to reduction process by using a washing table or the like, the object 1 must be placed on the
120 measuring table 2 again. This will increase labor and decrease work efficiency.

Measurement of a dot percentage is carried out in the processes of halftone photography and development also. The dot percentage
125 measurement can be carried out with the aforementioned conventional measuring device; however, the conventional measuring device is not suitable for frequently performing the

measurement for the following reasons: Since the light measuring section of the conventional device is provided at the lower portion of the case thereof, the light measuring section is out of the operator's field of vision, which makes it difficult to place the light measuring section at a portion to be measured of an object. A film density may be measured by performing the positioning only once; however, in measuring a dot percentage as described above, the operator has to take an uncomfortable position to direct the light measuring section to the portion to be measured. This is undoubtedly troublesome for the operator.

Two practical methods of measuring a dot percentage have been known in the art. In the first method, the shading of a dot film is converted into an electrical signal by means of, for instance, a vidicon to measure the area of a portion of the film where the density is higher than a predetermined value, thereby to measure the dot percentage. In the second method, the light transmittivity of a portion to be measured of the dot film is measured to obtain the dot percentage. The first method is advantageous in that it is not affected by fringes around dots and therefore its measurement can be achieved theoretically with high accuracy; however, it is disadvantageous in that the measuring device is bulky and expensive, and therefore not practical. The second method is also disadvantageous in that it is greatly affected by the fringes, and therefore errors are liable to be involved in measuring a halftone-photographed film having a large fringe area.

In general, the error due to the fringe is small or zero with dot percentages about 0% and about 100% and great with a dot percentage about 50%. In order to correct this error, in the second method, the multiplying factor of the display section is finely adjusted, or transmission light to be measured is subjected to photo-electric conversion, and then the amplification factor of the resultant electrical signal is finely adjusted. In this correction method, a film having a known dot percentage, preferably about 5%, is prepared, and the fine adjustment is carried out so that the measurement value of the film coincides with the known value. With the film subjected to this correction, the errors due to the fringe are relatively satisfactorily corrected with dot percentages about 0% and about 100%, but they are still great with a dot percentage about 50%, as indicated in Fig. 2. The relation of the dot percentage to the light transmittivity is not linear because of the influence of fringes, that is, it is expressed by a characteristic curve which is curved in the vicinity of 50% as shown in Figs. 3 and 4. Nevertheless, the conventional correction method assumes that the relation of the dot percentage to the light transmittivity is linear, and performs fine adjustment of this straight line slope. Accordingly, in the conventional correction method, a relatively great error remains in the vicinity of 50% when referred to the errors at dot percentages 0% and 100%.

When a dot film is subjected to reduction by

using an iron chelate group reducer, its portion subjected to the reduction is colored yellow-brown. When this film is measured in the second method, the light transmittivity is affected by the colored portion, and the measured dot percentage involves errors. These errors depend on the amount of reduction, and therefore the correction cannot be achieved by the measuring device according to the second method.

The present invention provides a dot percentage or density measuring device of portable type, which comprises:

a device body;

a supporting arm cantilevered from said device body;

a light receiving cylinder fixedly secured to the end portion of said supporting arm and having a lower end face which substantially coincides with the lower surface of said device body;

means for converting light from said light receiving cylinder into an electrical signal, said means being incorporated in said device body, said light being reflected light or transmitted light; and

a display device incorporated in said device body, for displaying said electrical signal as a dot percentage or density.

The characteristic features of the devices of the present invention will become more apparent from the following detailed description and the appended claims when read in conjunction with the accompanying drawings.

In the accompanying drawings:

The part (A) of Fig. 1 is an explanatory diagram showing a conventional dot percentage measuring device;

The part (B) of Fig. 1 is also an explanatory diagram for a description of the operation of the measuring device shown in the part (A) of Fig. 1;

Fig. 2 is a graphical representation indicating measurement values obtained according to a conventional correction method;

Fig. 3 and Fig. 4 are graphical representations each indicating light transmittivity with amount of correction;

Fig. 5 is a perspective view showing one example of a dot percentage measuring device according to this invention;

Fig. 6 is an explanatory diagram, partly as a block diagram, showing the internal arrangement of the measuring device shown in Fig. 5;

Fig. 7 is a perspective view showing another example of the dot percentage measuring device according to the invention, in which a reduction amount indicating device is additionally provided;

Fig. 8 and Fig. 9 are explanatory diagrams, partly as block diagrams, showing examples of the internal arrangement of the measuring device shown in Fig. 7, respectively,

Figs. 10 through 13 are perspective views showing various examples of the measuring device according to the invention;

Fig. 14 is a sectional view taken along line V—V in Fig. 10;

Figs. 15(A), 15(B) and 15(C) are vertical

sectional views showing different examples of a light receiving cylinder;

Figs. 16 and 17 are sectional views showing modifications of a light receiving cylinder in Fig. 10;

Fig. 18 is a block diagram showing a signal processing circuit;

Fig. 19 shows a positive and negative switching circuit;

Fig. 20 is a graphical representation optical wavelength with light transmittivity;

Figs. 21 through 24 are diagrams for a description of a correction principle according to the invention;

Fig. 25 is an explanatory diagram showing another example of the measuring device according to the invention;

Fig. 26 is a circuit diagram showing a part of the measuring device shown in Fig. 25;

Fig. 27 through Fig. 29 are graphical representations for a description of the operation of the measuring device shown in Fig. 25;

Fig. 30 is a graphical representation indicating relationships between dot percentages with light transmittivities and errors in actual measurement value;

Fig. 31 is an explanatory diagram showing another example of the measuring device according to the invention;

Fig. 32 is a circuit diagram showing one example of an optical detector employed in the measuring device shown in Fig. 31;

Fig. 33 is a block diagram showing one example of a correction circuit employed in the present invention;

Fig. 34 and Fig. 35 are explanatory diagrams showing other examples of the measuring device according to the invention;

Fig. 36 is a block diagram showing another example of the correction circuit employed in the invention;

Fig. 37 is a graphical representation indicating relationships between dot percentages and errors in actual measurement value in the correction circuit shown in Fig. 36;

Fig. 38 and Fig. 40 are block diagrams showing other examples of the correction circuit employed in the invention, respectively; and

Fig. 39 and Fig. 41 are graphical representations showing the correction characteristics of the correction circuits shown in Figs. 38 and 40, respectively.

A first example of a dot percentage measuring device according to this invention, as shown in Fig. 5, comprises an elongated microscope section 10 to observe a test piece 6 with dots from above, and semi-cylindrical dot percentage displaying section 20 which holds the middle portion of the microscope section 10 and displays a dot percentage on a meter 22 graduated in equal increment. A power switch 24 and the zero-adjustment knob 25 of the meter 22 are provided on the outer wall of the dot percentage displaying section 20. The internal arrangement of the device is as shown in Fig. 6. More specifically, the

microscope section 10 comprises an objective lens 11, a half-mirror 12, and an eye-piece 13.

The dot percentage displaying section is made up of a photo-electric converter 23 adapted to convert the quantity of light reflected by the half-mirror 12 into an electrical data, and the meter adapted to indicate the electrical data on its scale graduated in equal increment. In observing the sample, the test piece 6 is irradiated by a lamp 7 or a natural light.

If the dots on the test piece 6 are subjected to reduction by using a reducer portions around the dots are stained, causing erroneous measurement, because it is difficult for light from the lamp 7 to pass through the portion thus stained, that is, the portions allow light to pass therethrough in printing on a printing plate and form no dots.

During the development of the device, the inventor has found that light having wavelength in an infrared ray range can pass through the stained portions, but visible light and ultraviolet light cannot pass therethrough.

Therefore, it is desirable that the half-mirror 12 of the microscope section 10 is made up of an interference filter which reflects the infrared light toward the photo-electric converter 23 and permits the visible light or the like to pass therethrough so that it is directed toward the eye-piece 13. An infrared-ray passing filter may be disposed on an optical path extended from the half-mirror 12 to the photo-electrical converter. It is preferable that the photo-electric converter 23 has an element such as silicon photo-diode which receives infrared rays satisfactorily. The lamp 7 may be of an infrared ray source; however, this is not recommended because it is difficult to perform visual inspection.

In operation, the power switch 24 is turned on and the test piece 6 is disposed in place below the microscope section 10. Light passed through the test piece 6 enters the objective lens 11, and a part (or visible light or ultraviolet light) of the output light of the objective lens reaches the eye-piece 13, whereby the observer 8 can evaluate the configuration of the dots on the test piece 6. A part (or infrared light) of the output light of the objective lens 11 is reflected in a perpendicular direction by the half-mirror 12 to enter the photo-electrical converter 23 where it is converted into an electrical data corresponding to the input light quantity. The electrical data is indicated by the meter 22 (such as a voltmeter). As the light passed through the test piece is proportional to the dot percentage, the value indicated by the meter 22 is proportional to the dot percentage. For instance, if the test piece 6 is completely black, the meter indicates 100%, and if the test piece is transparent, it indicates 0%. Percentage indication on the meter 22 can be adjusted by the zero-adjustment knob 25 according to the quantity of light of the light source or the optical transmittivity of a film from the test piece.

As shown in Fig. 7, another example of the dot percentage measuring device is provided with a

reduction amount indicating device. In this case, a memory switch 26 is provided which temporarily stores a dot percentage and is operated in obtaining the amount of reduction. The internal

5 arrangement of the device thus organized is as shown in Fig. 8. Its microscope section 10 has an optical system made up of an objective lens 11, a half-mirror 12 and an eye-piece 13. Its dot percentage indicating section 20 comprises a
10 photo-electrical converter 23 for converting light reflected by the half-mirror 12 into an electrical data, an amplifier circuit 28 for amplifying the electrical data from the photo-electrical converter 23, a meter 22 for indicating the output of the
15 amplifier circuit 28 on its scale graduated in equal increment, a memory circuit 29 for storing the output of the amplifier 28 upon operation of the memory switch 26, a comparison/subtraction circuit for subjecting the value stored in the
20 memory circuit 29 and the output value of the amplifier circuit 28 to comparison and subtraction thereby to obtain a reduction data, and a meter 40 for indicating the output of the comparison/subtraction circuit as a reduction data or a dot
25 percentage change data.

In operation, the power switch 24 is turned on, and the test piece 6 is disposed in place below the microscope section 10. Light passed through the test piece 6 enters the objective lens 11, and
30 a part (or visible light or ultraviolet light) of the output light of the objective lens reaches the eye-piece 13, whereby the observer 8 can evaluate the configuration of the dots on the test piece 6. A part (or infrared light) of the output light of the
35 objective lens 11 is reflected in a perpendicular direction by the half-mirror 12 to enter the photo-electrical converter 23 where it is converted into an electrical data corresponding to the input light quantity. The electrical data is amplified by the
40 amplifier circuit 28. The electrical data thus amplified is indicated on the meter 22 (such as a voltmeter). Since the light passed through the test piece is proportional to the dot percentage, the value indicated by the meter 22 is proportional to
45 the dot percentage.

The output of the amplifier circuit 28 is applied to the memory circuit 29 and the comparison/subtraction circuit 30; however the output of the memory circuit 29 is equal to the
50 input thereof when the memory switch 26 is not operated. Accordingly, the same signals are applied to the comparison/subtraction circuit 30, and therefore the output of the comparison/subtraction circuit 30 is zero, which
55 is indicated on the meter 40. If the memory switch 26 is depressed, the memory circuit 29 stores and hold the output value of the amplifier circuit 28. As the dot percentage is varied by moving the test piece 6 or replacing it with
60 another one, the amount of light passing through the test piece 6 is varied and the output of the amplifier circuit 28 is also varied. In this operation, as the output value of the memory circuit 29 is maintained unchanged, the inputs to
65 the comparison/subtraction circuit 30 are

different in level from each other, and therefore an output signal corresponding to the difference is provided by the circuit 30 and is indicated by the meter 40.

70 Thus, with the dot percentage measuring device, the configuration of the dots can be measured by the microscope section and the dot percentage can be indicated by the meter. Furthermore, the dot reduction data or the dot
75 increment data can be indicated by the meter. This will facilitate improvement of off-set retouching process. The memory circuit 29 is cleared by depressing the memory switch again.

Another example of the dot percentage
80 measuring device according to the invention will be described with reference to Fig. 9 in which those components which have been previously described with reference to Fig. 8 have therefore been similarly numbered. In this example, the
85 output of the comparison/subtraction circuit 30 is applied to a comparison amplifier 31 where it is amplified and is then applied to the memory circuit 29. When the memory switch 26 is not operated (depressed), the input to the memory
90 circuit 29 is applied, as it is, to the comparison/subtraction circuit 30. Therefore, if two inputs to the comparison/subtraction circuit 30 are different in level, a signal corresponding to the difference is outputted by the circuit 30 to be
95 applied to the meter 40. Thus, the difference between the output of the memory circuit 29 and the output of the amplifier circuit 28 is indicated on the meter.

Next, the memory switch 26 is depressed to
100 connect the output of the comparison amplifier 31 to the memory circuit 29. If in this case two inputs to the comparison/subtraction circuit 30 are different in level from each other, a signal corresponding to this difference is outputted by
105 the comparison/subtraction circuit 30 to be applied to the comparison amplifier 31, as a result of which the comparison amplifier 31 outputs a signal so that the two inputs become equal to each other. If under this condition the memory
110 switch 26 is depressed, then the output signal of the memory circuit 29 coincides with the output of the amplifier circuit 28. If the memory circuit is opened, the output signal of the comparison amplifier 31 is not applied to the memory circuit,
115 and therefore the memory circuit 29 holds the output signal value obtained when the switch 26 is opened.

Similarly as in the above-described case, as the dot percentage is changed, the output of the
120 amplifier circuit 28 is also changed. As a result, the two inputs to the comparison/subtraction circuit 30 become different from each other, and a signal corresponding to this difference is provided, and is indicated as the reduction data or
125 the increment data by the meter 40. Thus, the same effect can be obtained by this example of the dot percentage measuring device.

Shown in Figs. 10 through 13 are other different examples of the dot percentage
130 measuring device according to the invention.

Each device is light and small so that it can be readily operated or handled by and carried with the operator. These devices can measure not only a dot percentage but also a dot density. Each device comprises: a case 60 made up of the upper and lower halves which can be separated from each other when required; a zero-adjustment dial 62 exposed outside the case 60; a power switch 64, and a measured value displaying window 66.

A recess 68 (70 or 72) is formed in one portion of the wall of the case. Cantilevered by a supporting arm 76 in the recess is a light receiving cylinder 74 which receives light reflected by and passed through a test piece.

The term "test piece" as used herein is intended to mean an object to be measured having an image formed with dots or an image of continuous tone, such as a screen negative film, a screen positive film, a printed material, a photographing film or the like.

In the example shown in Fig. 10, the recess 68 is formed at one corner of the case 60. The light receiving cylinder 74 and the supporting arm 76 are provided within the area of the recess 68, which is defined by extending the side walls of the case. In this example, the supporting arm and the light receiving cylinder are so designed as to introduce light passed through the test piece; however, they may be so designed as to introduce light reflected by the test piece as shown in Fig. 15(A). However, it is necessary that the mounting angles of the light source and the light receiving section are such that regular reflection light is not received. An arrangement meeting this requirement is shown in Fig. 15(B).

In this case, the test piece 88 is an opaque printed material. Optical fibers are divided into two bundles 90 and 92 by a holding member 96 in a light receiving cylinder 94. One 90 the bundles of optical fibers is directed to a light source 98 and the other 92 is directed to a light receiving element 100, in the case.

A reflecting mirror, a prism, a half-mirror or the like instead of the optical fibers may be employed as the light receiving means. Fig. 15(C) shows a case where a reflecting mirror and a half-mirror are used in combination. In Fig. 15(C), reference numerals 91, 93 and 95 designates the mirror, a lens, and the half-mirror, respectively.

The above-described light receiving cylinder 74 or 94 may be supported as illustrated in Fig. 16 or 17. The construction shown in Fig. 16 or 17 is intended to release impact which may be applied to the light receiving cylinder during measurement.

In the arrangement shown in Fig. 16, the aforementioned supporting arm 76 is replaced by a shock absorber 102 such as a spring or a rubber block (not shown).

In the case of Fig. 17, the supporting arm 76, the light receiving cylinder 74 and a part of the upper half of the case are formed as one unit. The part of the upper half of the case is coupled through a hinge 104 to the other part of the upper half of the case, and a portion, corresponding to

the supporting arm, of the one unit is coupled to the lower half of the case with a screw 106 through an elastic member 102 such as a spring.

In the example shown in Fig. 11, the recess 70 is formed in the middle portion of a side wall of the case, and the light receiving cylinder 74 is held as shown in Fig. 14, 16 or 17. In this case also, the light receiving cylinder 74 is positioned inwardly of the side wall or to be flush with the side wall. It is difficult for the operator's hand or the like to make access to the light receiving cylinder when compared with the light receiving cylinder in Fig. 10, and therefore the light receiving cylinder is scarcely damaged. However, it should be noted that as the recess is formed at the corner of the case in the case of Fig. 10, the operator readily hold it in his hand.

The recess 70 in Fig. 12 has the same shape as the recess in Fig. 11, but the supporting arm in Fig. 12 is protruded from a side wall of the recess. This arrangement is employed when it is convenient in association with an electrical circuit incorporated in the measuring device.

In the case of Fig. 13, the recess 72 is formed in such a manner that it extends from the side wall of the case to the bottom wall. In this point, the recess 72 in Fig. 13 is different from the recess 68 or 70 which extends from the top wall of the case to the bottom wall.

In the example of Fig. 13, as the light receiving cylinder 74 is provided below the slant wall of the recess 72, it is rather difficult to see the test piece when compared with the above described examples. However, the light receiving cylinder 74 is more satisfactorily protected from damage being covered by the top wall and the side walls.

The operation of each measuring device shown in Figs. 10, 11, 12 and 13, will be described with reference to a signal processing circuit shown in Figs. 18 and 19.

When, light passed through a transparent film 80 such as a screen positive film is utilized in measuring a dot percentage, a measuring position is specified by marking desired points of a light table 110 with round points 112 or the like in order to eliminate the occurrence of a measurement error due to the fluctuation in light intensity of the light table 110 on which the film is placed. Then, a portion having a dot percentage 0% of the test piece 80 is placed between the marks 112.

The power switch 64 is turned on, and the zero-adjustment dial 62 is operated so that a digital display section 66 is set to zero (0).

Then, a portion to be measured of the test piece 80 is placed between the marks 112, and the measuring device is placed on the portion so that the light receiving cylinder 74 confronts that portion. Thereafter, the operator reads a dot percentage indicated on the display section 66. Measurement of the dot percentage is carried out for various portions of the film and is recorded. If the resultant data is greater than a predetermined value, it is subjected to reduction process so that the dot percentage is reduced. If the resultant

value is smaller than the predetermined value, photographing is carried out again.

On the other hand, in the case of density measurement, the zero-adjustment is performed directly on the light table and between the marks, and then a portion to be measured of the test piece is placed between the marks for measurement.

In the case where the test piece 88 is an opaque printed material, the test piece is placed on a flat surface other than the light table, and the measurement is performed with the measuring device having the light receiving cylinder 94 shown in Fig. 15 similarly as in the above-described measurement.

Referring to Fig. 18, a DC component extracting filter is a circuit for eliminating light flickering due to AC power supply to improve the measurement accuracy. A negative and positive change-over switch 114 is provided in a circuit as shown in Fig. 19, so as to read negative and positive values. If the switch 114 is turned on, a positive dot percent or density is displayed, and if it is turned off, a negative dot percent or density is displayed.

An electric source 116 is a battery incorporated in the case; however, it may be provided outside the case so that it is connected through a cord to the measuring device.

If a dot percentage is measured, a dot density can be calculated from the dot percentage. In contrast, if a dot density is measured, a dot percentage can be calculated from the dot density.

Factors causing errors in dot percentage measurement using light transmittivity may be decreased in light transmittivity due to fringe and due to the coloring of yellow-brown in reduction process. The decrease in light transmittivity due to fringe is substantially constant if the conditions of halftone photography and development are constant, and it can be corrected with a predetermined value. However, as the light transmittivity is further decreased by reduction, it has been difficult to accurately correct the light transmittivity of a halftone film subjected to reduction. The result of measuring the spectral light transmittivity of a portion which has been colored brown by reduction with a iron chelate group reducer is as indicated in Fig. 20. As is apparent from Fig. 20, the spectral light transmittivity is such that light in the ultraviolet ray range scarcely passes through the brown portion, the transmittivity of light in the visible ray range is abruptly increased, and the transmittivity of light in the infrared ray range is more than 80%. Accordingly, the dot percentage measurement with light in the ultraviolet ray range or the visible ray range is greatly affected by the portion colored by reduction. However, the dot percentage measurement with light in the infrared ray range is less effected by such a portion. This will become more apparent from Figs. 21, 22, 23 and 24.

A first instance is shown in Figs. 21 and 22, in

which an iodine lamp is employed as the light source, and a silicon photo-diode is used as the light receiving section. A second instance is shown in Figs. 23 and 24, in which in addition to the components employed in the first instance an optical filter for cutting off the light in the ultraviolet ray range and the light in the visible ray range is additionally provided. Each of Figs. 21 and 23 indicates the relative sensitivity characteristic of the detecting section with respect to the wavelength of transmitted light. Each of Figs. 22 and 25 indicates the characteristic of an error caused by reduction. As is clear from these graphical representations, the first instance is most sensitive to the light in the infrared ray range and is also sensitive to the visible light. Therefore, the first instance is affected by the portion colored by reduction process, and accordingly, the measurement error is increased as the amount of reduction is increased. In the second instance, the optical filter is added to the first instance so as to decrease the sensitivity of the detecting section to the ultraviolet light and the visible light. In the case of the second instance, the dot percentage measurement is scarcely affected by the portion colored by reduction process, and the increment of the measurement error due to the increase of the amount of reduction is suppressed as shown in Fig. 24. The same effect can be also obtained by using a light source which does not emit ultraviolet light and visible light. Thus, if, after the influence of the reduction is eliminated to stabilize the amount of error, a function having a characteristic as shown in Fig. 4 (the characteristic being such that the light transmittivity is small or zero at about 0% and 100%, and is maximal at about 50%) is generated to be added, as a correction data, to the light transmittivity or a data related thereto, then a dot percentage can be obtained with high accuracy.

The arrangement of a device performing such an operation as described above is as shown in Fig. 25.

In the device shown in Fig. 25, light from a light source 121 passes through a test piece 122, and is introduced through a lens system 123 and a filter 124 to a photo-electrical converter 125, which output an electrical data corresponding to the quantity of light passed through the test piece. As the filter 124 allows only infrared light to pass therethrough, the influence of reduction can be eliminated. The output of the photoelectrical converter 125 is amplified to the operating level of a correction circuit 124 connected thereto. After the above-described correction is carried out, the dot percentage is displayed on a display device 128. Where an AC light source is used as the light source 121, it is preferable to insert a circuit (not shown) adapted to prevent light flickering between the amplifier 126 and the correction circuit 127.

In general, the amount of fringe is substantially constant if the conditions of halftone photography and development are fixed. Therefore, the

influence of fringe can be corrected by presetting a correction data. Such a correction data can be obtained by adding the data shown in Fig. 4 to the electrical data proportional to the light transmittivity.

A circuit for generating the above-described correction data, as shown in Fig. 26, is made up of operational amplifiers OP1 and OP2, a diode D and resistors R1 through R5. The output Vr of the operational amplifier OP1 is changed in amplification factor at the input voltage

$$\frac{R1+R2}{R2}V_B$$

as shown in Fig. 27, that is its characteristic curve is as a polygonal line. If the voltage Vr having such a characteristic and the input voltage Vs is subjected to addition in a suitable ratio in the operational amplifier OP2, then a signal approximating the amount of correction can be obtained as indicated in Fig. 26. That is, if the input voltage Vs is employed as an electrical signal proportional to the light transmittivity, V_D may be employed as an electrical signal approximating the amount of correction for the light transmittivity (Fig. 4).

If this correction signal is added in a suitable ratio to the signal proportional to the light transmittivity as shown in Fig. 29, then the value of light transmittivity in the vicinity of 50% can be corrected as desired without affecting the values at 0% and 100%. The value V_0 is the aforementioned amount of correction to be preset.

Fig. 30 shows an actually measured curve to indicate what errors the dot percentage measurement utilizing light transmittivity include. That is, the curve is obtained by averaging the test results of about thirty samples. The amount of error is defined as follows: A measurement value obtained according to the abovedescribed method is employed as a reference value. The amount of deviation of a value calculated from Equation $Ap = (1 - T) \times 100\%$ (where Ap is the dot percentage, and T is the light transmittivity) from the reference value is the amount of error. The one-dot chain line indicates a correction function with a polygonal line which has one refraction point so that the amounts of error at dot percentages Ap 5%, 45% and 100% coincide with one another. The correction function indicated by the one-dot chain line includes relatively great errors more than 1% in the vicinity of Ap 70—90%. This error may be reduced by providing the refraction point in the vicinity of Ap 55—60%, however, in this case, an error more than 1% is caused in the vicinity of Ap 35—45%. Therefore, in order to improve the accuracy, it is necessary to increase the number of refraction points. The dotted line in Fig. 30 has an additional refraction point at Ap 80% in order to reduce the errors in the vicinity of Ap 70—90%. That is, the dotted line indicates a polygonal line having two

refraction points to approximate the actually measured curve (solid line). However, if the number of refraction points is increased, the number of adjustment points is increased. For instance in the case where two refraction points are provided, as each adjustment point to be set for approximation has to specify three point positions in a plane, six factors are involved, which make the setting of a polygonal line for correction intricate.

As a result of investigation of a number of actually measured value, in the following embodiment of the invention is employed the fact that when the dot percentage of a screen film is measured by using the light transmittivity of the film, a characteristic curve for converting light transmittivity into dot percentage can be relatively readily approximated with a quadratic function with high accuracy.

In this embodiment, it is preferably to use a light source free of flickering and drift in the quantity of light emitted thereby, such as iodine lamp driven by a stable DC source. After passing through a test piece or a halftone film 133, the light emitted by the light source enters an aperture mechanism 134. The aperture mechanism operates to increase or decrease the cross sectional area of the optical path according to the variation in light intensity of the light source 131, thereby to correct a measurement error due to the variation in light intensity of the light source. For instance, in the case of using as the test piece a film having a dot percentage 0%, the aperture mechanism 134 is controlled so that a display device 135 indicates zero. Alternatively, the aperture mechanism may be controlled as follows. That is, by using a film whose dot percentage is known, preferably about 5%, the aperture mechanism is controlled so that the display device 135 shows that dot percentage. An optical detector 136 receives light passed through the aperture mechanism 134 and converts it into an electrical signal T proportional to the quantity of light thus received. A photoelectric tube, a photoconductive element, or a photodiode is employed as the optical detector 136.

Fig. 32 shows one example of the optical detector 136 which is made of a photodiode 261. The photodiode 261 is connected between the positive and negative input terminals of an operational amplifier 262, and a feedback resistor is connected between the input and output terminals of the operational amplifier 262.

The electrical signal T provided by the optical detector 136 is proportion to the average transmittivity of the measurement portion of the film, and the proportion factor is adjusted by the aperture mechanism 134. The electrical signal T is applied to a correction circuit 137 which operates to correct the measurement error at about 50% which may be caused by the effect of fringe, and an error due to a ghost dot. Fig. 33 is a block diagram showing one example of the correction circuit 137. If in this circuit the input T

is represented by an expression ($0 \leq T \leq 1$), then its correction output T_c can be expressed by the following Equation (1):

$$T_c = a_1 T - a_2 T^m \quad (1)$$

- 5 After being multiplied by the factor a_1 in a scale-factor element 271, the input T is applied to one input terminal of an adder 272. In addition, after being converted into $\log T$ in a logarithm converter 273, the input T is multiplied by the factor m in a scale-factor element 274. The output $m \log T$ of the scale-factor element 274 is converted into a value T^m by an inverse logarithm converter 275, the output of which is multiplied by the factor $-a_2$ in a scale-factor element 276. The resultant value $-a_2 T^m$ is applied to the other input terminal of the adder 272. As a result, the correction signal T_c in Equation (1) described above is obtained as the output of the adder 272. The signal T_c representative of the correction transmittivity is calculated into a dot percentage A_p by a calculation circuit 138 in accordance with the following Equation (2):

$$A_p = (1 - T_c) \times 100 \quad (2)$$

- The signal A_p proportional to the dot percentage of the test piece is displayed as "0%" by a display device 135 when it is zero (0), and as "100%" when 100. Thus, the corrected dot percentages of the test piece 133 can be obtained.

- 30 Fig. 34 is a block diagram showing another example of the measuring device according to the invention, in which light emitted by the light source flickers as in the case of a fluorescent lamp in a light table. In order to eliminate the effect of this flickering a DC component extracting filter 139 or a low-pass filter is employed. Thus, the output signal of an optical detector 136 is applied to a correction circuit 137 after its AC components have been removed by the DC component extracting filter 139. In this case, as the output of the correction circuit 137 is not linear to its output, a value obtained by inputting the DC component of a signal including an AC component does not coincide with a signal obtained by inputting the same signal directly to the correction circuit 137. Therefore, it is necessary to provide the DC component extracting filter 139 before the correction circuit 137.

- 50 Fig. 35 shows another example of the measuring device in which no aperture mechanism is employed. In this example, it is necessary that the signal is increased or decreased to a predetermined level by performing gain control by a gain control circuit 140 in the front stage of a correction circuit 137, and is then applied to the correction circuit 137. In this case also, as the characteristic of the correction circuit 137 is not linear, the output signal of the correction circuit 137 which is obtained by inputting a signal multiplied by a constant to the

- correction circuit 137 is different from the value which is obtained by multiplying by the same constant the output of the correction circuit 137 obtained by inputting the signal, as it is, to the correction circuit 137. Therefore, it is necessary to perform the gain control in the front stage of the correction circuit 137. A multi-revolution type variable resistor may be employed in the gain control circuit 140 in Fig. 35. However, this variable resistor is expensive and bulky, and accordingly it is not preferable to employ it in a small measuring device in the view point of a space available. Therefore, in the case of the small measuring device, it is necessary to use a variable resistor which is readily available and can cover all the range with one revolution. However, there is a problem to be solved. That is, in the case of the small measuring device which uses a light table as its light source, its necessary adjustment range is relatively large, three to four times in gain ratio, because the quantity of light from the light table fluctuates greatly. Accordingly, if it is intended to cover all the adjustment range with only one revolution of the small variable resistor, then it is rather difficult to perform fine adjustment. Thus, it is preferable to employ a thread-feed mechanism for the aperture mechanism and to use a multi-revolution type variable resistor with which the fine adjustment can be performed covering all the adjustment range, in the small measuring device.

- If the measuring device shown in Fig. 35 is so designed that the gain control circuit 140 is provided with at least two adjustment ranges which are suitably selected by an externally provided change-over switch, then the adjustment can be performed more readily.

- The measuring device shown in Figs. 31, 34 and 35 have been described with reference to the case where the correction is performed according to Equation (1). However, the accuracy can be increased if the following Equation (3) in which the number of terms is increased is employed:

$$T_c = \sum_{i=1}^n a_i T^m \quad (3)$$

- 105 Shown in Fig. 36 is an example of a correction circuit which perform such a function. Fig. 36 will become more apparent when referred to Fig. 33.

- An example of such a correction is illustrated in Fig. 37 which may be compared with Fig. 30. In this case, the following correction function is employed:

$$T_c = 1.23T - 0.2T^2 \quad (4)$$

- In Fig. 37, an actually measured curve is indicated by the one-dot chain line. The number of factors required to be determined for correction is only three: factors m , a_1 and a_2 ; however, the obtained approximation is considerably fine as is apparent from the graphical representation in Fig. 37.

- Fig. 38 shows a block diagram of a device adapted to perform the above-described

correction, the device being so designed that the adjustment can be readily achieved.

In this method, a signal T representative of a transmittivity which has reached a predetermined level through gain control is multiplied by a factor α to provide a value αT , whereby correction as to a base film density and a ghost dot is carried out, and the following function which becomes zero with $T=0.1$, and maximal with $T=0.5$ is generated:

$$T - T^m \quad (5)$$

The function is multiplied by a factor β , and result is added to the aforementioned αT , so as to obtain a signal T_c as to the transmittivity which is corrected at its middle portion. Then, the following calculation is carried out to obtain a signal A_p proportional to the dot percentage.

$$A_p = (1 - T_c) \times 100 \quad (6)$$

The parts (A) and (B) of Fig. 39 show correction curves obtained by such a process as described above.

A circuit shown in Fig. 40 carries out correction similar to those described with reference to Fig. 38. In this method, a portion $\alpha T=1$ is not affected. Correction curves obtained in this method are as shown in the parts (A) and (B) of Fig. 41. One of the merits of this method resides in that, as the factor α is adjusted initially in signal processing, the circuit for multiplying the factor α can be replaced by the aperture mechanism and the gain control circuit.

Claims

1. A dot percentage or density measuring device of portable type, which comprises:
a device body;
a supporting arm cantilevered from said device body;
a light receiving cylinder fixedly secured to the end portion of said supporting arm and having a lower end face which substantially coincides with the lower surface of said device body;
means for converting light from said light receiving cylinder into an electrical signal, said means being incorporated in said device body, said light being reflected light or transmitted light; and
a display device incorporated in said device body for displaying said electrical signal as a dot percentage or density.

2. A device as claimed in claim 1, which comprises:
a photo-electric conversion means for converting light received by a light receiving section into electrical data;
a memory means for storing an output value of said photo-electric conversion means; a comparison/subtraction means for subjecting the output value of said photo-electric conversion means and a value stored in said memory means to comparison and subtraction; and
a display means for displaying an output value

of said comparison/subtraction means, so that an amount of variation in dot percentage or density is displayed on said display means.

3. A device as claimed in claim 1 or 2 and in which a recess is formed in a portion of a side wall of a case of said device, said recess extended to the bottom wall of said case, and said light receiving cylinder for receiving transmission or reflection light is cantilevered in said recess.

4. A device as claimed in claim 3, in which said recess is formed in a corner of said case.

5. A device as claimed in claim 4, in which said recess is extended from the top wall of said case to the bottom wall of said case.

6. A device as claimed in claim 4, in which said recess is extended from a side wall of said case to the bottom wall of said case.

7. A device as claimed in claim 3, in which said recess is formed in a middle portion of a wall of said case.

8. A device as claimed in claim 7, in which said recess is extended from the top wall of said case to the bottom wall of said case.

9. A device as claimed in claim 3, in which said recess is extended from the top wall of said case to the bottom wall of said case.

10. A device as claimed in claim 3, in which said recess is extended from a side wall of said case to the bottom wall of said case.

11. A device as claimed in claim 7, in which said recess is extended from a side wall of said case to the bottom wall of said case.

12. A device as claimed in any one of claims 3 to 11, in which said light receiving cylinder for receiving transmission or reflection light is supported through a shock absorber in said recess.

13. A device as claimed in any one of claims 1 to 12, in which said light receiving cylinder for receiving transmission or reflection light is, in its entirety, made up of an elastic material.

14. A device as claimed in any one of claims 1 to 12, in which a lower portion of said light receiving cylinder for receiving transmission or reflection light is made of an elastic material.

15. A device as claimed in claim 1, in which relationships between transmittivities and dot percentages of a dot film are approximated with a linear combination function of a constant, integer power and non-integer power, and a dot percentage corresponding to a transmittivity is obtained in accordance with the linear combination function.

16. A device as claimed in claim 15, in which said dot percentage is obtained by approximation according to the following expression:

$$A_p = (1 - \alpha T + \beta T^m) \times 100$$

where A_p is the dot percentage, T is the transmittivity defined by an expression ($0 \leq T \leq 1$), and α , β and m (≤ 1) are constants.

17. A device as claimed in claim 1, which comprises a correction circuit for converting a function signal whose value is small or zero with

measured light transmittivities 0% and 100% and is maximal with a measured light transmittivity about 50% into a signal having a linear relation to light transmittivity.

- 5 18. A dot percentage measuring device substantially as described herein with reference to any one of Figures 5 to 41 of the accompanying drawings.

New Claims or Amendments to Claims filed 31

10 Dec. 1982, 21 Jan. 1983, 2 Feb. 1983.

Superseded Claims 1, and 15 to 18

New or Amended Claims:—

1. A dot percentage or density measuring device of portable type, which comprises:

- 15 a device body having a lower surface on which, in use of the device, the device body is supported; a supporting arm cantilevered from said device body;

20 a light receiving cylinder fixedly secured to the end portion of said supporting arm and having a lower end face which is substantially coplanar with said lower surface of said device body;

means for converting light from said light receiving cylinder into an electrical signal, said means being incorporated in said device body, said light being reflected light or transmitted light; and

30 a display device incorporated in said device body, for displaying said electrical signal as a dot percentage or density.

15. A device as claimed in any one of claims 1 to 14, in which relationships between transmittivities and dot percentages of a dot film are approximated with a polynomial function of a constant and an integer power, and a dot percentage corresponding to a transmittivity is

obtained in accordance with the polynomial function.

- 40 16. A device as claimed in any one of claims 1 to 14 in which relationships between transmittivities T and dot percentage A_p of a dot film are approximated by the following expression:

$$A = (1 - a_1 T + a_2 T^m) \times 100$$

- 45 where $m > 1$ and a_1 , a_2 and m are predetermined scale factors.

17. A device as claimed in any one of claims 1 to 14, in which relationships between transmittivities T and dot percentage A_p of a dot film are approximated with the following expression:

$$A_p = \left\{ 1 - \left(\sum_{i=1}^n a_i T^{m_i} \right) \right\} \times 100$$

$$= [1 - (a_1 T^{m_1} + a_2 T^{m_2} \dots + a_n T^{m_n})] \times 100$$

- 55 where $n > 1$ and $m_i \geq 1$ and a_i and m_i are predetermined scale factors.

18. A device as claimed in any one of claims 1 to 14 which comprises a correction circuit for combining an error signal, whose value is small or zero with measured light transmittivities of 0% and 100% and is maximal with a measured light transmittivity of about 50%, with the transmittivity signal to obtain a signal having a substantially linear relation to the dot percentage.

19. A dot percentage measuring device substantially as described herein with reference to any one of Figures 5 to 41 of the accompanying drawings.