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(54) Electrothermal printing apparatus.

(57) An electrothermal printing apparatus includes a print head comprising a plurality of thin wire print electrodes 30 mounted in a single plane. The electrodes 30 are held in a closely-spaced row in a block of electrically insulating resilient material 32. The resilience of the material is such that the wires are individually movable out of the planar alignment to a limited extent with respect to the other wires in the array. Silicone rubber is a suitable material. The material 32 is cut-away at 36 to form a bevelled edge giving improved contact between the head and the ribbon. A relatively rigid backing member 34 is provided to support the electrode array via the material 32. The print head is mounted adjacent an electrothermal print ribbon and a predetermined pressure is produced between the print head and the electrothermal print ribbon during printing operations.

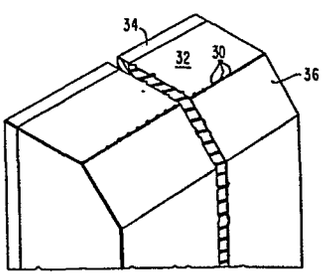

FIG.4

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ELECTROTHERMAL PRINTING APPARATUS

The invention relates to non-impact printers and, is more particularly concerned with electrothermal printers in which printing is effected by momentarily energising selected electrodes of an array of electrodes to cause discrete areas of a transfer ribbon to be resistance heated and release transfer material to a print medium to print characters and other indicia.

US Specification No. 2713822 (Newman) describes an early form of an electrothermal printer in which a three-layer resistive transfer ribbon is used in conjunction with a single stylus. By energising a circuit including the stylus facsimile images could be transferred to a receiving medium e.g. a paper sheet.

A later electrothermal printer is described in US specification No. 3744611 (Montanari). The Montanari electrothermal printer uses a resistive transfer ribbon and comprises a print head having a plurality of electrodes for electrically contacting the ribbon during printing. The printer comprises a key board for applying an input to control coding device which selectively applies voltages between the electrodes and a common return electrode to effect printing of the keyed input.

The Montanari electrodes are L-shaped and the shorter legs extend down through a slot in a plate on which the electrodes are mounted by passing the longer legs through an upwardly projecting land on the plate. The ends of the shorter legs bear against the ribbon which contacts the underside of the plate. The Montanari electrodes are sufficiently rigid to contact the transfer ribbon with the required contact pressure. To meet this standard of rigidity the electrodes have a cross-sectional area above a lower threshold cross-sectional area and this limits the resolution that can be obtained.

Known electrothermal printers, such as the Montanri printer, have been found to raise a number of problems when an attempt is made to modify them to meet the growing need for improved resolution and greater print

rates. The improved resolution requires smaller print dots which requires a smaller cross-section print electrodes. The increased print rates require that the print head be moved faster relative to the print medium in addition to the continuing requirement that the print head be maintained in physical contact with the resistive ribbon. These actions not only increase the wear on the print head but also make it more difficult to maintain the required degree of physical contact with the resistive ribbon. Prior to the present inventions these problems have not been successfully solved.

It is an object of the invention to overcome these problems and to provide a printer capable of improved resolution printing at relatively high speeds.

Accordingly the invention provides an electrothermal printer for non-impact printing using a resistive transfer ribbon, said printer comprising a print head having a plurality of electrodes for electrically contacting the ribbon during printing and means for selectively energising circuits between the electrodes to effect printing, said printer being characterised in that the electrodes are such that they are not sufficiently rigid resiliently to contact the transfer ribbon with the required contact pressure and in that the required contact pressure is obtained by supporting and stiffening each electrode over a substantial portion of its length adjacent the contact end by a support formed of insulating resilient but relatively rigid material.

The invention also provides a print head for resistive ribbon printing comprising an array of thin wire print electrodes mounted in a single plane; insulating means for resiliently positioning the array of print wire electrodes in a closely-spaced line so that the wires are individually movable out of the planar alignment to a limited extent with respect to other wires in the array; relatively rigid backing means for mounting the array in a relatively fixed position relative to said backing means; means for mounting said print head in a relatively fixed position relative to said print ribbon; and means for selectively applying a predetermined

pressure to the print head to produce a predetermined overall pressure between the print head and a print ribbon.

Accordingly the invention will now be hereinafter particularly described with reference to the accompanying drawings, in which:-

FIG. 1 is a perspective view of a printing apparatus embodying the invention;

FIG. 2 is a fragmentary schematic perspective view of the print head, the carrier and its drive mechanism;

FIG. 3 is a horizontal sectional view, to enlarged scale, taken along line 3-3 in FIG. 2;

FIG. 4 is a perspective view, also to enlarged scale, of the active printing end of the print head;

FIG. 5 is a perspective view of the print head in contact with the print ribbon together with illustrative electrical circuitry schematically indicated therein.

Description of the Preferred Embodiment

The printing apparatus embodying the invention is shown illustratively associated with a typewriter-like printing apparatus 10 comprising a conventional keyboard 11. The keyboard controls a print head 12 by means of a coding device of known type (not shown). Print head 12 is mounted on a carrier 13 that is movable transversely of apparatus 10 but parallel to the feed path of a ribbon 14. Print head 12 presses ribbon 14 against a record medium 15 that is backed up by a platen 16. As in conventional typewriters, ribbon 14 is unwound from a supply reel 17 and wound onto a take-up reel 18, and record medium 15 is fed upwardly in a

direction at right angles to the direction of movement of ribbon 14 and print head 12.

Print head 12 is mounted on carrier 13 by means to be described later which produces a predetermined overall pressure between the print head 12 and print ribbon 14. Carrier 13 is driven by carrier drive means 20 (FIG. 2) to effect horizontal movement of the print head. Carrier drive means 20 includes pulleys 21 and 22 about which is strung a cable 23 which connects to suitable clutch, drive shafts and the like 24.

Carrier 13 comprises a hollow rectangular member 25 which is mounted for movement on horizontal traverse members 26. Print head mounting member 27 is mounted on traverse members 28 for movement toward the print medium for printing operations and away from the print medium for non-printing operations. Traverse members 28 are fixed to hollow rectangular member 25 at a substantially right angle to horizontal traverse members 26. Suitable control means 29 are actuated to move print head mounting member 27 relative to member 25 toward print ribbon 14 and record medium 15 to produce a predetermined pressure between print head 12 and print ribbon 14. An adjustable stop 19 is provided to enable initial setting of the predetermined pressure. In the embodiment shown, control means 29 comprises a solenoid. However, it will be recognized that other suitable electromechanical or mechanical means may be used. Print head 12 is fixed to print head mounting member 27 in a position so that the print electrodes form an angle with respect to platen member 16. This angle is not critical and an angle of about forty-five degrees has been found to be suitable.

As best shown in FIGS. 3 and 4 and according to the invention, print head 12 comprises an array of thin electrodes 30 arranged in a closely spaced row. The electrodes are held in their equally closely spaced position by a suitable electrically insulating resilient material 32. A relatively rigid mounting member 34 is fixed to the electrode structure to permit the print electrode assembly to withstand the required pressure.

Print electrodes are electrically connected to a board member 31 which preferably has printed wiring patterns thereon. A support board member 33 is provided through which contact pins 55 are passed between electrical connector 37 and board member 31 to provide an electrical circuit from each print electrode 30 to one of the contacts in connector 37. A mounting block 38 is fixed into position between boards 31 and 33 to hold in a fixed position the end of mounting member 34, which is away from the active ends of the print electrodes. Connector 37 provides the electrical interface between print head 12 and the remainder of the printer, and suitable means such as a flex cable, for example, is provided to conduct signals to the print head. The print head is fixed to a suitable mounting member 39 which provides the mechanical interface to the print head mounting member 27.

The active tip ends of the print electrodes 30 which normally contact the print ribbon 14 are shown in FIG. 4. The electrodes 30 are held in an equally spaced line by electrically insulating resilient material 32 which maintains the electrodes spaced apart from mounting member 34. Silicone rubber is a suitable insulating resilient material due to its ability to withstand the heat generated during operation of the print head. The resilient material is formed with an angled relief portion 36 on the side away from mounting member 34 to enable better electrical contact between the print electrodes 30 and print ribbon 14. This construction also facilitates a limited movement of an individual print electrode out of alignment toward mounting member 34 (FIG. 4) without arcing or other electrical interference. Should debris or a localized ribbon imperfection affect one or more of print electrodes 30, the print head construction described herein permits limited movement of individual electrodes without causing the print head 14 to move out of contact with the ribbon which causes either no printing or poor quality printing to occur.

It is desirable to obtain printing having a resolution or print quality equal to that of engraved type. The minimum resolution that produces printing with resolution approaching that of engraved type is about 100

dots per centimeter, i.e. 250 dots per inch, resolution. For a printer of the resistive ribbon type, as disclosed here, to obtain about 100 dots per centimeter resolution, the electrodes are limited to a diameter of 25.4 microns to 76.2 microns (0.001 inch to 0.003). This requirement presents a severe technical problem since electrodes of this size are not self-supporting, and to ensure excellent print quality, a pressure of several hundred pounds per square inch that is in excess of 1400 Kilo-Pascals, is required between the individual electrodes and the resistive substrate.

Electrodes of this size are necessary since 100 dots per centimeter resolution means dots or lines on 101.6 micron (0.004) centers, and the thermal spreading characteristics of available resistive ribbons limits the size of the electrodes to 25.4 microns to 76.2 microns (0.001 to 0.003 inch). Electrodes of this dimension are difficult to retain on 101.6 micron (0.004 inch) centers, particularly since the electrodes are not self-supporting. In a particular embodiment, the print head comprised 40 thin tungsten wire electrodes, each 38.1 microns (0.0015 inch) in diameter and held accurately equally spaced on 101.6 microns (0.004 inch) centers by a suitable resilient insulating material which, in that embodiment, comprised silicone rubber. One suitable silicone rubber is a high temperature RTV silicone rubber made by General Electric Company which withstands temperatures up to 500°C. The electrode assembly was fixed to a relatively rigid mounting member which, in that embodiment, comprised spring steel 127 microns (0.005 inch) thick.

The printing electrodes are maintained in a closely-spaced line in pressure contact with ribbon 14, as can be seen in the diagram of FIG. 5. Ribbon 14 comprises a resistive layer 50, a conductive layer 51, and an ink transfer layer 52. The resistive layer 50 is in pressure contact with the print electrodes, and the ink transfer layer 52 is in contact with the record medium 15. Appropriate control means 53 is provided to generate suitable signals to selectively energize print electrodes 30 according to the graphic or character data to be printed. Upon energization

of one of the print electrodes 30, current flows from the electrode via the resistive layer 50 and conductive layer 51 to the common return path providing element 54. Element 54 is suitably connected to a reference potential such as ground. As current flows through resistive layer 50, the I^2R effect will cause heating of that portion of the layer 50 that extends from the tip end of the electrode 30 to the conductive layer 51. This localized heating of the resistive layer 50 by the current-resistance effect causes melting of the thermally transferable material in the contiguous portion of the ink transfer layer 52. By concurrent energization of selected ones of the printing electrodes 30 during movement of print head 12 in the direction of arrow 56 relative to print ribbon 14 and record medium 15, a desired pattern, such as character 55, can be imprinted on the record medium.

The construction of the print head according to our invention permits printing to be accomplished in a reliable manner with excellent print quality even though the print electrodes are not self-supporting, and a pressure of several hundred pounds per square inch must be maintained between the individual print electrodes and the resistive ribbon. In prior art printing apparatus, should debris or a slight imperfection in the surface of the resistive ribbon cause one of the print electrodes to be moved out of position, the entire print head would be moved out of position so that the required pressure could not be maintained between the individual print electrodes and the resistive ribbon. The result is either no printing at all or poor quality printing. In contrast with the prior art operation, the construction of our print head includes the resilient electrically insulating which normally holds the print electrodes in a closely spaced row but has sufficient resiliency so that individual print electrodes can be moved out of position to a limited extent while maintaining the required pressure between the other print electrodes and the resistive ribbon. The mounting member cooperates with the electrode assembly to impart the needed stiffness to withstand the required pressure while maintaining a degree of resilience to the print electrode area due to the spring like nature of the mounting member.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that various other changes in the form and details may be made therein without departing from the scope of the invention.

CLAIMS

1. An electrothermal printer for non-impact printing using a resistive transfer ribbon, said printer comprising a print head having a plurality of electrodes for electrically contacting the ribbon during printing and means for selectively energising circuits between the electrodes to effect printing, said printer being characterised in that the electrodes are such that they are not sufficiently rigid resiliently to contact the transfer ribbon with the required contact pressure and in that the required contact pressure is obtained by supporting and stiffening each electrode over a substantial portion of its length adjacent the contact end by a support formed of insulating resilient but relatively rigid material.

2. A printer as claimed in claim 1, further characterised in that the electrodes have a diameter of 25.4 microns to 76.2 microns (0.001 to 0.003 inch)

3. A printer as claimed in claim 1 or 2, further characterised in that the electrodes have a diameter of 38.1 microns (0.0015 inch) and are formed of tungsten wire.

4. A printer as claimed in claim 1, 2 or 3, further characterised in that the desired contact pressure is above about 1400 kPa - kilo-Pascals.

5. A printer as claimed in claim 1, 2 or 3, further characterised in that the desired contact pressure is between about 1400 kPa and 7000 kPa.

6. A printer as claimed in any one of claims 1 to 5, further characterised in that the supports are formed of elastomeric material.

7. A printer as claimed in any one of clams 1 to 6, further characterised in that the electrode supports are formed by a common sheet or slab of said material and in which the electrodes are embedded in a line with their contact ends substantially in the plane of an edge face of the sheet or slab.

8. A printer as claimed in claim 7, further characterised in that a generally triangular sectioned strip of the sheet or block is removed adjacent the electrodes to form a chamfered corner.

9. A printer as claimed in claims 7 or 8, further characterised in that a face of the sheet or block parallel to the plane containing the line of electrodes is secured to a planar support.

10. A printer as claimed in claim 9, further characterised in that the planar support is formed of spring steel.

11. A printer as claimed in any one of claims 1 to 10, further characterised in that the end portions of the electrodes remote from the contact faces project from their supports to contact conductive pads on a planar board having printed wiring thereon and through which the electrodes can be selectively energised.

12. A printer as claimed in any of claims 1 to 11, further characterised in that the print head is carried on a carrier block mounted on a carriage for movement towards and away from the ribbon, means for moving the carrier block towards the ribbon to establish the required contact pressure, and means for moving the carriage relatively across a medium on which printing is to be effected.

13. A print head for resistive ribbon printing comprising: an array of thin wire print electrodes mounted in a single plane; insulating means for resiliently positioning the array of print wire electrodes in a closely-spaced line so that the wires are individually movable out of the planar alignment to a limited extent with respect to other wires in the array; relatively rigid backing means for mounting the array in a relatively fixed position relative to said backing means; means for mounting said print head in a relatively fixed position relative to said print ribbon; and means for selectively applying a predetermined pressure to the print head to produce a predetermined overall pressure between the print head and a print ribbon.

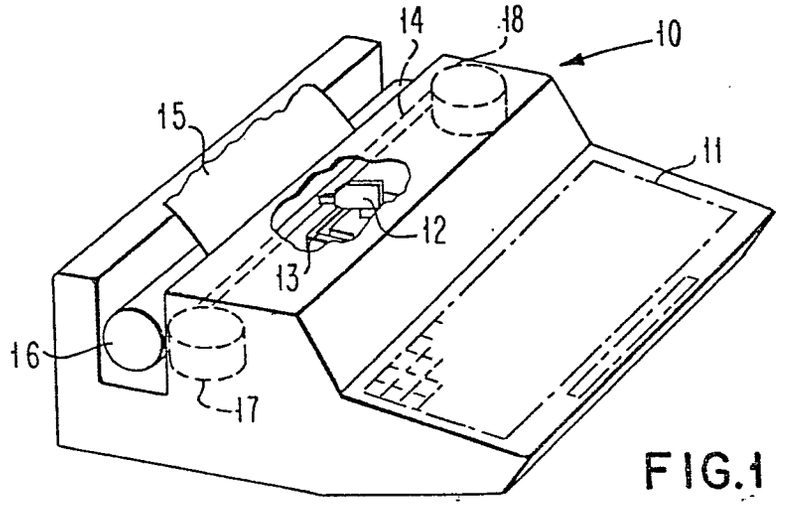

FIG.1

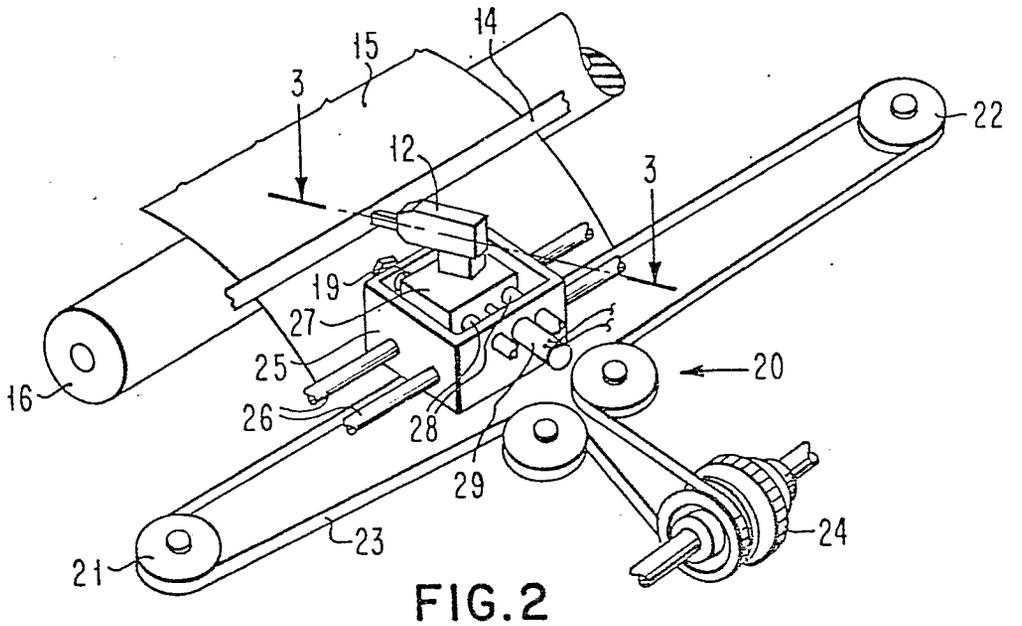

FIG.2

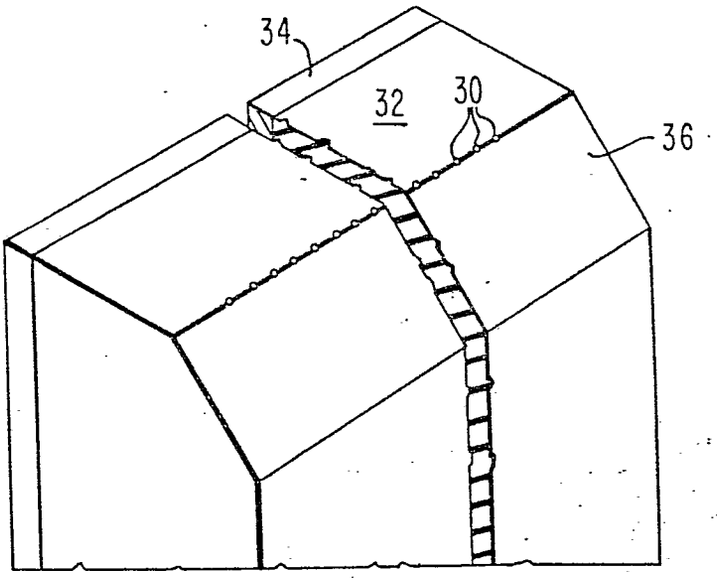

FIG.4

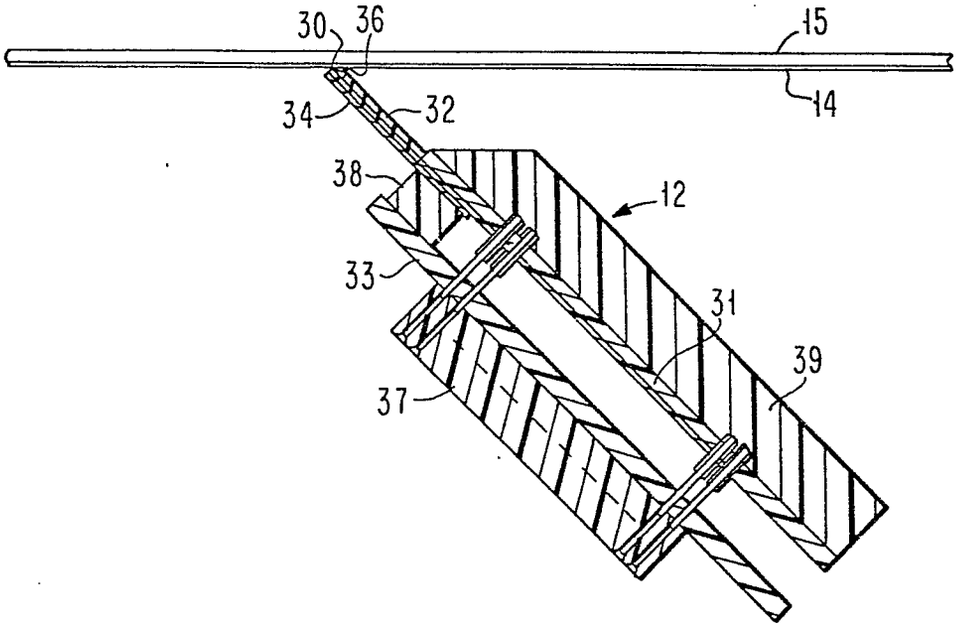
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FIG.3

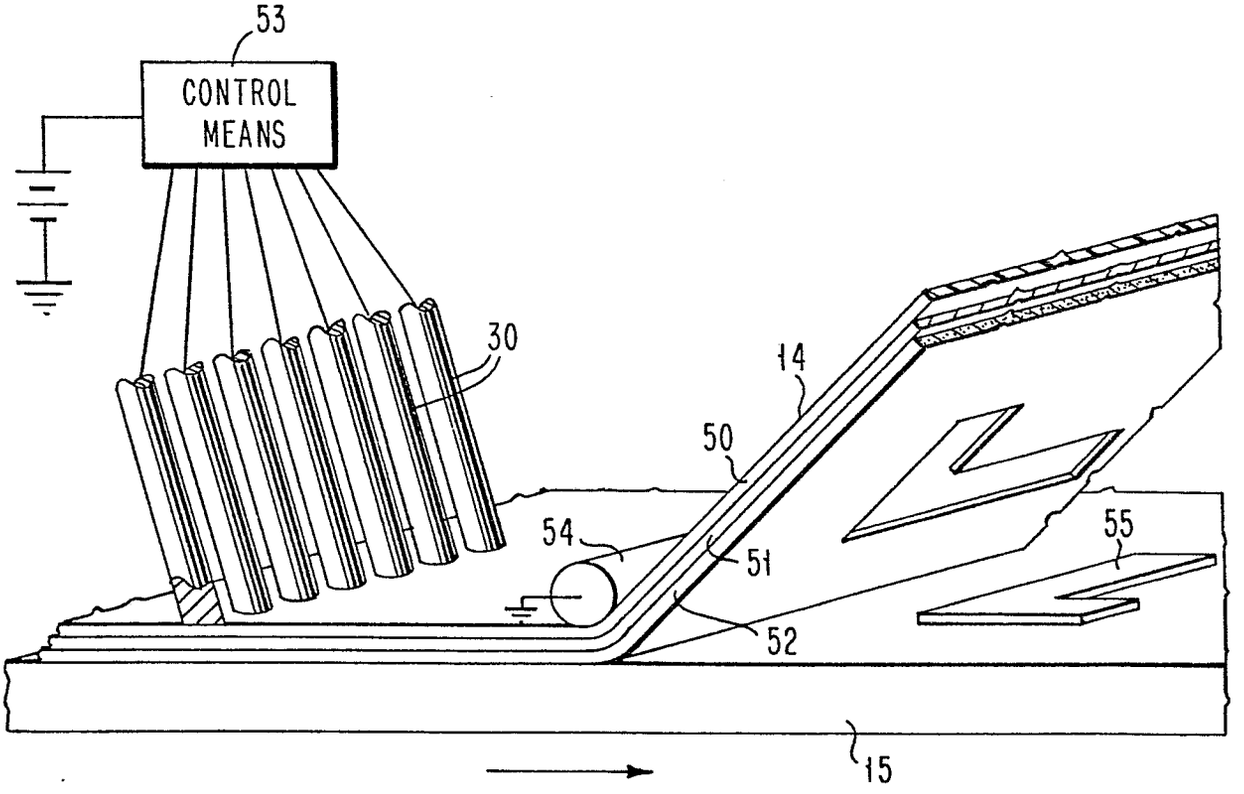
53
CONTROL MEANS
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FIG.5