United States Patent

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[33] **Great Britain**
[31] **2,558/69**

[54] **THERMAL BONDING MEANS FOR ELECTROGRAPHIC APPARATUS**
10 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** ..... **219/216,** 219/388, 250/65 ZE
[51] **Int. Cl.** **H05b 1/00**
[50] **Field of Search** 219/216, 388, 65.1; 250/65.2; 355/3, 8, 10, 11, 12; 117/17.5; 34/77

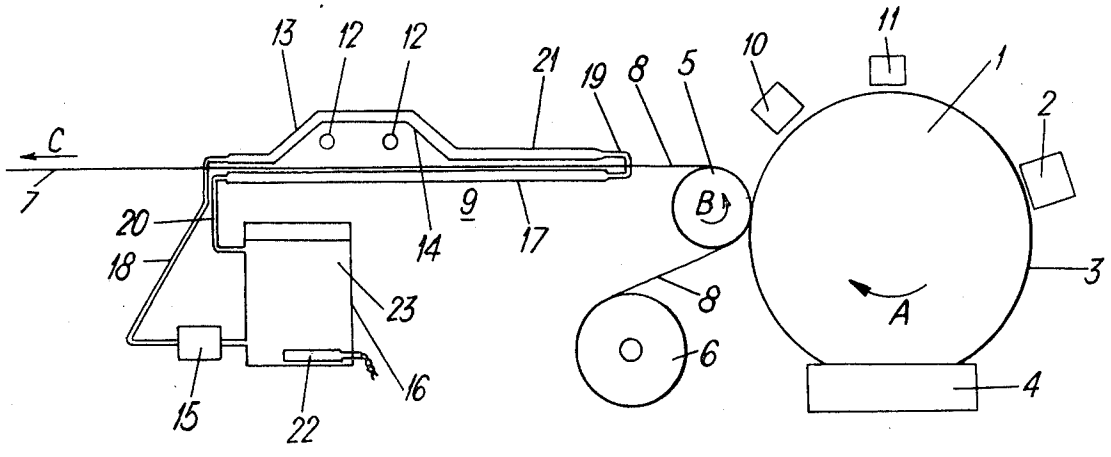
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ABSTRACT: Thermal bonding means with reduced power requirements for fixing powder particles to a web of paper in electrographic apparatus. The thermal bonding means utilize the direct application of infrared heat to the paper and in addition provide indirect heating by means which utilize the waste heat from the infrared application. The indirect means absorb the waste heat initially and reapply it so as to heat the paper and powder particles before and during the direct application of infrared heat.



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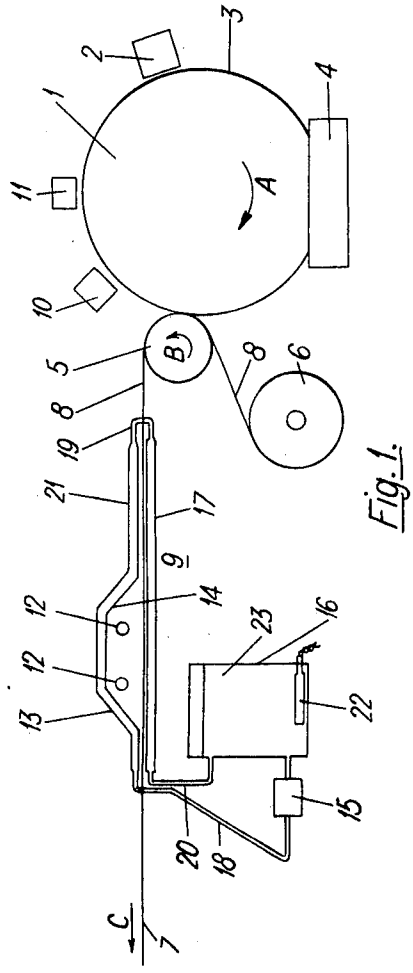


Fig. 1.

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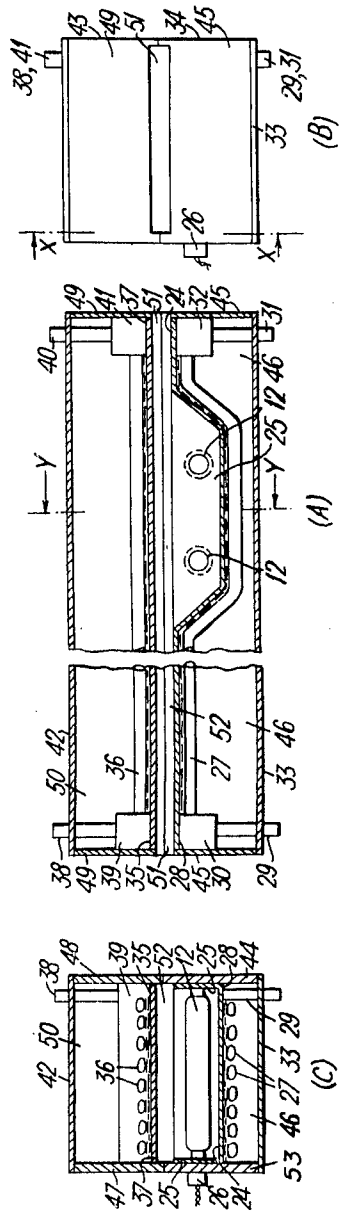


Fig. 2.

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THERMAL BONDING MEANS FOR ELECTROGRAPHIC APPARATUS

BACKGROUND OF THE INVENTION

The invention relates to electrographic apparatus.

The electrographic apparatus to which the invention relates is defined as apparatus of the kind wherein the recording surface of either a print drum or band is selectively magnetized or electrostatically charged to form a pattern or latent image thereon representative of information contained in a signal applied to the apparatus, wherein the print drum or band is passed through or relative to a powder applicator containing powder which is coated with a thermal fixing agent and which is attracted to the electromagnetically or electrostatically formed latent image to develop same and to form a powder image which may be viewed at a display position of the apparatus and/or transferred to a surface of a substrate by printing means which form part of the apparatus, and wherein the substrate is passed through or relative to thermal bonding means which form part of the apparatus and which cause the transferred powder pattern to be bonded to the substrate surface.

SUMMARY OF THE INVENTION

The invention provides an electrographic apparatus of the kind as defined above wherein the thermal bonding means include first means for directly heating the powder pattern formed on the substrate surface, and second means which utilize heat radiated by the first means to indirectly heat the powder pattern before it is heated by the first means.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other features according to the invention will be better understood from the following description with reference to the accompanying drawings, in which:

FIG. 1 diagrammatically illustrates an electrographic apparatus according to the invention, and

FIGS. 2A–2C respectively diagrammatically illustrate a sectioned side elevation, an end elevation and a sectioned end elevation of a practical arrangement for the thermal bonding means which form part of the electrographic apparatus illustrated in the drawing according to FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1, the electrographic apparatus diagrammatically illustrated therein is one arrangement according to the invention and includes; a print drum 1 which is rotatable in the direction of the arrow 'A' by means not shown in the drawing; a recording head assembly 2 for selectively magnetizing or electrostatically charging the recording surface 3 of the print drum 1 as it is rotated therepast to form a pattern or latent image thereon representative of information contained in a signal applied to the apparatus; a powder applicator 4 containing powder which is coated with a thermal fixing agent, for example a thermoplastic resin or wax, and which is attracted to the electromagnetically or electrostatically formed latent image to develop same and to form a powder image which may be viewed at a display position (not shown in the drawing) of the apparatus; a paper supply reel 6 from which a continuous web of paper 7 is fed over a pressure roller 5 which is rotatable in the direction of the arrow 'B' and which causes the surface 8 of the paper 7 to be pressed against the recording surface 3 of the print drum 1 in a manner such that the powder pattern on the recording surface 3 is transferred to the surface 8 of the paper 7, the linear speeds of the recording surface 3 and the surface 8 of the paper 7 being at this point the same; and thermal bonding means, indicated generally by reference 9, through which the web of paper 7 is passed, i.e. in the direction of the arrow 'C,' in order to cause the powder pattern to be bonded to the surface 8 thereof before it is delivered to the outside of the apparatus at a suitable delivery point.

The recording surface 3 of the print drum 1 completes its circuit by passing through or relative to a cleansing unit 10 whereat residual powder is removed from the recording surface 3. It then returns to the recording head assembly 2; and depending on the mode of operation of the latter, a preliminary erasive process, indicated in FIG. 1 by the presence of an electrostatic or electromagnetic erasure unit 11, may or may not be required.

It is to be noted that the print drum 1 could be replaced by a print band guided in a closed loop by a series of rollers.

It will be evident that if the pressure roller 5 is permanently biased towards the recording surface 3 the apparatus will print all information displayed by it as soon as the band or drum moves round through the printing station. While this mode of operation is possible it may not necessarily be desirable. The mode of operation may be such that an operator is presented with continuously varying input data and has the option of obtaining a permanent copy of any section of the displayed information he desires. In this instance it would be necessary for the operator to be able to control the application of the pressure roller 5 to the recording surface 3, for example by means of a remotely operated solenoid fitted to the roller 5, and to correspondingly control the supply of the continuous web of paper 7.

The term 'information' is here used in its widest sense and the apparatus may be used equally to display and provide permanent copies of alphabetical or numerical matter, pictorial matter such as graphs, diagrams or maps, or facsimile productions of any type of original. In most cases code conversion will be required in the driving circuits of the recording head assembly 2 in order to create the pattern or latent image corresponding, for example, to a numerical input signal; on the other hand with certain forms of head assembly and with an input derived from the line-by-line scanning of an original, the input signals may be applied directly to the elements of the recording head assembly 3.

The powder contained within the powder applicator 4 consists of small powder particles (e.g. magnetic iron oxide when the latent image is formed electromagnetically) which are coated with for instance a thermoplastic resin having a melting point in the temperature range 105° C. to 115° C. Thus the thermal bonding means 9 render the powder pattern on the surface 8 of the paper 7 permanent by heating it above its melting point so that the resin melts and wets the surface 8. After cooling the resin attaches the powder particles to the surface 8 of the paper 7 thereby providing a permanent copy which can withstand handling.

The thermal bonding 9 diagrammatically illustrated in FIG. 1, in order to reduce the power required to melt the resin and achieve an economy in the overall power consumption for the electrographic apparatus, effects the bonding of the powder pattern to the surface 8 of the paper 7 by directly heating it by infrared heat produced by for example quartz-iodine lamps 12 and by indirectly heating it by means which utilize the waste heat from the infrared lamps 12, i.e. the heat absorbed by the reflectors and lamp housing of the infrared lamps, before and during the time the powder pattern is directly heated by the lamps 12.

As shown in FIG. 1, the lamps 12 are located within a housing 13 by means not shown in the drawing. The housing 13, which is provided with a polished inner surface 14 to cause the infrared heat to be reflected towards the surface 8 of the paper 7, is either hollow or provided with a suitable tubing system to allow water to be circulated therein by means of a pump 15 from a reservoir 16. The outlet of the pump 15 is connected to the housing 13 via a tube 18.

The water within the housing 13 which is heated by the infrared heat radiated by the lamps 12 is passed through a heating plate section 17 and then back to the reservoir 16 via an interconnecting tube 20. The heating plate section 17 may be provided by either a hollow member or a plate having a suitable tubing system connected on one side thereof.

Thus during operation the heat absorbed by the reflector 14 and the lamp housing 13 causes the circulating water to be heated, therefore part of the heating plate section 17 and the lower part 21 of the lamp housing 13 raises the temperature of the paper 7 and thereby the powder pattern thereon before it enters the infrared heating region. The paper 7 would in practice be arranged to be in contact with the inner surface of the plate section 17 so that heat exchange would be by conduction.

On passing under the lamps 12 the temperature of the powder particles which form the powder pattern on the surface 8 of the paper 7 will, due to the infrared heat and the heat conducted from part of the plate section 17, rise to melt the resin coating thereof in order to facilitate the provision of the permanent record.

The temperature of the circulating water will be continually maintained by the heat absorbed by the lamp housing 13 and the plate section 17 thereby causing the temperature of the paper preheating section, i.e. formed by the lower part 21 of the lamp housing 13 and that part of the plate section 17 situated directly below the lower part 21 to be maintained. In practice, the lamp housing 13, water reservoir 16 and plate section 17 would be suitably lagged with heat insulating material to reduce heat loss.

When first starting the electrographic apparatus the circulating water temperature will not be at the required level to effect the preheating of the paper 7. If this initial starting delay cannot be tolerated, then a heater unit 22 could be provided within the reservoir 22 to raise the temperature of the water 23 within the reservoir 16 to say 80° C. prior to starting the apparatus. The heating unit 22 could also be used to maintain this water temperature level when the lamps 12 are not in use, for example during a mode of operation of the electrographic apparatus when permanent copies are only required on demand, in which case the lamps would only be switched on when a permanent copy is required.

With this method of thermal bonding, start-stop or intermittent paper feed modes would be aided since the temperature of the paper would reach say 80° C. in the preheating section during a stop period.

It can thus be seen from the above that the preheating of the paper 7 by the lower part 21 of the lamp housing 13 and that part of the plate section 17 situated directly below the lower part 21, as well as the heating of the paper 7 by the plate section 17 during the application of the infrared heat reduces the power required to melt the resin and thereby achieves an economy in the overall power required to bond the powder pattern to the surface 8 of the paper 7.

It should be noted that the heating plate 17 need only extend over that length of the paper 7 covered by the lower part 21 of the lamp housing 13, in which case the plate section 17 would only be effective to preheat the paper 7. This arrangement of the thermal bonding means would however result in a slight increase in the power requirements of the apparatus.

A practical arrangement for the thermal bonding means which form part of the electrographic apparatus illustrated in the drawing according to FIG. 1 is diagrammatically illustrated in the drawings according to FIGS. 2A–2C.

In this arrangement the lamp housing is formed by a metal plate 24, for example of copper, having a trapezium-shaped depression provided at one end thereof within which the lamps 12 are housed, the trapezium-shaped side members 25 which are secured to the plate 24 by conventional techniques, for example by a brazing operation, provide the means for mounting the lamps within the depression. Electrical connector units 26 are fitted to a sidewall 53 of one-half 34 of a housing member for the thermal bonding means into which the lamps 12 are fitted to facilitate the connection thereto of a source of electrical supply. The inner surface of the depression which acts as the reflector for the lamps 12 is either polished or provided with a surface coating of silver, chrome or similar material.

A plurality of metal tubes 27, for example of copper, are secured to the surface 28 of the plate 24 by conventional techniques, for example by a brazing operation, and the bore of each of the tubes 27 is connected at one end to the bore of a tube 29 via a connector block 30, while the other ends of the bores of the tubes 27 are connected to the bore of a tube 31 via a connector block 32. The tubes 29 and 31 which extend through a cover plate 33 for the half 34 of the housing member, would in practice respectively form part of the connectors 19 and 18 illustrated in the drawing according to FIG. 1.

The heating plate section 17 of FIG. 1 is in this arrangement of the thermal bonding means provided by a metal plate 35 having a plurality of metal tubes 36, for example of copper, secured to the surface 37 thereof by conventional techniques, for example by a brazing operation. The bore of each of the tubes 36 are connected at one end to the bore of a tube 38 via a connector block 39 and at the other end to the bore of a tube 40 via a connector block 41. The tubes 38 and 40 which extend through a cover plate 42 for the other half 43 of the housing member, would in practice respectively form part of the connectors 19 and 20 illustrated in the drawing according to FIG. 1.

The half 34 of the housing member which is constructed from a thermal insulation material, for example asbestos, and which comprises the sidewall 53, the cover plate 33, a sidewall 44 and end walls 45 completely encloses the tube 27 system, the free space 46 within this enclosure being filled with a thermal insulation material, for example vermiculite.

The half 43 of the housing member which is constructed from a thermal insulation material, for example asbestos, and which comprises the cover plate 42, sidewalls 47 and 48 and end walls 49 completely encloses the tube 36 system, the free space 50 within this enclosure being filled with a thermal insulation material, for example vermiculite.

The sidewalls 53, 44 and 47, 48 of the two halves 34 and 43 of the housing member extend beyond the plates 24 and 35 to provide a gap 52 therebetween when the two halves of the housing member are connected together by means not illustrated in the drawings. The mating edges of the end walls 45 and 49 of the two halves 34 and 43 of the housing member are slotted to provide an aperture 51 at each end of the housing member thereby facilitating the passing of the paper 7 into and out of the gap 52.

Thus in operation the lamp 12 connector units 26 are connected to a source of electrical supply, the bores of tubes 29 and 38 are connected together, the bore of the tube 31 is connected to the output of a water supply source i.e. to the discharge side of the pump 15 in FIG. 1, and the bore of the tube 40 is connected to the input of the water supply source i.e. to the top of the reservoir 16 in FIG. 1.

What is claimed is:

1. In apparatus of the type wherein charge patterns are formed on a recording surface and developed by charge attractable powder particles coated with a thermal fixing agent, and in which the powdered patterns are then transferred to a substrate surface, thermal bonding means for forming a permanent record of the charge patterns on the substrate surface, comprising first means for directly heating the powder pattern formed on the substrate surface, and second means which utilize heat radiated by said first means to indirectly heat the powder pattern before it is heated by said first means, said second means including fluid-circulating means, part of which forms a portion of said first means and the remainder of which is arranged to heat the powder pattern before it is heated by said first means and a fluid supply source connected to said fluid-circulating means, said fluid-circulating means having a lamp housing member having an extended portion with a pair of major surfaces such that one of the major surfaces of the extended portion is arranged adjacent to that part of the substrate surface which is subsequently heated by said first means, a first plurality of metal pipes to the other of the major surfaces of said extended portion and to a surface of said lamp

housing member, a metal plate member having a pair of major surfaces one of which is situated adjacent to the one major surface of the extended portion of the lamp housing member in a manner such that a gap is provided therebetween, the length of said plate member being such that it extends at least along the same section of the substrate as said extended portion of the lamp housing member, and a second plurality of metal pipes connected to the other of the major surfaces of the plate member, wherein the bores of said first plurality of pipes are connected at one end thereof to one end of the bores of said second plurality of pipes, and wherein the other ends of said bores of said first and second plurality of pipes are connected to said fluid supply source.

2. In apparatus of the type wherein charge patterns are formed on a recording surface and developed by charge attractable powder particles coated with a thermal fixing agent, and in which the powdered patterns are then transferred to a substrate surface, thermal bonding means for forming a permanent record of the charge patterns on the substrate surface comprising first means for directly heating the powder pattern on the substrate surface including at least one elongated radiant heating element, and second means for absorbing the waste heat generated by said first means and applying said absorbed heat to the substrate prior to the application of said direct heat to like portions of the substrate, said second means including a housing substantially forming with said substrate an enclosure around said heating element, and a heating plate section physically and thermally connected to said housing in front thereof in the direction of travel of the substrate, said heating plate section being arranged to be in contact with the substrate in order to impart thereto the absorbed waste heat from said first means by way of conduction in the preheating mode.

3. The arrangement according to claim 2 wherein said second means heat the powder pattern before and during the time it is heated by said first means.

4. The arrangement according to claim 2 wherein said first means include a source of infrared heat and said second means include fluid-circulating means, part of which forms a portion of said first means.

5. The arrangement according to claim 2 wherein the source of infrared heat includes at least one infrared lamp enclosed within a metallic housing member having a reflecting inner surface, and means for connecting a source of electrical supply to said infrared lamp.

6. The arrangement according to claim 15 wherein said second means include fluid-circulating means, part of which forms a portion of said first means and the remainder of which is arranged to heat the powder pattern before it is heated by said first means, and a fluid supply source connected to said fluid-circulating means.

7. The arrangement according to claim 6 wherein said part of the fluid-circulating means includes a hollow lamp housing member and said remainder of the fluid-circulating means is an extension of said hollow lamp housing member such that a major surface of the extended hollow part is arranged to be adjacent to and to effect the heating of that part of the substrate surface which is subsequently heated by said first means, wherein said remainder of the fluid-circulating means further includes a second hollow member a major surface of which is situated adjacent to said major surface of the extended hollow part of said hollow lamp housing member in a manner such that a gap is provided therebetween, said second hollow member being positioned to at least heat the same section of the substrate as said extended hollow part of said hollow lamp housing member and connected at one end to said extended part of said hollow lamp housing member, and wherein said fluid supply source is connected between the other end of said second hollow member and said hollow lamp housing member.

8. The arrangement according to claim 6 wherein said fluid-circulating means include lamp housing member having an extended portion with a pair of major surfaces such that one of the major surfaces of the extended portion is arranged adjacent to that part of the substrate surface which is subsequently heated by said first means, a first plurality of metal pipes to the other of the major surfaces of said extended portion and to a surface of said lamp housing member, a metal plate member having a pair of major surfaces one of which is situated adjacent to the one major surface of the extended portion of the lamp housing member in a manner such that a gap is provided therebetween, the length of said plate member being such that it extends at least along the same section of the substrate as said extended portion of the lamp housing member, and a second plurality of metal pipes connected to the other of the major surfaces of the plate member, wherein the bores of said first plurality of pipes are connected at one end thereof to one end of the bores of said second plurality of pipes, and wherein the other ends of said bores of said first and second plurality of pipes are connected to said fluid supply source.

9. The arrangement according to claim 7 wherein said fluid supply source includes a reservoir of fluid, the inlet of which is connected to said fluid-circulating means, and a fluid pump, the input side of which is connected to the reservoir outlet and the output side of which is connected to said fluid-circulating means.

10. The arrangement according to claim 9 wherein a heater unit is provided in said reservoir.

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