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ELECTROSTATIC CHARGING

Filed March 13, 1959

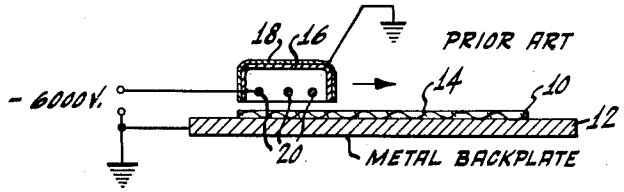


Fig. 1.

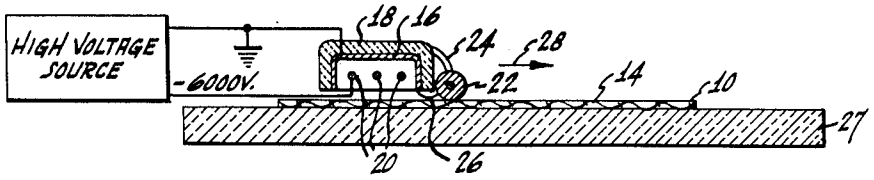


Fig. 2.

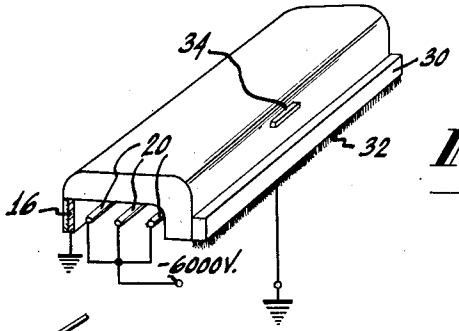


Fig. 3.

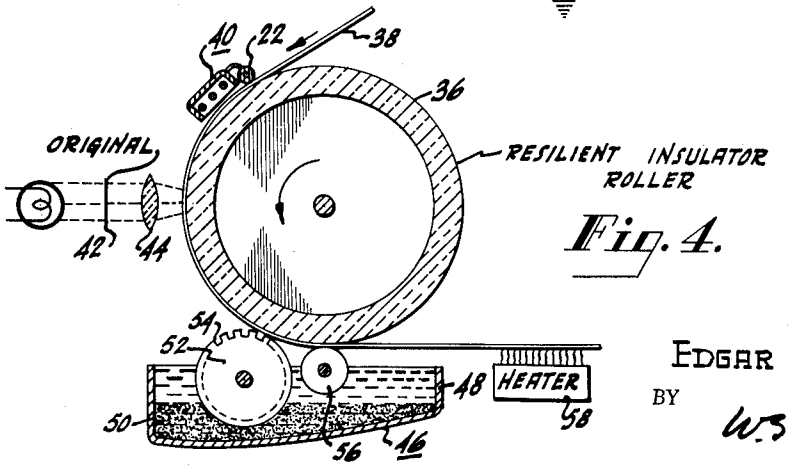


Fig. 4.

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ELECTROSTATIC CHARGING

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The present invention relates to the art of electrostatic recording and, more particularly, to a new and improved method and apparatus for electrostatically charging the surface of an electrostatic recording medium.

Electrostatic recording processes usually utilize a recording medium having a surface made of a composition including a photoconductive insulating substance. This surface must be charged before it is exposed to a light image in the normal recording process. This is ordinarily done by placing the recording medium over a grounded metallic backplate, photoconductive surface up, and passing a corona discharge over said surface. The ions (usually negative) thus produced are accelerated by the electric field established between the corona wires and the grounded backplate and are captured on the photoconductive surface, charging the same.

While the above method of charging produces very satisfactory results, it would be advantageous in certain applications to be able to charge the photoconductive surface without requiring the metallic backplate. For example, it is not convenient or, in some cases possible, to use a backplate when charging a photoconductive surface on a carton or other container. For one thing, the carton may be full so that the metallic backplate cannot be placed in position or the backplate may not fit into the carton. For another, even if empty, the cardboard or other material of which the container is made may be so thick that a suitable electric field will not develop between the high voltage wires about which the corona forms, and the backplate. Tests have shown that in such cases, that is, in cases in which the photoconductive surface is on a thick insulating backing, it is not possible to charge the photoconductive surface by conventional means. It is necessary instead to place a thin conductive layer on top of the thick insulating backing and to place the photoconductive surface coating over the conductive layer.

The elimination of the metallic backplate would also be advantageous in certain automatic printing processes in which liquid developers are employed. There, the paper is partially dried after the liquid developer is applied, by passing it between a transport roller and a polished metal squeegee roller. The transport roller, if it also serves as the backing layer during the charging of the paper, must be made of metal. In this case, when the paper is being dried, it is engaged between two nonresilient surfaces and, since the paper is not of absolutely uniform thickness, the squeegee roller does not provide uniform drying action. It would be better to use a resiliently surfaced roller for the transport roller as this would permit better engagement between the squeegee roller and the paper. Also, if the transport roller could be made of an insulator rather than a metal, the charged paper would adhere better and this would be advantageous in equipment such as office copiers, in which single sheets must be reproduced.

An object of the present invention is to provide a new and improved apparatus and method for electrostatically charging the photoconductive surface on a paper or other insulating medium, which does not require a metallic or other conductive layer located beneath said surface or beneath said insulating medium.

Another object of the invention is to provide a new method and apparatus for electrostatically printing labels on containers, when the latter are full or empty.

According to the present invention, an area of the

photoconductive surface of the recording medium is placed at a reference potential and an electrode at a widely different potential is placed close to an adjacent area of the same surface. Charge carriers such as ions of the same sign as the electrode are introduced in the field thus created and are accelerated by it to said surface, thereby charging the same. No metallic backplate is required.

A preferred form of the invention which is suitable for charging by hand includes thin wires about which a corona is formed by maintaining the wires at several thousand volts negative. An elongated, grounded, conductive member such as a polished steel roller is fixed to the housing for the wires in position to engage the photoconductive surface of the recording medium as the wires move along said surface. It is believed that a high voltage field is thereby established from the high voltage wires through and probably along the photoconductive surface, and to the grounded roller. The negative ions produced at the wires are accelerated by this field and some deposit on the surface charging the same.

The charging works best when the recording medium is humidified to a certain extent prior to being charged. It is believed that the medium in contact with the roller provides a resistive path along which the electric field develops and that the higher moisture content lowers the resistance and thereby enhances the field strength and the subsequent charging operation.

The invention will be described in greater detail by reference to the following description taken in connection with the accompanying drawing in which:

FIG. 1 is a drawing of a presently used apparatus for charging electrostatic recording paper;

FIG. 2 is a cross-sectional view of an apparatus for charging a sheet of electrostatic printing paper according to one form of the present invention;

FIG. 3 is a partially cut-away perspective view of a second embodiment of the present invention; and

FIG. 4 is a cross-sectional view of an automatic printing embodiment of the present invention.

FIG. 1, which is a drawing of a known charging apparatus, is referred to first. A sheet of electrostatic printing paper **10** is positioned on a metallic backplate **12**. The coated surface of the paper **14** is up. The electrostatic charger consists of a metallic housing or shield **16** within an insulator housing **18**. A plurality of fine wires **20** are located in the housing adjacent to the open side thereof and extend along the length of the housing. These wires are maintained at a voltage sufficiently high, such as —6,000 volts, for example, to produce a corona discharge. The metallic housing **16** is grounded as is the metallic backplate **12**. The paper is charged by passing the charger just described over the coated surface **14** of the paper.

A preferred form of the present invention is shown in FIG. 2. The housing and corona discharge wires are the same as those shown in FIG. 1 and are identified by the same reference numerals. The improvement consists of the grounded metallic roller **22** which is fixed to the housing as, for example, by support **24** and is maintained at the same potential as the metal portion or shield **16** of the housing. This is indicated schematically by the wire **26** shown connecting the roller to the housing. The electrostatic printing paper **10** need not be placed on a metallic backplate. It is instead positioned on an insulator such as lucite, rubber or any other suitable material as shown schematically at **27**. The paper is charged by moving the roller and the corona device together over the length of the paper. It has been found that the spacing between the roller and the closest wire should be not greater than about two inches or so and preferably less than this to give optimum performance.

It has been found that improved performance results when the recording medium is humidified to a certain extent prior to being charged. During dry weather this may be done by storing the paper or other recording medium in an atmosphere having a relative humidity of about 30–40% or more. However, often the relative humidity is 30 or 40% or more and on days like this, very good results may be obtained without separately humidifying the paper or other recording medium prior to charging.

While the theory of operation of the charger shown in FIG. 2 is not completely understood, it is believed to operate somewhat as follows. An electric field develops between the high voltage wires **20** and the grounded metallic roller **22**. Some of the electric field lines may go directly from the wires to the roller but many of them pass through the photoconductive surface of the recording medium and along the surface to the roller. It is believed that the photoconductive surface and possibly the insulating backing provides a resistive path to the high voltage field and that when the recording medium is humidified, the resistance of the path is lowered and the high voltage field thereby enhanced. In any case, the ions produced by the corona discharge at the wires are accelerated by the electric field and many of them are deposited on the surface thus charging the surface. It has been found also that better copy is produced when the recording medium is humidified, as indicated, than when it is very dry.

It might be expected that the charger of the present invention would operate only if the roller **22** preceded the corona discharge wires. In other words, it might be supposed that the charger would operate only if moved in the direction of arrow **28**. It might be surmised that if the roller followed the wires, the roller would discharge any charge previously deposited. However, in practice, this is found not to be the case. The charger operates regardless of the direction in which the roller is moved over the surface. The surface of the recording medium is relatively rough and it is believed that the smooth, metallic roller **22** engages only the high points of this surface. Accordingly, it is believed that the roller when it follows the corona wires does not completely discharge the surface but instead only discharges the high points on the surface. In any case, it has been found possible to obtain acceptable prints with the charging apparatus of the present invention when moved in the direction of arrow **28** of FIG. 2 or in the opposite direction.

If roller **22** is formed of a material which engages the photoconductive surface more intimately, it is desirable to move the charger over the surface only in the direction of arrow **28**. A roller of this type, for example, can be made of a resilient conductive material such as a carbon-loaded rubber or a conductive brush in which the brush fibers are relatively thin and relatively flexible. In such case the grounded member more fully discharges the photoconductive surface if it follows the high voltage corona wires.

A perspective view of another embodiment of the invention is shown in FIG. 3. A brush **30** with metallic fibers **32** replaces the roller **22** of the embodiment of FIG. 2. Numeral **34** identifies the switch which is turned on by hand during the charging step. As in the embodiment of FIG. 2, the metallic fibers **32** are maintained at the same potentials as the metallic portion **16** of the housing.

An automatic printing embodiment of the present invention is illustrated in FIG. 4. It includes a transport roller **36** which may be solid, or hollow, as shown, and is formed of a resilient insulator. Single sheets or a continuous sheet of electrostatic printing paper shown schematically at **38** pass over this roller. The charger of the invention is shown at **40** with the steel roller **22** thereof engaging the coated side of the paper and holding the paper against the insulator roller **36**. The metallic roller **22** may be made of polished steel, polished aluminum or the like. The roller grounds the paper and the remainder of the charger then charges the paper.

The original **42** is exposed to the charged paper through a suitable lens system illustrated schematically at **44** onto the charged electrostatic printing paper. The latent image is then developed at **46**. A liquid developer is employed which includes particles of a solid, electroscopic substance suspended in a liquid at the bottom of can **48**. These are shown by the dotted area **50**. The upper portion of the liquid is a clear wash solution. The roller which carries the liquid developer is shown at **52**. It is formed of a metal such as polished steel and has ridges formed along its entire circumference of the roller. Several of the ridges are shown at **54**.

As the insulator roller turns, the roller **54** applies liquid developer to the latent charge image on the electrostatic paper. The second roller **56** is a squeegee. It is preferably formed of a metal such as polished stainless steel to avoid excessive corrosion of the roller and to minimize wetting of the roller by the liquid. Roller **56** squeegees excessive developer on the paper into the clear wash liquid of the upper portion of container **48** and the wash liquid removes the excess developer from the roller. The use of a resilient insulator roller rather than the prior art metal roller is advantageous because it permits very efficient squeegeeing action between roller **56** and the resilient roller.

The fixing operation is shown schematically at **58**. A heater is located adjacent to the strip of moving electrostatic printing paper. The heater fuses the developed image, forming a permanent image on the paper.

Media of the type which may be charged with the apparatus and method of the present invention include, in general, a coating consisting of a particulate photoconductor in a binder on a paper or other insulator backing. Various types of papers which are suitable are described in an article by Grieg and Young appearing in the December 1954 issue of the RCA Review at page 469.

What is claimed is:

1. Apparatus for electrostatically charging an electrostatic printing medium comprising, in combination, a metallic housing having an open portion; means in said housing adjacent to said open portion for producing a corona discharge; and a metallic roller electrically connected to the housing and thereby maintained at the same potential as the housing extending from the housing and positioned to engage a surface of the medium adjacent to the portion at which the corona discharge is directed.

2. Apparatus for electrostatically charging the surface of an electrostatic printing medium comprising, in combination, a housing having an open end; means in said housing for producing a corona discharge at said open end; and a grounded surface-engaging metallic roller fixed to said housing and positioned to engage said surface as the apparatus passes over said surface.

3. An electrostatic charger comprising, in combination, an open-sided housing including a metallic shield; at least one fine wire in said housing and near the open side thereof for producing a corona discharge; and a conductive, surface engaging member extending along the length of said housing and fixed thereto, and electrically connected to said shield for engaging a surface of the medium to be charged.

4. Apparatus for electrostatically charging a sheet of electrostatic printing paper comprising, in combination, an elongated housing including a conductive shield and having an opening extending along the long dimension thereof; a plurality of fine wires in the housing adjacent to the opening therein and extending along the long dimension of the housing for producing a corona discharge; and an elongated conductive roller fixed to the housing and electrically connected to said shield extending substantially parallel to the long dimension thereof and positioned beyond the open end of the housing for engaging the paper during the charging operation.

5. Apparatus for charging a sheet of electrostatic printing paper having a photoconductive surface comprising, in combination, a roller formed of a resilient insulator; a grounded metallic roller engaged with the insulator roller, whereby, when the resilient roller is rotated and a sheet of electrostatic printing paper is passed between the metallic roller and the insulator roller with the photoconductive surface thereof adjacent to the metallic roller, the latter places the surface at ground potential; and a corona discharge means adjacent to the metallic roller and the insulator roller for charging said surface immediately after it passes between the two rollers.

References Cited in the file of this patent

UNITED STATES PATENTS

1,782,712	Chapman	Nov. 25, 1930
1,947,220	Nickle	Feb. 13, 1934
2,319,174	Wilson	May 11, 1943
2,333,213	Slayter	Nov. 2, 1943
2,626,865	Mayo	Jan. 27, 1953
2,692,178	Grandadam	Oct. 19, 1954
2,752,271	Walkup	June 26, 1956
2,756,676	Steinhilper	July 31, 1956