Dec. 2, 1958 J. J. SCHULZE 2,863,063

CHARGING OF PHOTO-CONDUCTIVE INSULATING MATERIAL

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Fig. 1.

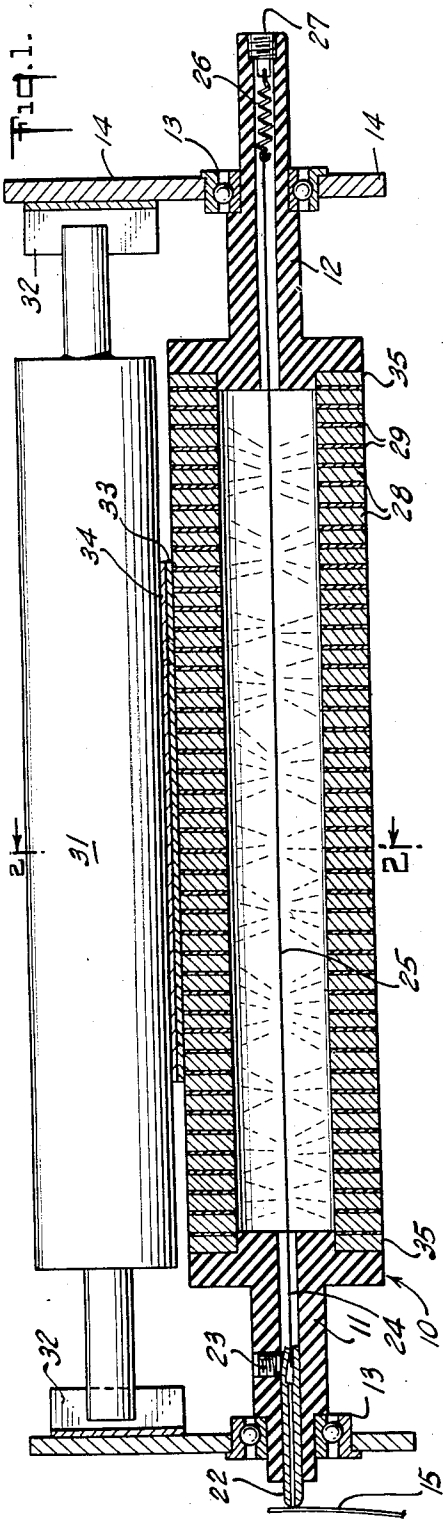


Fig. 4.

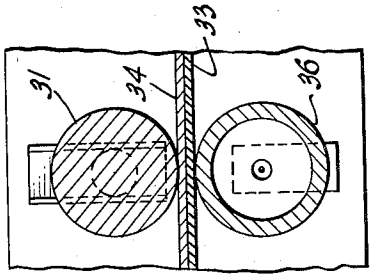


Fig. 3.

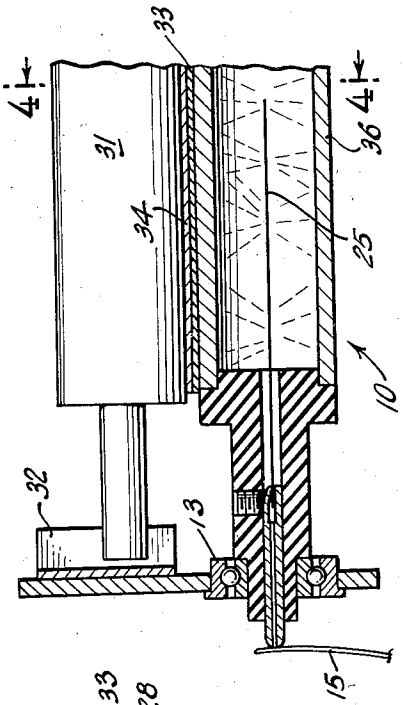
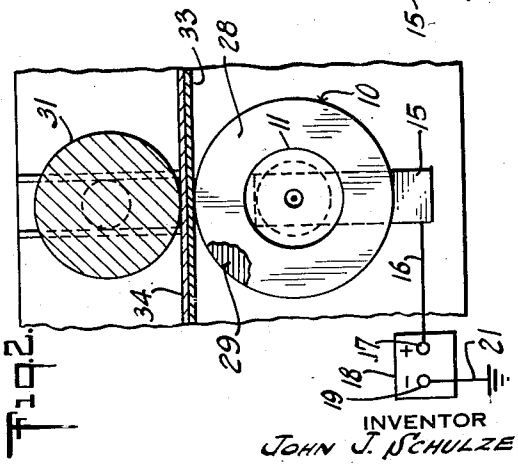


Fig. 2.



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CHARGING OF PHOTO-CONDUCTIVE INSULATING MATERIAL

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6 Claims. (Cl. 250—217)

This invention relates to apparatus for producing an electrostatic charge upon the surface of a photo-conductive insulating material, such, for example, as paper coated with a finely divided photo-conductor, e. g., zinc oxide applied to the paper as a solution or suspension in a dielectric film-forming vehicle. The vehicle may be a resin solution or suspension, such as a solution of a silicone resin in a suitable solvent or a suspension of a polyvinyl acetate resin in an aqueous medium. Since this invention may be applied to the production of electrostatic charges on any type of photo-conductive insulating material, it is believed that further description thereof is not necessary for a proper understanding of the invention.

Heretofore the charging of photo-conductive insulating material has been effected by corona discharge needles or wires. Such charging procedures have several disadvantages among which may be mentioned:

(1) The corona discharge needles or wires, being exposed to the atmosphere, generate ozone which escapes into the surrounding atmosphere so that it is objectionable to the operators of the equipment.

(2) The corona discharge wires or needles are delicate and hence readily inadvertently damaged in the operation of the equipment.

(3) When it is attempted to charge a photo-conductive insulating material while in contact with the translucent original it is invariably difficult to get a uniform charge because of poor contact between the translucent original and the photo-conductive insulating material.

(4) In prior procedures in an effort to produce a uniform charge, the photo-conductive insulating material is fed under the corona discharge and the translucent original then placed on the charged sheet before exposure. This registration of the original on the charged sheet is difficult particularly in hand operated machines.

It is an object of the present invention to provide apparatus for charging photo-conductive insulating material by corona discharge, which apparatus does not involve the above noted disadvantages.

Another object of the present invention is to provide a simple and compact corona discharge charging apparatus for applying a uniform charge, which apparatus is efficient in operation.

Still another object of this invention is to provide corona discharge charging apparatus for charging photo-conductive insulating material uniformly and which can be used to charge different sizes of sheets without requiring any adjustment of the charging apparatus.

Still another object of the present invention is to provide a corona discharge charging apparatus which will efficiently and uniformly charge photo-conductive insulating material while in contact with a translucent original and which insures good contact between the translucent original and the photo-conductive insulating material.

Still another object of this invention is to provide a corona discharge charging apparatus in which the fragile corona wire is effectively protected against possible injury.

Other objects and advantages of this invention will be apparent from the following detailed description thereof.

In accordance with this invention the corona discharge is effected within a roll or cylinder, herein referred to as a corona discharge roll, the periphery of which is electrically conductive and the photo-conductive insulating material passed between this corona discharge roll and the conductive periphery of a cooperating feed roller. In a preferred embodiment designed for charging sheets of different widths, the corona discharge roll has its periphery constituted of a plurality of conducting discs separated by thin intervening insulating discs which prevent the charge from leaking away laterally beyond the side edges of the sheet to be charged when the latter is passed between such corona discharge roll and the cooperating feed roll.

In the accompanying drawing forming a part of this specification and showing, for purposes of exemplification preferred forms of this invention, without limiting the claimed invention to such illustrative instances,

Figure 1 shows partly in section and partly in elevation a preferred embodiment of this invention. This figure shows a vertical section through the corona discharge roll and shows the cooperating feed roll in elevation;

Figure 2 is a section taken in a plane indicated by line 2—2 on Figure 1;

Figure 3 is a fragmentary view partly in section and partly in elevation showing a modified form of corona discharge charging apparatus embodying this invention; and

Figure 4 is a sectional view taken on the line 4—4 of Figure 3.

In the drawings 10 indicates a hollow corona discharge roll having at its ends non-conductive shafts 11 and 12 each mounted for rotation in a ball bearing 13 secured to the frame 14. Shaft 12 may be driven by a suitable source of power, such as an electric motor (not shown). One end of a brush 15 communicates with an electrical conductor 16 (Figure 2) connected to the positive terminal 17 of a high voltage generator 18 the negative terminal 19 of which may be grounded as indicated at 21. The other end of brush 15 contacts the terminal 22 (Figure 1) provided with a wire clamping screw 23 to which end 24 of a corona wire 25 is secured. The showing of the drawing is, of course, exemplary and shows the connections to the high voltage generator for applying a positive charge to the photo-conductive insulating material. If it is desired to apply a negative charge, the negative terminal 19 is connected to the brush 15 and the positive terminal 17 grounded.

The other end of the corona wire 25 is fastened to a tension spring 26 held in place within shaft 12 by a corona wire retaining screw 27. This wire, desirably, is disposed on the longitudinal axis of the corona discharge roll 10, i. e., is centrally disposed relative to the conductive periphery of this hollow roll.

The periphery of the corona roll 10 is constituted of a series of conducting discs 28 each separated from an adjacent disc by an insulating disc 29. The conducting discs may have a thickness of from 1/16" to 1/4", preferably 1/8", and the thin insulating discs have a thickness of from .005" to .030", preferably about .010". These conducting discs may be suitably cemented to the intervening insulating discs 29 or the assembly of conducting and insulating discs may be held together by insulated tie rods running from one end of the roll 10 to the opposite end.

Cooperating with the corona roll 10 is a feed roll 31 mounted for rotation in suitable guides 32 on frame 14

just above the corona roll 10. This roll 31 is thus grounded to the frame of the machine. The periphery of this feed roll is of conducting material. It is so positioned relative to the corona discharge roll 10 that the weight of roll 31 exerts pressure on the sheet of photo-conductive insulating material 33 and the translucent original 34 fed by these rolls. While in the embodiment of the invention shown in the drawing roll 31 is held in position over roll 10 by the guides 32, desirably of channel shape, in which roll 31 is mounted so that it is maintained in contact with roll 10 by gravity, it will be understood, a spring pressure mounting for roll 31 may be employed. In this way a sheet of photo-conductive insulating material alone, i. e., without the associated translucent original shown in Figure 2, or the assembly of both sheets may be fed without requiring any adjustment of the position of the roll 10 relative to roll 31.

High voltage generator 18 may be any known type of high voltage generator, such, for example, as a transformer-rectifier system, capable of providing a high voltage to the corona wire 25, say within the range of from 500 to 10,000 volts, preferably about 5,000 volts or higher. As such generators are well known, further description thereof is believed unnecessary.

The embodiment of the invention shown in Figures 1 and 2 and hereinabove described is adapted to charge sheets of photo-conductive insulating material having different widths not exceeding the distance between the end conducting discs 35 of the roll 10. Thus, by making roll 10 long enough, photo-conductive insulating sheets of any desired width may be charged uniformly. In the operation of this apparatus the charge from the photo-conductive discs extends beyond the edges of the conductive discs and partially covers the small area under the insulating discs 29. The translucent original 34 being a semi-conductor also helps to spread the charge. Exposure to light in the production of the desired copy disperses the charge further and results in uniform prints.

It will be noted that sheets of varying size narrower than the distance between the end conducting discs 35 on roll 10 of Figure 1 can be charged because the insulating discs 29 prevent charge from leaking away laterally beyond the side edges of the sheets; the charge actually goes through the conducting discs and into the photo-conductive insulating material, uniformly charging its surface.

It will be understood that the polarity and the relative positions of the translucent original and the photo-conductive insulating material may be varied as desired, i. e., the photo-conductive insulating material may either contact the periphery of the corona discharge roll 10 or of the feed roll 31 and similarly the translucent original may either contact the periphery of the feed roll 31, as shown, or be placed beneath the photo-conductive insulating material and thus contact the periphery of the corona discharge roll 10. Also, the relative positions of the rolls 10 and 31 may be reversed. When the translucent original is in surface contact with the corona discharge roll 10, the charge passes therethrough and collects uniformly on the surface of the superimposed sheet of photo-conductive insulating material.

The modification of Figures 3 and 4 differs from that of Figures 1 and 2 chiefly in that the corona discharge roll 10 instead of being composed of successive side-by-side conductive discs separated by insulating discs has the peripheral tubular outer wall 36 thereof of conductive material. In this embodiment of the invention the sheets of photo-conductive insulating material must be of a width at least equal to the length of the conductive periphery of the corona discharge roll 10 to prevent the charge from leaking away laterally beyond the side edges of the sheets. If the sheets are of a width less than the length of the conductive periphery of the corona discharge roll, contact or near contact between this roll and the conductive periphery of the feed roll 31, which is

grounded in both modifications, will cause the charge to leak away laterally beyond the side edges of the sheets with consequent poor charging.

The materials of construction may be any desired materials having the desired electrical properties. Thus, for example, the corona discharge wire may be a tungsten wire having a diameter of about 0.003 inch; the conductive discs 28 and 35 may be of metal, e. g., steel or copper or other conductive material; the insulating discs 29 may be a suitable resinous material, such as nylon, or phenolic resins, e. g., phenol formaldehyde resins, the non-conductive shafts 11 and 12 may be of a suitable resinous material, such as phenolic resins, the feed roll 31 may be of metal, such as steel or copper, and the brush 15 may be of flexible metal, such as steel, etc.

In the operation of the above described apparatus, it is only necessary to feed the leading end of each photo-conductive insulating sheet or assembly of such sheet with a translucent original to be copied into the bite between the rolls 10 and 31. Roll 31 maintains the sheet or assembly in contact with the periphery of roll 10, in the case of the assembly with good contact between the two sheets. Uniform charging of the photo-conductive insulating sheet takes place as the single sheet or assembly is fed through the two rolls. In the modification of Figures 1 and 2 each conductive disc 28 in contact with the sheet of photo-conductive insulating material charges the area of this sheet contacting the disc; the sheet is thus charged in lines each of which is slightly wider than the disc because the charge tends to spread beyond the width of the disc. Since the insulators 29 are relatively thin the charge produced in lines spreads sufficiently to form a uniform charge across the width of the sheet being charged. By exposure to light, the image is dispersed further and uniform prints result when the electrostatic latent image produced upon exposure to light is developed by the application of a developer powder, as is well known in the art.

In the operation of the apparatus of Figures 1 and 2 the sheets are charged when the width of the sheets is less than the distance between the end discs 35. If the position of the sheets is such that part of a disc 28 contacts the sheet and also touches the roll 31, a small uncharged border will be produced on the photo-conductive insulating sheet.

In operation it has been found that the charging apparatus of this invention requires materially less voltage to obtain the same charging as in the case of open corona wires, i. e., corona wires not enclosed, as in the present invention, but exposed to the surrounding atmosphere. Since the corona wire 25 is disposed within roll 10, the corona discharge is generated in a confined zone so that there is no ozone problem. Moreover, the tubular shell or walls of roll 10 protects the fragile corona wire against accidental injury. The intimate contact between the rolls 10 and 31 makes it possible to uniformly charge the photo-conductive insulating material while in surface contact with a translucent original, the feed roll 31 insuring excellent contact between the photo-conductive material and the original.

Furthermore, the charging apparatus of this invention permits the uniform charging of the photo-conductive insulating sheet while in contact with the translucent original so that the two sheets can be placed in registry and the resultant assembly fed through the charging apparatus thus eliminating the necessity of obtaining accurate registry between an already charged sheet and the original.

Since certain changes in the charging apparatus set forth, which embody the invention, may be made without departing from its scope, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A corona discharge charging apparatus for charging

a photo-conductive insulating material, comprising a tubular member having a peripheral wall of electrically conductive material, a corona discharge wire in said tubular member whereby said tubular member protects said corona wire against accidental injury and means for passing the photo-conductive insulating material in close proximity with the outer periphery of said tubular member to charge said photo-conductive insulating material.

2. A corona discharge charging apparatus for charging a photo-conductive insulating material, comprising a corona discharge wire, a tubular member completely enclosing and surrounding said wire, the peripheral walls of said tubular member being of electrically conductive material whereby said tubular member protects said corona wire against accidental injury and means for passing the photo-conductive insulating material in close proximity with the outer periphery of said tubular member to charge said photo-conductive insulating material.

3. A corona discharge charging apparatus for charging a photo-conductive insulating material, comprising a cylinder the periphery of which is of electrically conductive material, a corona discharge wire disposed within and on the longitudinal axis of said cylinder whereby said cylinder protects said corona wire against accidental injury and means for passing the photo-conductive insulating material in close proximity with the outer periphery of said cylinder to charge said photo-conductive insulating material.

4. A corona discharge charging apparatus for charging a photo-conductive insulating material, comprising a pair of feed rolls arranged to feed a sheet of photo-conductive insulating material, both of said rolls having their periphery of electrically conductive material, one of said rolls having a corona wire therein on its longitudinal axis and the periphery of the other roll being grounded.

5. A corona discharge charging apparatus as defined in claim 4, in which the roll having the corona wire disposed therein is constituted of a plurality of conductive discs, adjacent conducting discs being separated by a thin insulating disc.

6. A corona discharge charging apparatus as defined in claim 4, in which the roll having the corona wire therein has its periphery constituted entirely of electrically conductive material.

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