United States Patent

[11] **3,625,146**

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[54] **IMPRESSION ROLLER FOR CURRENT-ASSISTED PRINTING**
12 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** **101/153,** 29/132
[51] **Int. Cl.** **B41f 9/00**
[50] **Field of Search** ..... 101/153, 170, 216, 219, DIG. 15; 29/132

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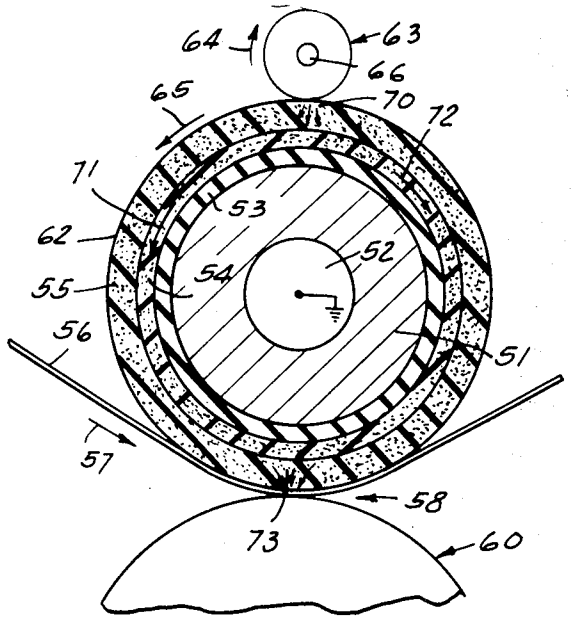
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Attorney—Hill, Sherman, Meroni, Gross & Simpson

ABSTRACT: An impression roll comprising a core of metal which can be assumed to be grounded, an insulating layer, preferably of rubber, on the core, and a semiconductive layer preferably of rubber providing the external surface but having a conductor internally thereof to provide a conductive path bypassing at least a substantial portion of the semiconductive layer.



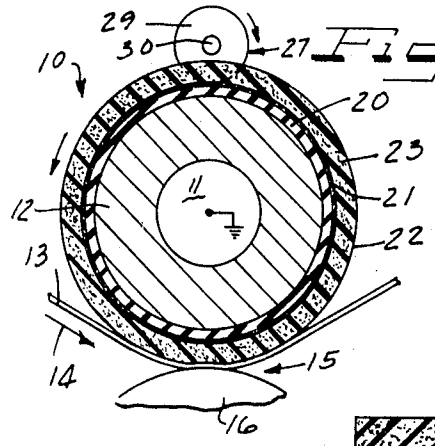


Fig. 1

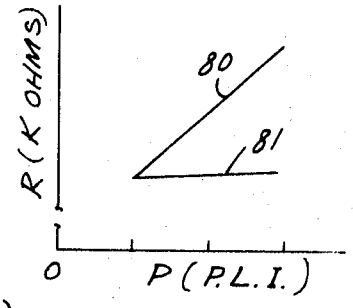


Fig. 6

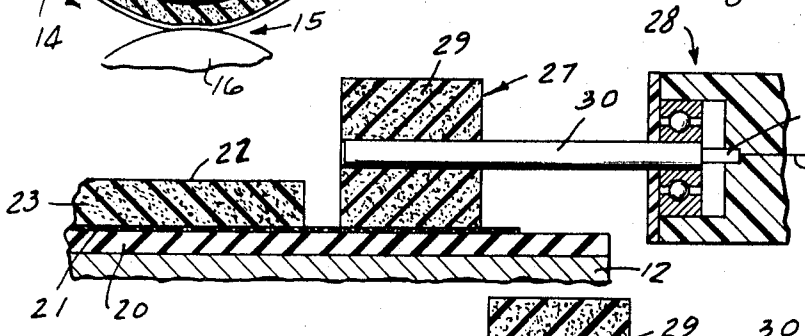


Fig. 2

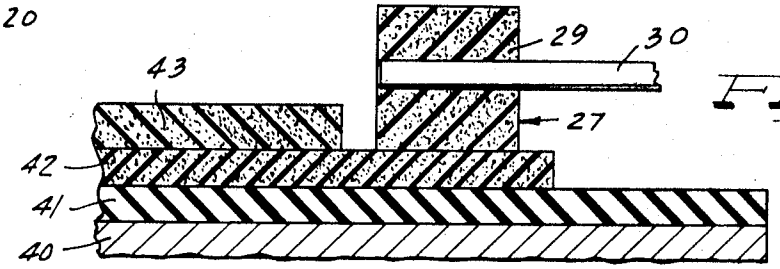
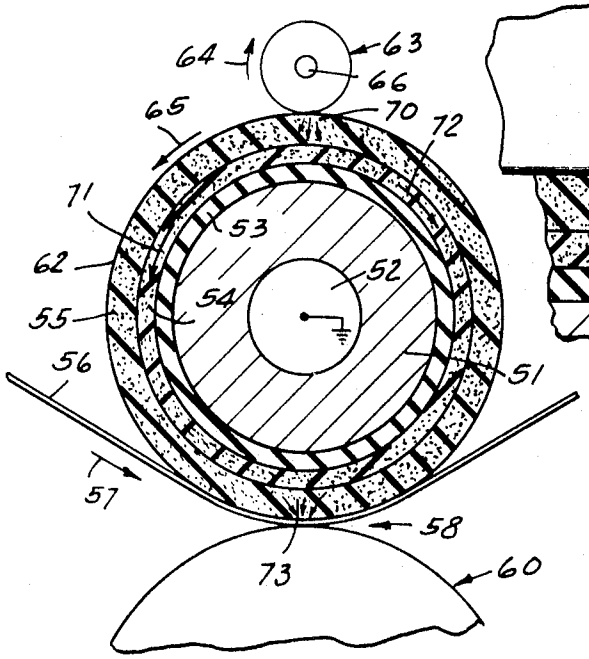


Fig. 3



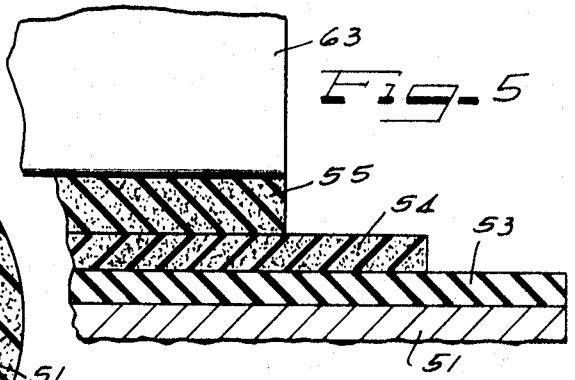


Fig. 5

Fig. 4

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IMPRESSION ROLLER FOR CURRENT-ASSISTED PRINTING

SUMMARY OF THE INVENTION

The present invention relates to an impression roll for an electric current assisted printing system such as a gravure printing system.

A major problem with an existing electrically assisted ink transfer system is the insulation of the impression roller from the press frame. An approach to insulation is to insulate the outer race of the impression roller bearing from the press frame. This will result in some arcing in the impression roller bearings, causing a safety hazard and exposing a large surface of the housing to the press operator creating a personnel hazard. To make the installation of the above system simple, and also inherently safe to hazards and personnel, the special impression roller of the present invention is proposed.

It is therefore an object of the present invention to provide a novel and improved impression roll for electric current assisted printing.

It is another object of the present invention to provide an impression roll construction which facilitates the reliable production of relatively optimum impression rolls.

A further object of the present invention is to provide an impression roll which is capable of reliable operation under different dynamic pressure conditions.

Still another object of the invention is to provide an impression roller which is capable of safe and reliable operation and does not require insulation of its shaft from the frame of the printing machine.

Still another and further object of the present invention is to provide an impression roller capable of accommodating a relatively substantial range of web widths in comparison with other systems.

Other objects, features and advantages of the invention will be readily apparent from the following description of certain preferred embodiments thereof, taken in conjunction with the accompanying drawings although variations and modifications may be effected without departing from the spirit and scope of the novel concepts of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a somewhat diagrammatic cross-sectional view illustrating a first impression roller in accordance with the present invention utilized in a gravure printing system;

FIG. **2** is a somewhat diagrammatic partial longitudinal sectional view illustrating certain details of the system of FIG. **1**;

FIG. **3** is a partial longitudinal sectional view similar to that of FIG. **2** but illustrating a modified impression roller in accordance with the present invention;

FIG. **4** is diagrammatic vertical sectional view of a preferred embodiment of impression roller in accordance with the present invention operating in an electric current assisted gravure printing system;

FIG. **5** is a somewhat diagrammatic partial longitudinal sectional view showing further details of the system of FIG. **4**; and

FIG. **6** is a graphical representation of certain dynamic operating characteristics of an impression roll in accordance with the present invention in comparison with a prior impression roller.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the embodiment of FIGS. **1** and **2**, an impression roll **10** is illustrated which is rotatably mounted on a grounded shaft **11** and has a metal core **12**. A web **13** of paper or the like is shown moving in the direction of arrow **14** through a nip region **15** formed between the impression roller **10** and a gravure printing cylinder **16** which may also be at ground potential.

By way of example, the metal peripheral surface of core **12** may have a nonconducting layer **20** formed of rubber or the like, on which is applied a conductive material as indicated at **21** which may be in the form of a metal screen, perforated

sheet stock, uninsulated wire in either sheet or strip stock, or formed of a powdered conductive material which is electrically interconnected so as to provide an electrically conductive path which is continuous about the circumference of the roll and is also continuous over the length dimension of the roll. It will be understood that the conductive layer **21** is formed in a relatively uniform manner so that electric current can be transmitted to the nip region **15** relatively uniformly with respect to the length of the nip.

The external peripheral surface of the roller **10** which is indicated at **22** is formed preferably by a layer of semiconducting material such as semiconductive rubber indicated at **23**. The layer **23** is preferably bonded to the insulating layer indicated at **20**, so that the entire roll **10** is preferably a unitary assembly.

With respect to the insulating layer **20**, it is preferred that the material have a radial thickness sufficient to withstand a potential of 20,000 volts without dielectric breakdown. The layer is bonded to the core **12** by conventional techniques. The material of layer **20** may be rubber, plastic, epoxy or any other forming type insulation material.

The layer of semiconducting material **23** is in contact with the conductive material **21**. One way of forming the conductive layer would be to utilize semiconductive material in sheet form and to provide the conductive material **21** between layers of the semiconducting material **23**.

FIG. **2** illustrates a way of applying electric potential to the conductive material **21**. In this embodiment, the conductive material **21** and the insulating layer **20** extend axial beyond the end **26** of the semiconducting material **23** so as to expose a continuous peripheral portion of the conductive material **21** for contact with a conductive roller **27** mounted for rotation on insulating bearing means indicated at **28**. By way of example, the conductive roller may be formed of a highly conductive rubber material **29** on a metal shaft **30**. Potential may be applied to the metal shaft **30** as indicated by the end contact **31** having an insulated lead **32** connecting therewith from a suitable source of electric potential. By way of example, the potential applied to the shaft **30** relative to ground may be in the range from 300 volts to 5,000 volts.

Where the semiconducting material **23** is formed from sheet stock, it will be understood that one or several layers of the semiconducting material would underlie the conductive material **21** while a plurality of further layers would overlie the conductive material **21**, the inner layers being coextensive with the insulating layer **20** as viewed in FIG. **2**, so that material of the same characteristics would be at the radial inner and outer sides of the conductive material **21**.

As a modification of the illustrated system, the conductive material **21** could be placed at ground potential, so that the conductive material would tend to remove static charge from the surface **22** of the roller. With this arrangement, it would still be possible to apply a potential to the periphery **22** of the roller, for example by means of a conductive roller such as indicated at **27** which would then preferably extend for a substantial proportion of the length of the peripheral surface **22**, and at a convenient location about the periphery of the roller **10**.

FIG. **3** illustrates a modification of the embodiment of FIGS. **1** and **2** wherein a metal core **40** is provided with an insulating layer **41**, for example of cushioning material such as rubber, or of the other materials mentioned for the layer **20**. On the layer **41** is a layer **42** of conducting material such as a highly conducting rubber. On the layer **42** is outer layer **43** of semiconducting material such as semiconductive rubber. Contact with the conductive material **42** may be by means of a roller **27** as in the embodiment of FIGS. **1** and **2**.

The conductive material of the layer **42** preferably has a resistivity of less than 100 ohm centimeters. In each of the embodiments, the outer layer **23** or **43** preferably has an electrical resistivity of the order of 10^4 ohm-centimeters to 10^8 ohm-centimeters, the materials exhibiting a durometer reading of from about 60 to about 90 by the Shore A scale. Preferably

the insulating layer 20 has a resistivity equal to or greater than 10^{12} ohm-centimeters.

Referring to the embodiment of FIGS. 4 and 5, there is shown an impression roller 50 having a central core 51 with a grounded metal shaft 52, an insulating layer 53, a conducting layer 54 and an outer semiconducting layer 55. A web of paper or the like is indicated at 56 traveling in the direction of arrow 57 through a nip region 58 between the impression roller 50 and a gravure printing cylinder 60, for example, which may be at ground potential as in the preceding embodiments. As in the previous embodiments, each of the layers may be formed of a resilient material such as rubber, the insulating layer 53 having a resistivity of 10^{12} ohm-centimeters or greater, the conductive layer having a resistivity of less than 100 ohm-centimeters, and the semiconducting layer having resistivity between 10^4 ohm-centimeters and 10^8 ohm-centimeters, for example. By way of example of an impression roller which has actually been built and successfully tested, the insulating layer 53 may have a radial thickness of three-sixteenths inch, the conductive layer 54 may have a thickness of one-fourth inch, and the outer semiconducting layer 55 may have a thickness of five-sixteenths inch.

In this embodiment, the outer peripheral surface 62 of semiconductive material may move in rolling contact with a contact roller 63 which may be entirely similar in construction to the roller 27, except that the length of the roller 63 preferably is approximately equal to the length of the impression roller 50. The directions of rotation have been indicated by arrows 64 and 65.

By way of example, a voltage in the range between 300 volts and 5,000 volts may be applied to the shaft 66 of roller 63 so as to produce a current flow path radially in the semiconducting material 55 as indicated by arrows in the region 70. Current flow then distributes circumferentially in opposite directions as indicated by arrows 71 and 72 substantially uniformly over the area of the conductive material 54, converging at the region indicated at 73.

Under normal operating conditions, the nip region 58 will have an extent in the direction of movement of the web 56 of the order of one-half inch, for example, and in this region the peripheral surface 62 will have a flat, where the surface is deformed by virtue of the pressure urging the impression roll 50 toward the gravure printing cylinder 60 which is of a rigid material. These same general operating conditions would apply to the other embodiments.

FIG. 6 illustrates dynamic resistance characteristics for a prior type of impression roller at 80 and for an impression roller such as indicated at 50 at 81. The ordinate values in FIG. 6 are determined by measuring the applied potential to the impression roll and the current flow thereto from the external circuit. The abscissa represents the pressure applied to the impression roller in pounds per linear inch at the nip region, that is the total pressure divided by the length of the flat in the peripheral surface 62 at the nip region 58. The characteristic curve 80 is obtained for an impression roller where the conductive material 54 is omitted, while characteristic 81 illustrates the fact that the resistance offered by the impression roller is relatively constant as a function of the applied pressure over a substantial range of operating pressures for the system. With the illustrated embodiments the current flow path bypasses a substantial majority of the semiconducting material so as to greatly reduce the effect of variations in the characteristics of the semiconducting material. Because of this result, it is found that the manufacturer of the impression roller is greatly facilitated and that reliable operation is readily obtained. Also the obtaining of relatively uniform results with different batches of semiconducting material is facilitated.

The dynamic resistance represented in FIG. 6 is obtained by operating the impression roller and printing cylinder at normal operating speed and with normal pressure therebetween, but in the absence of the paper web. That is, the peripheral surface 62 of the impression roller 50 would be in contact with the printing cylinder 60 over a flat having the usual dimensions such as one-half inch, but which dimension would vary as a function of the pressure applied to the impression roller. It is found that the effect of this dynamic operation is complex and difficult to analyze, because of the complex nature of the carbon chains within a semiconducting rubber material and because of the elastic memory and heating effects which occur under dynamic conditions. The structural relationships of the present invention tend to minimize the effects of such phenomenon, and thus render operation which is less sensitive to minor variations in composition and the like.

It is also found that with a construction in accordance with the present invention, the width of the web may be less than the length of the impression roller, and the amount of contact between the semiconducting surface 62 of the impression roller and the peripheral surface of the printing cylinder 60 may be much more extensive than could be tolerated in the system represented by the dynamic characteristic 80 in FIG. 6. Thus in accordance with the teachings of the present invention the web may be of a width which is substantially less than the operating length for flat region of the impression roller, that is less than 80 percent of the length of the flat region of the impression roller.

Where a backup roller is provided in engagement with the impression roller of the present invention, it is not necessary to successful operation that the backup roller be insulated from ground. As another embodiment, the backup roller could be insulated from the machine frame and utilized to transmit the electrical potential to the semiconducting surface 22 or 62, for example, in any of the illustrated embodiments.

I claim as my invention:

1. Means for assisting the transfer of ink, carried on a metal printing cylinder, to a web of substantially nonconductive material as the latter passes through a nip between the printing cylinder and a resiliently covered metal impression cylinder, comprising the combination of:

an outer covering of resilient material on said impression cylinder having a resistivity of the order of 10^4 ohm-centimeters to 10^8 ohm-centimeters, the external peripheral surface of said outer covering contacting the substantially nonconductive material of the web at the nip between the printing cylinder and the impression cylinder,

a layer of dielectric material having a resistivity substantially greater than that of said outer covering disposed between said outer covering and the metal of said impression cylinder,

an electrically conductive layer interposed between the outer covering and the layer of dielectric material for supplying electric potential to the interior side of said outer covering, said conductive layer having a conductivity substantially exceeding that of said outer covering,

an electrically conductive contact element mounted adjacent said impression cylinder and in physical contact with said outer covering at a region about the periphery of said impression cylinder remote from said nip, and

an electric circuit connected with said electrically conductive contact element for applying an electric potential between said electrically conductive contact element and said printing cylinder with the potential applied by said contact element being transmitted radially through said outer covering at said region remote from said nip from the the exterior side to the interior side of said outer covering and being transmitted circumferentially from said region through said electrically conductive layer to the portion of said outer covering instantaneously in contact with the substantially nonconducting material of said web at the nip, said layer of dielectric material insulating said electrically conductive layer from the metal of said impression cylinder, and the applied potential maintaining said outer covering and said printing cylinder at opposite polarities to charge the ink to a polarity opposite to that of said outer covering for attraction of the ink to the web at the nip between the printing cylinder and the impression cylinder.

2. The combination of claim 1 with said contact element being a conductive roller in direct rolling contact with the outer covering of said impression cylinder, and said conductive layer being formed of a resilient material having a resistivity of less than 100 ohm-centimeters and having a thickness of about one-fourth inch.

3. The combination of claim 1 with said layer of dielectric material having a resistivity equal to or greater than 10^{12} ohm-centimeters and having a thickness of about three-sixteenths inch, said electrically conductive layer having a thickness of about one-fourth inch and said outer covering having a thickness of about five-sixteenths inch.

4. The combination of claim 1 with said contact element being a conductive roller in direct rolling contact with the outer covering of said impression cylinder, and said conductive layer being formed of a resilient material having a resistivity of less than 100 ohm-centimeters and having a thickness of about one-fourth inch, said layer of dielectric material having a resistivity equal to or greater than 10^{12} ohm-centimeters and being entirely free of conductive material throughout the entire region between said electrically conductive layer and the metal core of the impression cylinder.

5. An impression roller comprising a metal core, an insulating layer on said core, an outer layer of semiconducting resilient material having a resistivity of from about 10^4 ohm-centimeters to about 10^8 ohm-centimeters, and an intermediate layer of electrically conductive resilient material having a resistivity of less than about 100 ohm-centimeters and a thickness about equal to the thickness of said outer layer, said intermediate layer being interposed between said outer layer and said insulating layer, and said insulating layer being of a substantial and uniform thickness and being entirely free of conductive material in the region between said metal core and said intermediate layer.

6. An impression roller according to claim 5 with said outer layer being of semiconducting rubber having a thickness of about five-sixteenths inch, and said intermediate layer being of conductive rubber material having a thickness of about one-fourth inch.

7. An impression roller according to claim 6 with said insulating layer being of resilient material having a resistivity of about 10^{12} ohm-centimeters or greater and a thickness of about three-sixteenths inch.

8. Means for assisting the transfer of ink, carried on a metal printing cylinder, to a web of substantially nonconductive material as the latter passes through a nip between the printing cylinder and a resiliently covered impression cylinder with a metal core, said means comprising the combination of:

an outer covering of resilient material on said impression cylinder having a resistivity of the order of 10^4 ohm-centimeters to 10^8 ohm-centimeters, the external peripheral surface of said outer covering contacting the substantially nonconductive material of the web at the nip between the printing cylinder and the impression cylinder,

a layer of dielectric material having a resistivity substantially greater than that of said outer covering disposed between said outer covering and the metal core of said impression cylinder,

an electrically conductive material disposed between the outer covering and the layer of dielectric material for supplying electric potential to the interior side of said outer covering, said conductive material having a conductivity substantially exceeding that of said outer covering and having an exposed contact portion integral with said conductive material and providing an exteriorly directed contact face axially offset from said outer covering,

an electrically conductive contact element in physical contact with the exteriorly directed contact face of said contact portion of said conductive material and mounted at a region about the periphery of said impression cylinder remote from said nip, and

an electric circuit connected with said electrically conductive contact element for applying an electric potential between said electrically conductive contact element and said printing cylinder with the potential applied by said contact element being transmitted by said conductive material to the interior side of said outer covering at the portion of said outer covering instantaneously in contact with the substantially nonconducting material of said web at the nip, said layer of dielectric material insulating said outer covering from the metal core of said impression cylinder, and the applied potential maintaining said outer covering and said printing cylinder at opposite polarities to charge the ink on the printing cylinder to a polarity opposite to that of said outer covering for attraction of the ink to the web at the nip between the printing cylinder and the impression cylinder.

9. The combination of claim 8 with said contact element being in direct rolling contact with the conductive material where said conductive material extends axially beyond said outer covering to provide said contact portion thereof.

10. The combination of claim 8 with said conductive material being formed in a resilient layer and having a resistivity of less than 100 ohm-centimeters.

11. The combination of claim 8 with said layer of dielectric material having a resistivity equal to or greater than 10^{12} ohm-centimeters and having a thickness of about three-sixteenths inch.

12. The combination of claim 8 with said conductive material forming a resilient layer having a thickness of about one-fourth inch and said outer covering having a thickness of about five-sixteenths inch.

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