(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 106 663**
A2

(12) **EUROPEAN PATENT APPLICATION**

(21) Application number: 83306185.6

(22) Date of filing: 13.10.83

(51) Int. Cl.³: B 41 M 5/26
B 41 M 7/00

(30) Priority: 20.10.82 US 435519

(43) Date of publication of application: 25.04.84 Bulletin 84/17

(84) Designated Contracting States: DE FR GB IT

(71) Applicant: XEROX CORPORATION
Xerox Square - 020
Rochester New York 14644(US)

(72) Inventor: Kellerman, Richard
1066 High Vista Trail
Webster New York 14580(US)

(74) Representative: Goode, Ian Roy et al,
European Patent Attorney c/o Rank Xerox Limited Patent
Department 338 Euston Road
London NW1 3BH(GB)

(54) **Thermal marking printer system.**

(57) A thermal marking printer system includes an image fusing station (34) following the thermal transfer station (16). At the thermal transfer station (16) an ink transfer ribbon (18), which carries a heat sensitive ink layer, is brought into contact with recording sheet (10). The printhead (30) comprises an array of individually addressable resistive elements. Energisation of selected elements causes a desired image to be transferred to the recording sheet. In one embodiment, the fusing step is implemented by reheating the transferred image as it emerges from the thermal transfer station. This reheating step causes the transferred image to penetrate further into the recording sheet providing an improved, matte-type finish and reducing the transferred image gloss thereby lessening subsequent handling problems.

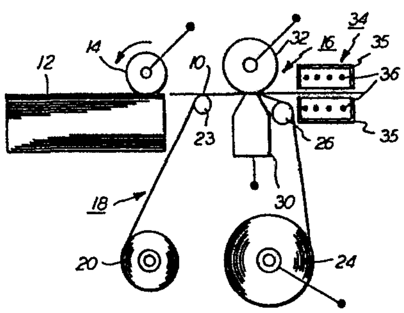

FIG. 1

EP 0 106 663 A2

THERMAL MARKING PRINTER SYSTEM

The present invention relates to a thermal marking printing apparatus and, more particularly, to such an apparatus of the kind which includes a printhead having selectively addressable, discrete, heating elements; means for moving a donor web member bearing a heat-sensitive coloring substance on one surface thereof into contact with said printhead; and means for bringing a recording sheet into contact with said web member whereby portions of said coloring substance undergoing localized heating are transferred to said recording sheet;

Thermal printers are finding increasing acceptance in the office environment as facsimile terminals, printer plotters and computer output terminals. The main advantages of such printers are reliability, quietness, clean operation, compactness, speed and low cost.

Thermal printers fall into two broad functional categories: direct printing and transfer printing. In the direct system, a paper having a thermally sensitive wax coating is selectively heated causing color changes in the coating. This type of system has not found wide acceptance due to the cost of the coating, the unpleasant feel and appearance of the coating materials and gradual fading of the output copy.

In the transfer type of printer a donor ribbon with a coated marking material, (typically a heat sensitive ink) is transported between a thermal printhead and a plain paper recording sheet. The printhead is electrically activated to selectively apply heat to the donor sheet causing melting and transfer of portions of the marking material onto the paper in a desired image configuration. This system does not have the above noted disadvantages associated with the direct transfer papers but does have additional problems which have hitherto not been completely resolved. One problem has been an unsatisfactory "fix" of the thermally transferred ink on the paper recording sheets. In prior art transfer-type devices, such as those disclosed in U. S. Patents 2,917,996; 3,453,648 and 3,855,448, the particular marking material is transferred at a print station where a selectively energized printhead is brought into contact with a donor web interposed between the printhead and the recording sheet. The discrete segments of heated marking materials melt and flow from the donor web to the surface of the recording paper, only superficially penetrating or wetting, the recording sheet surface. The transferred marking material resolidifies very quickly and, on exiting from the print-transfer zone, the final image mainly resides on, rather than in, the paper surface. The final images therefore comprise semi-glossy solid areas which are highly susceptible to handling-induced gloss and line-edge raggedness. A related drawback to these prior art systems is that an optimum transfer can be enabled only by using "thin" inks. Use of thicker inks would be more desirable but their use has hitherto not been possible because the thicker inks result in even more unacceptable glossy output images and, more seriously, even less abrasion/smudge resistance.

The present invention is intended to provide a thermal marking printing apparatus of the kind specified in which these disadvantages of known thermal marking systems are overcome. The apparatus of the invention is characterised by a post-transfer fusing station, adjacent the path of said recording sheet, adapted to fuse said transferred portions onto said recording sheet. This increases ink penetration into the paper thereby producing more of a matte-like finish to the final image. This post-transfer enhancement permits greater latitude in selection of the heat sensitive ink since the operating parameters of the fusing operation can be selected to match the ink characteristics.

An apparatus in accordance with the invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 shows in schematic form a thermal transfer printing system utilizing a post image transfer fusing station.

Figure 2 shows an electrical schematic block diagram of the control system for controlling the sequential operation of Figure 1 system.

Figure 3 shows an enlarged view of the printing and fusing stations.

Figures 4 and 5 are photomicrographs of portions of a recording sheet showing transferred ink penetration both before and after fusing.

Figure 6 shows the printing system of Figure 1 further including a pre-transfer recording sheet heating station.

Figure 7 shows a color thermal transfer system utilizing a plurality of post image fusing stations.

Figure 1 illustrates a thermal printing system according to the present invention. A recording sheet 10, is fed from the top of a supply tray 12 by means of feed roller 14, into a thermal printing zone generally designated as 16. An ink transfer ribbon 18, consisting of a heat sensitive ink layer formed on a thin film substrate, is fed from feed roller 20, passes over tensioning roller 23, proceeds through printing zone 16 and is wound around takeup roller 24 via another tensioning roller 26. Printing zone 16 is defined by a full width thermal print head 30 and opposed backup roller 32.

As is known to those skilled in the art, the printing face of a thermal printhead comprises an array of individually addressable, resistive elements. Upon receipt of input signals from a remote source, corresponding to information to be printed, selected elements are heated. A representative printhead construction is Rohm KH-106 Thermal Print Head. When the printhead face, extending the full width of sheet 10 is brought into contact with the back of the inked ribbon in printing zone 16, localized heating and melting of the normally solid surface ink layer occurs. Liquid fluidized ink segments are then transferred to recording sheet 10, forming an image thereon. As recording sheet 10 leaves the printing zone 16, it passes through a fusing station 34 where the paper, as well as the transferred image, is thermally treated so as to enhance the quality of the transferred image. Further details of the printing and fusing station will be presented below. On emerging from station 34, recording sheet 10 may be collected by any appropriate means.

Figure 2 shows an electrical schematic in block diagram form of a control system for controlling the operation of the various electrically activated components shown in Figure 1.

Circuit 40 is a sequence controller which, in conjunction with receipt of a print signal, sequentially controls the following:

1) a drive circuit 42 for energizing a step motor 44 which drives paper feed roll 14;

2) a drive circuit 50 for energizing a step motor 52 which drives takeup roller 24;

3) a fuser control circuit 54 for energizing fuser station 34.

The additional input to controller 40 is a print signal from the remote source.

Referring to Figures 1 and 2, upon initiation of a print cycle, a sheet of paper 10 is removed from tray 12 by means of feed roll 14. Feed roll 14 is driven in the indicated direction by step motor 44. The paper advances into print zone 16 where a portion of the inked ribbon 18 has also been advanced into the print zone by the takeup roll 24 operated by step motor 52. The passage through the print zone is sufficiently constricted so that sheet 10, ribbon 18 and printhead 30 are in contact with each other. Coincident with the paper advance; a print signal is applied to printhead 30 selectively energizing resistive elements on the printhead and causing localized heating and melting of the ink. The fluidized ink is transferred to the sheet 10. Sheet 10 continues to move through zone 16, a fresh portion of ribbon 16 is advanced and the print operation is repeated until sheet 10 has been completely marked with the information contained in that particular series of print signals.

Figure 3 is an enlarged view of the ink printing station 16 and the fusing station 34 during an image transfer sequence.

Referring now to Figure 3a, ribbon 18, as it advances into printing zone 16, is seen to consist of a thin dielectric film 40, upon which is formed a layer 42 of a normally solid but thermally fusible ink. In one embodiment, film 40 is a 10 - 15 µm thick condenser paper and layer 42 comprises carnuba wax, dispersed in a carbon pigment and hot melted coated onto film 40 to a thickness of about 6 G/m^2.

As the print face of printhead 30 contacts the back of film 40, heat from the selectively heated resistors comprising the printhead face is transferred through film 40 to layer 42 fluidizing a portion of the ink layer and causing it to transfer to the surface of sheet 10. Ink layer 42, as it proceeds through print zone 16, is therefore reconstituted into two possible conditions. Segments 42a have become fluid and have transferred to paper 10 while non-heated segments 42b remain as a coating on film 40. Because of the rapid resolidification of the transferred ink, once the heating contact with printhead 30 is removed, segments 42a have only wetted the surface of the sheet 10 achieving a superficial penetration to a typical depth w of about 3µ. (The total thickness of a typical plain paper recording sheet is 95-100 µ.) The remainder of transferred segment 42a is torn away from film 40 and forms the visible image overlying the surface of the paper. It is this raised portion of segment 42a which constitutes the output copy gloss in the prior art systems referred to above and which leads to subsequent handling problems.

Sheet 10 with the transferred image 42a on the surface thereof, subsequently enters fusing station 34. Station 34 consists of two radiant type fusers 35, each having a plurality of resistance elements 36 connected to a power source (not shown). An exemplary fuser of this type is disclosed in U. S. Patent 2,965,868.

Fusers 35 apply heat at a temperature of 100° C to sheet 10 and to transferred ink segments 42a. Upon initial application of heat, segments 42a begin to melt, spreading slightly and becoming even more glossy. But then the reheated transferred segments rapidly matte as the ink penetrates further into the paper surface. At a temperature of $\sim$ 100° C for a period of $\sim$16 seconds, the reheated ink will have penetrated a total depth of w' (5μ) as shown by the dotted line. As sheet 10 emerges from station 34, the finished sheet has a transferred image in a full matte configuration which is both more visually attractive and abrasion-resistant. For a 1024 receiver sheet, the optical density is slightly reduced from 1.39 to 1.17.

The above observations on ink penetration are confirmed by references to Figures 4 and 5 which are photomicrographic (at 50X) of a portion of the ink-covered paper surface both before and after the fusing step. In Figure 4, only a few strands 58 of paper fiber are visible through the ink layer while, in Figure 5, many paper fibers are visible, indicative of the penetration of the transferred ink during fusing. (Both Figures 4 and 5 have been overexposed for purposes of clarity.)

From the above example the invention enables the use of a thicker, thermally-fusible ink, which has a melting range of 60° to 80°C. Thicker inks are known to produce higher quality output print since the print density improves due to the greater covering power of the ink. A thicker transferral ink is also mechanically deformable and so promotes closer conformation of the donor sheet to the receiver sheet in the print station than is possible with prior art print systems using thinner type inks. This conformation is highly desirable since it lessens the line/edge raggedness due to the roughness of the typical receiver sheet surface. The post-transfer fusing parameters can be made to "match" the characteristics of the thicker ink.

An alternative embodiment of the invention is shown in Figure 6. In this figure, a pre-transfer station 34a consisting of a third radiant fuser 35' has been positioned upstream of the printing station 16. In this embodiment, paper 10 is heated before entering the print station so as to achieve an initial penetration depth w (during transfer) greater than that achieved by the unassisted transfer.

The present invention is also particularly useful for color thermal transfer systems. In these systems, two or more ink transfer operations are involved, each transfer resulting in a transferred ink layer of a different color with the cumulative transferred image being the final desired color image. Since the receiving sheet will have more than one transferred layer on its surface, the problem of gloss and subsequently handling are even more acute than the single transfer step.

Referring to Fig. 7, there is shown, in schematic form, a color transfer system 60 comprising three recording stations 62, 64, 66. Station 62 comprises a first back roller 70, a donor sheet 72 comprising a layer of magenta ink coated on a substrate, first thermal recording head 74, feed roll 76 and takeup roll 78 for moving sheet 72 through printing zone 80.

Station 64 comprises a second back roller 82, a donor sheet 84 comprising a layer of yellow ink coated on a substrate, second thermal recording head 86, roll 88 and takeup roll 90 move sheet 84 through printing zone 92.

Station 66 comprises a third back roller 94, a donor sheet 96 comprising a layer of cyan ink coated on a substrate, third recording head 98, roll 100 and takeup roll 102 moving sheet 96 through print zone 104.

Fusing stations 106, 108 and 110 are located downstream from stations 62, 64, 66 respectively.

In operation, a transfer sheet 112 is fed into the first recording zone 80 wherein the magenta ink is transferred in accordance with the selective heating applied to printhead 74. This transferred layer is heated at fusing station 106 to cause further penetration of the transferred ink into the surface of sheet 112. In like fashion, sheet 112 passes through stations 64 and 66 receiving additional transferred layers of the yellow and cyan ink where it is thermally fused at fusing stations 108, 110. Upon emergence from fusing station 110, sheet 112 has thereon the desired color image having the preferred matte-like finish.

For certain applications it may be preferable to use only one fusing station (110) omitting stations 106, 108.

In conclusion, it may be seen that there has been disclosed an improved optical imaging system. The exemplary embodiments described herein are presently preferred, however, it is contemplated that further variations and modifications within the purview of those skilled in the art can be made herein. For example, other post-transfer fusing methods may be utilized e. g. a roller may be heated to a suitable temperature and brought into contact with both sides of the receiver sheet or cold-pressure fusing techniques known in the xerographic art may be applied.

CLAIMS:

1. A thermal marking printing apparatus including:

a printhead (30) having selectively addressable, discrete, heating elements;

means (20, 23, 26, 24) for moving a donor web member (18) bearing a heat-sensitive coloring substance on one surface thereof into contact with said printhead; and

means (14, 32) for bringing a recording sheet (10) into contact with said web member (18) whereby portions of said coloring substance undergoing localized heating are transferred to said recording sheet; characterised by

a post-transfer fusing station (34), adjacent the path of said recording sheet, adapted to fuse said transferred portions onto said recording sheet.

2. The apparatus of claim 1 wherein said coloring substance is a heat-sensitive ink.

3. The apparatus of claim 2 wherein said ink is a thick ink normally solid at room temperature but having a melting range of 60° C to 80°C.

4. The apparatus of any one of claims 1 to 3 wherein said fusing station (34) comprises radiant heater means (36) adapted to simultaneously heat said recording sheet while reheating said transferred coloring substance.

5. The apparatus of any one of claims 1 to 4 further including heating elements (34a) disposed in the path of said recording sheet adapted to apply heat to said sheet prior to said web member contact.

6. The apparatus of any one of claims 1 to 5 including a plurality of print stations (62, 64, 66), said print stations each comprising a printhead (74, 86, 98) having selectively addressable, discrete heating elements,

means (76, 78; 88, 90; 100, 102) associated with each of said printheads for moving a donor web member (72, 84, 96) bearing a heat sensitive coloring substance on one surface thereof into contact with the printhead, said substance being of a different color at each station,

means (70, 82, 94) for conveying the recording sheet successively into said print stations into contact with said web members whereby portions of said coloring substances undergoing localized heating are transferred in succession to said recording sheet, and

at least one fusing station (106, 108, 110) adjacent the path of said recording sheet, said fusing station being adapted to fuse coloring substance previously transferred to the sheet.

7. The apparatus of claim 6 wherein a fusing station is located downstream from each print station.

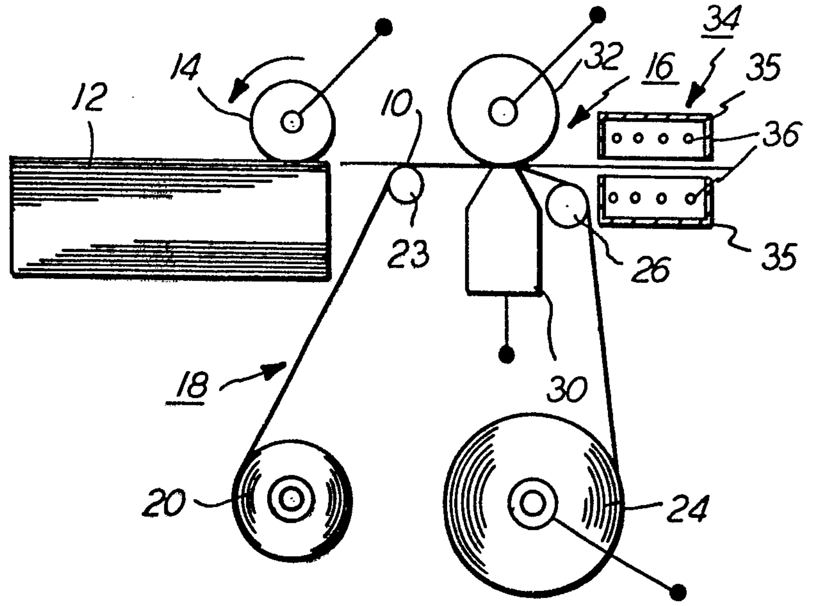

FIG. 1

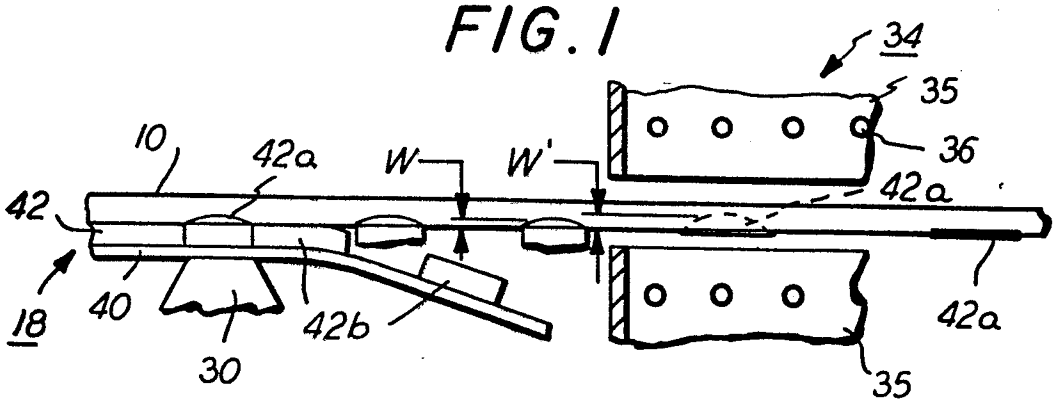

FIG. 3

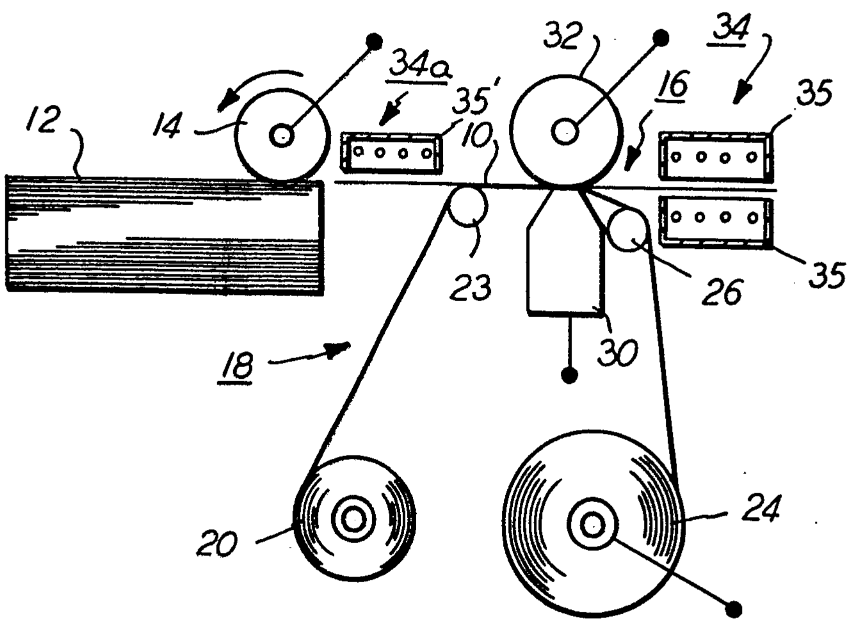

FIG. 6

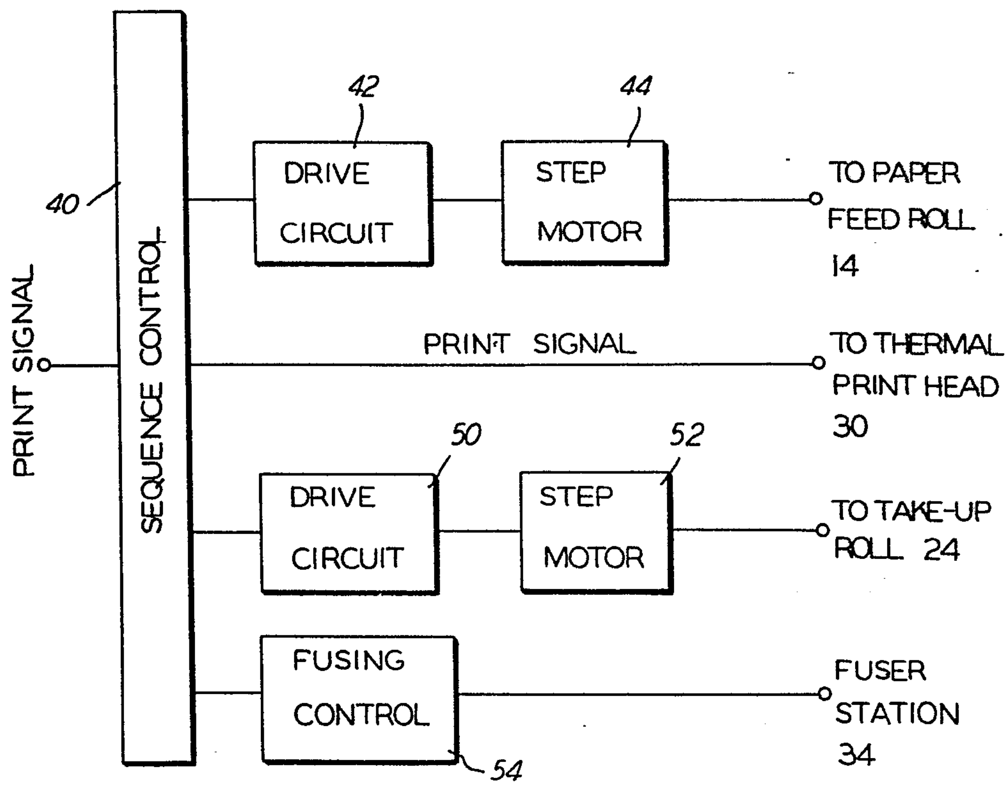
PRINT SIGNAL
40
SEQUENCE CONTROL
42
DRIVE
CIRCUIT
44
STEP
MOTOR
TO PAPER
FEED ROLL
14
PRINT SIGNAL
TO THERMAL
PRINT HEAD
30
50
DRIVE
CIRCUIT
52
STEP
MOTOR
TO TAKE-UP
ROLL 24
FUSING
CONTROL
54
FUSER
STATION
34

FIG. 2

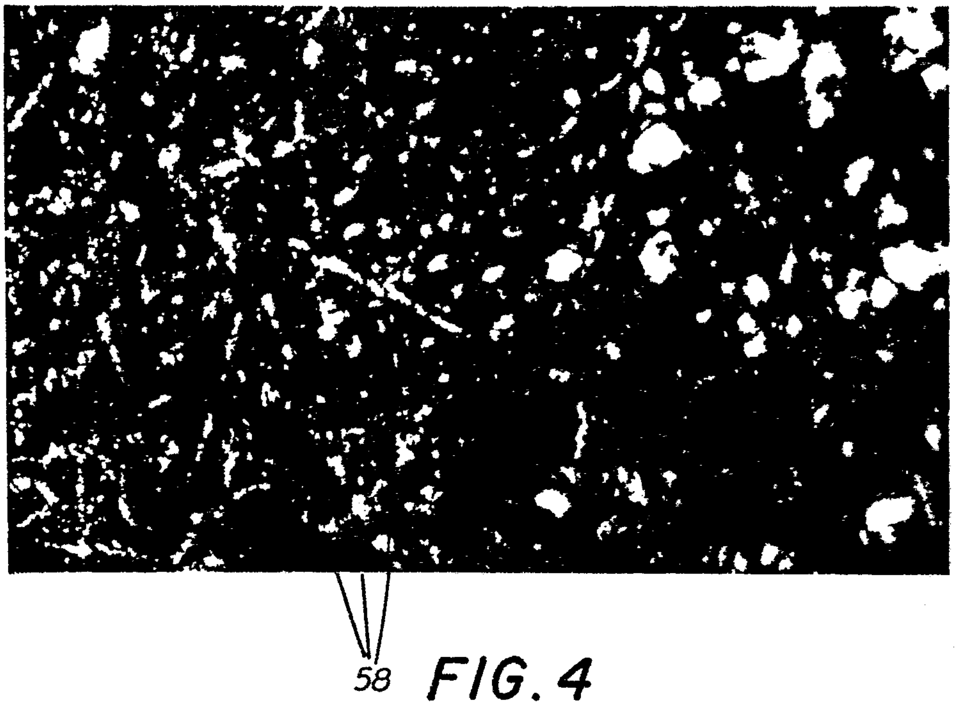

FIG. 4

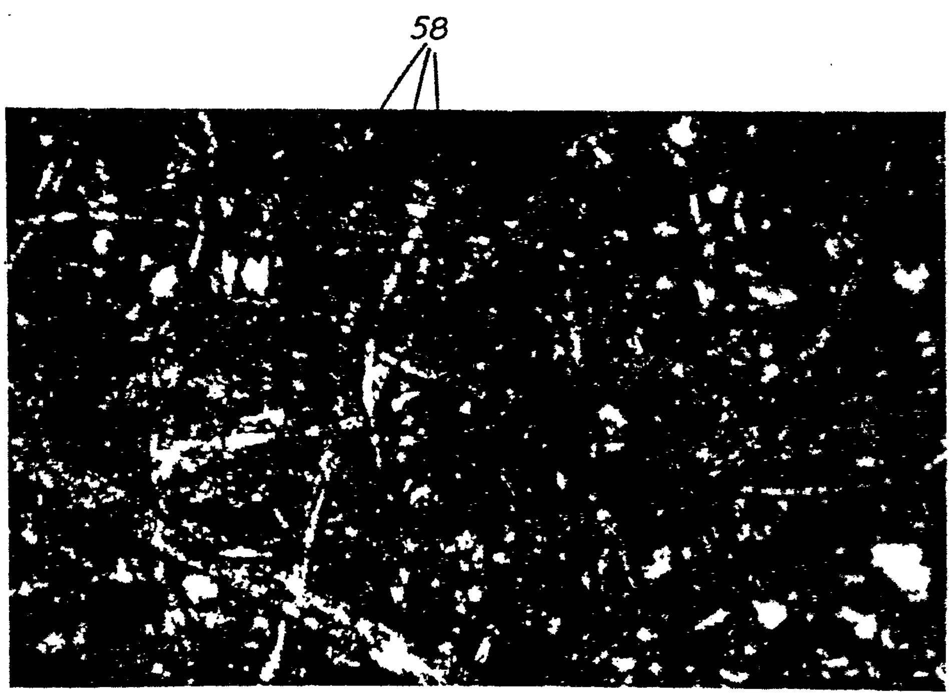

FIG. 5

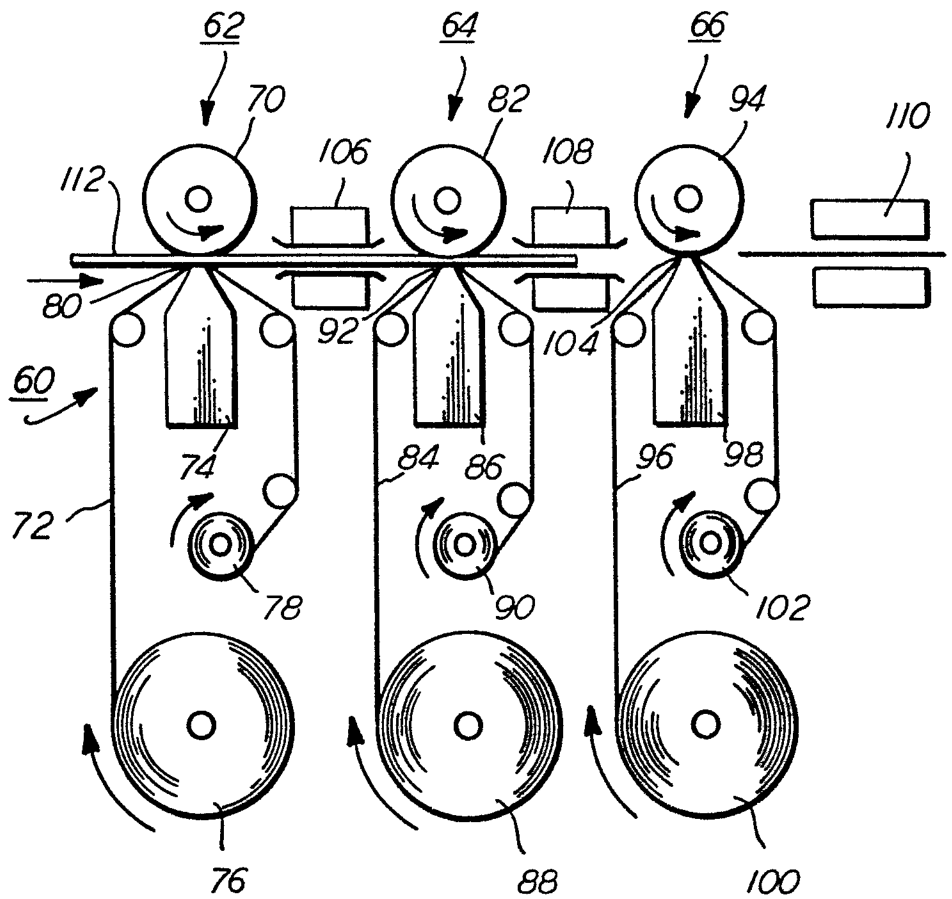
62
64
66
70
82
94
110
106
108
112
80
92
104
60
74
84
86
96
98
72
78
90
102
76
88
100

FIG. 7