

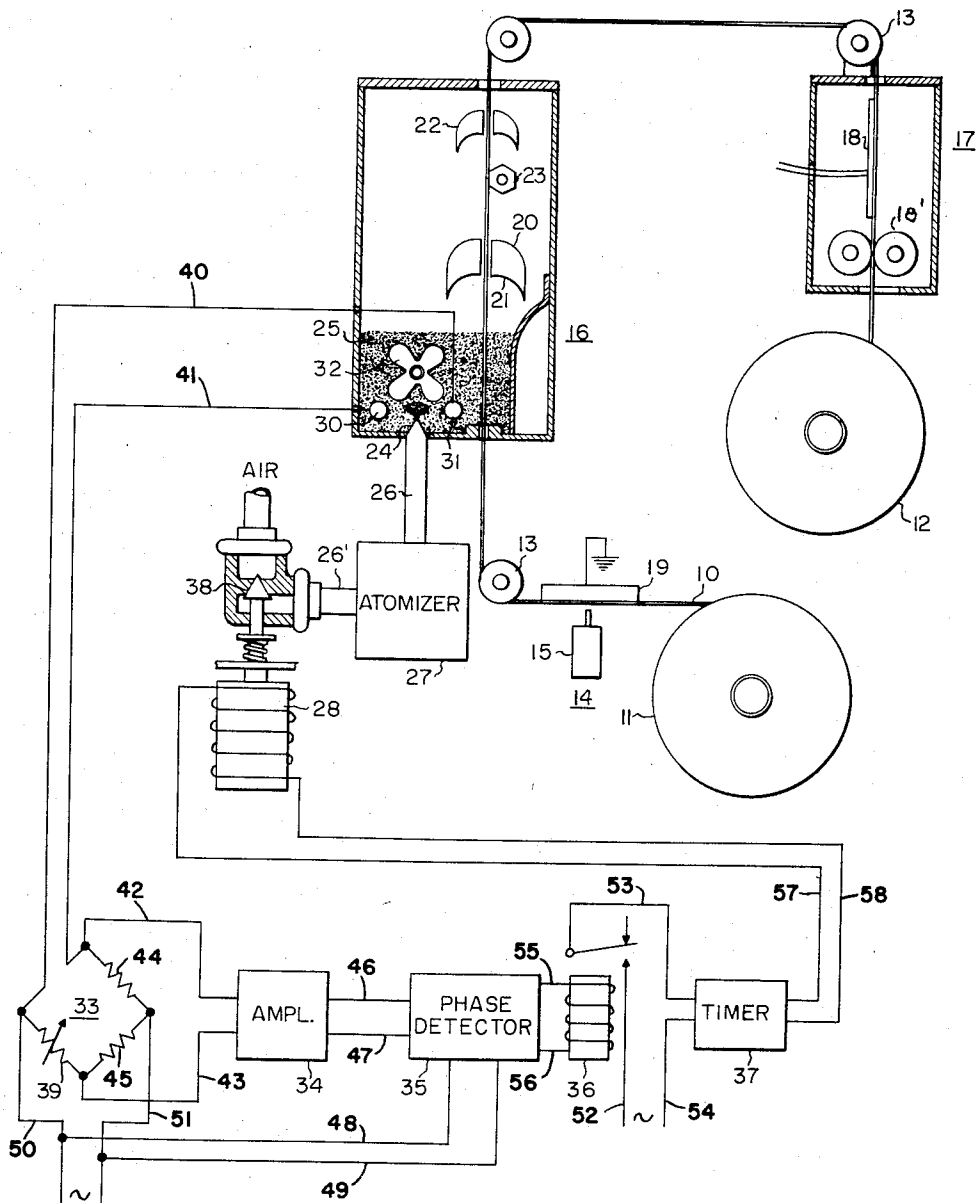
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ELECTROGRAPHIC INKING POWDER MOISTURE CONTROL

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ELECTROGRAPHIC INKING POWDER MOISTURE CONTROL

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The present invention relates to the art of printing and more particularly to an apparatus for making electrostatic images on a dielectric surface and for rendering such images permanently visible.

While the use of electrostatic phenomena in producing images is now recognized as a radical substitute for conventional printing methods of the mechanical pressure type, there are many problems yet to be solved. Of these the matter of finding a suitable inking material for rendering the electrostatic latent image visible in a permanent form is an important one. The inking material, usually a finely divided powder, must not only be of a color contrasting with that of the recording medium to be readily readable but must also have the correct physical properties to adhere to the medium over the image areas. The ink also should provide low background discoloration by having relatively little tendency to adhere to the recording medium in nonimage areas. The thermal properties of the ink are an additional factor in the successful operation of a recording device when heat processing is required to fix the visible image.

It has been found that the moisture content of the ink material by determining its resistivity vitally influences the formation of sharply defined characters of substantially constant uniform appearance. Variation of the moisture content in most cases is due principally to the normally slightly moist ink powder drying out when exposed to a less humid atmosphere or other dehumidifying agent. This may lower the moisture percentage below that necessary to obtain reliable printing of acceptable characters.

It is, therefore, a general object of the invention to provide an improved apparatus for electrostatic printing.

Another object is to provide an electrical printing apparatus capable of operating at high speed while reliably producing well defined characters of substantially uniform appearance.

Another object is to provide an electrostatic printing apparatus wherein there is a tendency for variation of the electrical resistance of the inking powder to occur due to moisture content change, a means for maintaining a predetermined constant moisture percentage regardless of atmospheric or other environmental conditions.

A further object is to provide an electrostatic printing apparatus wherein improved recorded characters are reliably obtained.

Other objects and features of the present invention will be found throughout the following more detailed description of the invention particularly when considered with the accompanying drawing.

In the accompanying drawing:

The figure is a schematic view of an electrical printing apparatus equipped with a control compensating for variations in moisture content of an ink powder and embodying one form of the present invention.

Referring to the drawing the recording medium 10, such as a tape having a high resistivity surface, is shown schematically in the figure as travelling from a storage

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reel 11 to a take-up reel 12. Between the two reels the tape passes over various guide rolls 13, which include suitable means for maintaining a constant tension thereon. Adjacent the storage reel 11, at recording station 14, the medium 10 receives an electrostatic latent image from electrical discharges produced between electrodes of the indicated recording head 15 and a grounded electrode 19. The recording medium 10, impressed with the latent image, is then transported past an inking station, generally identified by the reference character 16, wherein it is exposed to a suitable inking powder capable of adhering to the medium in the areas of the latent image. Leaving the inking station 16 the inked medium 10 is finally fed through a heat processing, or fixing, station, generally identified by the reference character 17, wherein the visible inked image is made permanent, for example by the temporary partial softening of a thermoplastic surface coating of the medium through the action of heating element 18 and the imbedding of the particles of the ink therein by rolls 18'. Preferably the ink utilized in a homogeneous, dry, electrically uncharged powder of any color that will contrast with the recording medium. An example of an inking powder that has proven successful is suitably dyed commercially available lycopodium powder, because, among other properties, it has the correct particle size properly to adhere to the surface of a recording medium of a given surface smoothness.

In the present instance the inking station 16 is in the form of a receptacle having a mass of ink powder therein through which medium 10 is drawn. The medium enters through the bottom of the receptacle and travels upwardly past two baffles 20 mounted (by means not shown) in spaced relation in order that upwardly propelled loose particles of powder may be deflected back into the powder mass. This deflection is aided by forming arcuate faces 21 on the respective baffles 20 in the path of the propelled powder. It may be desirable to provide a second pair of baffles 22 adjacent the top of the receptacle and also spaced for the passage of the tape or medium 10, to deflect air-borne powder which escapes the baffles 20. Preferably a vibratory means is provided to remove excess inking powder which if left on the surface of the medium would result in undesirable background discoloration. This may comprise a rotatable polygonal member 23 positioned between the two pairs of baffles and in contact with the uncharged surface of the medium 10. Suitable driving means (not shown) is provided for this vibratory member. Further details of printing apparatus of the above character are shown and described in application S.N. 443,646, filed July 15, 1954 by H. Epstein and F. Innes, entitled, "Electrographic Printer."

In the operation of electrostatic printing apparatus of the described type theoretical considerations indicate that a relatively low resistivity inking powder is desirable. This is confirmed by practice and is further referred to in application S.N. 625,212, filed November 30, 1956, entitled "Electrographic Printing Ink" by Robert E. Benn and Herman Epstein, which application is assigned to the assignee of this application. Variation in the moisture content of the inking powder, by varying the resistivity, has a seriously disturbing effect upon the uniformity of the resulting printed characters, such variation being in part due to the drying out of the normally slightly moist powder when exposed to a drier atmosphere and in part to its prolonged contact with the surfaces of the moving dry recording medium. Aside from the deterioration of the printed characters, excessive dryness in a light, very finely divided powder makes the powder difficult to handle in the inking operation, the powder being very sensitive to even slight air currents. Generally stated, the desideratum is to obtain a substantially constant percentage of

moisture in an inking powder, which tends to dry out. According to this invention an automatic control actuated by change in resistivity is provided by means of which the moisture content is maintained substantially constant.

For the purpose of bringing a too dry powder up to the predetermined percentage of moisture, a spray nozzle 24 is positioned to introduce an atomized liquid, which may be simply water or which may comprise other ingredients in aqueous solution, into the powder 25 in the receptacle 16 according to requirements. The nozzle 24 is the outlet of a pipe 26 leading from a source of moisture, such as atomizer 27 arranged to be actuated by air from a suitable source of pressure (not shown) by way of any suitable means, such as a cylinder and piston (not shown), which, preferably, does not allow the air, or at least not a large amount of air, to exit with the atomized liquid. The actuating supply of air preferably is pulse-controlled for rapid action as by means of a solenoid unit 28 in an electrical circuit responsive to variation of the electrical resistance of the inking powder.

As a means for detecting such variation of resistance, two electrodes 30 and 31, which may, according to one design, be formed of 1/4" metallic rod 1" long, are mounted to pass through the wall of receptacle 16 and be embedded in the mass of powder at a location for effective sampling of the powder condition, as reflected in the resistance measured between the electrodes. An agitator 32 is mounted for rotation within the mass of powder and may be driven by any suitable means (not shown). Operation of agitator 32 dissipates that portion of the powder into which the liquid is sprayed from nozzle 24 and tends to maintain a uniform moisture condition throughout the entire powder mass, more particularly in that portion which comes in contact with the recording medium.

In the drawing the sampling electrodes 30 and 31 are shown connected via conductors 40 and 41 in one arm of a normally balanced bridge circuit 33, including resistors 44 and 45, supplied with AC voltage via conductors 50 and 51 and having an output, as a result of unbalance, which serves as a measure of the departure of the moisture content of the inking powder from a selected percentage. The bridge circuit 33 may be initially calibrated for zero output against the resistance of a test body of powder having the desired moisture percentage, as a standard of comparison, or may be adjusted on the basis of printing quality by means of variable resistor 39 in its circuit. In this connection it may be noted again that the inking powder normally tends to dry out so that only the addition of moisture is required to maintain the predetermined moisture percentage for efficient printing.

When bridge circuit 33 becomes unbalanced in the direction corresponding to rise in the predetermined normal resistance of the powder between electrodes 30 and 31, due to a lowered moisture content, the bridge output voltage is delivered to the control circuit by way of conductors 42 and 43, an amplifier 34, conductors 46 and 47, and a phase detector 35, this latter being a known circuit for detecting voltage or current of a selected one of two opposite phases and being supplied for this purpose through conductors 48 and 49 from the same A.C. source as the bridge circuit. Current of the phase detected by circuit 35, representing increased powder resistance, is arranged to actuate through conductors 55 and 56 a relay 36 and close, via conductors 52, 53 and 54 and the contacts of relay 36, the circuit of a pulse timer 37, also supplied from an A.C. power source. Timer 37, as long as it remains operated, supplies a pulse every thirty seconds via conductors 57 and 58 to repeatedly open a valve 38 in air pipe 26' for a short period, through the operation of solenoid unit 28. The opening of valve 38 supplies actuating air to atomizer 27 causing a momentary burst of wet vapor to be injected into the powder mass which tends to restore the desired moisture condition. The thirty second spacing of the pulses of atomized moisture allows time for agitator 32 to distribute the moistened pow-

der throughout the active portion of the powder mass and thereby promotes the establishment of a steady state of powder resistivity without overcontrol.

It will now be apparent that a complete unitary control system has been disclosed for electrostatic printing mechanisms whereby inking powders, of the type adapted to adhere to charged images on a recording tape, are maintained in a substantially constant predetermined moisture condition, to result in sharp, clear legible characters. The apparatus described herein is by way of illustration, only, and not by way of limitation of the invention. The limits of the invention are defined solely in the appended claims.

What is claimed is:

1. In an electrostatic printer for recording information on a recording medium having a recording station; an inking station; and a fixing station, said inking station comprising a receptacle adapted to contain a powdered mass of substantially electrically uncharged ink whose resistivity is a function of the percentage of moisture in said ink, and means for feeding a recording medium through said ink; the improvements comprising: electrical circuit means for measuring the resistivity of the ink in said receptacle; and means responsive to said means for measuring the resistivity for introducing a moistening agent into said ink to increase the percentage of moisture of the ink whenever the resistivity of said ink exceeds a predetermined value.
2. In an electrostatic printer for recording information on a recording medium, said printer having a recording station; an inking station; and fixing station; said inking station comprising a receptacle adapted to contain a powdered mass of substantially electrically uncharged ink, the resistivity of said ink being a function of the moisture content of the ink, and means for feeding a recording medium through said ink; the improvements comprising: a pair of electrodes fixedly mounted in said receptacle so that they are normally embedded in the ink and so that they are a given distance apart; a bridge circuit; electrical circuit means connecting said pair of electrodes to said bridge circuit so that the resistance of the ink between said electrodes is in one arm of said bridge circuit; an atomizer for injecting water vapor into said receptacle; circuit means responsive to an imbalance in said bridge circuit due to the resistivity of the ink exceeding a predetermined value for causing said atomizer to inject periodically water vapor into said receptacle; and an agitator in said receptacle for causing the moisture content of the ink to be substantially uniform throughout the mass of the ink.
3. An inking device constituting an inking station in an electrostatic recording system, the said inking device comprising: a receptacle adapted to contain a powdered mass of substantially electrically uncharged ink whose resistivity is a function of the percentage of moisture in said ink; means for feeding a recording medium through said ink; electrical circuit means for measuring the resistivity of the ink in said receptacle; and means responsive to said resistivity measuring means for introducing a moistening agent into said ink to increase the percentage of moisture of the ink whenever the resistivity of said ink exceeds a predetermined value.

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