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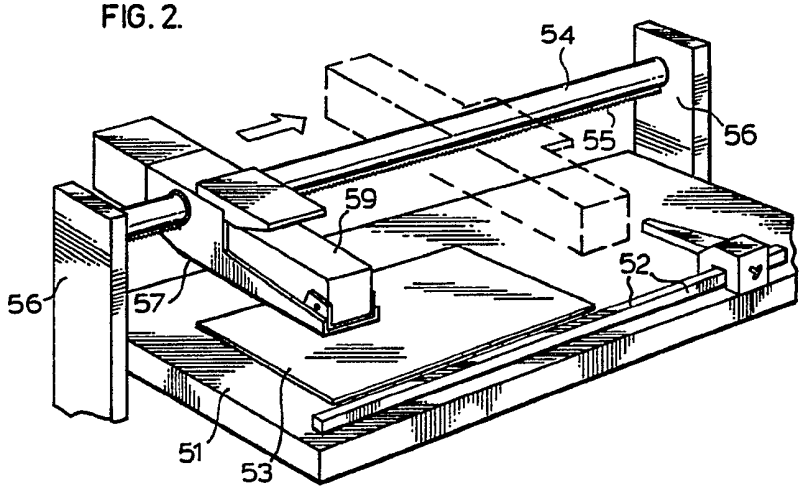
(54) Colour data evaluation in a printing process

(57) Apparatus for the control of colour in a printing process comprises a table (51) on which a work (53) is positioned. A densitometer (59) of a colour measuring device (50) is moved over the work (53) along a rack (54) to obtain colour data along a predetermined line scanned by the densitometer (59). The measuring device (50) is used to obtain sets of colour data along the same predetermined locus from a colour proof, a printing plate and/or a final print. A comparison of the data readings may be utilised to control a printing press and/or to produce colour control charts. The collection and utilisation of the colour data may be computerised.

FIG. 2.



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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

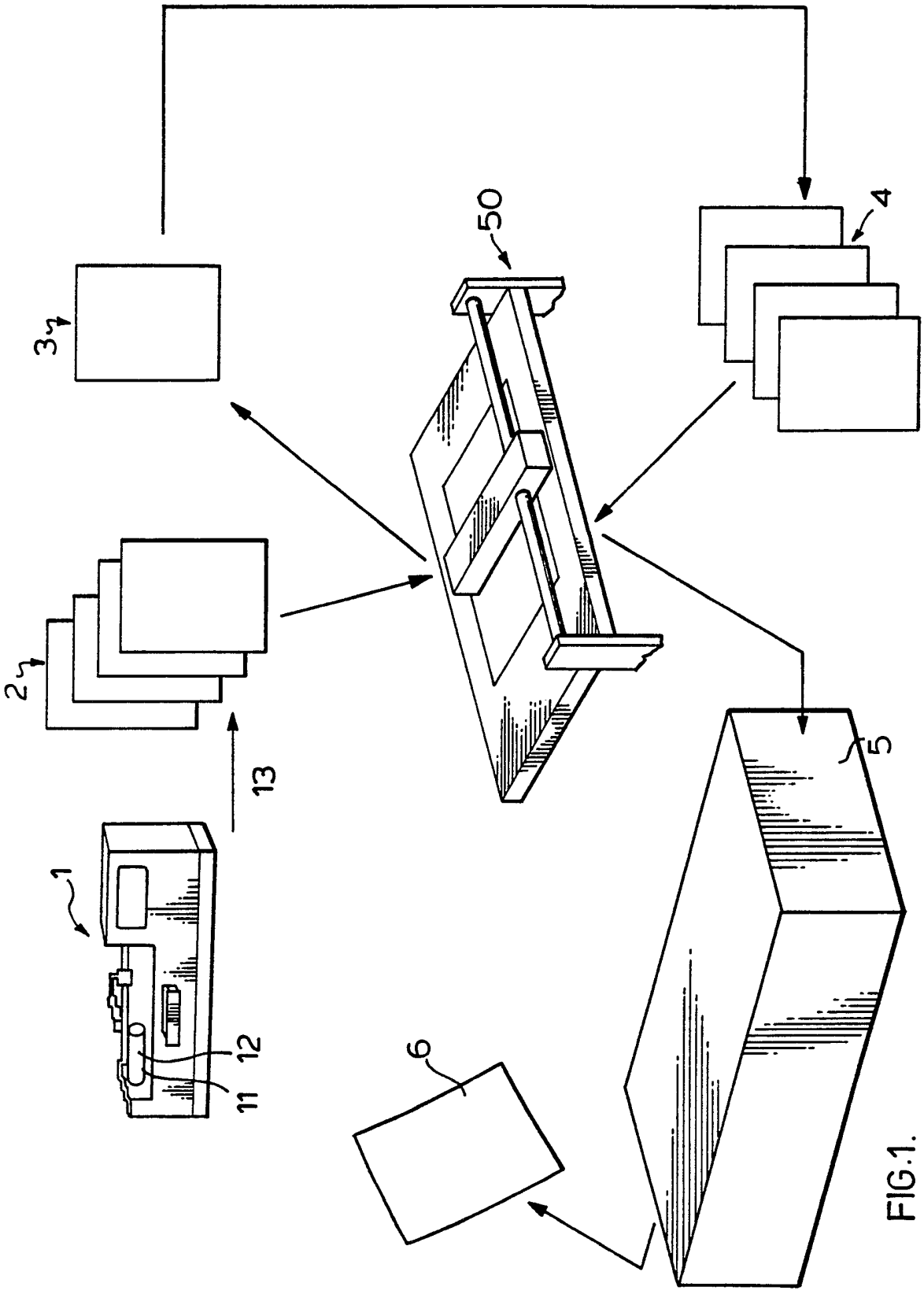


FIG.1.

FIG. 2.

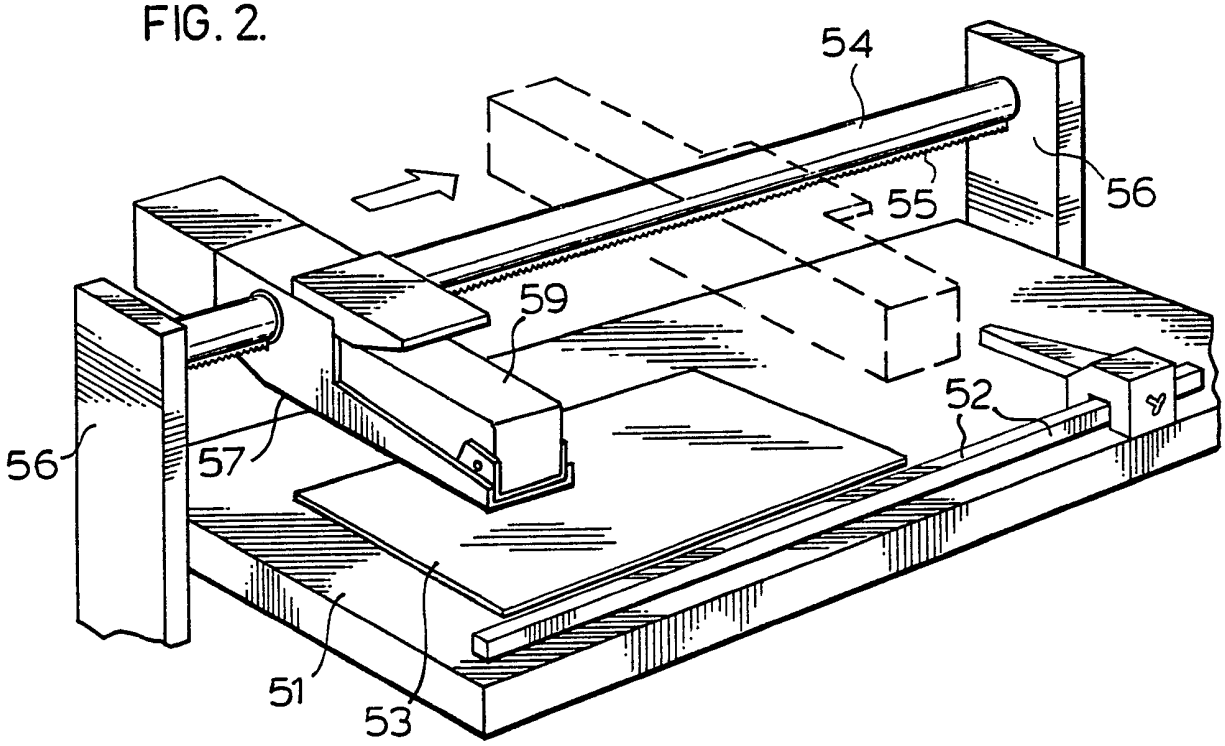
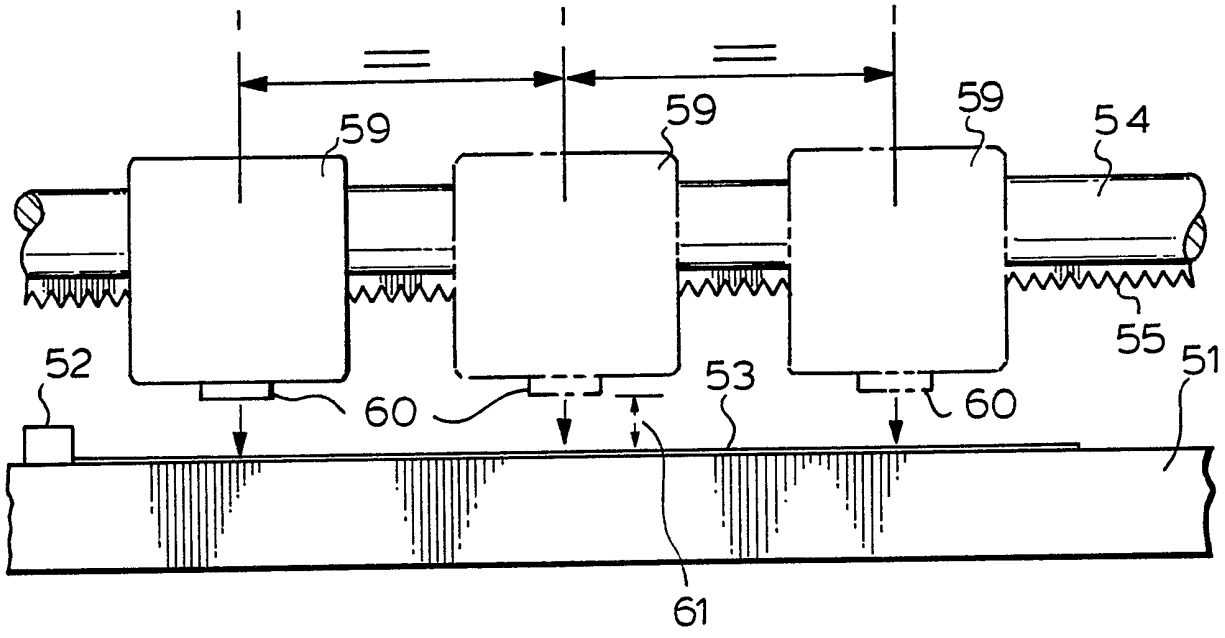


FIG. 3.



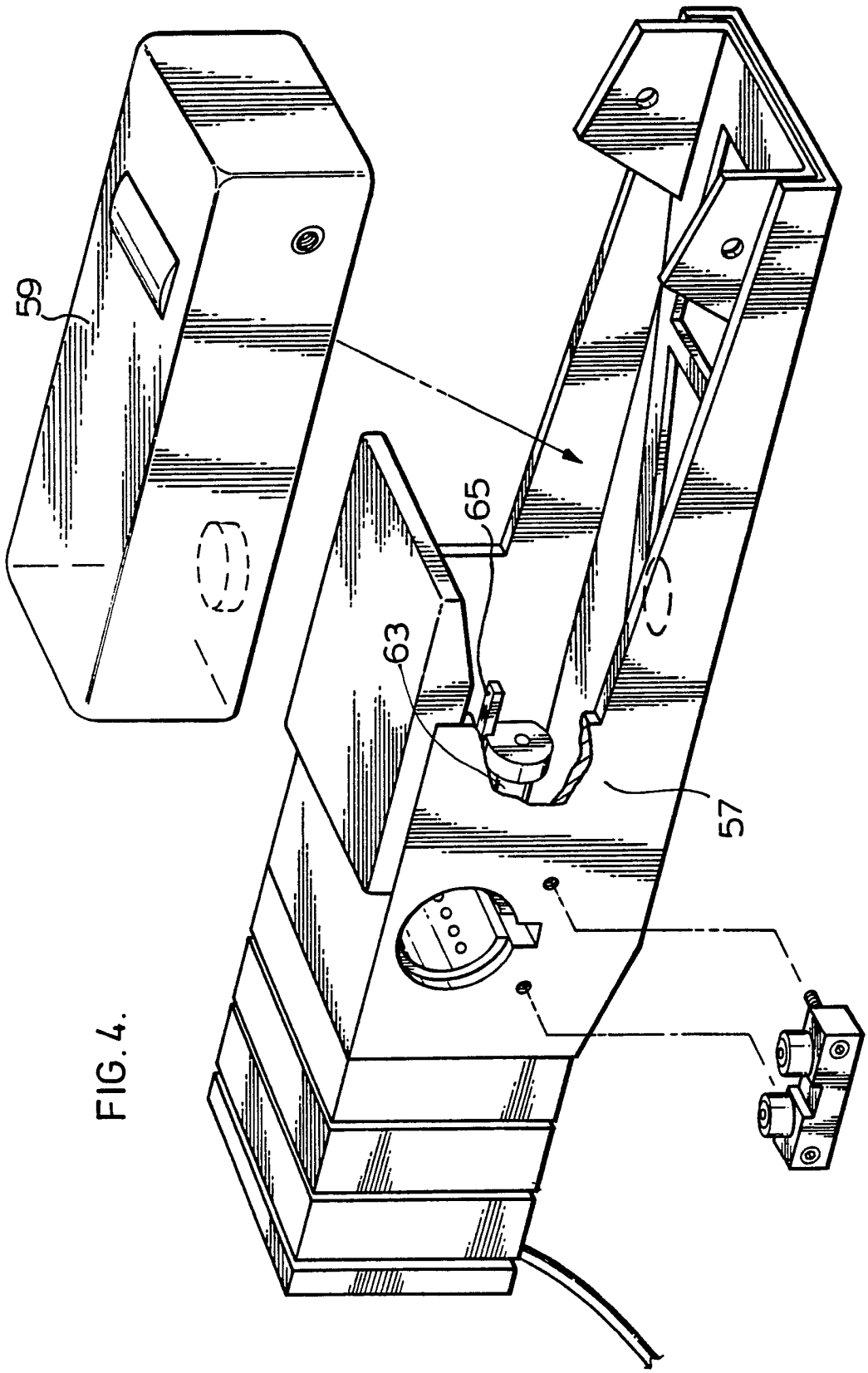


FIG. 4.

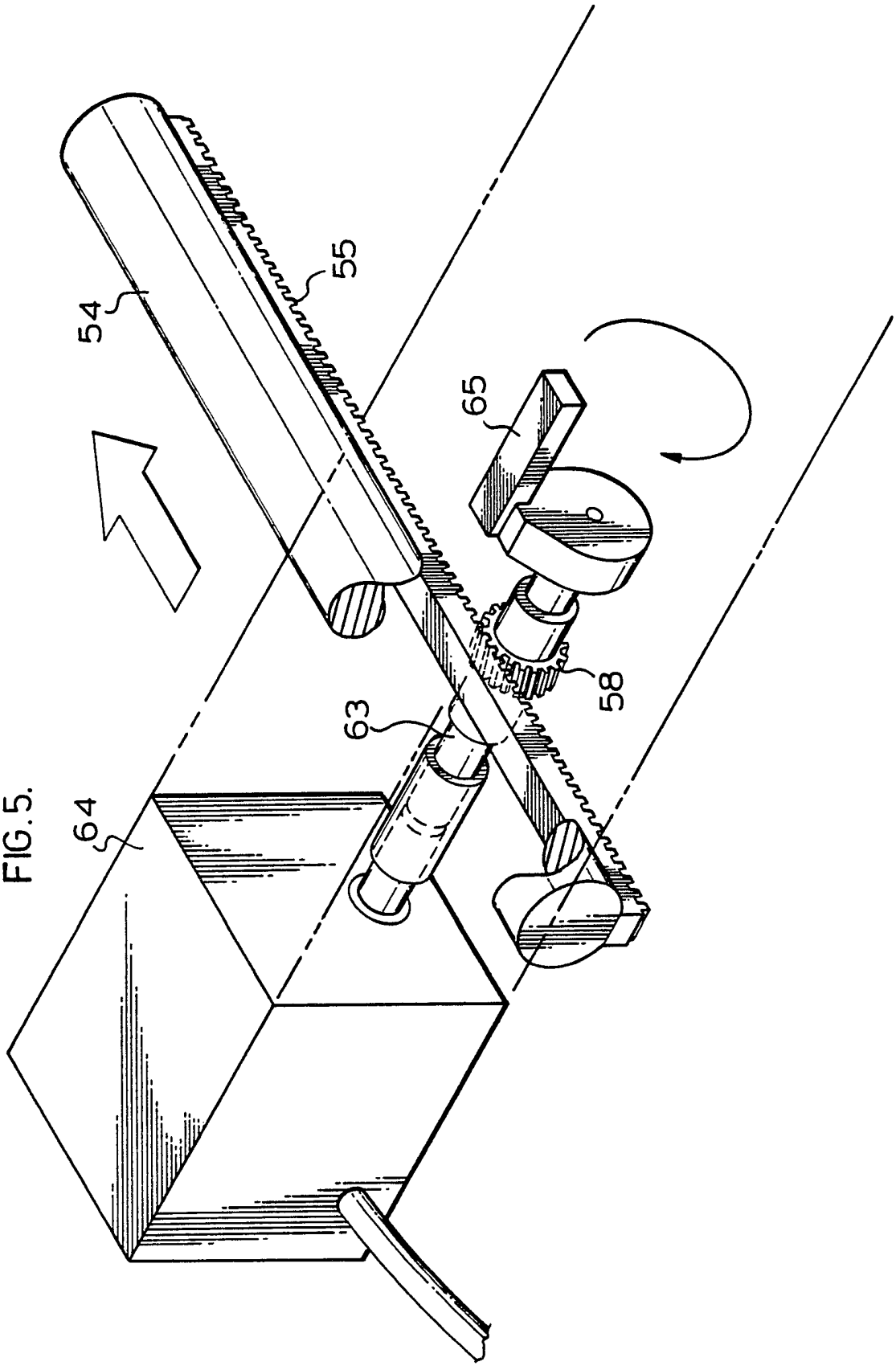


FIG.5.

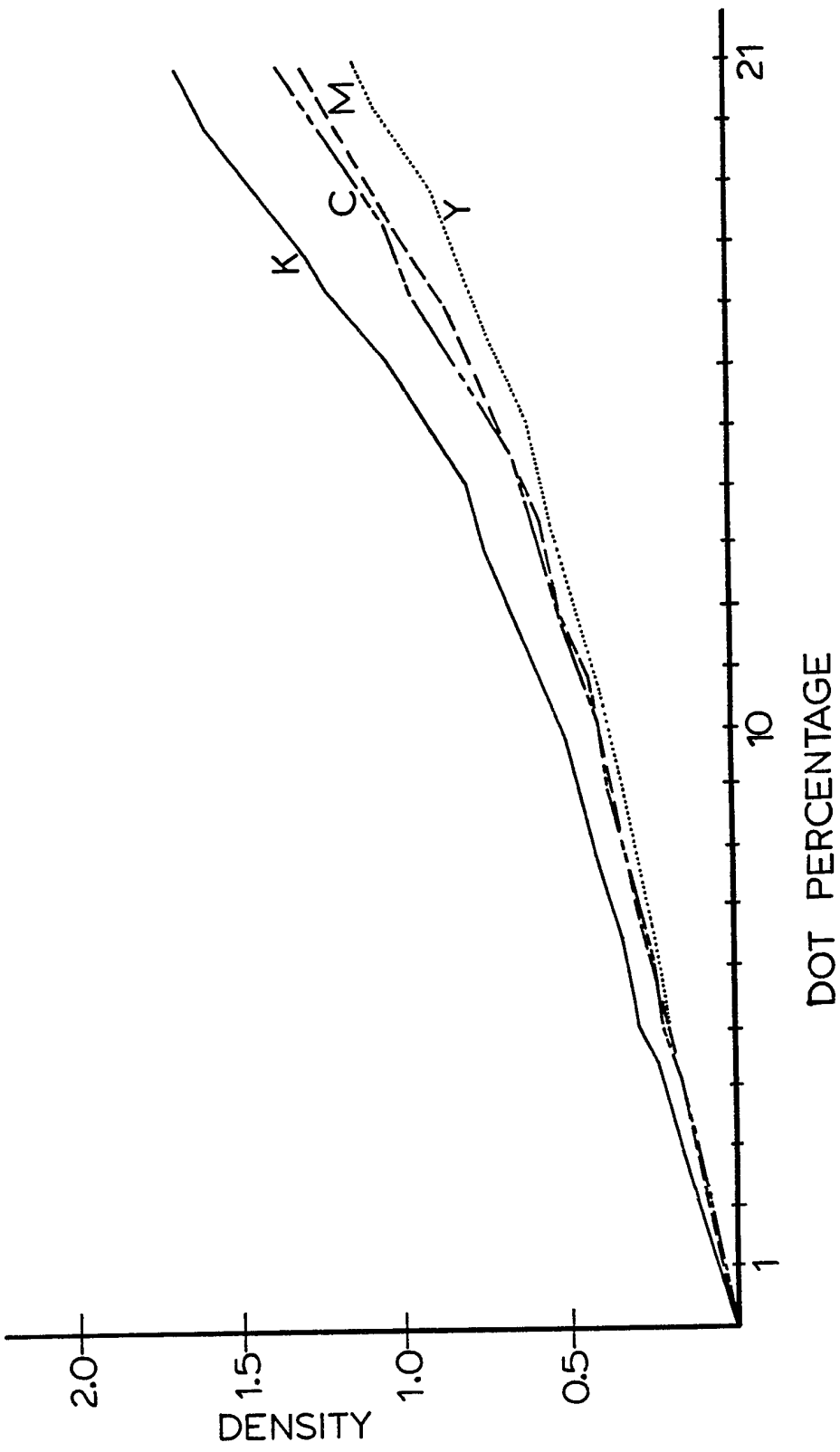


FIG.6.

FIG. 7.

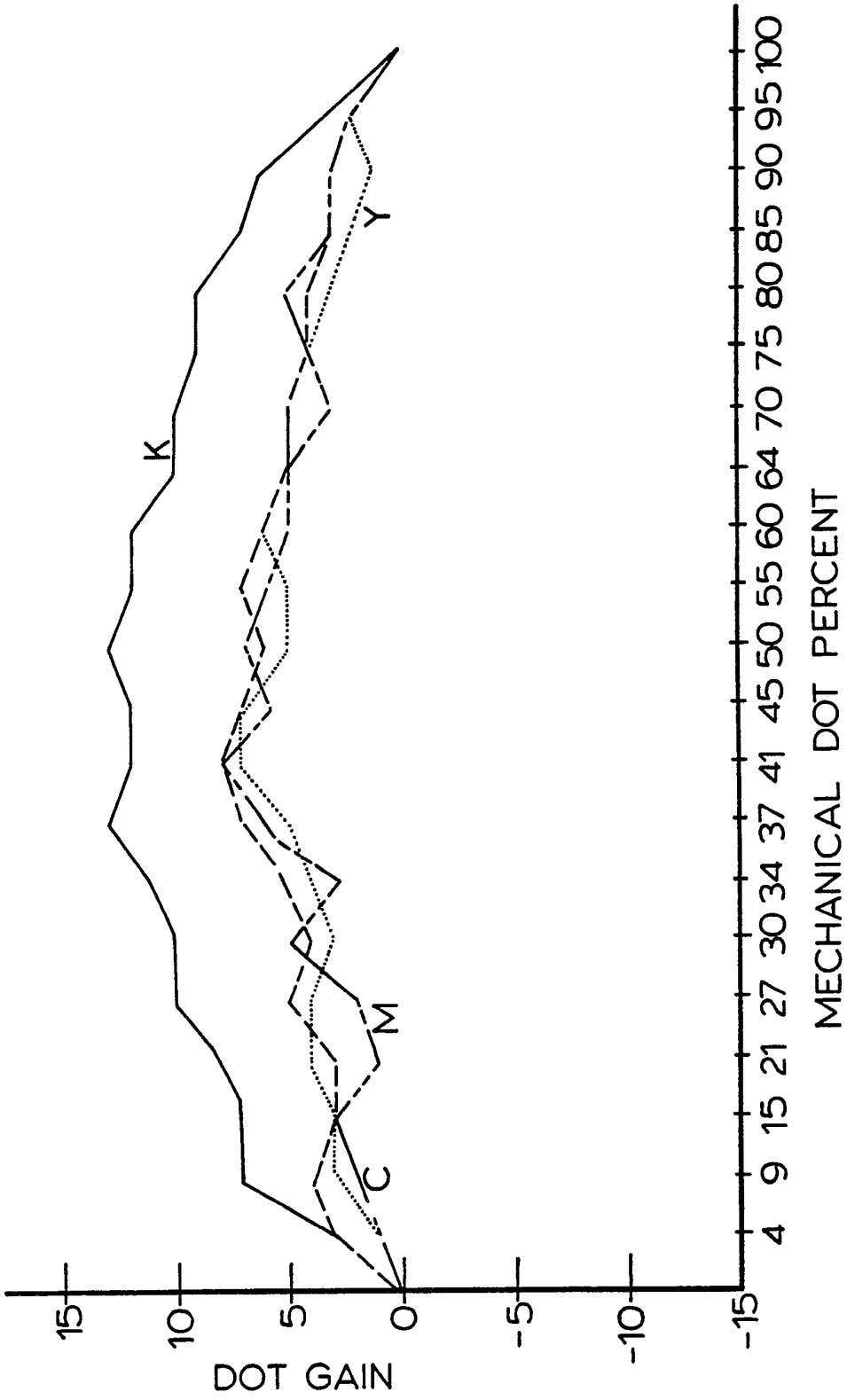
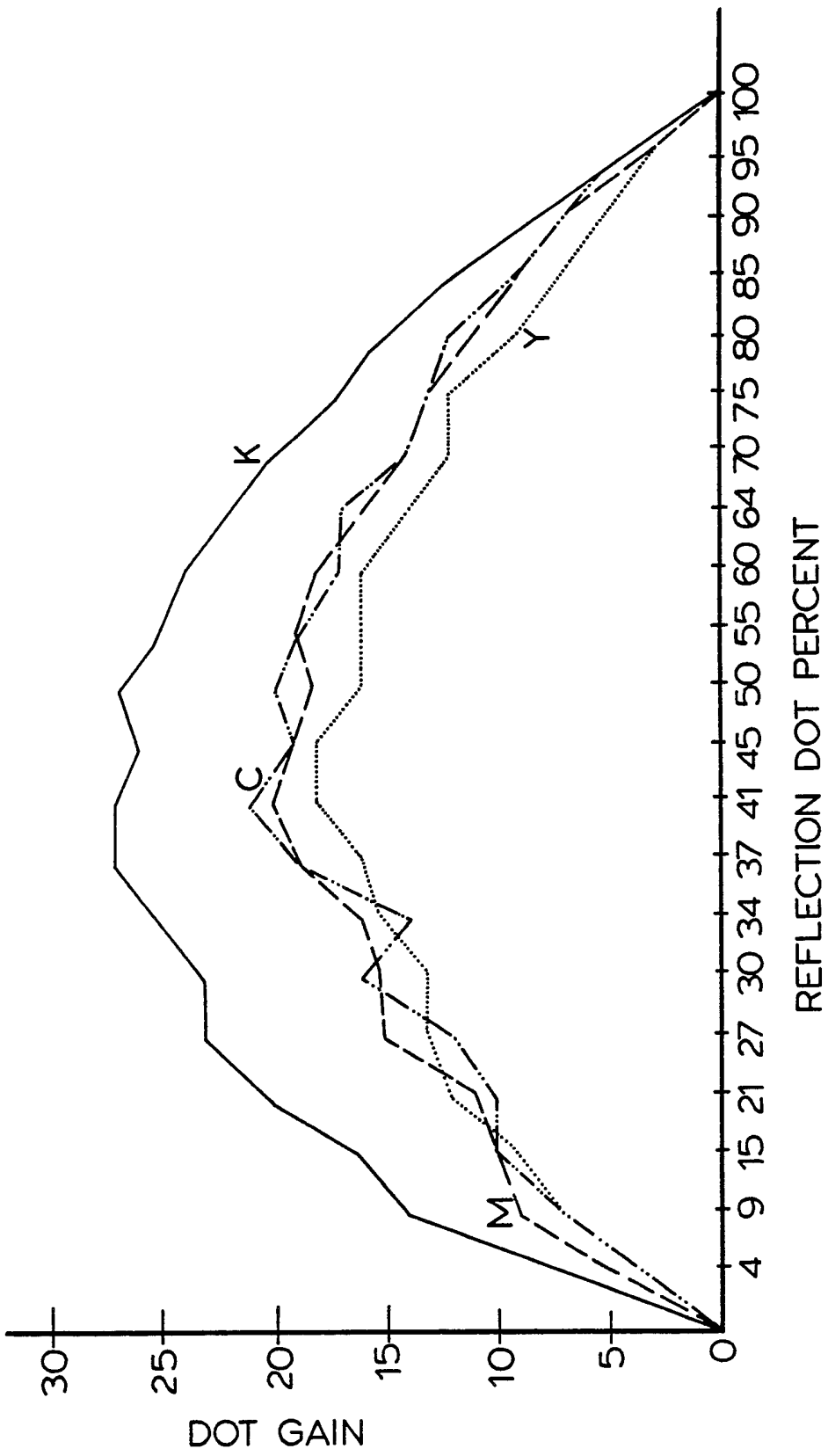

DOT GAIN
15
10
5
0
-5
-10
-15
4 9 15 21 27 30 34 37 41 45 50 55 60 64 70 75 80 85 90 95 100
MECHANICAL DOT PERCENT
K
Y
M
C

FIG.8.


DOT GAIN
30
25
20
15
10
5
0
4 9 15 21 27 30 34 37 41 45 50 55 60 64 70 75 80 85 90 95 100
REFLECTION DOT PERCENT
K
C
M
Y

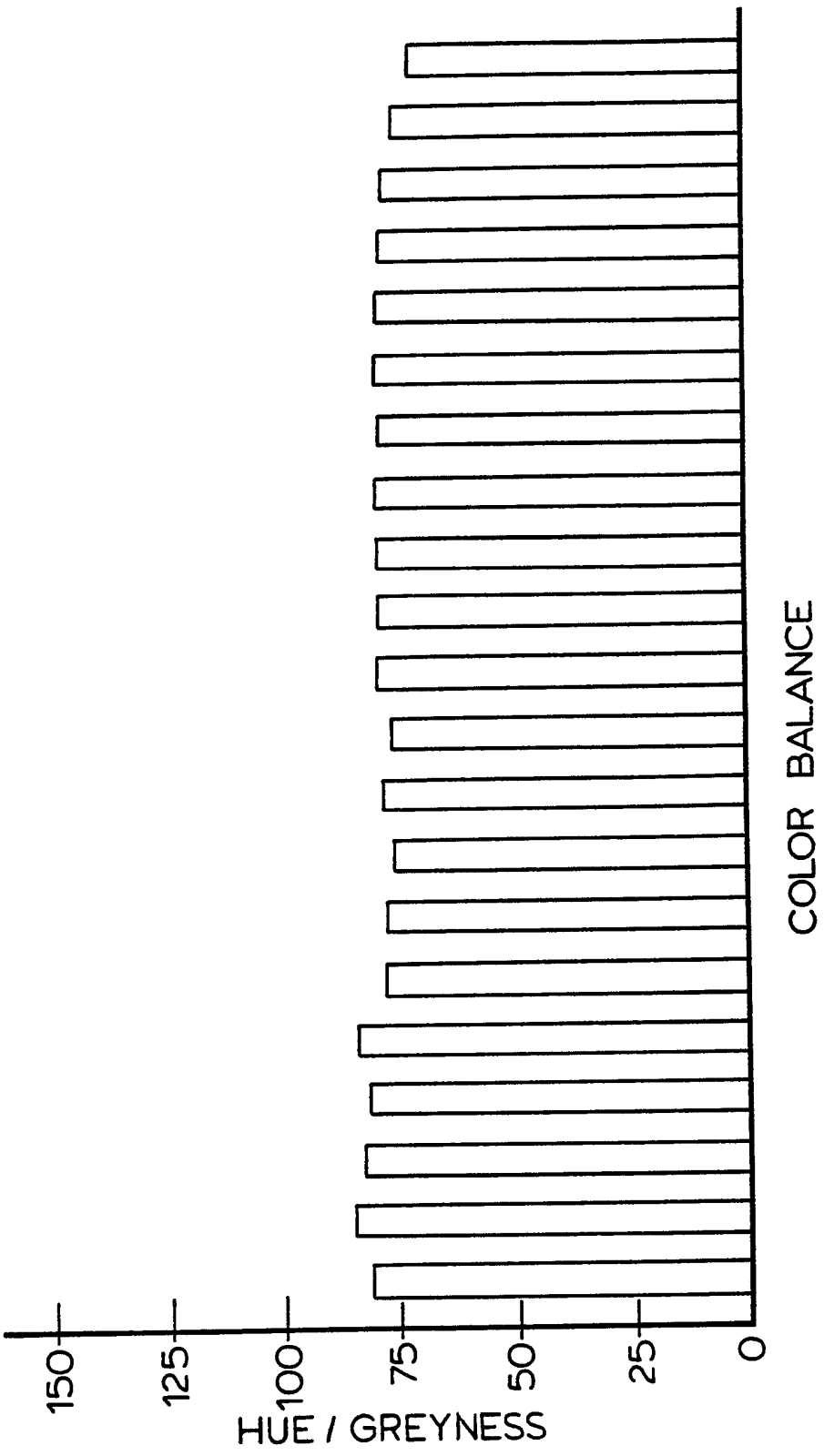


FIG. 9.

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PROCESS AND APPARATUS FOR COLOUR DATA EVALUATION

TECHNICAL FIELD

This invention relates to the field of printing and, in particular, relates to a process and an apparatus for the control of colour in off-set printing.

BACKGROUND ART

The production of printed works in off-set printing usually involves the following steps. A customer presents a colour picture to be reproduced. The picture is scanned by a scanner in order to separate and measure the values of the four colours, black, cyan, magenta and yellow in the picture. From the scanner data, four films, each of one of the colours mentioned above, are prepared. These films are then used to create a proof of the picture to demonstrate to the customer the result expected from a final printed product. The customer, upon approval of the proof, authorizes the printer to proceed with the printing. The films are then used to create four plates that are used by the printing machine to apply the corresponding colours to paper in order to create a colour picture.

Fundamental to this procedure is the ability to predict and to maintain the colours at each of the different steps. Each of the steps involves different technology and apparatus. Thus, translation from one step to another requires an understanding of the relative position or calibration of the apparatus used at each step to that used at the others. The problem of developing a working understanding is commonly aggravated by having the different processes and apparatus for each stage at different locations and operated by different entities.

The final step in the procedure is the printing press. Ultimately, all the step taken prior to printing are for the purpose of enabling the printing press to replicate a close facsimile of the picture submitted by the customer. A printing press is adjusted during operations by use of ink keys or controls that regulate the ink fed to the paper. Each ink key controls the flow of ink at a predetermined location along a line perpendicular to the direction of the paper travel through the press rolls. In this manner, the press operator controls the amount of ink fed to a small ribbon-like area of the paper extending in the direction of travel of the paper through the rolls. Thus, ink is applied to the paper to be printed in a plurality of parallel bands, the thickness of ink of each band being individually controlled by its respective ink key. Other important factors which control the printing of a picture include the dot location, dot size and dot density of the printing plates. Dot location on one of the four colour plates controls where that colour will be applied to the picture by the press. Dot size affects the amount of ink applied to a particular location, but so does the amount of ink fed to the band in which the dot appears. Dot density affects that amount of colour applied to a given area. Other factors also affect the colours applied to the paper, including paper quality and colour, ink consistency and colour and such other normal variables that occur in the supply of materials and the practice of any process.

A printing press operator attempts to correct and to adjust for colour discrepancies between the printed product and the proof using the ink keys. A number of methods have been developed to assist the operator or to automate this process. Sometimes colour control strips containing standard colours are printed together with the

picture. These colour control strips may be measured by an instrument known as a densitometer which provides data on the four standard colours. Then the operator may determine the variation of the printed colour from the standard and make adjustments to the ink feed controls appropriately to bring the printing press into line with the standard colours. When these adjustments are made, it is hoped that the printed work will conform to the proof accepted by the customer. In the event that there is still a discrepancy, the machine operator may make manual adjustments in order to correct any residual discrepancies. In some cases, colour bars are not used for one reason or another and it is left to the printing press operator to adjust the printing press using his skill and judgment in order to have the printed work conform with the proof. The time and the corresponding expense for adjusting the printing press to conform to the proof is dependent upon the skill and luck of the operator in many cases.

U.S. patent 4,649,502 discusses the problem of evaluating printing quality and regulating ink feed controls in an off-set printing machine. It considers the use of colour control strips which may be used on a printing press while it is running using "machine densitometers" or off-line by using "automatic scanning densitometers". It notes that an example of a computer-control printing machine with a close circuit control is described in U.S. patent 4,200,932. It also discusses U.S. patent 3,376,426 in which a multi-colour printing machine is regulated by means of a machine densitometer without colour measuring strips and notes that this system has not been found to be practical. It also notes U.S. patent 4,561,103 which discloses a method for machine evaluation of printed products without

colour control strips in which the printed products are scanned photoelectrically over the entire image surface area on the printing machine while it is running using a machine densitometer. This patent relies on scanned values obtained from individual image elements and a comparison of those values with similar values obtained from a reference product. U.S. patent 649,502 describes a process in which a reference is divided for individual printing colours into a plurality of image elements and for each image element, there is a determination of the reference surface coverage for the individual printing colours. The reference is in the form of at least one of a printing plate upon which the printing process is based and a printed product which has previously been determined to be satisfactory. The process also includes a weighting factor indicating a measure of assurance with which the prevailing surface coverage may be determined. The printed product is divided into image elements in the same manner as the reference and the reflectance is measured for each printed product image element to calculate the actual surface coverage for each of the printing colours from the respective reflectance. Deviations of actual surface coverage from the reference coverage may then be determined from the respective reflectance and values for the ink feed control elements can be set from the weighted deviations. See also U.S. patents 4,660,159 and 4,665,496.

DISCLOSURE OF THE INVENTION

The present invention is directed a means and a process for the collection, comparison and utilization of colour value data at any of the steps in the printing procedure from the scanner to the final printing process for control purposes. It does not require the

complex separation of a picture into a checkerboard of image elements as contemplated by the aforementioned prior art with attendant complexity in measurements and control. This invention provides a simple method and apparatus which provides good and practical control data.

The process of this invention permits calibration checks of apparatus at various steps in the printing procedure. To elaborate, a scanner views a picture to define the basic picture information such as, colour and the dot location, size and density to obtain films that will reproduce the colour, clarity and sharpness or definition of the original picture. While a scanner and a printer will ordinarily be calibrated to a grey balance before scanning and printing respectively, there are variables of the scanner data that may be affected by conditions on the press. For example, the selection of dot size on the scanner will be affected by the ink thickness setting of the printing press. It is possible that the dot size selected by the scanner will not appear at the correct size in the printed work because the ink settings at calibration in the press were different than anticipated during calibration of the scanner. Consequently, the current practice of achieving grey balance in each machine independently may not resolve all potential problems. In the process of this invention the data obtained from the scanner is obtained at grey balance, stored and compared to the printed products of the press at grey balance to ensure matching of all data in the calibration process.

Second, the process of this permits ongoing monitoring and control of the printing process. in this process a scanner operator generates a first set of original films from the picture

supplied by the customer. The gradation values of these films are obtained and recorded. Final films are then generated (via contacting) from the original films and gradation values of the final films are also obtained and recorded. The values of the original films and the final films are compared and a graphical presentation of any variance can be depicted. If variances are within tolerances, a pre-press proof may be produced from the final films. If variances are outside of tolerance limits, then corrections may be made from the variance data detected. Once a pre-press proof has been made, it too may be measured to establish the gradation values of the proof and that information may be obtained and recorded. Once again, these values may be graphically depicted to show any variance between the films and the proof. If errors are within tolerances, one continues to the next step. If errors are outside of tolerances, then one returns to make the necessary corrections. In the next step, printing plates are produced from the final films and the gradation values of these plates are obtained and recorded and graphical representations of any variances are depicted to assess whether errors are within tolerances or require correction. The pre-press proof date now becomes the reference data for balancing the printing press. The printing press produces the picture and is scanned to generate data which is then compared to the pre-press proof data. Variances may be graphically depicted and guide the press operator in his adjustment of the press parameters to bring the printed image into accordance with the proof. Continual scanning of press sheets during production may be used to maintain acceptable performance standards.

In the apparatus of this invention, a measuring device,

such as a densitometer, may obtain data transmitted from a scanner, or measure colour data from a proof, a printing plate or a printed picture. To simplify the description hereafter the various forms will be referred to generically as a "work") The data is obtained and measured in accordance with this invention, along a thin band linearly traversing a work at a same, i.e., a congruent, location of the picture. Thus data readings may be taken at each of the different stages and compared to detect any variance in the data along that same band in another work of that production.

Stated in general terms, the apparatus comprises a positioning means to support a work in a first plane to be measured, a measuring means in a second plane parallel to and spaced apart by predetermined distance from the work in the first plane and directed at a small area of the work to obtain colour data, a traversing means for establishing a uniform and repeatable movement between the work in the first plane and the measuring means in the second plane to obtain a stream of data from a predetermined locus across the work. In some embodiments of the apparatus, a storage register stores accumulated data, a comparator means compares data from different works and generates indicators of variances. In other embodiments, the indicators of variances may be fed directly to control means to effect corrections. In one preferred embodiment, the apparatus of this invention comprises a table having mounted over it a carriage adapted to traverse on a rack at a fixed distance above the table. A densitometer, which comprises the measuring means, is mounted in the carriage and directed downward onto the table. A picture to be scanned is placed in positioning means on the table. The densitometer in the carriage moves at a uniform pace along the

rack to scan a locus at a predetermined position across the picture. The positioning means fixes the work to be scanned so that each scan repeats along a locus through the exact same location of the work, whether it be a proof, plate or final print. The data obtained by the densitometer for scans of different works of the same picture may then be compared to determine any variances in values of the colours.

In order to facilitate the recording and entering of information and the comparison and display of data, a computer and appropriate software may be used. The computer may take direct digital readings from a scanner and from a densitometer and record this information in its data banks. The information may then be conveniently displayed and compared on a computer screen or in computer printouts or provided on-line to control apparatus during production.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more apparent to one skilled in the art to which it pertains from the following detailed description when read with reference to the drawings in which:

Figure 1 is a schematic representation of the relationship of the present invention in the stages of the printing process.

Figure 2 is a view of the carriage means of this invention.

Figure 3 is a depiction of the movement of the densitometer across a picture.

Figure 4 is a detailed depiction of the manner in which the densitometer fits into its carriage.

Figure 5 is a depiction of the driving mechanism and the

trigger to activate the densitometer.

Figure 6 is a graph depicting the readings obtained from the densitometer where the x-axis is the reflection density and the y-axis is the density.

Figure 7 is a graph depicting the relationship of dot gain along the y-axis to the mechanical dot percent along the x-axis as obtained from the densitometer readings.

Figure 8 is a graph depicting the relationship of dot gain along the y-axis and reflection dot percent along the x-axis.

Figure 9 is a bar chart illustrating the relationship of hue/grey along the y-axis and colour balance along the x-axis.

MODES FOR CARRYING OUT INVENTION

The process of printing a picture or other lithographic work is depicted schematically in Figure 1. In the first step, a scanner (1) is used to take initial readings of a picture. The data is then used to prepare film transparencies generally depicted at (2) which are used to create a proof or "ok" sheet (3) to be approved by the customer. The films (2) are also used, following approval, to prepare printing plates generally depicted at (4). These plates (4) are used in a printing press (5) to print the final product (6).

The scanner (1) usually comprises a glass cylinder (11) upon which an original transparency (12) is mounted and rotated. A scanning head (13) is moved over the transparency (12) to obtain readings and measurements regarding the values of the four colours black, cyan, magenta and yellow, including the dot location, density and size. The data obtained from the scanner (1) is used to prepare four films (2) in the colours of black, cyan, magenta and yellow.

From these, the proof (3) is made. During this process a number of variables may be introduced into the system. First there is the calibration of the scanner (1). There is also variables of stock colour, exposure, registration of the films, choice of colours (warm or cold) and the choice of the gradation at the scanner (1). Accordingly, the process does not necessarily result in a proof (3) that exactly conforms to the original transparency (12). However, it will be sufficiently close that a customer can be satisfied with it. If not, corrections can be made to bring the proof into line with the customer's specifications. Similar types of variables may be introduced into the process from the stage of the films (2) to the production of the printing plates (4). There are other variables introduced when the plates are used in a printing press (5) so that the final product (6) may not exactly conform to the proof (3) notwithstanding that procedures are carefully followed. The result is that the operator of the printing press (5) often has to make adjustments to the printing press ink keys during production in order to bring the final product (6) in line with the proof (3). Furthermore, when he changes from production of one job to another his adjustments that he made to bring his previous product (6) into line with the proof (3) may put his press (5) off for the purpose of the next run. Accordingly, many adjustments may be required during a production day depending on how many different jobs are run.

The present invention may be used to calibrate the press (5) to the scanner (1). This is important because often scanners and presses are located in different locations. Even if the press and scanner are within the same company, there may be inadequate communication between their operators so that sometimes films

produced by a scanner cannot be run successfully on the press. Therefore the first step is to establish first gradation values during the colour separation process on the scanner. These gradations are a series of dot percent values ranging from 0% to 100% which are taken when the scanner has been calibrated to a grey balance. In a preferred embodiment the values are input into a computer (not shown) and stored in a register for future use. Next, measurements may be taken from works printed on the press (5). The press should be brought to grey balance as well for these readings. The data from the press may then be compared to the data from the scanner to determine whether it is printing in harmony with the values obtained from the scanner (1). If not, adjustments can be made accordingly.

Once the printer printing press (5) has been balanced to the scanner (1), the present invention may be used to check for variations at each stage of the process prior to and during production. For example, as shown in Figure 1, the measuring means (50) of this invention may be used to measure the values of the proof (3) and the printing plates (4) or the final print (6).

A preferred embodiment of the apparatus of this invention is shown in Figures 2-5. Figure 1 shows a table (51) with positioning means (52) to fix the location of a work (53) to be measured in the first plane of the surface of the table (51). A rack (54) having a toothed edge (55) is mounted on supporting struts (56 and 56) to lie parallel to the surface of the table (51). A carriage (57) is mounted on the rack (54) to extend from the rack (54) over the work (53) parallel to the surface of the table (51). As shown in Figures 2 and 3, a densitometer (59) having a reading lens (60) on

its underside is carried within the carriage (57) with the lens 60 projecting through the carriage. The lens (60) is maintained in a second plane parallel to the surface of the table (51)at a predetermined distance (61) above the work (53) as the carriage (57) moves along the rack (54). As shown in Figure . 5, movement along the rack (54) is accomplished by means of a gear (58) which engages the toothed edge (55) of the rack (54). The gear (58) is fixed to a shaft (62) which is driven by driving means (64). A trigger (65) is mounted eccentrically to the axis of the shaft (63). At each full rotation the trigger (65) activates the densitometer (59) to take a reading. Thus, a reading is taken at each new position of the densitometer (59) as it moves along the rack (54).

Figures 6, 7, 8 and 9 show typical examples of comparative analysis that may be plotted from the data taken from the apparatus described above. This data may be accumulated in computer registers, reproduced, compared and plotted using appropriate software and computer hardware. The results, displayed graphically or in text, may be used to monitor production at various steps and may be used for on-line production controls.

It will be appreciated by those skilled in the art that the objects of this invention may be achieved by other equivalent apparatus constructed to obtain the stated functions.

CLAIMS

1. A process for the control of colour in a printing process comprising the steps of;
obtaining a first set of colour value data along a predetermined locus across a work,
obtaining a second set of colour value data along the same predetermined locus across another work, and
comparing the sets of colour data readings as a guide for control of one or more steps in a printing procedure.

2. A process as claimed in Claim 1, wherein the first set of colour value data is obtained from a scanner, and the second set is obtained from a press, and wherein the first set is compared to the second set for the purpose of calibrating the scanner to the press.

3. A process as claimed in Claim 1 or Claim 2, wherein the first set of colour value data is input digitally into a register of a computer, and the second set is obtained from a digital input from a measuring means that measures colour value data of a printed work.

4. A process as claimed in any preceding claim, further comprising the steps of
positioning a work in a first plane,
positioning a colour value data measuring means in a second plane substantially parallel to and spaced from the work in the first plane by predetermined distance,
establishing repeatable relative movement between the measuring means and the work along a predetermined locus across the work,
repeating the above process steps with other works to obtain comparative colour data readings as a guide for control of one or more steps in a printing procedure.

5. A process as claimed in Claim 4, in which each set of colour value data readings are digitally input from the measuring means into a computer and are stored in a register.

6. A process as claimed in Claim 5, wherein said stored data readings are recorded and reproduced in comparative charts as a control guide.

7. A process as claimed in Claim 5 or Claim 6, wherein each set of stored data readings are compared to obtain variances which are then digitally input to an ink key control of a press for automatic control of press settings.

8. Apparatus for obtaining colour value data for controlling the colour in a printing process comprising; positioning means for supporting a work in a first plane to be measured,
measuring means arranged in a second plane substantially parallel to, and spaced apart by predetermined distance from, the work in the first plane and directed at a small area of the work to obtain colour data,
traversing means for establishing a uniform and repeatable movement between the work in the first plane and the measuring means in a second plane to obtain a set of colour value data along a predetermined locus across the work.

9. Apparatus as claimed in Claim 8, further comprising transmitting means for transmitting the set of data to recording means arranged to record a plurality of sets of data.

10. Apparatus as claimed in Claim 8 or Claim 9, wherein the measuring means comprises a densitometer.

11. Apparatus for the control of colour in a printing process comprising;
a substantially flat surface arranged in a first plane,
positioning means for positioning a work in a fixed location on said surface,
a densitometer mounted in a second plane substantially parallel to the first plane and directed onto the surface to measure colour value date along a predetermined locus across said work,
motive means for moving the densitometer along the locus, and
recording means arranged to receive colour value data from the densitometer.

12. Apparatus as claimed in Claim 11, wherein the flat surface is located on a table, and further comprising,
a rack mounted over and substantially parallel to said surface,
a carriage mounted on the rack and traversable across the surface along the predetermined locus across the work on said surface whilst remaining in a second plane substantially parallel to and spaced from the first plane by a predetermined distance.

13. A process for the control of colour in a printing process substantially as hereinbefore described with reference to the accompanying drawings.

14. Apparatus for the control of colour in a printing process substantially as hereinbefore described with reference to the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17
(1. Search report)

Application number
GB 9419650.8

Relevant Technical Fields

(i) UK Cl (Ed.M) G1A - ACDC, ACDX, AHC; H4F - FAAX, FDG

(ii) Int Cl (Ed.5) B41F; G01J

Search Examiner
S J DAVIES

Date of completion of Search
22 DECEMBER 1994

Databases (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii)

Documents considered relevant following a search in respect of Claims :-
1-7

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X, Y	GB 2107047 A	(KOTOBUKI) see eg page 7, line 13 - page 8, line 10	X: 1-6 Y: 7
Y	US 5122977	(PFEIFFER) see eg Figure 1	7
X	US 4660159	(OTT) see eg column 3, lines 35-64	1, 3

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).