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(54) METHOD AND APPARATUS FOR CLASSIFYING
 INFORMATION BEARING MEDIA FOR PHOTOGRAPHIC
 REPRODUCTION



- (71) We, EASTMAN KODAK COM-
 PANY, a Company organized under the Laws
 of the State of New Jersey, United States
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 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 per-
 formed, to be particularly described in and
 by the following statement:—
 The present invention relates to photo-
 graphic printing mechanisms and more par-
 ticularly, to an exposure controlling method
 and apparatus for such mechanisms.
 There have been problems in printing
 originals or information bearing media onto
 sensitized material such as photographic print-
 ing paper. For the sake of discussion, the
 original may be considered to be divided
 into a first or subject portion which is nor-
 mally centrally disposed of the original and
 a second or peripherally disposed portion. When
 reproducing or printing the original onto the
 sensitized material, it is preferable that the
 subject portion be correctly exposed for den-
 sity in black and white prints and for both
 colour and density in colour prints even if
 this procedure results in improper exposure
 of the peripheral portion. In the prior art,
 the density of the original has been deter-
 mined by illuminating the original and measur-
 ing the average transmission of the entire
 original, i.e., large area transmission density
 (LATD), to provide signals indicative of the
 exposure density and also the colour balance
 of the original to be reproduced. This has
 frequently resulted in the wrong exposure
 and/or colour balance of the subject portion
 of the reproduced print, because the back-
 ground or foreground is significantly different
 in density or spectral distribution. This
 phenomenon is known in the art as "subject
 failure". In U.K. Patents Nos. 1,229,677 and
 1,346,695, apparatus and methods are dis-
 closed for measuring the density of an original.
 More specifically, there is disclosed apparatus
 including a radiation sensitive assembly in-
 cluding a peripheral part for measuring the
 transmission density from a peripheral por-
 tion of the original and centrally disposed
 or subject part for measuring the density of
 the central portion of the original. More
 specifically, the subject part may illustratively
 include a plurality of radiation sensitive ele-
 ments for measuring and providing a signal
 indicative of the density of discrete portions
 of the subject portion of the original. The
 signals derived from the radiation sensitive
 elements are applied to an auctioneering cir-
 cuit which operates to provide a signal indi-
 cative of the radiation incident upon an in-
 cremental area of the subject portion of the
 original having the highest density. The sig-
 nals derived from the peripheral portion and
 from the auctioneering circuit are applied
 to a coefficient summing amplifier or circuit
 to provide a signal indicative of the density
 classification and/or color correction to be
 made in reproducing or printing the original.
 Though the apparatus and method descri-
 bed in the above-identified application
 provides for the classification of originals to
 thereby permit the satisfactory reproduction
 of the original in many instances, difficulty in
 classification may arise for originals whose den-
 sity relationship between the central and peri-

[Price 25p]

pheral areas or between the upper and lower portions of the peripheral area unexpectedly varies. Generally, originals may present abnormal scenes which may be generally placed into two categories. First, originals may be exposed to scenes which are back-lighted such as portraits or outdoor scenes having a bright sky in the upper half of the original. The first type of scene usually requires a very low classification, i.e. the printer exposure control, which is based on LATD, must be corrected to achieve a density balance that is lighter than normal. To achieve a low classification, the exposure may be reduced in terms of length and/or intensity of exposure. However, if such first scenes are measured by the above-identified apparatus, the maximum density of the subject portion that is measured may relate to the upper or sky portion of the scene rather than the subject or centrally disposed portion of the scene. As a result, the apparatus would provide a signal indicative of a high classification because the signal indicative of the maximum density would be of too high a value. Thus, the apparatus does not compensate for the density subject failure of this type of scene, but in fact provides a classification of an opposite nature to thereby aggravate the density subject failure problem.

The second type of scene which produces occasional errors in the above-described method of density classification is a front lighted scene wherein extremely high brightness contrast between the subject area and a deeply shaded or dark background portion exists. Originals of such scenes are not normally given sufficient exposure because the classification coefficients used in the above-described apparatus are derived as a compromise between the conflicting, extreme demands required by the front lighted scenes and the backlighted scenes. The high contrast, front lighted scenes requiring high density classification values, i.e., additional exposure, tend to have an opposite relation between the densities of the upper and lower peripheral portions of the original from those of back-lighted scenes. An example of the second type of scene is provided by those originals taken at night or indoors with a flash wherein the background is relatively dark or of low brightness and where the foreground is illuminated with high brightness.

According to the present invention there is provided a method of classifying information media (originals) for photographic reproduction wherein radiation derived from different portions of an original is measured, characterized in that the extreme density portion of the central portion of the original is measured (measurement a), the average density of an upper peripheral portion of the original is measured (measurement b), and the

average density of a lower peripheral portion of the original is measured (measurement c), and in that the measurements are combined to provide a classification signal.

By the term "extreme density" as used herein is meant the maximum density of a negative original or the minimum density of a positive original.

Preferably said measurements a, b and c are provided in the form of electrical signals, to be combined to form a classification signal. The exclusion of the subject-related central portion, when measuring the upper and lower peripheral portions, is significant. Inclusion of the central portion decreases the reliability of the scene type discrimination. Further, the "upper" and "lower" densities and the central maximum density provide more accurate correction predictors when they are mutually exclusive. Making them overlap each other makes them more interdependent and reduces their power to differentiate between different scene characteristics.

According to the invention an apparatus for carrying out the method for measuring radiation derived from different portions of an original comprises means for providing a signal representing the density of said discrete portion of the central area of the original which has the extreme density, means for providing a signal representing the average density of an upper peripheral portion of the original excluding the subject area, and means for providing a signal representing the average density of a lower peripheral portion of the original excluding the subject area.

According to one aspect of the invention said apparatus comprises a mechanical scanner having a rotating disc with apertures disposed therein corresponding to the central portion, to the upper and to the lower peripheral portions of the original. According to another aspect of the invention said apparatus comprises a flying spot scanner system whose video output signal is selectively dissected to represent the upper and lower portions of the peripheral portion and the central portion of the viewed scenes.

According to still another aspect of the invention such apparatus includes a radiation sensitive assembly including a substantially centrally disposed or subject part comprising a plurality of radiation sensitive elements for sensing the density of discrete portions of the central portion of the original, a peripheral part for sensing the radiation derived from the peripheral portion of the original which peripheral part is divided into a first (or upper) part and a second (or lower) part for sensing corresponding peripheral portions of the original, and a background function circuit responsive to the signals derived from the upper and lower peripheral parts to provide a signal indicative of the relationship between the densities of the corresponding

upper and lower portions of the original, and to indicate the presence of an original having an abnormal scene.

As mentioned, the central area is established by means of a fixed array of radiation sensitive elements (spots) or by a line-scanning raster. In either case, the responsive area is one small spot within that subject area. This spot has a fixed area that might correspond, for example, to the smallest significant highlight in the subject. Its area falls anywhere in the central area but not necessarily in the exact center of the picture. This apparatus cannot be triggered by brightness perturbations anywhere from the peripheral portion of the original.

In an illustrative embodiment of this invention, the signals developed by radiation sensitive elements of the subject part are applied to an auctioneering circuit for providing a signal indicative of the discrete area of maximum density within the subject portion of the original. First, second and third coefficient summing amplifiers receive signals derived from the upper and lower parts of the peripheral part of the radiation sensitive assembly, and the auctioneering circuit. The first, second and third coefficient summing amplifiers are provided with coefficients to provide the appropriate classification respectively for a backlighted scene, a normal scene, and a front lighted scene. A signal related to one of the output signals derived from these coefficient summing amplifiers may be selectively applied to a printer or other reproducing apparatus dependent upon the signal derived from the background function circuit.

Further preferred embodiments and features of the invention are outlined in the following description taken in conjunction with the accompanying drawings, in which:—

Fig. 1 is a schematic diagram of a radiation sensitive assembly and circuitry for interpreting signals derived therefrom according to one embodiment of apparatus according to the invention;

Fig. 2 illustrates one embodiment of an apertured disc for mechanically scanning portions of the original to be reproduced.

Referring now to Fig. 1, there is shown a radiation sensitive assembly 10 disposed to receive a radiation image, which is derived from the original to be reproduced and is focused or directed thereon by a suitable lens assembly (not shown). The radiation sensitive assembly 10 is designed to be sensitive to radiation derived from various portions of the image and to provide signals indicative thereof. More specifically, the radiation sensitive assembly 10 includes a peripheral part 12 for receiving radiation derived from the peripheral portion of the original. In an illustrative embodiment of this invention, the assembly 10 shown in the drawing may be used with a photographic printer which re-

ceives classification signals in a manner to be described, to thereby control the exposure of a radiation sensitive medium.

In considering a large number of originals, e.g. negatives, such negatives have a composition arranged in well recognized categories. In evaluating an original, the original may be considered to have a centrally disposed subject portion which is normally considered to include the highlight or point of interest of the original, and a peripheral portion. A further division of the peripheral portion may result in separately considering the upper or first peripheral portion corresponding to the background portion or area of the original as distinct from the lower or second peripheral portion corresponding to the foreground portion or area of the original. It may be understood when using the terms upper and lower to describe various areas of the peripheral portion of an original, that the point of interest is taken with respect to the manner in which the general public will use their camera to take a picture of a scene. For example, in outdoor scenes, the background portion would typically be the sky, whereas the foreground portion of the peripheral portion may be of the landscape in the foreground or that portion relatively close to the picture taker.

In accordance with the teachings of this invention, this method and apparatus distinguishes between the upper and lower peripheral portions of the original with respect to the density and/or spectral distribution of the original to thereby improve the reproduction of the original onto a radiation sensitive medium. The peripheral or first part 12 of the radiation sensitive assembly 10 is divided as shown in Fig. 1 into an upper U-shaped part 12a and into a lower U-shaped part 12b, each part preferably covering approximately 30% of the area of the original. The parts 12a and 12b, which typically exclude the point of interest in the original, provide electrical signals indicative of the integrated or average radiation directed thereon from the corresponding upper and lower peripheral portions of the original. Alternatively, the parts 12a and 12b could comprise preferably rectangular horizontal strips at the top and bottom of the original, preferably each part covering approximately 20% of the area of the original. It is important to note that in either embodiment the peripheral parts exclude the central portion of the original because this increases the reliability of scene type discrimination. Further, the radiation sensitive assembly 10 includes a second or centrally disposed radiation sensitive part 14 for receiving radiation from the point of interest in the original. As shown in Fig. 1, the central part 14 may in one illustrative embodiment be comprised of a plurality of radiation sensi-

tive elements 15 disposed in an array covering the relatively small centrally disposed part amounting, preferably to approximately 16% of the total area of the original. The radiation sensitive elements 15 sense radiation derived from discrete portions of the central portion of the original to provide signals indicative thereof. Electrical connections are made to the elements 15 in a manner well known in the art to provide individual signals from each of the radiation sensitive elements 15.

Another illustrative embodiment of a radiation sensitive assembly 10 is shown in Fig. 2. In this embodiment, the original containing the scene to be viewed is imaged by a lens (not shown) upon a rotating scanner disc 210. Behind the disc 210 is a field lens (not shown) to focus the image transmitted by the scanning disc 210 upon a photomultiplier (also not shown). The disc includes two U-shaped apertures 211 and 212 for measuring the integrated or average radiation from the lower and upper portions, respectively, of the peripheral portion of the original; ten apertures 213a—213k located at different radii for scanning the central portion of the original; a reference aperture 214 for providing a reference level of the scan; and a gating aperture 215 whose function will become apparent below.

Four light sources with cooperating photocells are positioned, as shown in Fig. 2, at 90° (scan), at 132° 53' (reference), at 171° 30' (upper peripheral portion) and at 200° 30' (lower peripheral portion) to allow gating of the scans. The disc 210 is shown in the position in which the gating aperture 215 is at the light source—photocell unit positioned at 200° 30'. In this position of the disc 210, the U-shaped mask aperture 211 is positioned over the projected film gate 216 to permit measurement by the photomultiplier of the transmission of the lower portion of the peripheral portion of the original. As the disc rotates in a counterclockwise direction as viewed in Fig. 2, aperture 213a is positioned over the film gate 216 as the peripheral notch 217a passes over the light source—photocell unit positioned at 90° and the photomultiplier is actuated to measure the transmission of the discrete portion of the central portion of the original viewed by aperture 213a. In a similar manner, peripheral notches 217b—217k pass over the light source photocell unit positioned at 90° upon further rotation of the disc 210 and gate the corresponding apertures 213b—213k positioned over film gate 216 for measurement by the photomultiplier of discrete portions of the central portion of the original. When the scans of the central portion of the original have been completed, further counterclockwise rotation of the disc 210 positions the gating apertures 215 at the light source—photo-

cell unit positioned at 132° 53'. In this position of the disc, the reference aperture 214 is positioned over the projected reference 218 and the photomultiplier is actuated to measure the transmission of the reference 218. Finally, the gating aperture 215 is at the light source—photocell unit positioned at 171° 30' when the U-shaped mask aperture 212 is positioned over the film gate 216 and the photomultiplier is actuated to measure the transmission of the upper portion of the peripheral portion of the original.

Neutral density material is placed over the U-shaped apertures 211 and 212 to adjust the photomultiplier signals for these apertures to a level equal to the signal for the apertures 213a—213k.

In another illustrative embodiment (not shown) the radiation sensitive assembly 10 could take the form of a television camera tube of a flying spot scanner system whose video output signal is selectively dissected to represent the upper and lower portions of the peripheral portion and the central portion of the viewed scene.

It is to be understood that the measurements obtained with the radiation sensitive assemblies using a disc or a television camera are with modifications obvious to those skilled in the art processed similarly as described below in connection with assembly 10.

The radiation sensitive element 15 of assembly 10 have leads or electrical connectors which are connected to an auctioneering or selecting circuit 20 for selecting the one signal derived from the radiation sensitive elements 15 indicative of that discrete portion of the original having the greatest (or maximum) density. The responsive discrete portion may fall anywhere within the central area, but not necessarily in the exact center of the picture. It may be realized, that if the original is a negative, that the portion of highest density will be represented by that signal of lowest magnitude, whereas if the original is a positive, radiation transmitted through the densest portion of the positive original will produce a signal of highest amplitude. For clarity, only a single line has been shown conveying the plurality of signals from each of the radiation sensitive elements 15 to the auctioneering circuit 20. Auctioneering circuits per se are well known in the art. Illustratively, the auctioneering circuit 20 may take the form of that circuit described by HH Koppel in "Transistorized Elements and High Accuracy Control Loops", reprint No. T-11, Bailey Meter Company, (presented at the 17th annular automation conference, October 15—18, 1962). It should be noted that the present invention utilizes an absolute density measure, the maximum density, as the subject-related brightness characteristic. The maximum density measure is highly sensitive to exposure level variations in camera ex-

posure of most front lighted scenes and counteracts the neutral correction deficiencies of the integrated measure (LATD) which is biased toward the minimum density. Except for the backlighted scenes, the maximum density is assumed to be indicative of the exposure level of the subject of the original. For backlighted scenes, the foreground becomes more indicative of the subject exposure and is appropriately weighted in that equation as explained in detail later. In such equations the maximum density is used proportionally and in combination with the upper and lower densities in determining the density correction.

The output signal derived from the upper part or element 12a is applied to a readout circuit 18 whereas the output signal derived from the lower part or element 12b is applied to a readout circuit 16 to provide respectively signals D_U and D_L (not shown) indicative of the average or integrated value of radiation falling upon the upper and lower part of the peripheral part 12. In the array, the upper and lower parts or elements 12a and 12b may be either of a photoconductive or photovoltaic type provided that the circuits 16 and 18 are designed to give essentially logarithmic response, i.e. the output signal derived therefrom is proportional to the density of the corresponding areas of the original. The response of commonly known photoconductive cells is essentially logarithmic when operated with a high load resistance, and if used as part of the radiation sensitive apparatus 10, the readout circuit 16 and 18 could illustratively take the form of a variable resistance in the order of 250K connected in series with the elements 12a or 12b. An output signal is derived from the common point between the radiation sensitive element, and the variable and high resistance elements.

The output signals derived from the readout circuits 16 and 18 are applied to each of a plurality of summing circuits (or coefficient or summing amplifiers) 22, 24 and 26, and also to a background function computer or generator 28. Further, the output signal derived from the auctioneering circuit 20 is applied to each of the summing circuits 22, 24 and 26. Illustratively, the summing amplifiers 22, 24 and 26 may take the form of operational amplifiers whose output signals C_b , C_n and C_r are representative of the sum of input signals derived from the circuits 16, 18 and 20.

As indicated in Fig. 1, the output signals derived from the circuits 16, 18 and 20 are coupled as input signals to summing amplifier 22 are applied to coefficient determining impedance elements A_{11} , A_{11} and A_{x1} to provide a coefficient or weighting factor to the signals derived from these respective circuits. In a similar manner, the input signals coupled to the summing amplifiers 24 and 26, are

applied to variable impedance elements designated in a manner similar to that indicative above to provide selective coefficients to the input signals applied to these circuits.

Further, the output signals derived from the readout circuits 16 and 18, are applied to the background function computer 28 to provide an output signal Z which is applied to a classification discriminator 30. As will be explained later, the background function computer 28 serves to sum the signals applied to its inputs b_1 , b_2 and b_3 and may take the form of a summing or operational amplifier. As shown in the drawing, three classification signals C_b , C_n and C_r derived respectively from the summing amplifiers 22, 24 and 26 are applied to the classification discriminator 30, which provides an output signal C related or corresponding to one of the input signals derived from the summing amplifiers 22, 24 and 26 dependent upon the input signal derived from the background function computer 28. As indicated above, the output signal C derived from the classification discriminator circuit 30 is applied to a printer interface circuit 32 for indicating the correct classification or exposure of the print.

In the above-mentioned U.K. Patents Nos. 1,229,677 and 1,346,695 there is described apparatus for sensing radiation from the peripheral portion and from the centrally disposed subject portion of the original to provide an output signal for controlling the reproduction or printing of the original onto a radiation sensitive medium. As described therein, an output signal indicative of the density corresponding to the average transmittance of the peripheral area of an original is provided and is designated at D_o . Further, an output signal indicative of the maximum density of a discrete portion of the central or subject portion of the original is provided. As described therein, the signal D_o and the signal indicative of maximum density X_1 are summed by an appropriate summing amplifier to provide a signal represented by the following equation:

$$-V = K_0 + K_1 X_1 + K_2 D_o$$

where V_o is a voltage representing the classification of the original, K_0 is a constant, and K_1 and K_2 are coefficients. The signal V_o may be used to classify or to control the exposure of the print as it is reproduced onto a radiation sensitive medium. More specifically, the signal may be used to predict density classification and/or color correction to correct the subject errors which are based on the large area transmission density (LATD) method of exposure determination.

In accordance with the teachings of this invention, the performance of the radiation sensitive apparatus described in the above-identified patents may be improved by divid-

ing or splitting the peripheral part described therein into an upper part for sensing the upper portion of the original and a lower part for sensing radiation derived from the lower or foreground portion of the original. As will be explained in greater detail later, the object of dividing the peripheral part of the radiation sensitive assembly is to determine the relationship between the radiation transmitted through the upper peripheral portion and the lower peripheral portion of the original and to use this information to (a) discriminate between two or more scene types which require different classification equations; and (b) serve as predictors in the separate classification equations which are selected by the discriminant function. The classification equations differ significantly in the sign and/or magnitude of the coefficients by which the terms are multiplied. As a result the method and apparatus of the present invention provides a proportional output and greater sensitivity and selectivity of the response in the classification (or exposure) of an original bearing certain abnormal scenes.

As shown in Fig. 1, three sets of summing amplifiers 22, 24 and 26 and coefficient determining, impedance elements A_{ui} , A_{li} and A_{xi} (where $i=1, 2$ or 3) are provided to generate output signals for the exposure control or classification of originals carrying normal scenes, backlighted scenes, and front lighted scenes, respectively. In addition, the background function computer 28 serves to select and apply the particular classification signal dependent upon the type of scene which is viewed by the radiation sensitive apparatus 10. More specifically, the background function computer 28 generates a signal Z indicated by the following equation:

$$Z = b_1 + b_2 D_U - b_3 D_L$$

where b_2 and b_3 are coefficients, b_1 is a constant input signal. D_U is the signal derived from the readout circuit 18 and D_L is the signal derived from the readout circuit 16. As shown in the drawing, the signal Z is generated by the background function computer 28 and is applied to the classification discriminator 30 which provides a signal corresponding to one of the input signals derived from the summing amplifiers 22, 24 and 26 dependent upon the signal Z . More specifically, if the signal Z is greater than a level S_1 , the signal Z generated by the classification discriminator 30 will represent the signal generated by the summing amplifier 22 and will provide the appropriate correction for originals bearing scenes which are backlighted. If the signal Z is greater than or equal to a level S_2 and less or equal to the level S_1 , the classification discriminator 30 will generate a signal corresponding to the signal derived from the summing amplifier

24 to thereby provide a normal classification signal for scenes whose composition do not includes upper and lower peripheral portions of greater contrast. If the signal Z is less than the level S_2 , the signal generated by the classification discriminator 30 will correspond to that signal generated by the summing amplifier 26 to thereby correct for front lighted scenes.

The output signals derived from each of the summing amplifiers 22, 24 and 26 are effected by a special set of coefficients as determined by the impedance elements A_{ui} , A_{li} and A_{xi} (where $i=1, 2$ or 3) which adjust each of the output signals for a particular type of scene. For example, the summing amplifier 22 provides the output signal C_b to provide classification correction for a backlighted scene according to the following equation:

$$C_b = a_1 + a_{u1} D_U + a_{l1} D_L + a_{x1} X$$

The output signal C_n derived from the summing amplifier 24 provides classification correction for a substantially normal scene according to the following equation:

$$C_n = a_2 + a_{u2} D_U + a_{l2} D_L + a_{x2} X$$

Further, summing amplifier 26 provides an output signal of C_f providing classification correction for a high contrast front lighted scene according to the equation:

$$C_f = a_3 + a_{u3} D_U + a_{l3} D_L + 2a_{x3} X$$

In the above given equations, C_b , C_n and C_f are classification voltage signals derived from the summing amplifiers 22, 24 and 26; a_1 , a_2 and a_3 are constant input signals, a_{ui} , a_{li} and a_{xi} ($i=1, 2$ and 3) are coefficients determined by the impedance elements A_{ui} , A_{li} and A_{xi} , and X is the signal derived from the auctioneering circuit 20. The coefficients a_{u1} , a_{l1} and a_{x1} may be selectively chosen with respect to value and polarity.

While the three separate equations listed above are shown in the drawing as being derived from three separate summing amplifiers 22, 24 and 26, it should be understood that a single coefficient summing amplifier or unit could be used with three sets of coefficient impedance networks selected by a background discriminator.

The coefficients for the above-identified equations and the discrimination limits S_1 and S_2 can be determined by statistical analysis by analyzing originals from a large population of originals to be printed. From experience, it has been noted that the coefficients may vary according to the season and that there may be slight changes in the coefficients for those used during the winter and summer seasons for example. However, the operation of the coefficients to increase or decrease the exposure of a print according to

tively high green density in the foreground portion; blue sky scenes would result in relatively high blue density in the upper peripheral area; wood paneling would be evidenced by relatively high red density and low blue density in the upper area and so forth. By providing separate colour measurements and determining separate upper and lower peripheral density as well as separate central-maximum densities for each colour, a broader range of scene classifications can be determined to correct for colour subject failure and density subject failure.

WHAT WE CLAIM IS:—

1. A method of classifying information media (originals) for photographic reproduction wherein radiation derived from different portions of an original is measured, characterized in that the extreme density portion of the central portion of the original is measured (measurement a), the average den-

8. A method according to any one of the original is measured (measurement b), and the average density of a lower peripheral portion of the original is measured (measurement c), and in that the measurements are combined to provide a classification signal.

2. A method according to claim 1, characterized in that each of the measurements "a", "b" and "c" is provided as an electrical signal, the signals being combined to form said classification signal.

3. A method according to claim 1 or 2 characterized in that the measurements "b" and "c" are made on upper and lower peripheral portions which together surround the central portion.

4. A method according to claim 1 or 2, characterized in that the measurements "b" and "c" are made on upper and lower peripheral portions which have the shape of rectangular horizontal strips.

5. A method according to claim 4, characterized in that each horizontal strip constitutes approximately 20% of the total area of the original.

6. A method according to any one of the preceding claims, characterized in that the density of a plurality of small spots of the central portion is measured, the small spots having a fixed area.

7. A method according to any one of the preceding claims, characterized in that the classification signal is provided for at least two types of originals separately, and that only one of these classification signals is selected as the final classification signal for modifying the exposure signals.

8. A method according to any one of the preceding claims, characterized in that a classification signal is provided for three types of originals (i.e. backlighted, front lighted and normal).

9. A method according to any one of the preceding claims, characterized in that the classification signal is the sum of the signals (X , D_u , D_L) representing measurement a, measurement b, and measurement c, respectively, and in that each of said signals is differently weighted depending upon the type of the original.

10. A method according to claim 9, characterized in that the classification signals are provided according to the following equations:

$$C_b = a_1 + a_{u1} D_u + a_{l1} D_L + a_{x1} X.$$

$$C_n = a_2 + a_{u2} D_u + a_{l2} D_L + a_{x2} X.$$

$$C_f = a_3 + a_{u3} D_u + a_{l3} D_L + a_{x3} X.$$

whereby the coefficients generally lie in the following ranges:

		D_u	D_L	X
	Normal	a_{u2} is of a negative value	a_{l2} is of a negative value	a_{x2} is of a positive value
85	Backlighted	a_{u1} is of a more negative value than a_{u2}	a_{l1} is equal to or of a less negative value than a_{l2}	a_{x1} is of a less positive value than a_{x2}
90	Frontlighted	a_{u3} is equal to or more of a negative value than a_{u2}	a_{l3} is equal to or of a less negative value than a_{l2}	a_{x3} is of a more positive value than a_{x2}

11. A method according to any one of the preceding claims, characterized in that at least one classification signal is provided, which is used to correct the red, blue and green exposure control signals which are preferably derived from LATD measurements.

12. A method according to any one of the preceding claims, characterized in that the measurements a, b and c are made with white light.

13. A method according to any one of the preceding claims, characterized in that

5 tively high green density in the foreground portion; blue sky scenes would result in relatively high blue density in the upper peripheral area; wood paneling would be evidenced by relatively high red density and low blue density in the upper area and so forth. By providing separate colour measurements and determining separate upper and lower peripheral density as well as separate central-maximum densities for each colour, a broader range of scene classifications can be determined to correct for colour subject failure and density subject failure.

WHAT WE CLAIM IS:—

15 1. A method of classifying information media (originals) for photographic reproduction wherein radiation derived from different portions of an original is measured, characterized in that the extreme density portion of the central portion of the original is measured (measurement a), the average den-

20 8. A method according to any one of the original is measured (measurement b), and the average density of a lower peripheral portion of the original is measured (measurement c), and in that the measurements are combined to provide a classification signal.

25 2. A method according to claim 1, characterized in that each of the measurements "a", "b" and "c" is provided as an electrical signal, the signals being combined to form said classification signal.

30 3. A method according to claim 1 or 2 characterized in that the measurements "b" and "c" are made on upper and lower peripheral portions which together surround the central portion.

35 4. A method according to claim 1 or 2, characterized in that the measurements "b" and "c" are made on upper and lower peripheral portions which have the shape of rectangular horizontal strips.

5. A method according to claim 4, characterized in that each horizontal strip constitutes approximately 20% of the total area of the original. 45

6. A method according to any one of the preceding claims, characterized in that the density of a plurality of small spots of the central portion is measured, the small spots having a fixed area. 50

7. A method according to any one of the preceding claims, characterized in that the classification signal is provided for at least two types of originals separately, and that only one of these classification signals is selected as the final classification signal for modifying the exposure signals. 55

8. A method according to any one of the preceding claims, characterized in that a classification signal is provided for three types of originals (i.e. backlighted, front lighted and normal). 60

9. A method according to any one of the preceding claims, characterized in that the classification signal is the sum of the signals (X , D_U , D_L) representing measurement a, measurement b, and measurement c, respectively, and in that each of said signals is differently weighted depending upon the type of the original. 65

10. A method according to claim 9, characterized in that the classification signals are provided according to the following equations: 70

$$C_b = a_1 + a_{u1} D_U + a_{l1} D_L + a_{x1} X.$$

$$C_n = a_2 + a_{u2} D_U + a_{l2} D_L + a_{x2} X.$$

$$C_f = a_3 + a_{u3} D_U + a_{l3} D_L + a_{x3} X.$$

whereby the coefficients generally lie in the following ranges: 75

	D_U	D_L	X
Normal	a_{u2} is of a negative value	a_{l2} is of a negative value	a_{x2} is of a positive value
85 Backlighted	a_{u1} is of a more negative value than a_{u2}	a_{l1} is equal to or of a less negative value than a_{l2}	a_{x1} is of a less positive value than a_{x2}
90 Frontlighted	a_{u3} is equal to or more of a negative value than a_{u2}	a_{l3} is equal to or of a less negative value than a_{l2}	a_{x3} is of a more positive value than a_{x2}

95 11. A method according to any one of the preceding claims, characterized in that at least one classification signal is provided, which is used to correct the red, blue and green exposure control signals which are preferably derived from LATD measurements.

12. A method according to any one of the preceding claims, characterized in that the measurements a, b and c are made with white light. 100

13. A method according to any one of the preceding claims, characterized in that



the three equations listed above, may be summarized as follows for an illustrative sample of negative originals:

		D_u	D_l	X
5	Normal	a_{u2} is of a negative value	a_{l2} is of a negative value	a_{x2} is of a positive value
	Backlighted	a_{u1} is of a more negative value than a_{u2}	a_{l1} is equal to or of a less negative value than a_{l2}	a_{x1} is of a less positive value than a_{x2}
10	Frontlighted	a_{u3} is equal to or more of a negative value than a_{u2}	a_{l3} is equal to or of a less negative value than a_{l2}	a_{x3} is of a more positive value than a_{x2}

In the foregoing chart, it is assumed that normally the principal subject is related to the central area that on occasion, the lower peripheral area may include the principal subject, e.g. in flash scenes, and that the upper peripheral area includes the principal subject. Thus, for a backlighted scene in which the upper peripheral density and/or maximum density may be read erroneously high, the changes made in the coefficients with respect to the coefficients used for the normal equation, serve to provide a print that is lighter or less exposed than normal for backlighted scenes. Conversely, the coefficient changes indicated for the high contrast, front lighted scenes having relatively low upper density and/or high lower density will result in greater exposures of the original to provide darker prints than normal. The magnitude of the above-coefficient changes is dependent on the sample of the originals and are interdependent with the constant terms a_1 , a_2 and a_3 which, according to the invention, may be selectively adjusted to provide appropriate bias in the print density for each category.

Though this invention has been described and shown in terms of a three equation system, i.e. three equations to provide exposure classification for front lighted, normal and backlighted scenes respectively, it will be understood that the invention could operate with two equations and that one of the summing amplifiers and its set of coefficient elements could be deleted. For example, the summing amplifier 24 and the set of coefficient determining impedance elements A_{u2} , A_{l2} and A_{x2} could be deleted, and the sets of coefficient determining impedance elements associated with the summing amplifiers 22 and 26 could be adjusted to compensate for a normally lighted scene.

Thus, there has been shown apparatus for sensing radiation derived from various portions of an image to classify or control the exposure of an original onto a radiation sensitive medium in order to compensate for

various abnormal scenes of the original. If the printing system utilizes the large area transmission density (LATD) matrix method of exposure determination, it is possible to choose coefficients in the LATD matrix that will improve the density correction provided with the automatic classifier. When using the invention in connection with a black and white original only one LATD measurement can be made and only one classification signal is possible.

Further, though this apparatus has been described for correcting subject density failure, it is understood that this apparatus could be adapted to provide classification signals for colour originals. In connection with the classification of colour originals reference is made to the above-mentioned U.K. Patent No. 1,346,695. The following two approaches can be used.

First, it is possible to provide only one classification signal according to the invention, which will be used to correct the LATD measurements of the three different colors. In this case, the classification signal will be derived from the original preferably by using white light. Second, it is possible (and this would avoid not only the subject density failure but also the color subject failure) to provide two or three classification signals (in the case of three classification signals, one classification signal is for red, the second for green and the third for blue). This can be accomplished by: (1) placing the discrete photocells in groups, each member of the group being sensitive to light of a different colour, (2) taking sequential readings by means of three radiation sensing arrays (similar to that shown in Fig. 1) with red, green and blue filters disposed to transmit red, green and blue light onto the separate arrays, or (3) using beam splitters to simultaneously project the image on mosaic arrays of differing spectral sensitivities. Negative originals having scenes with predominating green grass in the foreground or lower background portions of the scene will be evidenced by rela-





for correcting the colour subject failure, classification signals for two, or three colours are provided by taking colour density (red, green and blue) measurements from the upper and lower peripheral portions and the maximum density of the central portion.

14. A method according to any one of the preceding claims, characterised in that the signals originating from measurements b and c perform a dual function in discriminating between two or more scene types which require different classification equations, and in serving as predictors in the separate classification equations which are selected by the discriminant function.

15. A method according to any one of the preceding claims, characterised in that the measurements a, b and c are carried out simultaneously.

20 16. A method of classification information media for photographic reproduction, substantially as described herein with reference to Fig. 1 or Fig. 2 of the accompanying drawings.

25 17. Apparatus for use in carrying out a method according to any one of claims 1 to 16, characterised by means for providing a signal representing the density of that portion of the central area of the original having an extreme density, means for providing a signal representing the average density of an upper peripheral portion of the original, and means for providing a signal representing the average density of a lower peripheral portion of the original.

35 18. Apparatus according to claim 17, characterised by a mechanical scanner having apertures therein corresponding to the central portion and/or the upper and lower peripheral portions of the original.

40 19. Apparatus according to claim 18 characterised in that the mechanical scanner comprises a rotatable disc.

45 20. Apparatus according to claim 17, characterised by a flying spot scanner system whose video output signal is selectively dissected to represent the upper and lower portions of the peripheral portion of the central portion of the viewed scene.

50 21. Apparatus according to claim 17, characterised by a radiation-sensitive assembly having a first radiation sensitive assembly having a first radiation sensitive means responsive to radiation from the central portion of the original for providing a first signal (X) indicative of the density of the extreme density portion of the central portion, a second radiation sensitive means responsive to radiation from the upper peripheral portion to provide a second signal (D_u) indicative of the average density of the upper peripheral portion, and a third radiation sensitive means responsive to radiation from the lower peripheral portion to provide a third signal (D_l)

indicative of the average density of the lower peripheral portion. 65

22. Apparatus according to claim 21, characterised by having means for focusing or directing the radiation image derived from the original onto the radiation sensitive assembly. 70

23. Apparatus according to claim 21 or 22, characterised in that the second and third radiation sensitive means together surround the first radiation sensitive means. 75

24. Apparatus according to claim 21 or 22, characterised in that the second and third radiation-sensitive means are rectangular horizontal strips at the top and bottom respectively, each arranged to sense approximately 20% of the total picture area. 80

25. Apparatus according to any one of claims 21 to 24, characterised in that the first radiation sensitive means is arranged to sense a relatively small centrally disposed portion of the original of about 16% of the total original area. 85

26. Apparatus according to any one of claims 21 to 25, characterised by having first circuit means responsive to the first (X), second (D_u) and third (D_l) signals for providing a first classification signal C_b representative of an original having an upper peripheral portion of relatively high density, a second classification signal C_l representative of an original having a lower peripheral portion of a relatively high density, and/or a third classification signal C_n representative of a normal original, and second circuit means responsive to the second (D_u) and third (D_l) signals for providing a selection signal for selecting either the first classification signal C_b or the second classification signal C_l dependent upon the relationship between the second and third signals (D_u and D_l). 90 95 100 105

27. Apparatus according to claim 26, characterised in that said second circuit means provides a first selection signal if the difference between the second (D_u) and third (D_l) signals is not more than a first predetermined value, a second selection signal if the difference between the second (D_u) and third (D_l) signals is not less than the first predetermined value nor greater than a second predetermined value, and a third selection signal if the difference between the second (D_u) and third (D_l) signals is not less than the second predetermined value. 110 115

28. Apparatus according to claim 26 or 27, characterised in that the first circuit means is responsive to the first, second and third signals to provide a first exposure correction signal for reproduction of the first type of original, and a second exposure correction signal for reproduction of the second type of original, and that the second circuit means is responsive to the second and third signals to provide a third exposure correction signal related to either the first or second 120 125

exposure correction signals dependent upon the difference between the second and third signals.

29. Apparatus according to any one of the preceding claims 26 or 27, characterised in that a single coefficient summing amplifier or unit is used with each of three sets of coefficient impedance networks selected by a background discriminator.

30. Apparatus according to claim 29, characterised in that the summing amplifier and the set of coefficient elements (A_{12}), (A_{13}) and (A_{23}) can be overridden, and that the sets of coefficient elements associated with the remaining summing amplifiers are adjustable to compensate for a normally lighted scene.

31. Apparatus according to any one of the preceding claims 21 and 30, characterised in that the first radiation sensitive means comprises a plurality of radiation sensitive elements each of which has a size sufficient to determine the density of a small fixed area of the central portion.

32. Apparatus according to claim 31, characterised in that said first radiation sensitive means comprises individual assemblies of radiation sensitive elements which are respectively responsive to radiation of the red, green and blue wavelengths.

33. Apparatus according to any one of the preceding claims 21 to 32 characterised in that said second radiation sensitive means and said third radiation sensitive means are broken up into a plurality of regions sensitive to radiation of green, blue and red wavelengths, the red sensitive regions being connected to a summing circuit, the green sensitive regions being connected to a summing circuit, and the blue sensitive regions being connected to a summing circuit.

34. Apparatus according to claim 17, characterised in that a plurality of radiation sensitive assemblies are provided, and in that

means are provided for moving an original successively to a first position at which the image of the original is projected onto a first image reading assembly and to second and third positions, respectively, so that the image of the original is directed onto second and third image reading assemblies, each of the image reading assemblies being connected to

35. Apparatus according to claim 17, characterised in that means are provided for projecting the image of an original onto a plurality of image reading assemblies by means of first and second beam splitters which are disposed in the projection path to direct the image of the original onto first and second assemblies, a third assembly being arranged to receive the transmitted image.

36. Apparatus according to claim 18 or 19, characterised in that means are provided by which the original to be reproduced is imaged by a lens upon a rotating scanner disc, behind which a field lens is provided to focus the image transmitted by the scanner disc upon a photomultiplier.

37. Apparatus according to claim 36, characterised in that the scanner disc comprises a reference aperture and a gating aperture, and in that four light sources with cooperating photocells are positioned to allow correct gating of the scans.

38. Apparatus according to claim 36 or 37, characterised in that the disc comprises respective peripheral notches operatively associated with the scanning apertures.

39. Apparatus for classifying information bearing media for photographic reproduction, constructed substantially as described herein with reference to and as shown in, Fig. 1 or Fig. 2 of the accompanying drawings.

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