United States Patent [19]

Swanberg

[11] **3,865,480**

[45] **Feb. 11, 1975**

[54] **ELECTROSTATIC CONTROL OF FAN FOLD PAPER STACKING**

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[22] Filed: **Dec. 20, 1973**

[21] Appl. No.: **426,991**

[52] **U.S. Cl.** ..... **355/3 R,** 270/61 F, 270/79

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

[58] **Field of Search** ..... 270/61 F, 79; 271/193; 355/3 R, 16, 51, 14; 317/262 A, 2 R, 2 A; 226/94

[56] **References Cited**

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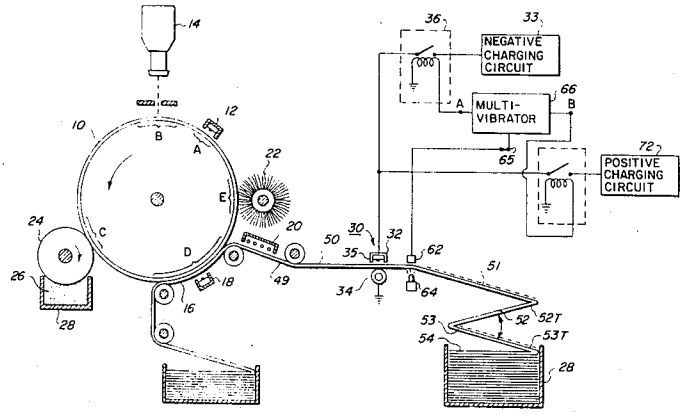
[57] **ABSTRACT**

Apparatus for producing compact stacking of fan fold paper by creating electrostatic attraction forces between facing sheets of the fan fold. The attraction forces can be provided by charging, such as with a corona generator, alternate sheets of the fan fold such that they have an electrostatic charge greater than any residual or ambient charge on the adjacent sheets. More compact stacking is achieved by charging every sheet with the charge on each sheet having a polarity opposite to the polarity of the charge on each of the two adjacent sheets.

14 Claims, 2 Drawing Figures



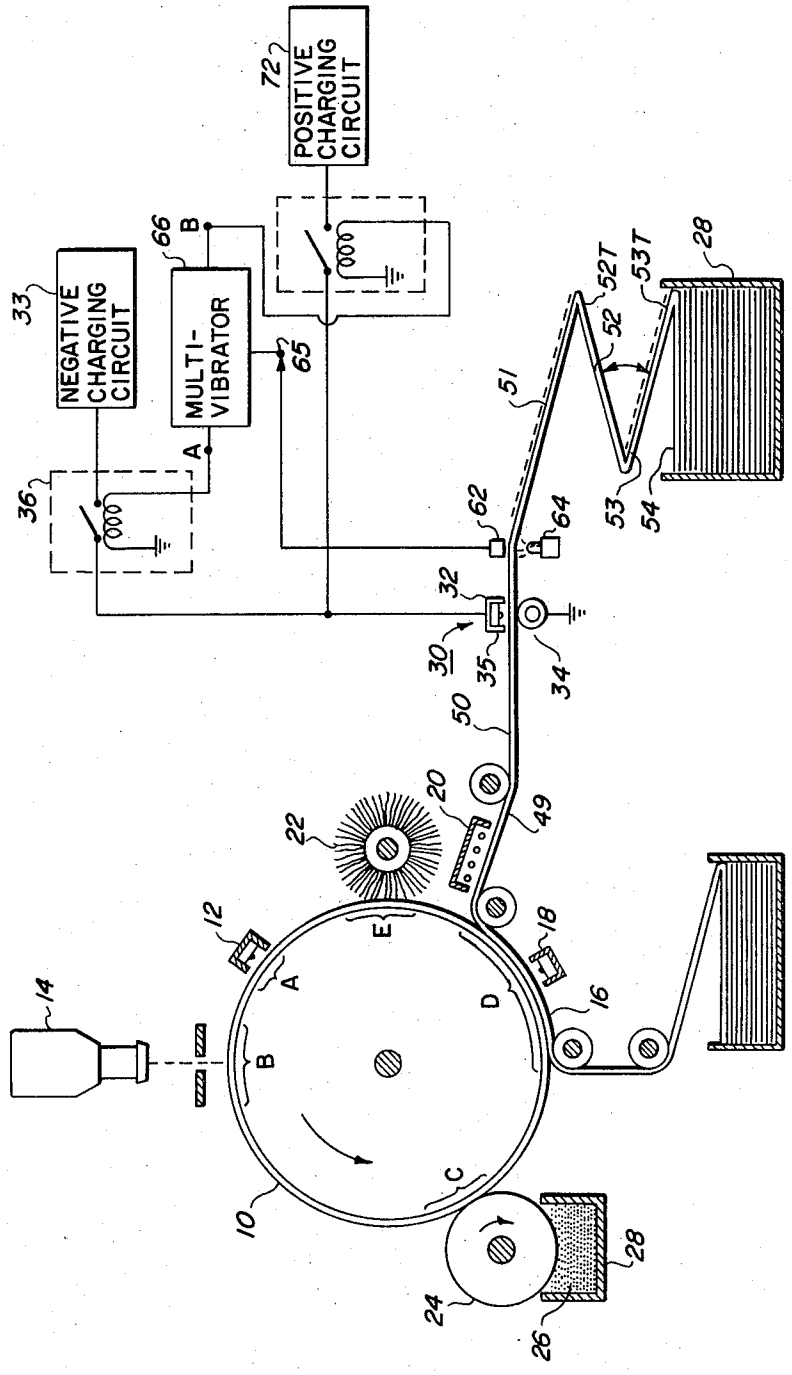

POSITIVE CHARGING CIRCUIT
72
NEGATIVE CHARGING CIRCUIT
33
MULTI-VIBRATOR
66
65
36
A
B
51
52T
53T
52
53
54
28
62
64
32
30
35
34
50
20
49
22
12
18
14
16
10
24
26
A
B
C
D
E

FIG. 1

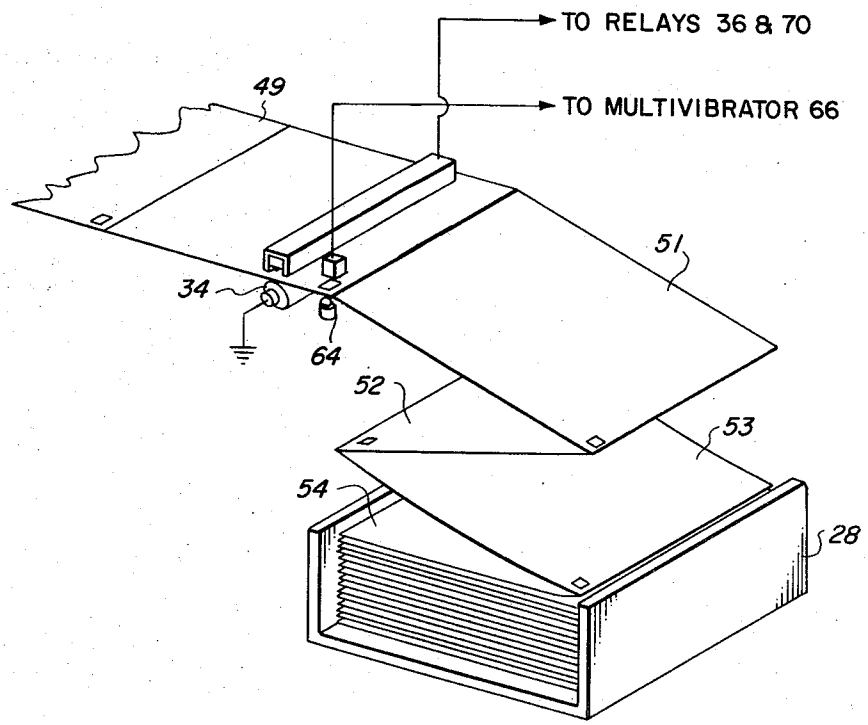


FIG. 2

ELECTROSTATIC CONTROL OF FAN FOLD PAPER STACKING

BACKGROUND OF THE INVENTION

In electrostatic copiers and highspeed printers utilizing fan fold paper stacking, the paper stacks with the edges bowed. The "bow" effect, caused by the repulsion forces produced by the residual charges on the sheets of the fan fold, prevents close paper packing. Pneumatic and mechanical systems for preventing bowing are noisy and may produce mechanical damage to the paper.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide improved fan fold paper or sheet stacking.

It is a further object of the present invention to provide close packing of fan fold paper.

It is another object of the present invention to remove the bowing of fan fold paper without mechanical damage to the paper.

In accordance with the invention, the bowing of the fan fold paper is eliminated by electrostatically charging selected sheets of the fan fold to a value higher than the residual charge on the adjacent sheets or to a polarity opposite to that of the residual charge on the adjacent sheets. When alternate sheets of the fan fold are charged to a polarity or magnitude different from the residual charge on the fan fold, close packing of the fan fold sheets can be achieved since adjacent faces of the sheets are unevenly charged or oppositely charged, resulting in attraction forces therebetween and thus compact stacking. When all sheets of the fan fold are charged with adjacent sheets of the fan fold having opposite polarity charges, stronger attraction forces exist between adjacent faces of the sheets and even more compact stacking is achieved.

In the xerographic copying process, a residual charge exists on the sheets of the fan fold paper due to the charging of the paper during the copying process. Since the residual charges are of the same polarity, negative or positive depending upon the polarity of the corotron charge, and of substantially the same magnitude, they repel each other, and hence the sheet stack with the edges "bowing." By providing a charge of a magnitude greater than the residual charge, or a polarity opposite to that of the residual charge, on sheets of the fan fold, a sufficient electrostatic attraction force is created to cause the sheets of the fan fold stack to collapse into the desired flat stack configuration, thereby eliminating "bowing" at the edges of the fan fold.

Other objects of the invention will become readily apparent to those skilled in the art in view of the following detailed disclosure and description thereof, especially when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view of a xerographic processor utilizing the apparatus of the present invention.

FIG. 2 is an isometric view of the "bowing-preventing" charging apparatus of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Although the present invention is applicable to any device having a fan fold paper stack, such as high-speed printers and electrostatic copiers, it is particularly useful in the environment of electrostatic copiers since that class of devices places a residual charge on the fan fold stack. Accordingly, the invention will be described in the environment of an electrostatic copier, although it can be utilized with other systems having fan fold paper output.

Referring to FIG. 1 of the drawings, there is shown a xerographic reproduction system employing the present invention. In this apparatus, the xerographic plate is in the form of a drum **10** which passes through stations A through E in the direction shown by the arrow. The drum has a suitable photoconductive surface, such as one including selenium overlying a layer of conductive material, in which a latent electrostatic image can be formed. The various stations around the periphery of the drum which carry out the reproduction process are: charging station A, exposing station B, developing station C, transfer station D, and cleaning station E. Stations A, B, C, D, and E represent conventional means for carrying out the charging, exposing, developing, transferring and cleaning processes. Apart from their association with the novel fan fold stacking arrangement to be described, they form no part of the present invention.

At station A a suitable charging means **12,** for example, a corotron, places a uniform electrostatic charge on the photoconductive surface of the drum **10.** As the drum **10** rotates, a light pattern, via a suitable exposing apparatus **14,** for example, a projector, is exposed onto the charged surface of the drum to form a latent image thereon. The latent image formed on the surface of the drum **10** is developed or made visible by the application of a finely divided, pigmented, resinous powder, called toner, at developing station C. At developing station C, a toner roller **24** is positioned so that a portion of its periphery comes in contact with toner **28** and drum **10.** After the drum **10** is developed at station C, it passes through transfer station D, including fan fold copy paper **16,** corona charging device **18,** and fuser **20.** Charing device **18** can provide a positive or negative charge on paper **16** but for the purpose of explaining the invention the charge developed by device **18** is assumed to be negative. Following transfer of the developed image to the copy sheet, the drum rotates through cleaning station A, comprising a cleaning device such as a rotating brush **22.** Following affixing of the developed image by fuser **20,** the fan fold copy paper **16,** having a plurality of equally sized sheets of which sheets **49–54** are representative, is stacked in a fan fold stacking bin **28.**

In fan fold stacking, the paper stacks with the common sides in contact, that is, top to top and bottom to bottom, as shown in FIG. **1.** Any residual charge on the sheets of the paper **16** hinders stacking, since surfaces having a residual charge of the same polarity and magnitude are brought into contact with, or placed adjacent, each other. The equally charged facing surfaces repel each other, and this repulsion produces "bowing" of the fan fold stack, especially at the edges or folding points thereof.

In accordance with the invention, the "bowing" effect is overcome by the addition of a charging device **30,** including a negative corotron device **32,** a conventional corotron charging circuit **33,** and a grounded plate or roller **34.** The charging device **30** is situated

between fuser **20** and the stacking bin **28.** The corotron **32** includes a high voltage wire **35** of any suitable non-corrosive material, such as stainless steel or a platinum alloy, having, for example, a diameter of about 0.0035 inches. The corotron is coupled to charging circuit **33** by, for example, an electromagnetic switch **36** such that when switch **36** is closed, the desired amount of electrostatic charge, about 300 volts, will be produced on the upper surface of the paper **16** relative to the bottom surface. Suitable corotron devices and suitable charging circuits therefor are described in U.S. Pat. Nos. 3,604,925 and 2,836,725.

The charging device **30** is activated periodically upon closure of switch **36** such that only alternate sheets of the fan fold are charged thereby. For example, as shown, the top surfaces of sheets **51** and **53** are charged negatively with respect to the bottom surfaces of sheets **51** and **53** which in this embodiment are at ground potential, whereas the sheets **52** and **54** are not charged by charging device **30.** Thus, alternate facing sheets of the fan fold have unequal charges. For example, the top surface **53T** of sheet **53** has a greater charge than the top surface **52T** of sheet **52** which has only the residual charge thereon. As a result of the electrostatic charge differential between the facing surfaces **53T** and **52T**, an attraction force exists between these surface, which force draws these facing surfaces together (as shown by the two-arrow line) to provide a fan fold stack without bowing. Similarly, other adjacent surfaces having unequal charges are drawn together.

Charging of alternate sheets of the fan fold can be achieved by switching the charging device **30** on only when odd numbered sheets of the fan fold are passing under the corotron **32.** For example, switching of the corotron could be achieved by providing a small aperture **60,** as shown in FIG. **2,** adjacent the leading edge of each sheet of the fan fold. A photocell **62** would produce a voltage pulse each time that one of the apertures passes between the photocell and a light **64.** The voltage pulses are applied to the input terminal **65** of a bistable multivibrator **66,** or similar or equivalent bistable circuit, having output A or 1, and output B or 0, such that every other aperture would produce a voltage pulse at the A output of the multivibrator circuit **66.** By coupling the A output of the multivibrator to the coil of relay **36,** the corotron is turned on only when every other sheet of the fan fold paper is passing thereunder, thereby charging only every other sheet of the fan fold. Multivibrator **66** is conventional, a suitable multivibrator for generating binary outputs is shown and described on page 471 of Electronic Circuits Manual by Markus, Copyright 1971.

Even tighter stacking of the fan fold can be achieved by providing alternate sheets of the fan fold with an electrostatic charge of a different polarity. For example, the polarity of the voltage applied to the wire **35** could be switched in synchronism with the passage of the fan fold paper such that, for example, the odd numbered sheets would have a negative charge on the top surface thereof, and the even numbered sheets would have a positive charge on the top surface thereof. As shown in FIG. **1,** charging of adjacent sheets of the fan fold to different polarities could be achieved by connecting a second electromagnetic switch **70** to wire **35** and a positive charging circuit **72.** By coupling the B output of multivibrator **66** to the coil of switch **70,** the wire **32** is coupled to the positive charging circuit **72** when even-numbered (the even-odd designation being arbitrary) sheets are passing under the charging device **32** and coupled to the negative charging device when odd-numbered sheets are passing under the charging device **32.** FIG. **2** shows a portion of the fan fold stack when both the positive and negative charging circuits have been alternately coupled to the corona wire **35.** With this arrangement, strong attraction forces exist between negatively-charged surfaces **53T** and positively-charged surface **52T.**

While the invention has been described in relation to a particular embodiment thereof, various changes may be made without departing from the scope of the invention. For example, means other than the photo-electric triggering means for the charging devide **30** can be used and separate charging devices can be used for providing the required negative and positive charges on alternate sheets of the fan fold.

What is claimed is:

1. In an apparatus for processing a fan fold paper stack in which at least a portion of said fan fold paper stack is imaged by an imaging apparatus and then stacked in a receptacle, the improvement comprising:

means, disposed between said imaging apparatus and said receptacle, for charging selected sheets of said portion of said fan fold paper stack.

2. The apparatus of claim **1** in which said means charges alternate sheets of said portion of said fan fold paper.

3. The apparatus of claim **1** in which said means charges alternate sheets of said fan fold to one polarity, and said apparatus includes additional means for charging the sheets of said fan fold intermediate said alternate sheets to the other polarity.

4. In an apparatus for processing a fan fold paper stack in which at least a portion of the paper stack comes in contact with a printing member and is then stacked in a stacking bin, the improvement comprising:

means, disposed between said printing member and said bin, for charging selected sheets of said portion of said fan fold paper stack.

5. The apparatus of claim **4** in which said means charges alternate sheets of said portion of said fan fold.

6. The apparatus of claim **4** in which said means charges alternate sheets of said fan fold to a first polarity, and said apparatus further includes additional means for charging the sheets of said fan fold intermediate said alternate sheets to a second polarity.

7. In an apparatus for processing a fan fold paper stack, in which at least a portion of said fan fold paper stack is imaged by an imaging apparatus and then stacked in a receptacle, the improvement comprising:

means, disposed between said imaging apparatus and said receptacle, for charging selected sheets of said portion of said fan fold with charges of one polarity and other selected sheets of said portion of said fan fold with charges of the opposite polarity.

8. The apparatus of claim **7** in which alternate sheets of said portion of said fan fold are charged to said one polarity and the sheets of said fan fold intermediate said alternate sheets are charged to said opposite polarity.

9. The method of providing flat stacking of processed fan fold paper in a stacking bin subsequent to complete imaging of at least areas of the fan fold paper comprising the step of:

charging selected sheets of at least a portion of said fan fold paper prior to stacking of said portion of said fan fold paper in said stacking bin.

10. A method of providing flat stacking of processed fan fold paper in a stacking bin comprising the step of:

charging selected sheets of said fan fold with a charge of one polarity and other selected sheets of said fan fold with a charge of the opposite polarity.

11. The method of providing flat stacking of processed fan fold paper in a stacking bin comprising the steps of:

a. charging alternate sheets of said fan fold with a charge of one polarity, and

b. charging the sheets of said fan fold intermediate said alternate sheets with a charge of the polarity opposite to said one polarity.

12. In a xerographic apparatus for providing an image on a stack of fan fold paper by transferring the image on a photoconductive surface to said fan fold paper and then stacking the fan fold paper in a stacking bin, the improvement comprising:

means disposed between said photoconductive surface and said stacking bin for charging selected sheets of said portion of said fan fold paper.

13. The apparatus of claim **12** in which said means charges alternate sheets of said portion of said fan fold.

14. The apparatus of claim **12** in which said means charges to a first polarity alternate sheets of said fan fold and charges to a second polarity the sheets of said fan fold intermediate to said alternate sheets.

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