United States Patent

Kurahashi et al.

[15] **3,635,555**

[45] **Jan. 18, 1972**

[54] ELECTROPHOTOGRAPHIC COPYING DEVICE

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[73] Assignee: **Canon Kabushiki Kaisha,** Tokyo, Japan

[22] Filed: **Nov. 18, 1969**

[21] Appl. No.: **877,673**

[30] **Foreign Application Priority Data**

Nov. 25, 1968	Japan	43/102728
Feb. 19, 1969	Japan	44/15143
Mar. 19, 1969	Japan	44/21016
Feb. 28, 1969	Japan	44/15576
Nov. 25, 1968	Japan	43/86281
Nov. 25, 1968	Japan	43/86280
Nov. 25, 1968	Japan	43/86279
Nov. 25, 1968	Japan	43/86278

[52] **U.S. Cl.** **355/8,** 355/10, 355/68, 355/75

[51] **Int. Cl.** **G03g 15/00**

[58] **Field of Search** 355/3, 8, 10, 7, 68, 75, 25

[56] **References Cited**

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Primary Examiner—Samuel S. Matthews
Assistant Examiner—Richard A. Wintercorn
Attorney—Watson, Leavenworth and Kelton

[57] **ABSTRACT**

A high-speed electrophotographic copying device is provided which has an original holder having a plurality of original holding surfaces so as to successively set a plurality of originals to be copied at the exposure position without time loss to accomplish the change, means for detecting when two or more sheets of photocopying paper are fed simultaneously through a fault in the feeding means, means for diverting such papers from the exposure section in response to signals from said detecting means, means for detecting a fault in the guide means associated with the charging means, means for detecting the contrast of the original so as to control automatically the exposure, means for detecting the concentration of developing solution from the contrast of the image developed and automatically maintaining the concentration of the developing solution at an optimum level by controlling the addition of concentrated developing solution, and air-conditioning means for recovering or removing the developing solution vapor contained in the air in the device and purifying the air.

20 Claims, 34 Drawing Figures

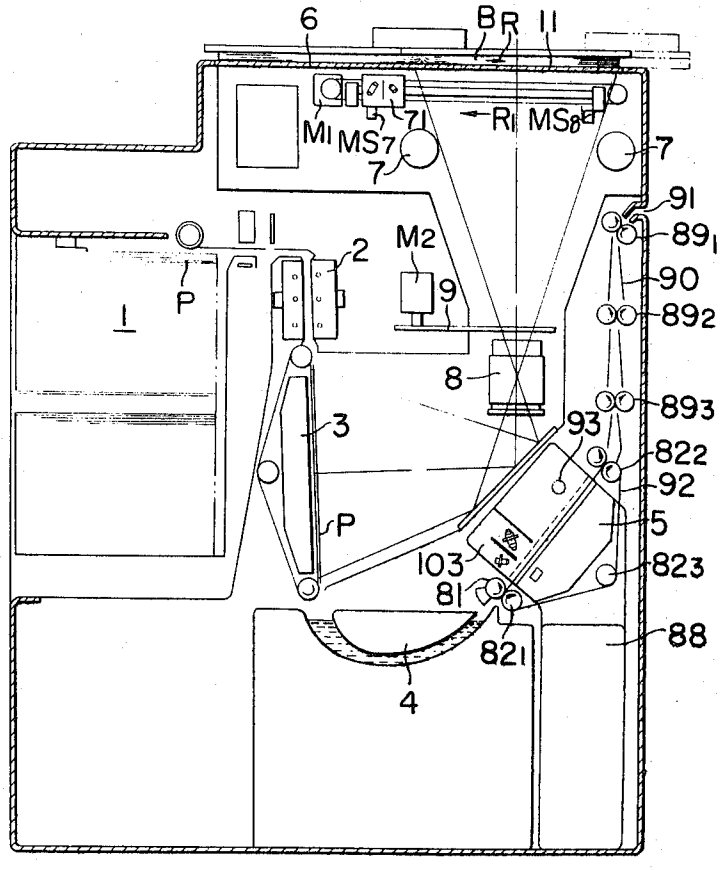


FIG. 1

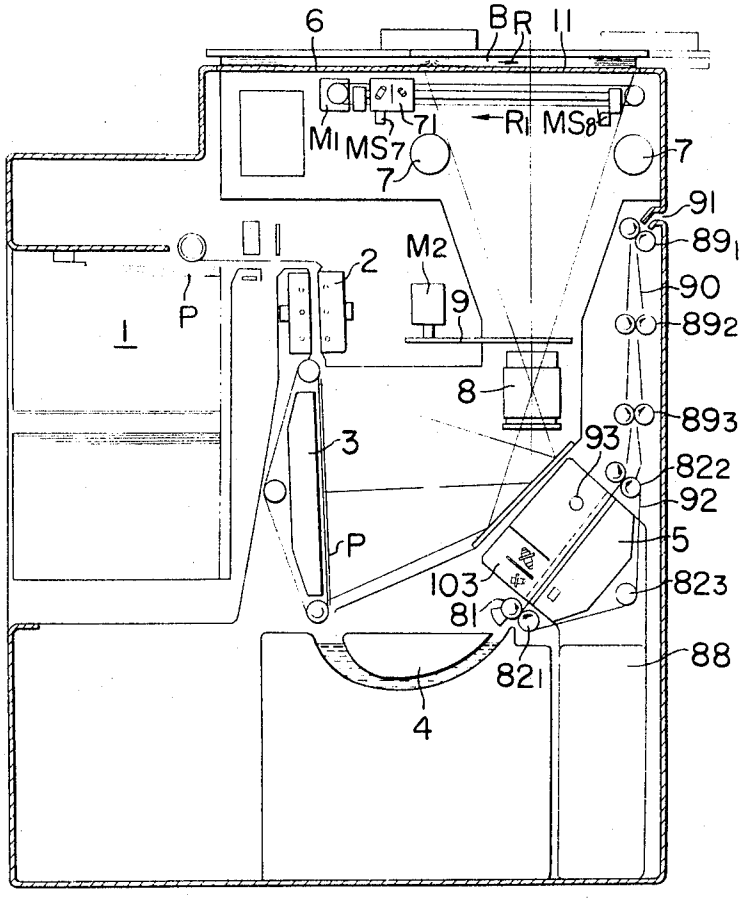

6
BR
11
M1
MS7
71
R1
MS8
7
7
91
89 1
M2
2
90
P
9
892
1
8
893
93
3
822
92
5
P
103
823
81
821
88
4

FIG. 2

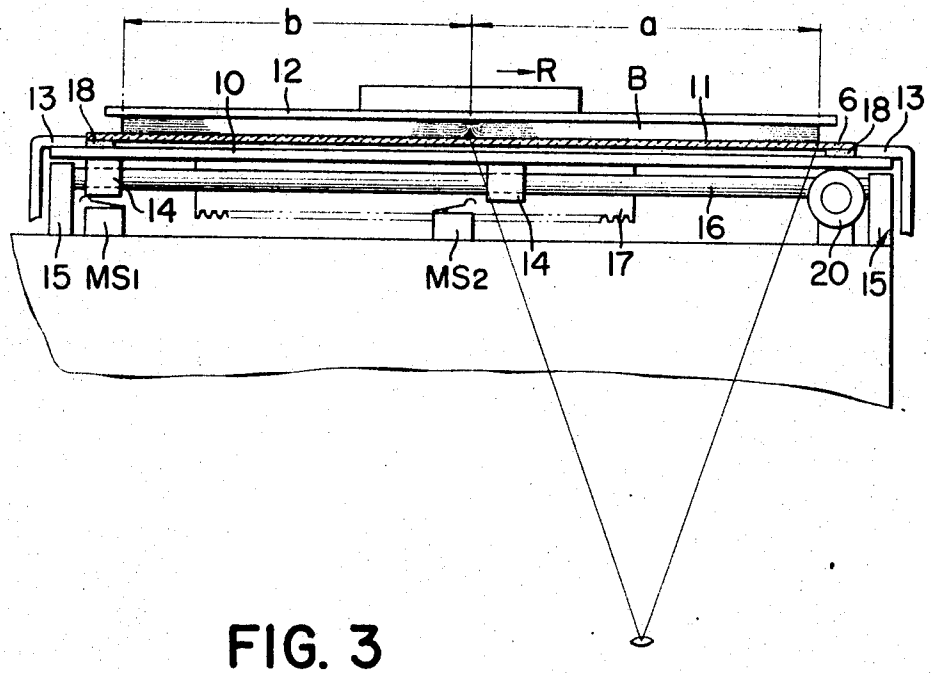

b
a
R
B
10
12
11
13
18
6
18
13
14
16
15
MS1
MS2
14
17
20
15

FIG. 3

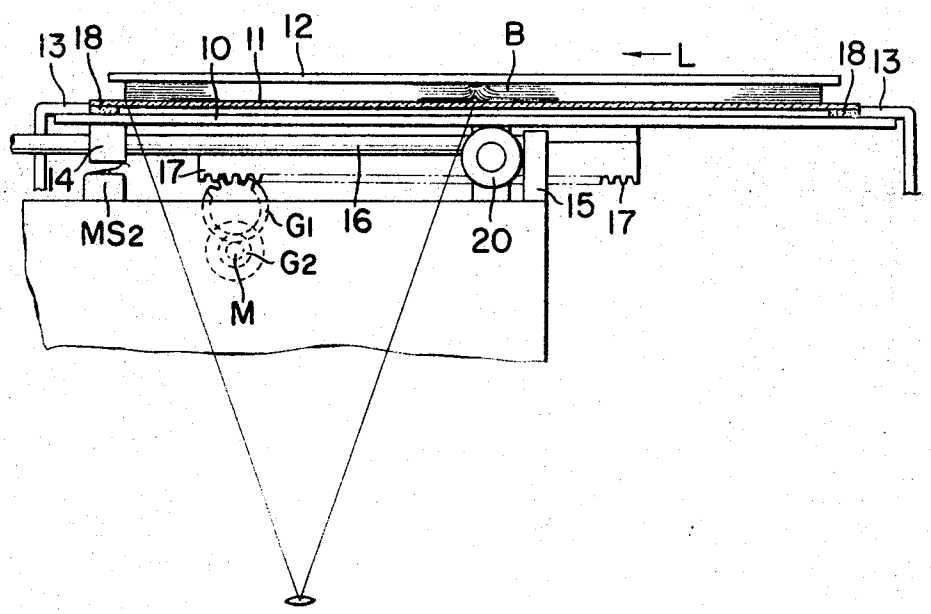

13
18
10
11
12
B
L
18
13
14
17
MS2
G1
G2
M
16
20
15
17

FIG. 4

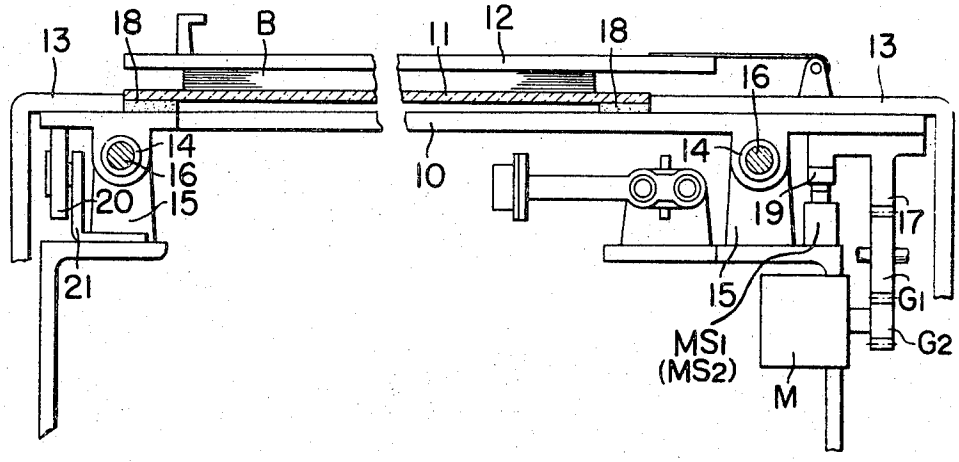


FIG. 5

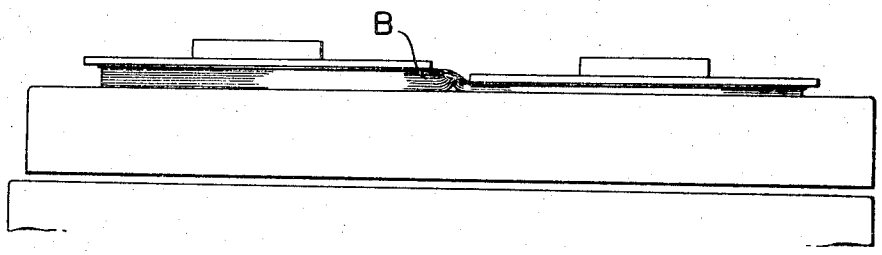


FIG. 6

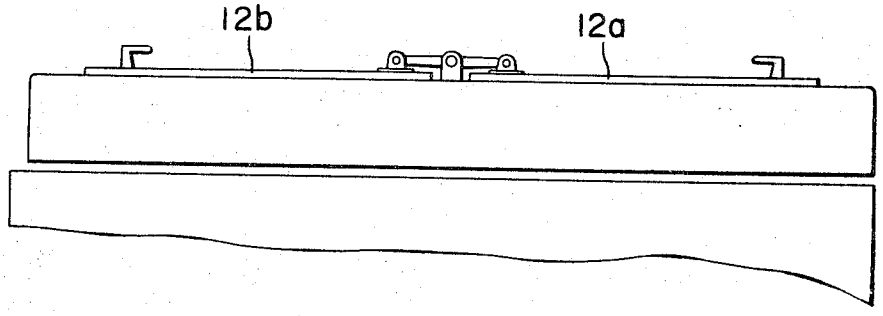


FIG. 7

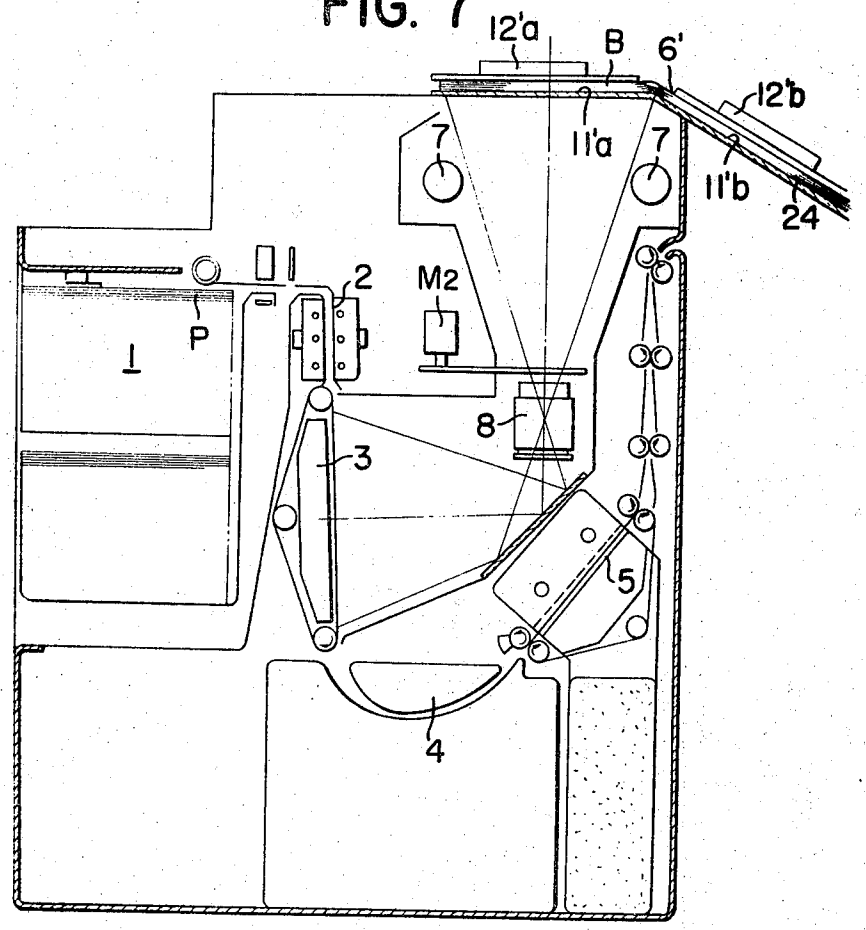


FIG. 8

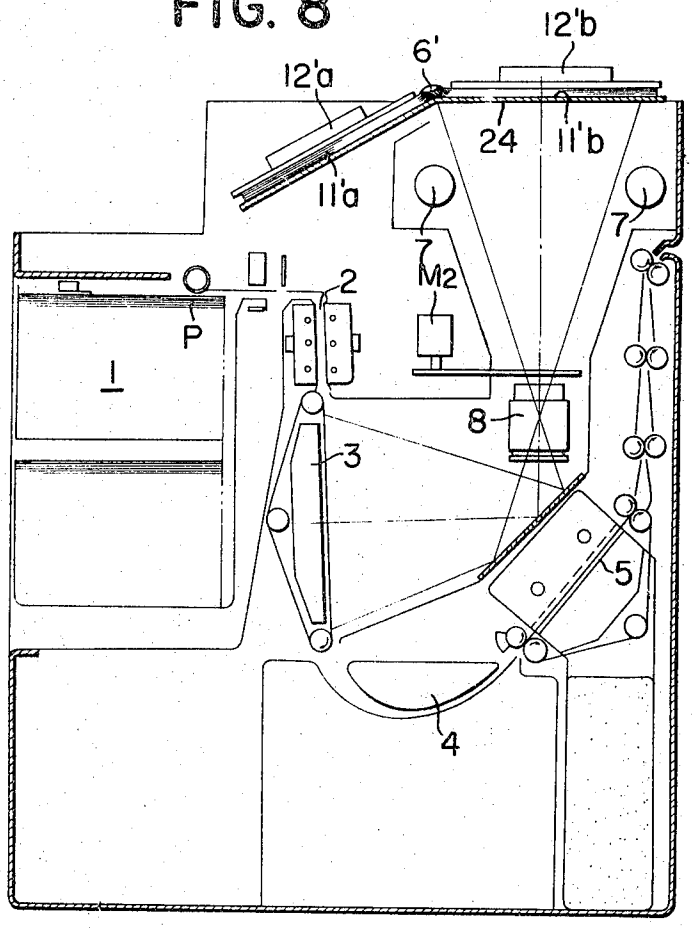


FIG. 9

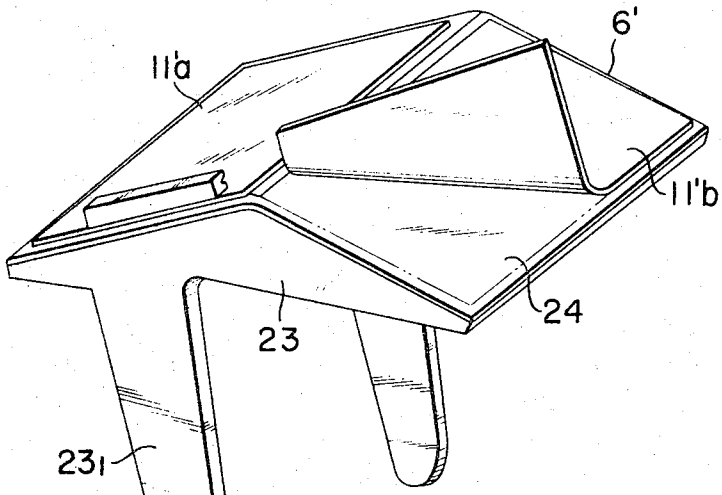

6'
11'a
11'b
24
23
23i
26
25
28
27

FIG. 10

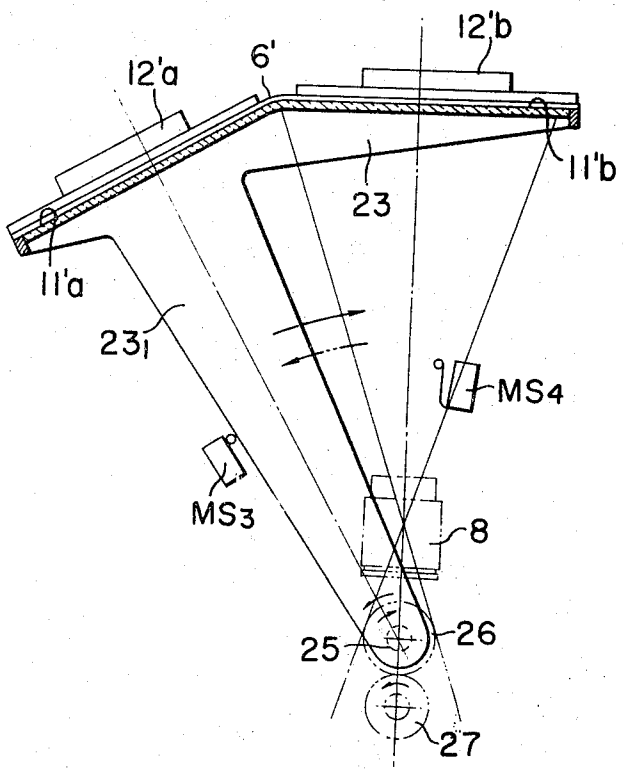

12'b
12'a
6'
11'b
23
11'a
23i
MS4
MS3
8
25
26
27

FIG. 11

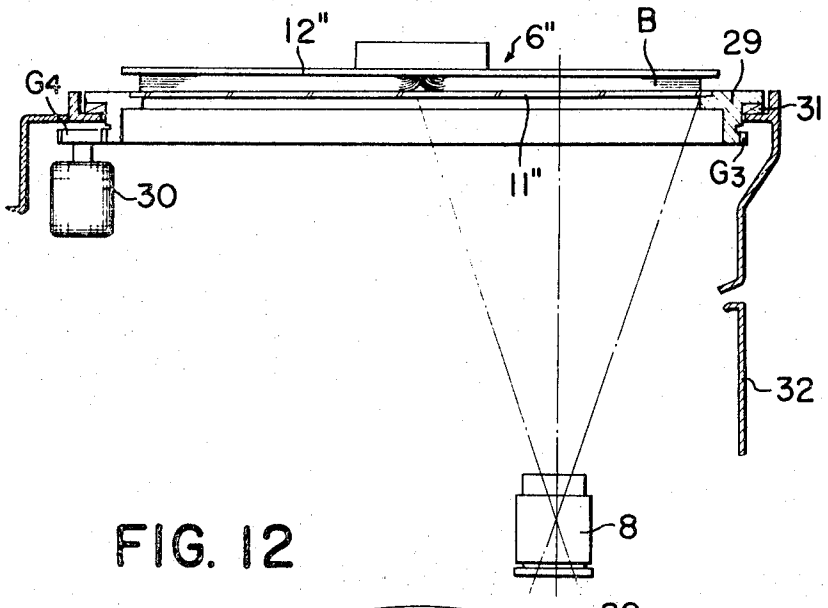


FIG. 12

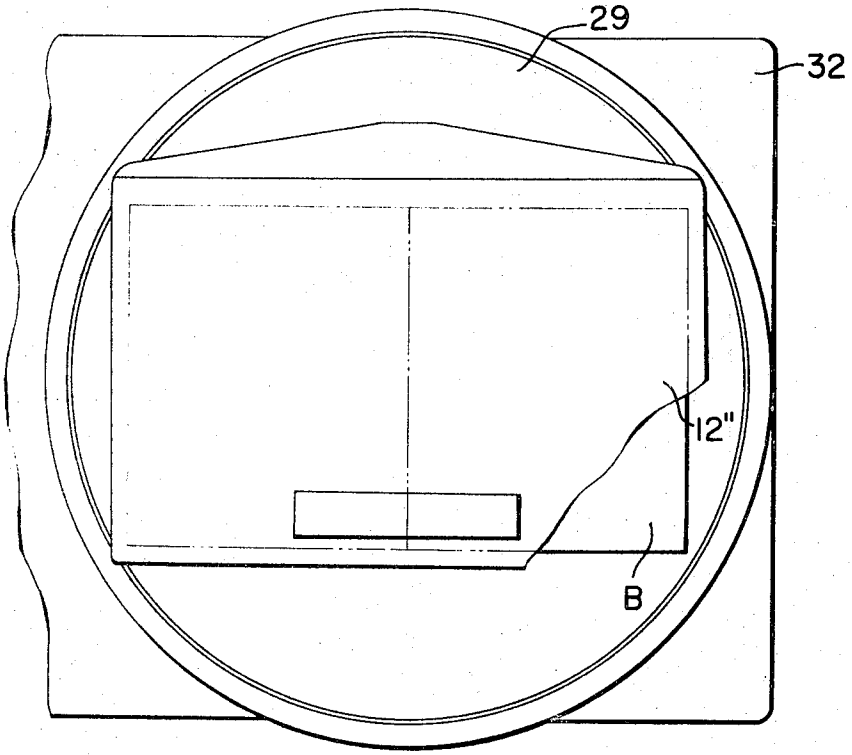


FIG. 13

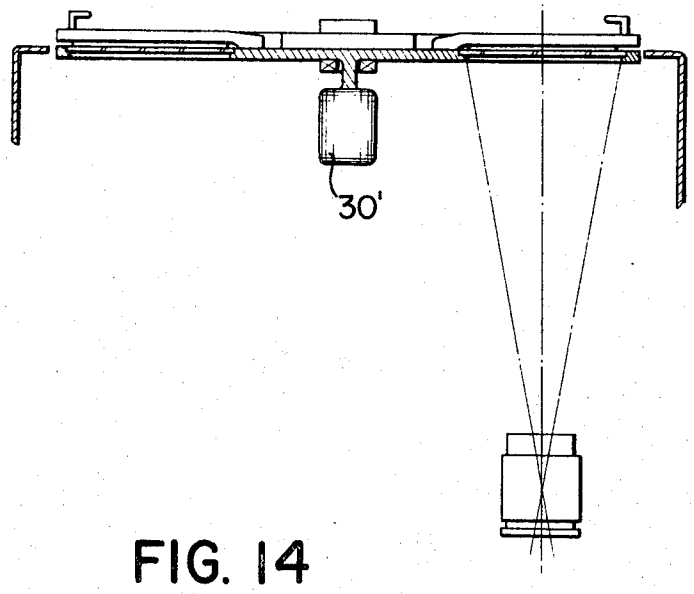


FIG. 14

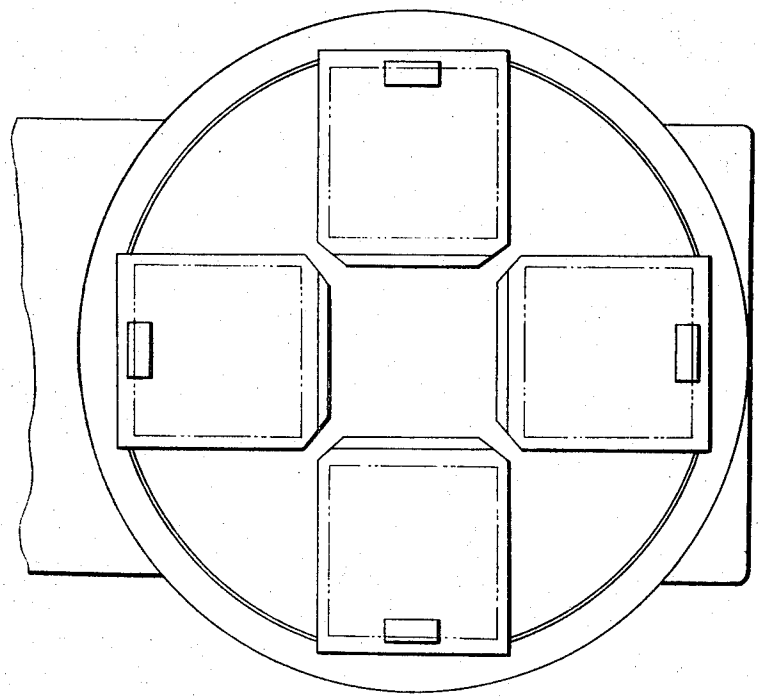


FIG. 15

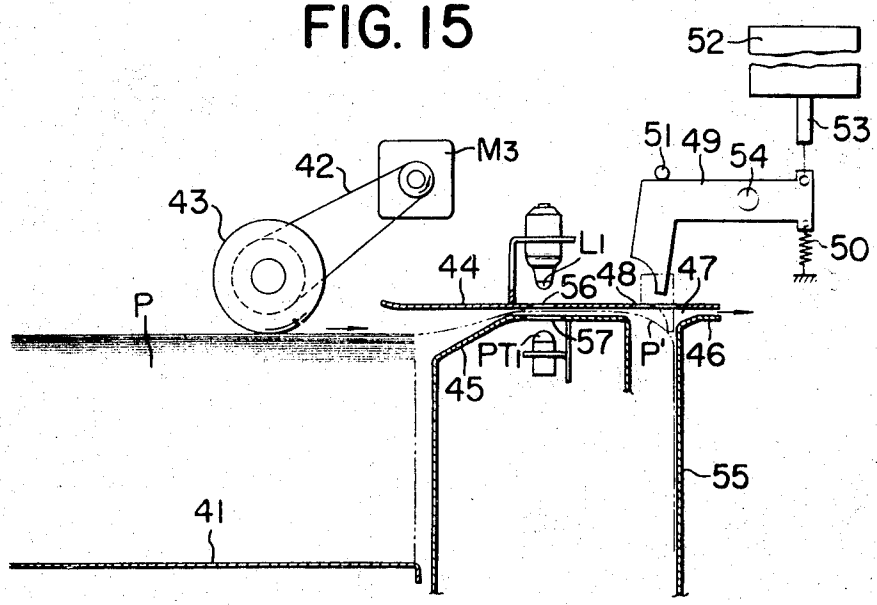


FIG. 20

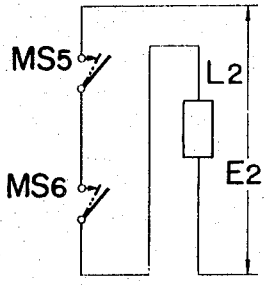


FIG. 16

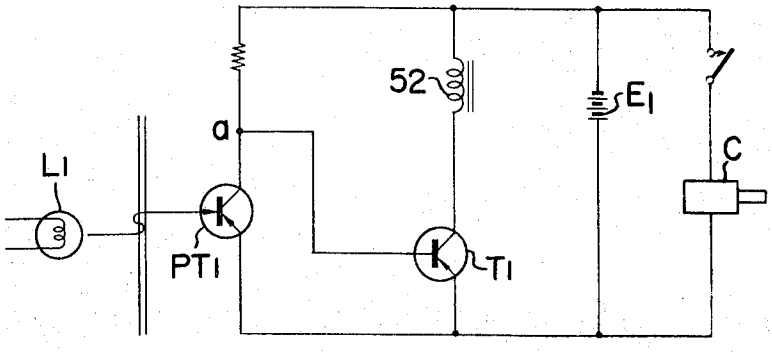


FIG. 17

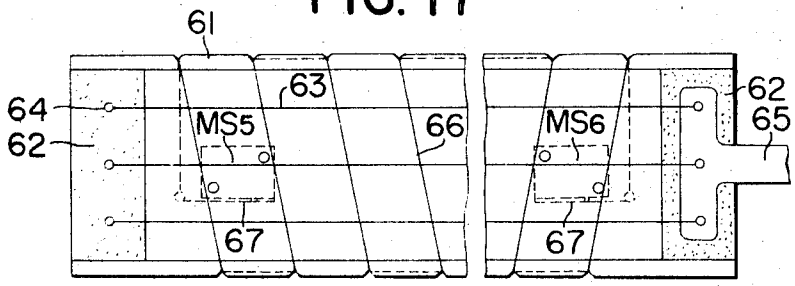


FIG. 19

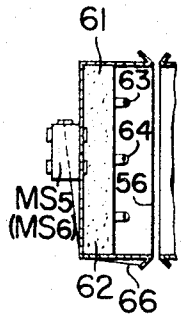


FIG. 18

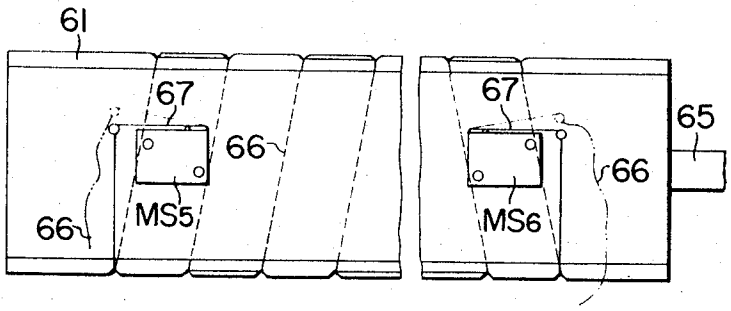


FIG. 22

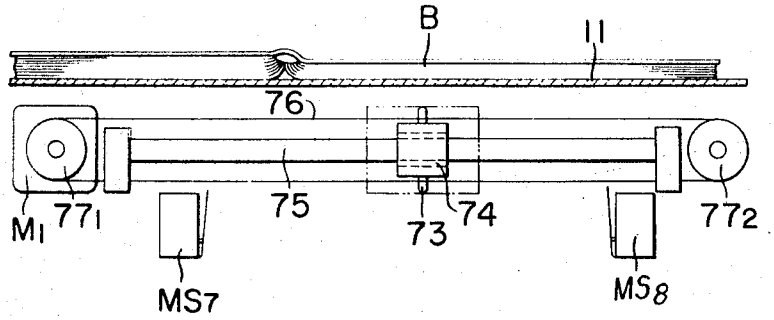


FIG. 21

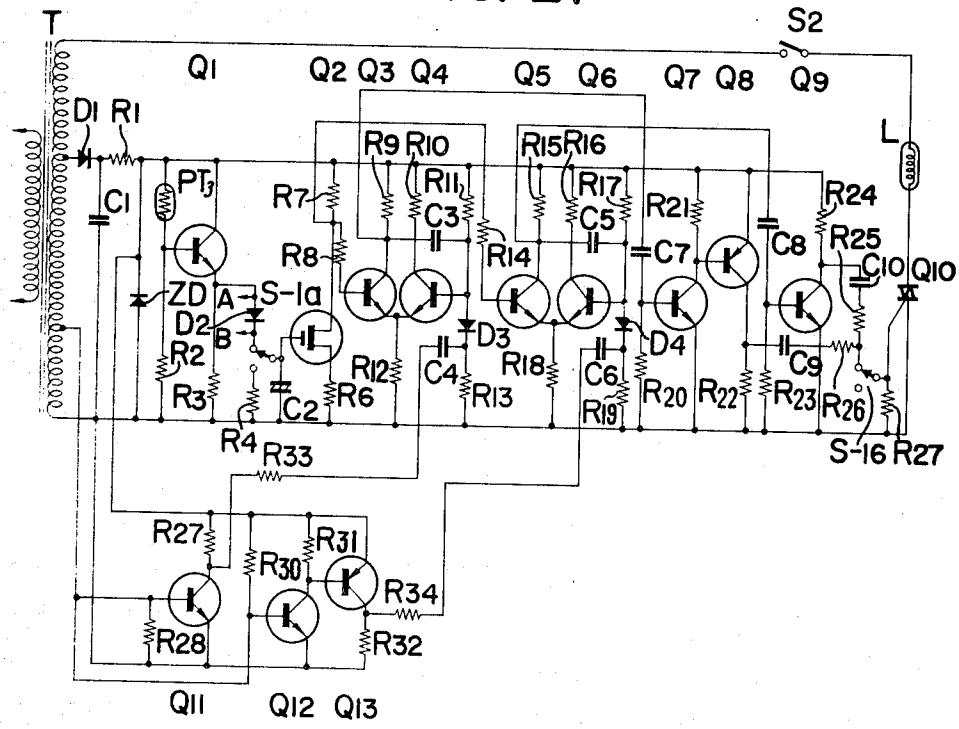

T
S2
Q1
Q2 Q3 Q4
Q5 Q6
Q7 Q8
Q9
D1 R1
L
R9 R10
R15 R16
C1
PT3
R7
R11
C3
R17
C5
R21
R24
R8
R14
C7
C8
R25
C10
Q10
ZD
A
S-1a
D2
B
D3
D4
R2
C4
C6
C9
R3
R12
R6
R13
R18
R19
R20
R22
R23
R26
C2
R4
R33
S-16
R27
R27
R31
R30
R34
R28
R32
Q11
Q12 Q13

FIG. 23

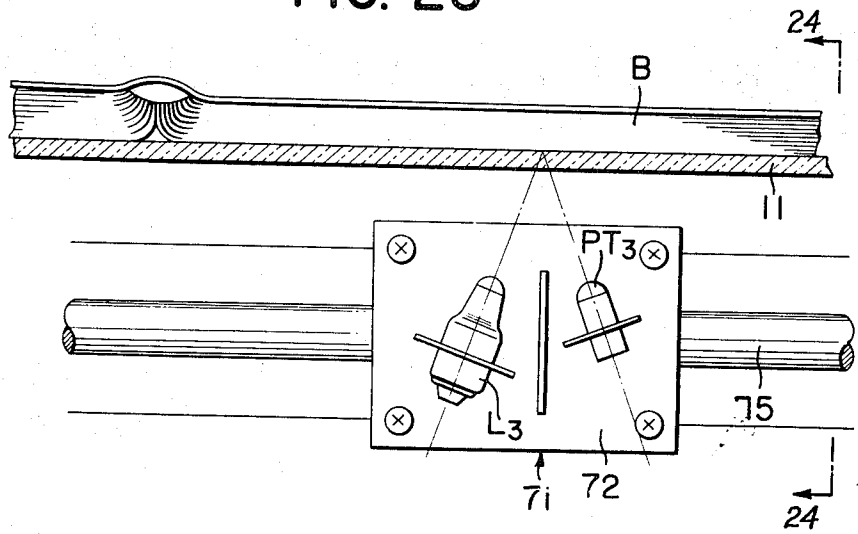

24
B
11
PT3
L3
75
71
72
24

FIG. 24

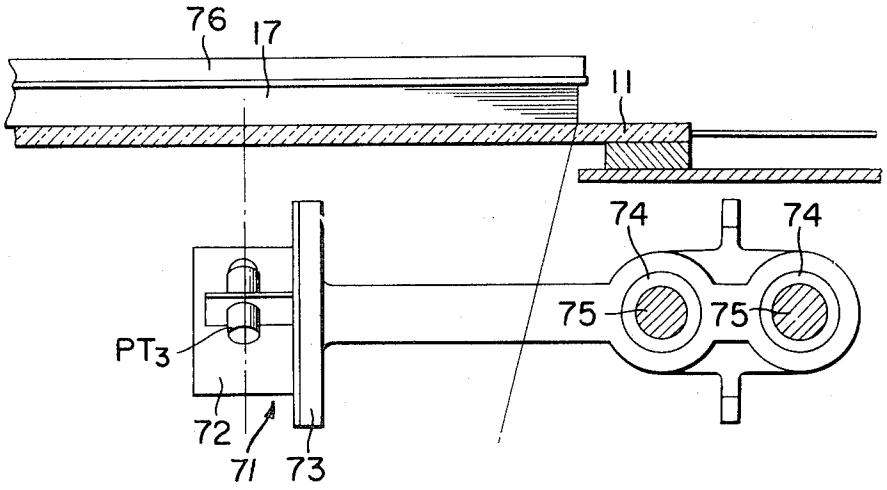


FIG. 25

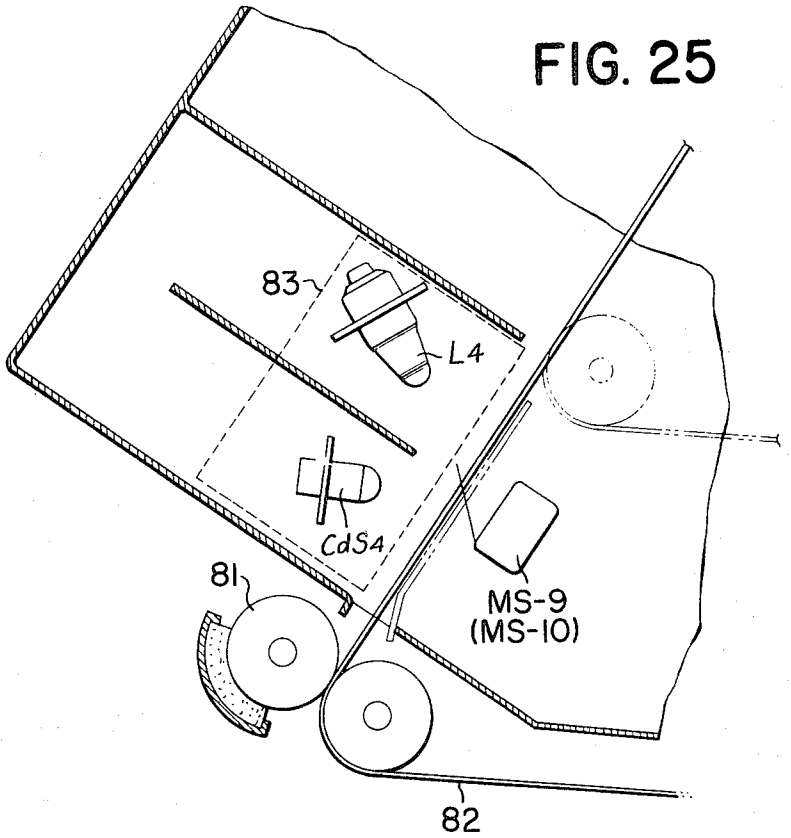


FIG. 26

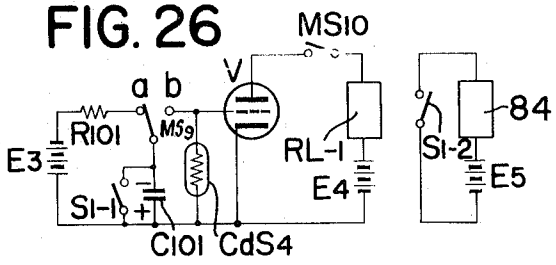


FIG. 28

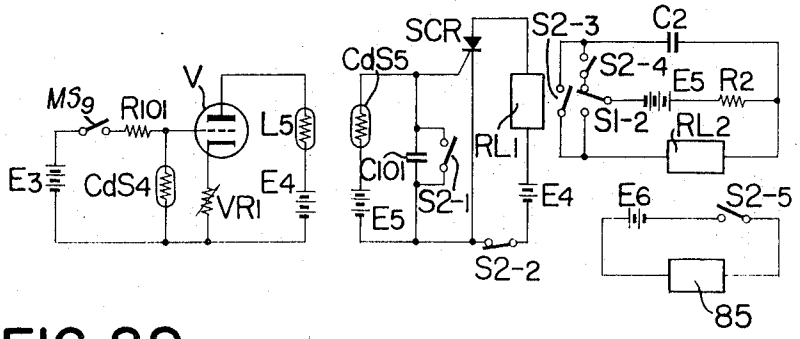


FIG. 29

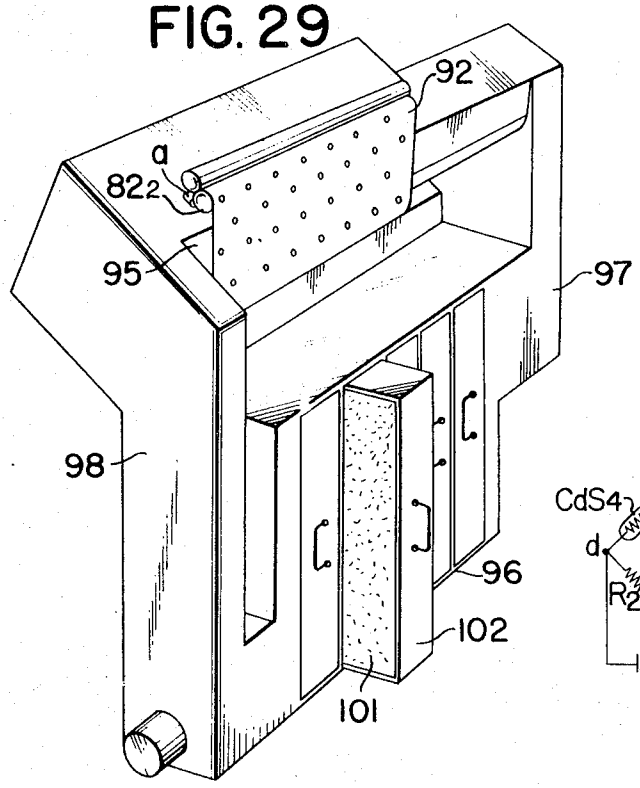


FIG. 27

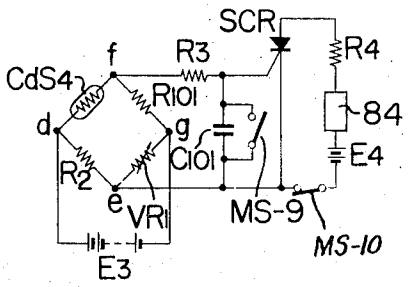


FIG. 30

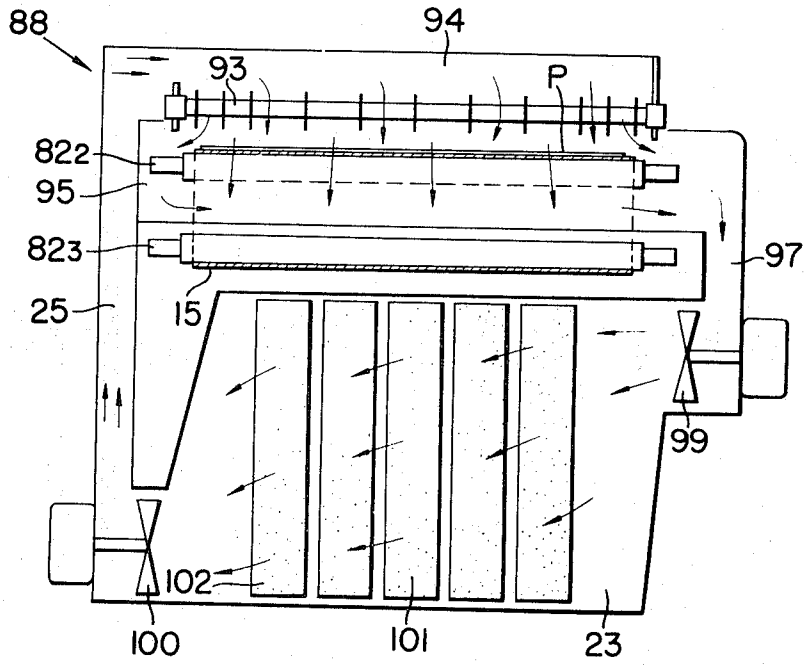


FIG. 31

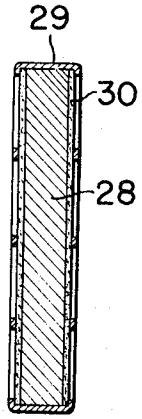


FIG. 32

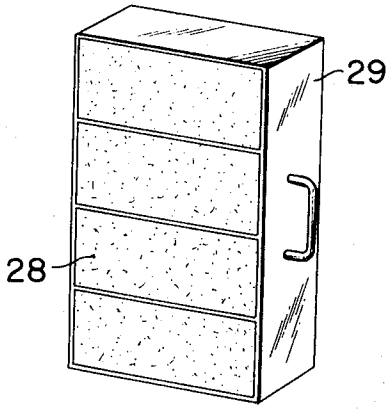


FIG. 33

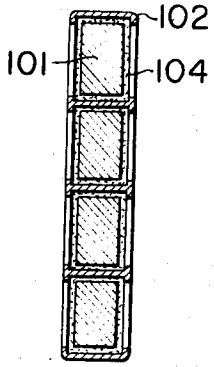
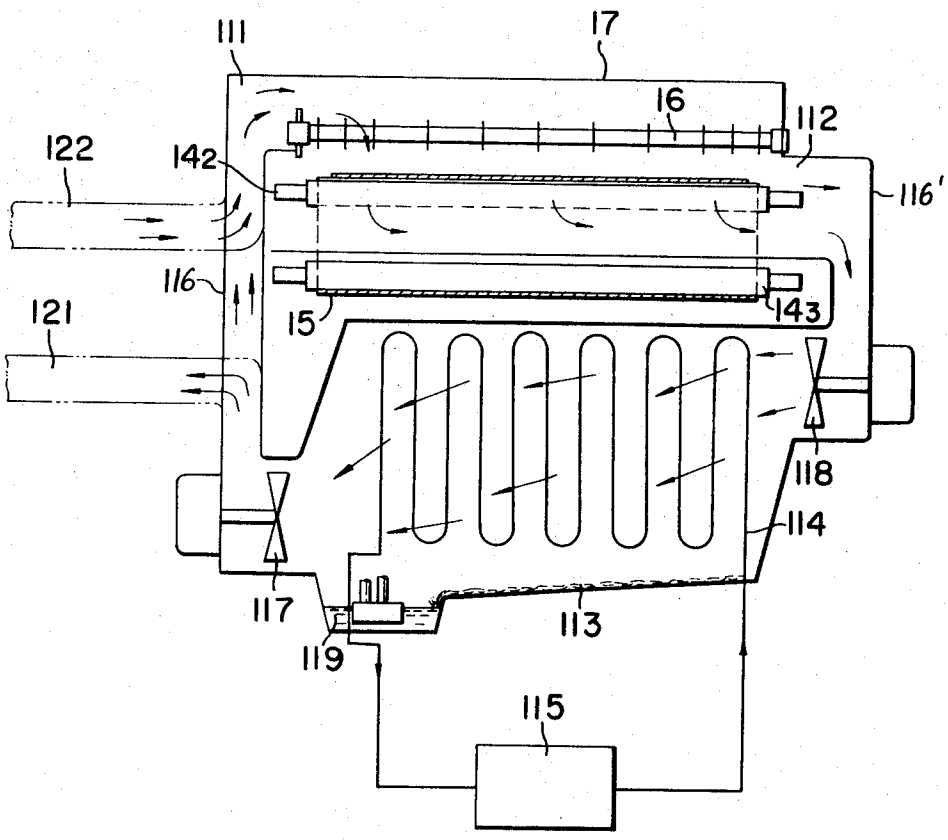


FIG. 34



ELECTROPHOTOGRAPHIC COPYING DEVICE

The present invention relates generally to an electrophotographic copying device and more particularly to a novel high-speed electrophotographic copying device which eliminates time loss normally required to change originals, ensures accurate feeding of photocopying paper, detects faults in the guide means associated with the charging means, automatically adjusts the exposure and concentration of the developing solution, and eliminates harmful developing solution vapor, thereby facilitating and ensuring high-speed, safeguarded copying operation.

The problems encountered in a conventional electrophotographic copying device when high-speed copying operation is desired are as follows:

a. The time loss is great because the copying machine must be stopped each time a page or sheet of the original is replaced, then the new page or sheet to be copied must be set at the exposure position and the copying machine must be started again such that continuous copying cannot be carried out;

b. High-speed copying is prevented because breakdown of the copying machine is caused when two or more photocopying papers are fed simultaneously with at least one of them being wasted;

c. When the photocopying paper guide wire or string of the charging means is damaged or disconnected and when the photocopying papers are fed successively, they become jammed in the charging means, thus resulting in the failure and breakdown of the charging means. This tendency is more noticeable in the case of a high-speed copying operation;

d. Time and material losses are great because a trial copy is generally made in order to adjust the exposure factors such as aperture of the copying lens, copying speed, etc., depending upon variation in the originals so as to provide uniform quality copies;

e. In order to obtain continuously better quality image copies, the concentration of developing solution must be adjusted to maintain the optimum concentration. In the conventional method, a portion of the developing solution is directed to a concentration detector such that additional pump, piping, etc., and a sealed concentration detector must be provided in the developing section or means, thus resulting in the developing section being large in size, complicated in construction and operation.

f. The developing solution vapor from the developing section as well as from the fixing-drying means fills the copying machine so that the machine is susceptible to deterioration in mechanical and electrical qualities and to contamination. Furthermore, the vapor discharged from the copying machine into the surrounding atmosphere might be harmful to the health of an operator and cause contamination of the atmosphere. Especially in case of a high-speed copying operation, much developing solution vapor is generated especially from the fixing-drying section.

Accordingly, the primary object of the present invention is to provide an improved high-speed electrophotographic copying device which substantially eliminates the above-described problems or defects of the conventional device.

Another object of the present invention is to provide a high-speed electrophotographic copying device in which two opened pages of a book or the like may be successively and automatically copied; and, in case of sheetlike originals, one original may be replaced with the next original to be copied during the time when the other original is being copied. A further object of the present invention is to provide a high-speed electrophotographic copying device of the type which can feed photocopying paper one by one accurately without causing more than one sheet of photocopying paper to fed simultaneously.

A still further object of the present invention is to provide a high-speed electrophotographic copying device having a safety device which gives an alarm signal immediately when the photocopying paper guide wire or string associated with the charging means is disconnected or loosened.

A yet another object of the present invention is to provide a high-speed electrophotographic copying device having means for automatically regulating the exposure factors by detecting the brightest area of an original to be copied.

A still further object of the present invention is to provide a high-speed electrophotographic copying device having means for automatically regulating the exposure factors in response to the information from an electronic circuit which is so constructed as to detect the average brightness of an original to be copied from the contrast thereof.

A still further object of the present invention is to provide a high-speed electrophotographic copying device having means for automatically adjusting the concentration of developing solution by detecting the contrast of a visible image formed upon a photocopying paper and regulating the addition of concentrated developing solution in response to the detected signals.

A still further object of the present invention is to provide a high-speed electrophotographic copying device having means for recovering the developing solution vapor from the air containing vapor within the machine, thereby purifying the air.

An additional object of the present invention is to provide a thermal control system for a high-speed electrophotographic copying device of the type described hereinabove in order to recirculate said purified air separated from the developing solution vapor in the copying device for various advantageous purposes.

The above and other objects, features and advantages of the present invention will become more apparent from the following description of some illustrative embodiments thereof with reference to the accompanying drawings, in which:

FIG. 1 is a longitudinal sectional view of one embodiment of a high-speed electrophotographic copying device in accordance with the present invention;

FIG. 2 is a fragmentary side view of an original holder thereof;

FIG. 3 is a view similar to FIG. 2 illustrating the original holder being displaced so that an original held upon the left half thereof may be set at the exposure position;

FIG. 4 is a sectional view of an original holder;

FIGS. 5 and 6 and side views illustrating two dependent original pressure plates;

FIG. 7 is a longitudinal sectional view of another embodiment of the present invention having an original holder consisting of two sections connected with each other at an angle;

FIG. 8 is a view similar to FIG. 7 illustrating the displacement of the original holder;

FIG. 9 is a perspective view of the original holder employed in FIGS. 7 and 8;

FIG. 10 is a longitudinal sectional view thereof;

FIGS. 11 to 14 illustrate a further embodiment of a circular original holder in accordance with the present invention;

FIG. 15 is a longitudinal sectional view of one embodiment of a photocopying paper feeding device in accordance with the present invention;

FIG. 16 is a diagram of an electric circuit thereof;

FIG. 17 is a front view of charging means having a safety device in accordance with the present invention;

FIG. 18 is a rear view thereof;

FIG. 19 is a transverse sectional view thereof;

FIG. 20 is a diagram of a fault detection circuit thereof;

FIG. 21 is an electric circuit diagram of one embodiment of an exposure factor controlling device in accordance with the present invention;

FIG. 22 is a fragmentary enlarged elevational view thereof;

FIG. 23 is a fragmentary enlarged plan view of an original tone or contrast detecting mechanism;

FIG. 24 is a view viewed in the direction of the line 24—24 of FIG. 23;

FIG. 25 is an enlarged view of one embodiment of a developing solution concentration detecting device in accordance with the present invention;

FIGS. 26 to 28 are diagrams of electric circuits thereof;

FIG. 29 is a perspective view of one embodiment of a fixing-drying device having a developing solution recovery device in accordance with the present invention;

FIG. 30 is a longitudinal sectional view thereof;

FIGS. 31, 32 and 33 are detailed views illustrating developing solution absorbing members; and

FIG. 34 is a longitudinal sectional view of another embodiment of a fixing-drying device having a developing solution absorbing device in accordance with the present invention.

Referring to FIG. 1, photocopying paper P is fed one by one from a photocopying feeding means 1, electrostatically charged by charging means 2 and then introduced into exposure means 3. In this case, an original B placed upon an original holder 6 is projected upon the photocopying paper P upon the exposure means 3 through a copying lens 8 by the light from a light source 7. The paper P having an electrostatic latent image formed by the exposure is developed in a developing means 4 into a visible image and thereafter fixed and dried in a fixing-drying means 5, thereby providing a copy.

The present invention is comprised of various improved means in order to attain high-speed copying operation through the steps described above.

The original holder is provided with two or more original holding surfaces and one of the originals held thereupon is set at the exposure position for photocopying and then the next original is set at the exposure position by displacing the original holder, and so on.

Referring to FIG. 2, the original such as a book B is opened and placed upon a glass plate 11 of the original holder with the page to be copied being in contact with the glass plate 11. First the page *a* is copied upon a preselected number of photocopying papers and thereafter the holder 6 is displaced in the direction indicated by the arrow R so that when the page *b* is set at the exposure position, the holder 6 is stopped as shown in FIG. 3. Thereafter, the holder 6 is displaced in the direction indicated by the arrow L to the initial position shown in FIG. 2 where the original is replaced and the same exposure steps described above are repeated. Means for starting the exposure at the position shown in FIG. 3 by replacing the original without displacing the holder 6, means for preventing the displacement of the original holder when only the section *a* is used, etc., may be provided as needs demand.

As best shown in FIG. 4, the original holder 6 comprises a base 10, the glass plate 11, an original pressure plate 12 and a cover 13. The base 10 is so arranged as to move freely along guide rods 16 supported by standards 15 of the main body of the photocopying machine, the base 10 being carried by the guide rods 16 through bearings 14. The original holder 6 is driven through a rack 17 formed integral with the base 10 and in mesh with a gear G_1 which in turn is in mesh with a gear G_2 carried by the shaft of a motor M mounted upon the main body.

The original B to be copied is placed upon the glass plate 11 secured upon the base 10 through spacers 18 and is pressed against the glass plate 11 by the original pressure plate 12. First the section *a* of the original is exposed or copied at the position shown in FIG. 2 and thereafter by signals generated upon completion of the copying of section *a*, the motor M is driven so that the original holder 6 is displaced in the direction indicated by the arrow R in FIG. 2 through the gears G_1, G_2 and the rack 17 and is stopped when the section *b* is set to the exposure position. The signals for stopping the original holder 6 may be easily generated through the microswitches MS_1 and MS_2 which are actuated by a cam 19 fixed to the base 10. Reference numeral 20 designates a roller rotatably fixed to a supporting member 21 fixed to the main body on the side opposite the rack 19 of the original holder 10.

When the original pressure plate 12 is divided into two sections each of which is adapted to press only the section *a* or *b* of the original against the glass plate 11 as shown in FIG. 6, sheetlike originals may be replaced at the section *a* when the original is being copied at the section *b*. Furthermore, even when the thickness of the originals are different in the sections *a* and *b* as shown in FIG. 5, the originals may be securely pressed against the glass plate 11 so that the defect of producing an out-of-focus copy because the thinner page section of the opened book is not sufficiently pressed against the glass plate in the conventional photocopying machine is completely eliminated.

The second embodiment illustrated in FIGS. 7 and 8 will be described hereinafter. The most significant feature of this embodiment resides in the fact that the original holders are connected with each other at an angle and in their unique displacement. The original holder 6' comprises two original holding surfaces 11'*a* and 11'*b* which are reciprocatingly displaced so as to alternately position the centers of the holding surfaces 11'*a* and 11'*b* in alignment with the optical axis of the copying lens 8 for exposure.

The original holder 6' has its glass plate 24 fixed upon a supporting frame 23, thereby providing the two original holding surfaces 11'*a* and 11'*b*, and has also two original pressure plates 12'*a* and 12'*b*, respectively. The original holder 6' may be manually or automatically reciprocated so as to move toward or away from the optical axis of the copying lens. To automatically reciprocate the original holder 6', as shown in FIGS. 9 and 10, the legs of the supporting frame 23 are rotatably mounted upon the main body through a shaft 25 and caused to rotate by a motor 28 through a gear train 26 and 27. For example, microswitches MS_3 and MS_4 may be positioned at the ends of the stroke of the legs 23_1 so that the direction of rotation of the motor 28 may be automatically reversed.

In operation, the original placed upon the surface 11'*a* is first copied and upon completion of the copying of the original upon the surface 11'*a*, the original holder 6' is rotated so that the original holding surface 11'*b* is set at the exposure position (shown in FIG. 8). When the original is not a book or the like, the original upon the holding surface 11'*a* may be replaced with the next one while the original upon the surface 11'*b* is exposed so that upon completion of the exposure of the original upon the surface 11'*b*, the original holder 6' may be rotated so as to set the holding surface 11'*a* at the exposure position. Thus it is seen that the loss of photocopying operation time due to the replacement of the originals can be avoided, thus resulting in high-speed photocopying operation.

The reversed V-shaped original holder 6' as shown in FIGS. 7 to 10 is advantageous when the originals are books and the like because the pages to be copied may be securely pressed against the glass plate without causing any damage to the binders of the books and the like.

A third embodiment of an original holder in accordance with the present invention is illustrated in FIGS. 11 to 14. A circular or disk-shaped original holder is provided with two or more than two original holding surfaces so that upon completion of the exposure of the first original, the original holder can be rotated by motor 30 or 30' so as to set the second original at the exposure position and so on. A gear G_4 carried by the shaft of the motor 30 is in mesh with a gear G_3 supported upon a frame member 32 through thrust bearings 31 so as to rotate the original holder 29. A variation shown in FIGS. 13 and 14 has four original holding surfaces and is rotated by a driving motor positioned at the center of the original holder.

FIG. 15 illustrates one embodiment of a photocopying paper feeding system in accordance with the present invention. In the high-speed photocopying machine, when two photocopying papers or sheets are fed at the same time, breakdown of the machine will occur and at least one copying paper is wasted. Therefore, in the conventional method the thickness of the photocopying paper is detected by microswitches or other suitable means so as to prevent the feeding of a plurality of photocopying papers at the same time. However, when the thickness of the paper is too thin, detection becomes very difficult so that the detection device must be amplified mechanically, thereby resulting in a large-sized and expensive detection device which tends to break.

The present invention provides a photocopying paper feeding system which utilizes photoelectric elements, is reliable in

operation with a higher degree of accuracy and can eliminate the defects encountered in the conventional device.

From the stack of photocopying papers P mounted upon a stand 41, photocopying paper is fed into the photocopying section one by one from the top of the stack by means of a motor M_3, a belt 42, a feed roller 43 and guide members 44 to 46. Across the photocopying paper in the transverse direction relative to the path thereof are disposed a light source L_1 and a phototransistor PT_1 such as CdS in opposed relation in such a manner that when only one photocopying paper is being advanced, no signal is generated but when two or more papers are advanced through the passage at the same time, signals are generated and transmitted through a suitable amplifier and the like to a direction changing mechanism, thereby closing the passage 47 so as to change the direction of feed of the photocopying paper and discharge it out of the guide member.

The direction changing mechanism is such that a closing member 49 adapted to fit into an opening 48 formed through a guide member 44 is provided and normally biased so as to abut a stop 51 by means of a spring 50. When an electromagnet 52 is energized by signals transmitted from the photoelectric detecting system L_1 and PT_1 so as to attract a plunger 53, the closing member 49 connected thereto is rotated about a pivot 54 so that the leading or lower portion of the closing member 49 is inserted into the opening 48 as indicated by the broken line in FIG. 15, thereby closing the passage 47. Thereupon, the photocopying paper P' is diverted when advanced through the passage 47 so as to be discharged out of the passage 47 along a guide member 55. It is understood that the closing member 49 may be so arranged as to move upwardly, opposed to the arrangement shown in FIG. 15. Alternatively a valve may be opened by the signals transmitted from the photoelectric detecting device L_1 and PT_1 so as to blow compressed air into the opening 48 thereby changing the direction of advancement of the photocopying paper. The light source L_1 and the photoelectric element or transducer PT_1 may be disposed in the openings 56 and 57 formed in the guide members 44 and 45 respectively. It must be noted that when the photoelectric detecting device of the construction described hereinabove is employed in an electrophotographic copying machine, the spectrum of the light emitted from the light source L_1 must be so selected that the photocopying paper irradiated will not be subject to fatigue (preirradiation effect or hysteresis). Alternatively the light source L_1 must be so arranged that the light beam therefrom will impinge upon the photocopying paper outside of the area within which the image is formed.

FIG. 16 is one embodiment of an electric circuit for the erroneous feed preventive device described above with reference to FIG. 15. When two or more photocopying papers are advanced, the light quantity impinged upon the element PT_1 is reduced so that the potential at point *a* is raised, thereby increasing the collector current of a transistor T_1. Thus, the electromagnet 52 is energized. Reference characters E_1 and C designate a source of voltage and a corona discharging device, respectively, to be described hereinafter.

In charging means 2 illustrated in detail in FIGS. 17 and 18, electrically insulating strings such as nylon are extended so as to serve as a guide for smoothly leading the photocopying paper P through the charging means 2. However, a guide string may be damaged or disconnected by an abnormal discharge of the charging means 2 or by the photocopying paper itself. If the photocopying papers P are continuously fed when the string is disconnected, they become jammed in the charging means 2, thus resulting in breakdown of the charging means.

In view of the above, the present invention provides safety means which gives an alarm signal immediately when the guide string is disconnected, thereby eliminating faulty operation such as described above. The charging means of this embodiment comprises guide means for guiding photocopying paper or the like, the charge means itself, and means for electrically detecting faulty operation of this guide means. In FIGS. 17 and 18, reference numeral 61 designates a charging section frame; 62, an insulated support; 63, charging wires; 64, charging wire supporting pins; 65, an electrode connecting plate or terminal; and 66, the guide string. Switches MS_5 and MS_6 are attached to the frame 61 at suitable positions on the side or bottom thereof so as to be normally opened by the tension applied from the guide string 66 and closed when the guide string 66 is cut or loosened, thereby actuating a buzzer or lighting a lamp L_2 so as to give an alarm signal or stop the photocopying paper feeding mechanism. The string 66 may be suitably operatively connected to the switches MS_5 and MS_6. In the instant embodiment, both ends of the guide string 66 are connected to the actuating members 67 of the switches MS_5 and MS_6 so as to normally open them by the tension of the string 66 while when the tension is relieved the switches MS_5 and MS_6 are closed as shown in FIG. 18 by the broken lines.

The path defined by the guide string 66 is preferably converged in the direction of advancement of the photocopying paper and the guide string 66 is preferably extended slanting in opposite directions in the right and left sections of the passage.

The image quality of the copy obtained with electrographic copying machines or the like varies largely depending upon the nature of the original. When the copying speed is slow and only a small number of different copies from different originals are involved, the exposure factors may be suitably controlled by trial so that better quality copies may be obtained. But when the copying speed is high and various kinds of copies are required from different originals, trial copying will cause disadvantageous loss in time and materials.

The present invention also provides a method for eliminating such disadvantage as described above, which method is characterized by irradiating the surface of an original with uniform light rays, detecting the reflected or transmitted light rays by a phototransistor, thereby detecting the brightest portion of the original, and changing automatically the aperture of the exposure system or the intensity of the light from the light source in response to said detection, thereby obtaining uniform quality copies all the time.

A better quality copy has sharp contrast; that is, the dark area (printed area) of the original must be copied as the dark area and the white area (unprinted area) must be copied as the white area in the copy. In other words, the brightest area of the original (generally the base of the original having no printing or the like) must be copied as a white area in the copy while the darker area must be copied as a darker area. For example, in the case of electrophotographic copying, the reflected or transmitted light from the brightest area of the original dissipates all the charge upon the sensitized surface of the photocopying paper while the reflected or transmitted light from areas darker than the brightest area will not completely dissipate the charge upon the photocopying paper. Therefore, the brightest area of the original must be detected. This is accomplished in accordance with the present invention by scanning the surface of an original with a light beam, detecting the reflected or transmitted light beam with a photoelectric transducer such as a phototransistor, memorizing in an electronic circuit the maximum light intensity detected, and in response to said maximum light intensity detected, controlling the power source for the light source with an ignition phase control element or controlling the aperture diaphragm with a servomechanism, thereby automatically controlling the exposure.

FIG. 21 is an electric circuit of one embodiment of an automatic exposure control system based upon the principle described above. The contrast of an original is detected by a phototransistor PT_3 so as to convert the contrast into voltage signals, and the maximum peak value, corresponding to the brightest area of the original, is memorized in the circuit. Thereafter, the exposure determining or regulating mechanism is actuated by the memorized peak value in order to adjust the contrast of the original.

The original B to be copied is placed upon the original holder 6 and is projected by a projection system consisting of light source 7 and copying lens 8 upon photocopying paper P which is fed one by one from the photocopying paper feeding section 1 and is charged in the charging section 2. The paper P provided with an electrostatic latent image by the above step is developed in the developing section 4 into a visible image and fixed and dried in the fixing-drying section 5, thereby providing a copy.

FIG. 23 illustrates one embodiment of a contrast detecting device in which a light source L_3 emits light toward the original B set upon the transparent plate 11 of the original holder 6, and the light reflected by the original B is detected by the phototransistor PT_3. The light source L_3 and the phototransistor PT_3 are disposed upon a support 72 at a suitable angle relative to each other so that the most desirable effect can be attained. The support 72 is fixed to a supporting arm 73 whose one end is supported through a bearing 74 upon a rail 75 made integral with the main body of the copying machine so that the arm 73 and consequently the support 72 are slidable along the rail 75, as shown in FIG. 22. As best shown in FIG. 24, the rail 75 is arranged outside the optical path and the detecting device generally designated by 71 may be displaced sufficiently to cover the area of the original B to be copied. The supporting arm 73 is connected to a string or wire 76 wound around pulleys 77_1 and 77_2 as shown in FIG. 22 so that the arm 73 may be displaced in both directions by a motor M_1, thereby permitting the scanning of the whole surface of the original B by the detecting device 71. The stroke of this displacement may be suitably adjusted by microswitches MS_7 and MS_8.

As shown in FIG. 1, the detecting device 71 is normally positioned out of the optical path, and by the detection start signals, the motor M_1 rotates causing movement first in the direction indicated by the arrow R. After displacing the detecting device 71 by a predetermined stroke the microswitch MS_8 causes motor M_1 to reverse direction of rotation so that the device 71 is moved in the direction indicated by the arrow R_1 and returned to its normal or initial position whereupon microswitch MS_7 stops the scan. A motor M_2 is driven by signals in response to the maximum intensity of light reflected from the original and detected by the detecting device 71 so as to rotate an aperture diaphragm or blade 9 in front of (or within) the lens, thereby setting the aperture. Alternatively, said signals may be used to control the power source voltage for the light source 7 through an ignition phase control element or the like, thereby varying the intensity of light illuminating the original surface.

From the foregoing, it is seen that according to the present invention, the exposure factors are determined depending upon the brightness of the brightest area of an original surface so that optimized exposure factors are provided when an easy-to-see copy making the best use of the brighter area of the base of the original is required, thus eliminating the trial copying operation as well as material loss and improving the copying efficiency.

The photocopying paper has generally a limited sensitivity range so that it is impossible to reproduce any contrast range of the original with a higher degree of accuracy or fidelity. Thus when the contrast between the original base and the printed area thereof is detected so as to adjust the exposure to an intensity of light intermediate that of light reflected from the base and light reflected from the printed area of the original, intermediate contrast copies or prints may be advantageously obtained even though the contrast between the photocopying paper base and the image formed area thereof is not as distinct as that of the original.

For this purpose, the output of the photovoltage transducer circuit in FIG. 21 is not applied to the memory circuit, but opposed to the embodiment described above, is applied to an integrating circuit from which are derived pulses representative of the variation in voltage (variation in contrast of the original). These pulses are stored in the memory so that the exposure determining or regulating mechanism described hereinabove is actuated by signals representing the intensity of light intermediate those of light reflected or transmitted from the brightest area and the darkest area of the original. Thus, a suitable intermediate exposure can be attained.

In high-speed electrographic copying machines, in order to obtain better quality copies or prints successively, it is required that the concentration of the developing solution be detected so as to maintain optimum concentration thereof by adding concentrated developing solution to a reservoir or developing solution tank. In the conventional method, a portion of the developing solution is directed to a concentration detecting section so as to detect the concentration of the developing solution. But this method has the following defects:

1. Additional pump and piping for directing the developing solution to the detecting section, and a sealed detector are required;

2. The developing device inevitably becomes large in size and complicated in construction due to the attachment of the equipment described in (1) above so that the attachment and removal of the developing device becomes difficult;

3. Detection error is inevitably caused by the concentration detector which may be a photoconductor unless it is always kept clean by eliminating the adhesion of developing solution thereto; and

4. Due to variation in the characteristics or qualities of the developing solution, the amount of toner adhered to a copy paper might be reduced gradually, resulting in very vague copies. Accordingly the present invention provides a method for detecting the concentration of the developing solution from the developed visible image of the copy immediately discharged from the developing section without detecting the concentration of the developing solution directly therefrom, thus eliminating the above-described defects and disadvantages, in the conventional method.

According to the present invention, a developing solution concentration detector 83 is disposed along the path of the copy P being advanced from the developing section 4 through a pair of squeezing rollers 81 and conveyor belt 82. In the embodiment illustrated in FIG. 25, the detector 83 is disposed between the squeezing rollers 81 and 82_1 and the fixing-drying section or means 5, but it is understood that the detector 83 may be positioned at any position along the passage of the developed copies P. Alternatively, a plurality of detectors 83 may be provided if required.

The detector 83 comprises for example a light source L_4, a photoconductor CdS-4 and a switching element such as a translator, a thyristor, an electron tube, etc., which constitute a balance circuit. As shown in FIG. 25, the light from the light source L_4 is reflected by the copy P and the light reflected depending upon the tone of the image of the copy P is impinged upon the photoconductor CdS-4. When reflected light is utilized as described above, it is preferable to provide the conveyor belt 82 with a suitable reflecting surface or to provide a suitable reflecting member so that the light may be reflected thereby even when no copy is being carried. Alternatively, the above detection circuit may be so arranged that it is actuated only when the copy is advanced by providing suitable copy detecting means such as microswitches. Furthermore, a light source L_4' may be positioned in opposed relation with a photoconductor CdS-4' across the copy passage. In this case, the conveyor belt must be transparent or have a slit or the like through which the light from the light source may reach the photoconductor. The light source L_4 may be an infrared ray lamp used for fixing the image in the fixing-drying section.

It is preferable to attach the above-described concentration detecting means to the guide plates for the copies P, when it is placed outside of the fixing-drying section.

When the image contrast upon the copy discharged from the developing section falls below a predetermined level or value, the intensity of the light impinged upon the photoconductor CdS-4 changes, thereby detecting a decrease in the

concentration of the developing solution and actuating the balance circuit of the detector **83**. When the balance circuit is energized, a plunger, for example, may be actuated so as to open a valve of a concentrated solution reservoir (not shown) thereby supplying the concentrate until the optimum image is obtained.

The mode of operation of the balance circuit of the detector **83** will be described in more detail hereinafter. The balance circuit is so constructed that the maximum tone of the copied image may be detected and signals are generated when this maximum tone falls below a predetermined level. Alternatively, the balance circuit may be so constructed that the number of copies being copied may be counted and the signals may be generated when the number reaches a predetermined number. First, the former type balance circuit will be described with reference to FIGS. **26** and **27**. The circuit shown in FIG. **26** uses an electron tube V as a switching element, and until a copy P is transported, a microswitch **MS9** closes a contact *a* while a microswitch **MS10** is opened or OFF and the capacitor **C101** is charged. Upon advancement of the copy P, the microswitch **MS9** closes a contact *b* while the microswitch **MS10** is ON so that the discharge circuit of the capacitor **C101** may be established through the photoconductor CdS–4. In this case, immediately after the microswitch **MS9** closes the contact *b*, the grid of the tube V is biased to a negative voltage by the charged capacitor **C101** so that the electron tube V is nonconductive. Therefore, if the contrast of the image is dark, the discharge time constant [R (resistance of CdS–4) × **C101**] of the capacitor is high so that the electron tube V will not be driven into the conductive state until the copy has passed through the detector and the microswitch **MS9** closes again the contact *a*.

On the other hand, when the image is lighter in contrast, more light is reflected so that the resistance of CdS–4 is reduced, whereby the capacitor **C101** is discharged while the copy is passing through the detector. Therefore, the grid bias of the electron tube V is reduced so that the electron tube V is driven into the conductive state, thereby causing current to flow through the circuit consisting of E4 (+)→(RL1)→(MS10)→V→E4 (−) and energizing the relay RL–1. Upon energization of the relay RL–1, the contact S1–2 is closed so that the plunger **84** is actuated, thereby opening the valve of the concentrated developing solution tank so as to supply concentrated developing solution. Alternatively, a counter instead of the plunger **84** may be actuated so that when the relay RL–1 is actuated twice or three times, the valve is opened.

In the circuit shown in FIG. **27**, variable resistor **VR1**, a photoconductor **CdS4** and fixed resistors **R101** and **R2** constitute a bridge circuit and the adjustable resistor **VR1** is so adjusted that when a predetermined intensity of reflected light impinges upon the photoconductor **CdS4**, the bridge may be balanced.

When the image of the copy P advanced into the detector is too light more light is reflected so that the resistance of the photoconductor **CdS4** is decreased. Therefore the potential at the point *f* becomes higher than that at the point *e* so that the bridge circuit is unbalanced, whereby the capacitor **C101** is charged through the resistor R_3. After a predetermined time, the voltage of the charging capacitor **C101** reaches the actuating or firing voltage of the thyristor SCR. When the thyristor SCR is turned on, the circuit E4(+)→**84**→**R4**→SCR→(MS10)→E4(−) is established so that the plunger **84** is actuated so as to add concentrated developing solution.

After the copy P has passed through the detector, the microswitch **MS10** is turned off so that the plunger **84** is returned to its initial or normal position, thereby closing the valve of the concentrated developing solution tank. Simultaneously, the microswitch **MS9** is closed so that the capacitor **C101** is discharged. It is noted that instead of actuating the plunger **84**, a counter may be actuated so as to open the valve after the SCR is energized two or three times.

The second-type balance circuit will be described hereinafter with reference to FIG. **28**. When the copy P is advanced into the detector, **MS9** is closed so that a voltage drop appears across the photoconductor **CdS4**. Since the resistance of the photoconductor **CdS4** varies in response to the intensity of light impinged thereupon, the resistance is increased when the image is dark since the reflected light is less. Therefore the grid bias of the electron tube V becomes positive so that the electron tube V is driven into the conductive state, thereby turning on a light source **L5**.

The light from the light source **L5** impinges upon the photoconductor **CdS5** thereby decreasing its resistance and causing the capacitor **C101** to be charged therethrough. When the charge voltage reaches a predetermined level, the thyristor SCR is driven into the conductive state, thereby energizing the relay **RL1** so as to close its contacts **S2–1** and **S2–3** and open **S2–2** and **S2–4**. Therefore, the capacitor **C2** is discharged so that relay **RL2** is energized. Simultaneously, the capacitor **C101** is short circuited and the thyristor SCR is deenergized. The relay **RL2** closes its contact **S2–5** so as to actuate a counter **85**, thereby storing the consumption of the concentrated developing solution. When the content of the counter **85** reaches a predetermined value, the valve of the concentrated developing solution tank is controlled so as to supplement the concentrate.

On the other hand, when the size of an image is small so that the consumption of the developing solution is less, more light is reflected from the copy P so that the resistance of the photoconductor **CdS4** is decreased, whereby the cathode of the electron tube V is applied with a suitable bias through the adjustable resistor **VR1**, thereby decreasing the current flowing across the electron tube V. Therefore, the intensity of light of the lamp **L5** is weak. Thus, it takes a long time before the capacitor **C101** is charged so that the firing of the thyristor SCR is delayed and consequently it takes a long time before the content of the counter **85** reaches the predetermined value. Thus, it is seen that in proportion to the consumption of the developing solution, the concentrated developing solution is supplemented.

According to the present invention, the developing solution concentration detector is disposed along the path of the copies discharged from the developing section as described hereinabove so that the concentration may be detected from the image tone of the copies. Thus it is seen that the concentration of the developing solution may be detected irrespective of the variation in the characteristics or qualities of the developing solution with a higher degree of accuracy so that the detection error may be reduced. Therefore, uniform and better image copies may be obtained all the time. Furthermore, since the concentration detector is not disposed within the developing section, the pump, the piping and the like for directing the developing solution to the concentration detector are eliminated so that the construction of the developing section or device can be made simple and the handling and operation of the device are also facilitated.

In the conventional wet type developing electrophotographic copying machines, the vapor of the developing solution is generated by the developing means **4** and the fixing-drying means **5**. Especially when high-speed photocopying operation is desired, much of the vapor will be produced. When the air in the photocopying machine is filled with such vapor, the machine tends to become contaminated and deteriorates in its mechanical and electrical characteristics so that the vapor must be discharged out of the machine. However, if the vapor as generated is discharged, the surrounding atmosphere will be contaminated, causing an adverse effect upon the health of the operators.

Accordingly, the present invention also provides a method and device for eliminating such defect as described above by introducing the air containing vapor of the developing solution into a vapor collection chamber where the vapor is absorbed by a suitable absorbent, thereby cleaning the air. The absorbent will operate for a long time when it has a large capacity, but it is difficult to provide a uniform density layer of absorbent if the absorbent material is just packed into a large

container or the like, so that the flow of the air containing the vapor of the developing solution through such irregularly packed layers of the absorbent material is worse resulting in very inefficient filtration. Furthermore, especially at the inlet and outlet of the air, the degree of deterioration of the absorbent material is much different so that the efficiency, economy, and handling will be much improved when the much deteriorated portions of the absorbent material is replaced. The developing solution vapor is mainly generated in the fixing-drying means so that when the vapor in this means is satisfactorily treated, there will be left almost no vapor in the copying machine and the vapor may be satisfactorily recovered.

As shown in FIGS. **29** and **30**, developing solution vapor collection chamber **88** is communicated with the fixing-drying section **5** so as to remove the vapor and discharge it and control the best of the purified air by circulating the air through suitable sections of the machine. This vapor collection chamber in accordance with the present invention will be described in more detail hereinafter.

The exposed paper P is developed in the developing section **4** so as to form a visible image and then introduced into the fixing-drying section **5** where the toner is fixed upon the paper P and the solution is dried, thereby providing a finished copy or print, which is discharged through a discharge port or opening **91** through rollers **89–1** to **89–3** and a guide **90** FIG. **1**. In the electrophotographic copying machine of the type having the construction as described above, a considerable amount of the vapor is generated in the fixing-drying section **5** and fills the machine together with the vapor produced in the developing section.

According to the present invention, the air in the vicinity of the fixing-drying section **5** is drawn into the duct through a fan and the developing solution is filtered and separated in the developing solution vapor collection chamber **88** so that only purified air may be discharged into the surrounding atmosphere or back into the machine.

The fixing-drying section or means **5** has a belt **92** wound around the rollers **82–1** to **82–3** and a suitable heating means such as an infrared ray heater **93**. The fixing-drying section **5** is enclosed by a wall **103** having only a small gap through which is advanced the paper P. The fixed and dried copy paper P is discharged out of the machine as described hereinabove.

In the instant embodiment shown in FIGS. **29** and **30**, the collection chamber **88** includes a blowing chamber **94**, a suction chamber **95** and a developing solution recovery chamber **96**. The air in the recovery chamber **96** is introduced through a duct **98** by a fan **100** into the blowing chamber **94**. The air blown from the blowing chamber **94** is heated by a heater (not shown) and then blown against the copy P so as to press it against the conveyor belt **92** upon which is fixed the copy P and by which the fixed copy P is discharged out of the machine. The air containing vapor of the developing solution produced upon fixing is drawn into the suction chamber **95** by a motor driven fan **99** and introduced into the recovery or collection chamber **96** through a duct **94** for forced circulation. The collection chamber **96** is packed with developing solution absorbent such as active carbon **28** so that the vapor is all absorbed in the chamber **96**. Therefore the air introduced into the blowing chamber **94** contains no vapor of the developing solution and is purified. The above absorbent is packed in a cassette so that the deteriorated cassette may be replaced with ease, thereby improving the efficiency and handling. As shown in FIGS. **31** and **32**, into a frame **102** having both sides opened is packed an absorbent **101** of the type in which active carbon or the like is packed into a porous member **104** having a better air permeability. The cassette having the construction described above is detachably mounted into the collection chamber **96**. When the absorbent is of finely divided particles, the particles at the lower portion of the cassette might be compressed too much so that the function of the absorbent in the upper and lower portions of the cassette might be different. To eliminate such defect, as shown in FIG. **33**, the cassette may be divided into a plurality of sections. As the porous member **101**, glass wool, porous moltprene, cloth, screen, paper and so on may be employed.

Another embodiment of the vapor-collecting device will be described hereinafter with reference to FIG. **34**. An air-blowing inlet **111** is formed along one sidewall of the fixing-drying section **5** and the air is heated and blown against the back surface of the copy P advanced by the conveyor belt **92**. Thereafter, the air is drawn through a suction port **112** formed at the other side of the device. Below or at any other suitable position of the fixing-drying section **5** is provided a collection chamber **113** in which is disposed a cooling tube **114** in zigzag or any other suitable form so as to circulate the coolant such as cooled air, cooling water, freon gas, etc., by means of a pump **115**.

The inlet **111** and the suction port **112** are communicated with the front and rear sides of the collection chamber **113** through ducts **116** and **116'**, respectively, so that the air may be circulated by motor-driven fans **117** and **118**. When the air is circulated in the direction indicated by the arrows by the motor driven fans **117** and **118**, the air containing vapor of the developing solution generated in the fixing-drying section **5** and being heated comes in contact with the cooling tube **114** so that the vapor is condensed and separated from the air and drops so as to be collected into the developing solution reservoir **119**. The air purified and lowered in temperature may be immediately directed toward the inlet **111**, but in the instant embodiment, the air is made to pass through a tube **121** so as to be discharged in the vicinity of the light source **7** (for illuminating the original). On the other hand, the air heated around the light source **7** may be drawn into a tube **122** so as to direct the air to the inlet **111**. Thus it is seen that the heat control described above may be effected with a higher degree of efficiency.

Alternatively not only the air in the vicinity of the fixing-drying section **5** but also the air in the vicinity of the developing section **4** may be sucked into the collection chamber so as to separate and collect the vapor of the developing solution and to blow the cooled and purified air into the vicinity of the light source for projecting the image of the original, whereby all the air within the machine may be conditioned.

What is claimed is:

1. A high-speed electrophotographic copying device comprising in combination: an original holder, original-illuminating means, photocopying-paper-feeding means, charging means, exposure means, developing means, and a housing for enclosing all of said means, characterized in that said original holder has at least two original holding surfaces, each surface having an area at least substantially commensurate with the total field covered by said exposure means during a single exposure cycle, and said holder is movable between exposure cycles to position said holding surfaces selectively in an exposure position for alternatively and selectively copying during any one exposure an original on one of said holding surfaces.

2. A high-speed electrophotographic copying device according to claim **1**, wherein said original holder is reciprocatingly movable relative to said original illuminating means in its movement relative to said exposure position.

3. A high-speed electrophotographic copying device according to claim **1**, wherein there are two of said original-holding surfaces and said surfaces are interconnected with an angle therebetween, said original holder being mounted for rocking movement about a pivot axis to alternatively position one or the other of said original-holding surfaces at said exposure position.

4. A high-speed electrophotographic copying device according to claim **1**, wherein said original-holding surfaces are joined in a circular pattern and said original holder is mounted for rotation about a center substantially at the center of said pattern whereby a plurality of originals, each on a separate one of said holding surfaces, may be selectively positioned at said exposure position.

5. An electrophotographic copying device comprising in combination: an original holder, original-illuminating means, photocopying-paper-feeding means, means for detecting the presence of more than one sheet of photocopying paper at any one time in a passage for photocopying papers fed by said feeding means, means for changing the direction of the feed of said photocopying paper in response to information from said detecting means, charging means, exposure means, developing means and a housing for enclosing all of said means.

6. An electrophotographic copying device as set forth in claim 5, wherein said detecting means comprises a light source and a photoelectric element disposed across said photocopying paper passage in opposed relation to each other.

7. An electrophotographic copying device as set forth in claim 6, wherein said photocopying paper fed by said feeding means is a sensitized paper and said light source emits light whose spectrum is outside the spectrum to which said sensitized paper is sensitive in order to avoid causing fatigue of said sensitized paper.

8. An electrophotographic copying device as set forth in claim 6, wherein said photocopying paper fed by said feeding means is a sensitized paper and said light source is so arranged that the light emitted therefrom impinges on said sensitized paper outside of the image forming area.

9. An electrophotographic copying device comprising in combination: an original holder, original-illuminating means, photocopying-paper-feeding means, charging means, exposure means, developing means and a housing for enclosing all of said means, characterized in that said charging means includes, in addition to said charging means, means for guiding an object to be charged, and means coupled thereto for electrically detecting a discontinuity in said guide means.

10. An electrophotographic copying device as set forth in claim 9, wherein said detecting means includes a switching element responsive to said guide means for altering its condition upon the appearance of a discontinuity.

11. An electrophotographic copying device comprising in combination: an original holder, original-illuminating means, photocopying-paper-feeding means, charging means, exposure means, developing means and a housing for enclosing all of said means, characterized in that said device further comprises means for scanning the surface of an original with a beam of light, means for photoelectrically detecting the brightest area of said original during said scanning with said light beam, and means for adjusting the exposure during copying of the whole surface of said original as a function of said brightest area for causing dissipation of all of the charge upon said photocopying paper only in areas corresponding to said brightest area.

12. An electrophotographic copying device comprising in combination: an original holder, original-illuminating means, photocopying-paper-feeding means, charging means, exposure means, developing means and a housing for enclosing all of said means, characterized in that said device further comprises means for scanning the surface of an original with a beam of light, means for photoelectrically detecting during said scanning by said light beam an intermediate brightness level between the darkest and brightest areas of said original, and means for adjusting the exposure during copying of the whole surface of said original such that said exposure is set to said intermediate brightness level.

13. An electrophotographic copying device comprising in combination: an original holder, original-illuminating means, photocopying-paper-feeding means, charging means, exposure means, developing means, means for automatically adjusting the concentration of developing solution, and a housing for enclosing all of said means, characterized in that said means for automatically adjusting the concentration of developing solution comprises a light source disposed along the path of photocopying papers after development, a photoelectric element adapted to receive the light reflected from a visible image developed upon said photocopying paper, means for determining the concentration of developing solution by the intensity of said reflected light, a concentrated developing solution reservoir, and means for opening and closing said reservoir in response to the information provided by said determining means.

14. An electrophotographic copying device comprising in combination: an original holder, original-illuminating means, photocopying-paper-feeding means, charging means, exposure means, wet developing means, fixing-drying means, and a housing for enclosing all of said means, characterized in that there is further provided means for circulating air through said fixing-drying means, means for purifying air by removing therefrom developing solution vapor, and means for passing said air from said fixing-drying means containing developing solution vapor through said purifying means to remove said vapor before recirculating the purified air back to said fixing-drying means for hastening drying of said photocopying paper.

15. An electrophotographic copying device comprising in combination: an original holder, original-illuminating means, photocopying-paper-feeding means, charging means, exposure means, wet developing means, fixing-drying means, and a housing for enclosing all of said means, characterized in that there is further provided a developing solution collection chamber including an absorbent member, said absorbent member being divided into sections which are detachably mounted in said collection chamber, and means for drawing the air containing developing solution vapor from the fixing-drying means and passing it through said absorbent member in the collection chamber.

16. An electrophotographic copying device according to claim 14, further including means for heating said purified air and blowing it against the developed photocopying paper.

17. An electrophotographic copying device comprising in combination: an original holder, original-illuminating means, photocopying-paper-feeding means, charging means, exposure means, wet developing means, fixing-drying means, and a housing for enclosing all of said means, characterized in that the device further comprises condensing means, means for passing air containing developing solution vapor from the fixing-drying means through said condensing means to remove said vapor therefrom by condensation, and means for blowing the cooled purified air from the condensing means into the device.

18. An electrophotographic copying device according to claim 17, wherein the cooled purified air is discharged in the vicinity of a heat-producing component in the device to prevent overheating thereof.

19. An electrophotographic copying device comprising in combination: an original holder, original-illuminating means, photocopying-paper-feeding means, charging means, exposure means, wet developing means, fixing-drying means, and a housing for enclosing all of said means, characterized in that there is further provided condensing means, means for passing air containing developing solution vapor from the fixing-drying means through said condensing means to remove said vapor therefrom by condensation and provide purified air, and means for heating said purified air and discharging the heated air into said fixing-drying means.

20. An electrophotographic copying device comprising in combination: an original holder having at least two original-holding surfaces, original-illuminating means, photocopying-paper-feeding means, means for detecting when more than one photocopying paper is fed simultaneously from said feeding means, means responsive to said detecting means for changing the direction of advancement of said photocopying paper when more than one photocopying paper is detected, charging means having means for electrically detecting a fault in the guide means thereof, means for scanning an original with a light beam, means responsive to the light from said beam which is reflected by said original for detecting the brightest area of said original, means responsive to said detected brightest area for adjusting the exposure of said photocopying paper, liquid developing means for developing exposed photocopying paper, means responsive to the

developed image for automatically adjusting the concentration of the developing solution, fixing-drying means for said developed paper, means for drawing air containing developing solution vapor from said fixing-drying means, and means for recovering said vapor from said air.

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,635,555 Dated January 18, 1972

Inventor(s) KURAHASHI et al.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 69, before "fed" insert --be--.
Column 2, line 42, "and" (second instance) should read --are--; line 72, before "view" insert --side--.
Column 5, line 3, "mounted" should read --supported--.
Column 6, line 74, before "peak" insert --maximum--.

Signed and sealed this 19th day of September 1972.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
☆ U.S. GOVERNMENT PRINTING OFFICE : 1969 O—366-334

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