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XEROGRAPHIC CHARGING DEVICE

2,790,082

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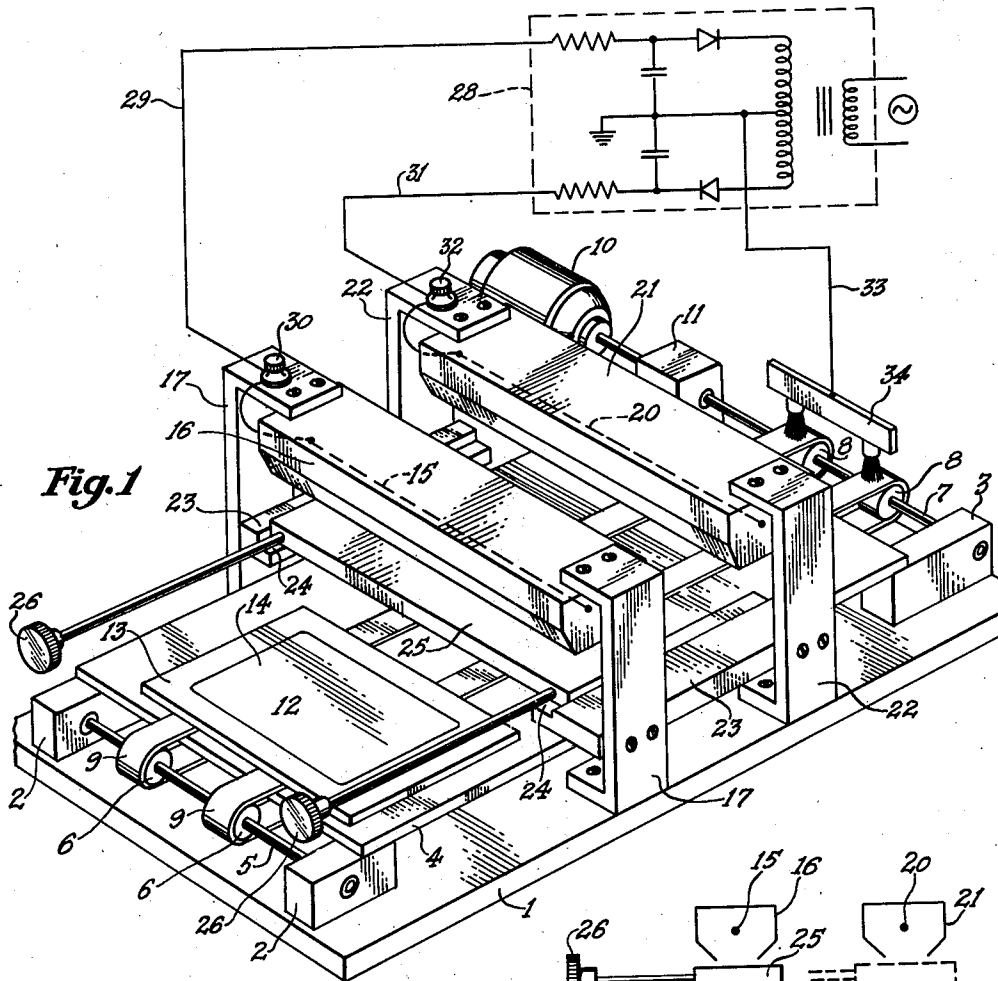


Fig. 1

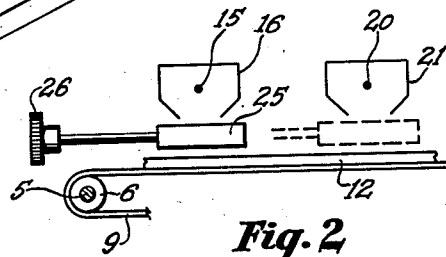


Fig. 2

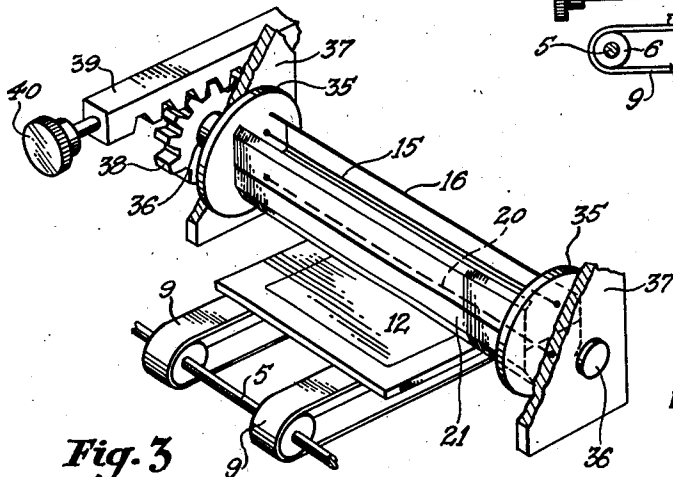


Fig. 3

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XEROGRAPHIC CHARGING DEVICE

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7 Claims. (Cl. 250—49.5)

This invention relates to the field of xerography and, particularly, to improvements in charging apparatus for selectively placing a positive or negative electrostatic charge on a xerographic plate by corona discharge means.

In a general application of the process of xerography, as disclosed in Carlson Patent 2,297,691, issued October 6, 1942, a xerographic plate comprising a coating of photoconductive insulating material on a conductive backing is given a uniform electric charge over its surface and is then exposed to the subject matter to be reproduced, usually by conventional photographic techniques, such as by camera, projection, or contact exposure, depending upon the type of application. This exposure discharges the plate areas in accordance with the light intensity which reaches them, thereby creating an electrostatic latent image on or in the plate coating. Development is effected with a finely divided material, such as an electroscopic powder, which is brought into contact with the coating and is held thereon electrostatically in a pattern corresponding to the electrostatic latent image. Finally, the powder image is transferred to a suitable base, such as paper, and is fixed thereon by fusion or by use of a solvent, in accordance with the type of powder employed.

In the process disclosed in the above patent, the xerographic plate preferably comprises a photoconductive layer of sulphur or anthracene on a brass or aluminum backing, and electrostatic charging of the plate is accomplished by rubbing the photoconductive surface with silk, fur, or a soft brush. Although this procedure is suitable for many applications, subsequent developments have shown that plates having a photoconductive layer of selenium on an aluminum backing are more practical for most commercial applications, and that such plates may be charged more effectively and more efficiently by the use of a corona discharge device.

In general, corona charging may be accomplished in a variety of ways, in accordance with the requirements of a particular application. For example, the corona discharge device may comprise a single wire or series of parallel wires, that are fed from a high voltage source, relative to which the plate may be moved at a uniform rate of speed to place an electrostatic charge thereon. Conversely, the plate may be held stationary and the corona discharge unit may be moved relative to it to deposit a charge thereon. In other devices, it is expedient to hold both the plate and the discharge device stationary during the charging operation. In all instances, it is essential that the electrostatic charge placed on the xerographic plate be uniform throughout in order to provide good quality in the finished copy, and that the charge be of a predetermined magnitude and polarity, depending upon the type of copy to be made.

Typical examples of corona type charging devices are disclosed in Carlson Patent 2,551,582, issued May 8, 1951, Walkup et al. Patent 2,588,675, issued March 11, 1952, Carlson Patent 2,588,699, issued March 11, 1952, and Sabel et al. Patent 2,600,580, issued June 17, 1952. These arrangements permit the charging of a plate to a higher

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potential than can be obtained frictionally and the plate potential can be predetermined approximately, by regulating the charging voltage and controlling the speed at which the plate is passed under the charging source. In general, most commercial xerographic machines employ comparable types of charging devices wherein the xerographic plate is charged by means of a positive polarity corona discharge electrode. However, in certain applications it is also required that means be provided to charge a plate with a negative polarity. For reasons believed to be soundly supported by theoretical consideration it has been found necessary to charge certain xerographic plates positively and to charge certain others negatively. Another example of such a requirement occurs in the "multiple copy process" disclosed in my co-pending application Serial No. 387,469, filed October 21, 1953.

In the method of the invention disclosed in the above mentioned application, a single electrostatic latent image is formed and developed in conventional manner and is utilized for the formation of a plurality of copies of the image. Specifically, this is accomplished, in one embodiment of the invention, by laying a piece of paper over an electrostatic charge pattern that has been developed on a xerographic plate with a conventional type of developing agent or powder, applying a uniform electrostatic charge over the surface of the paper, such charge being of a polarity to attract the powder image to the paper, then applying another uniform electrostatic charge of opposite polarity over the surface of the paper to repel the powder image from the paper and return it to the plate surface on which it was originally formed, and then separating the paper from such plate surface. In the process of being electrostatically attracted to and then repelled from the surface of the paper, a portion of the developing powder comprising the original powder image adheres to the surface of the paper and forms a readily readable image thereon. By repeating the foregoing charging and reverse charging steps, using successive sheets of paper, a limited number of usable copies, usually on the order of eight to twelve, can readily be made from a single powder image.

The precise physical phenomenon that produces the above result is not specifically known. The effective splitting of the original powder image in this process may result from the fact that some of the charged powder particles induce opposite charges in the paper that are not overcome by the reverse polarity corona charging step. Again, the residual powder image remaining on the paper may result from a physical entrapment of powder particles in the interstices of the paper. Finally, other undefined intermolecular forces may be responsible for the end result. In any event, the process is widely employed in any xerographic installation whenever it is required to make a limited number of copies of an original since the charging and reverse charging steps of this technique can be accomplished in a matter of seconds as compared to the two or three minutes required to make individual prints by conventional manual xerographic methods.

In order to permit the practice of the above mentioned "multiple copy process," xerographic machines now in general use are provided with independent power supplies for producing positive and negative corona or with a single center tapped power supply whereby the same result may be obtained. In either case a single corona discharge electrode is employed so that it is necessary to include an electrical switching mechanism in the circuit between the power supply and the discharge electrode. Inasmuch as the corona voltages are on the order of 6,000 to 7,000 volts, the switching mechanism must be located in a position to eliminate the possibility

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of contact by the operator and is usually actuated by a low voltage relay circuit that may be safely operated by the operator. A circuit of this type is inherently costly and requires rather elaborate electrical shielding and, since arcing is inherent in the switching mechanism, also requires an appreciable amount of maintenance to maintain it in proper working order.

The principal object of the present invention is to improve the construction of corona discharge electrode control means for use in xerographic systems. A further object is to provide improved means for effecting selective positive or negative corona charging of a xerographic plate. A further object is to provide a mechanical switching device for selectively applying positive or negative corona during a xerographic plate charging operation. A further object is to provide a compact, low-cost device for producing positive or negative corona, selectively, and which provides a maximum of operator safety and requires a minimum of maintenance.

Briefly, these and other objects of the invention are attained by the use of a power supply with a double output, one positive and one negative, connected to two corona discharge electrodes so that both electrodes function simultaneously, and effecting the switching from positive to negative discharge, and vice versa, by selectively positioning a discharge electrode shield to prevent corona emission from one or the other of the corona electrodes, or by selectively positioning the discharge electrodes to place the desired one in operative relationship to the xerographic plate to be charged.

The invention is disclosed in the accompanying drawings, in which:

Fig. 1 is an isometric view of a xerographic plate charging apparatus equipped with one form of the invention;

Fig. 2 is a schematic end elevation of the corona switching mechanism of Fig. 1; and

Fig. 3 is a schematic isometric view of an alternate form of the invention.

Although it will be apparent that the invention disclosed herein may conveniently be employed as a plate charging apparatus in any desired type of xerographic system, the invention is disclosed, for purposes of illustration, in conjunction with a laboratory type plate charging apparatus which is an adaptation of that shown in co-pending application S. N. 154,295, filed April 6, 1950, in the name of Lewis E. Walkup. Essentially, such a device comprises a xerographic plate supporting and conveying apparatus for moving the xerographic plate in spaced relation and at a predetermined speed with reference to a plate charging station, and includes a suitable power supply to provide the required voltages for the plate charging corona electrodes.

Specifically, the plate supporting and conveying mechanism includes a base plate 1 (see Fig. 1), preferably formed of insulating material, on which are secured spaced pairs of nylon blocks 2 and 3 that support a rectangular insulating platform 4 at the corners thereof. Journalled for rotation in suitable bearings in blocks 2 is a shaft 5 on which are mounted a pair of pulleys 6. At the opposite end of base plate 1, a similar shaft 7 is journalled in blocks 3 and is provided with a pair of pulleys 8 secured thereto. Extended around opposing pairs of pulleys 6 and 8 are a pair of endless belts 9 which may be formed of flexible metal strips or metal impregnated webbing to provide a conductive medium. Shafts 5 and 7 are spaced vertically relative to insulating platform 4 so that the upper portions of endless belts 9 slide over the top of the platform and are supported thereby, whereas, the return portions of the belts extend beneath the platform. For driving belts 9, the apparatus is provided with a motor 10 that is connected to shaft 7 through a suitable speed changing mechanism 11 whereby the belts may be driven at any desired linear speed.

With this type of conveying mechanism, a xerographic plate 12, which by way of example is illustrated as a

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conventional commercial component comprising an aluminum backing member 13 having an amorphous selenium layer 14 thereon, may be laid on endless belts 9 at the forward end of the apparatus and be conveyed rearwardly by frictional engagement with the belts. Such an arrangement insures that a plate may be passed in predetermined spaced relation to a charging station, and at any desired speed relative thereto.

The charging apparatus of the invention includes a positive corona discharge electrode wire 15 (see also Fig. 2) that is suspended in a shield assembly 16 having its top, side, and end members formed of insulating material and being open along its bottom area to permit the egress of corona. Insulating member 16 is supported from the upper flanges of a pair of channel members 17 that are secured on base plate 1. Similarly, a negative corona discharge electrode wire 20 is suspended in an insulating shield assembly 21 that is supported by a second pair of channel members 22 mounted on the base plate 1. Supported between adjacent pairs of channel members 17 and 22 are a pair of guide rails 23 each being provided with a stepped slide portion 24 for supporting and guiding a rectangular shielding plate member 25 that is formed of insulating material. Guide rails 23 are of such length that insulating plate member 25 may selectively be positioned directly beneath the opening in either of the insulating shield assemblies 16 or 21, by means of handles 26 that are secured to plate 25.

For supplying charging voltages to electrodes 15 and 20, the invention may include any convenient type of power supply 28, such as the half wave rectifier type shown in the drawings, from which a positive high voltage is supplied, via lead 29 and terminal 30, to electrode 15 of the positive corona charging station, and negative high voltage is supplied, via lead 31 and terminal 32 to electrode 20 of the negative charging station. The ground lead of the rectifier circuit may be connected via a lead and conductive brush assembly 34 to contact the conductive endless belts 9 whereby the xerographic plate 12 is suitably grounded through its backing plate 14 during charging operation of either polarity.

In the arrangement thus disclosed, a xerographic plate may be charged either to a positive or to a negative polarity, depending upon the type of charging required for a given application. This result is achieved by a manual positioning of shielding plate 25 whereby the high-cost electrical switching apparatus generally employed for this purpose is replaced by an extremely simple and low cost device that requires a minimum, if any, maintenance.

It should be noted that both the positive and the negative discharge electrodes 15 and 20 are continuously energized during a charging operation of either polarity. Although this arrangement results in a slight power loss, it is well known that corona from a wire is dependent upon the field surrounding the wire and that the strength of this field is determined by the wire potential, the wire size, and its environment. For example, a wire isolated in space requires a much higher voltage to produce a given corona than a wire contained within a grounded conducting cylinder. Furthermore, merely putting an insulator in the vicinity of a discharge electrode will cause the insulator to acquire as high a charge as the wire itself and thus reduce the field around the wire to reduce its current consumption. Therefore, in the present arrangement, discharge electrodes 15 and 20 are substantially completely surrounded by their respective shielding assemblies 16 and 21, respectively, so that the movement of shielding plate 25 opposite the opening in either shielding assembly substantially reduces the power requirements of the inoperative electrode during the period that it is shielded. As a result, the total power loss from the system of the invention is reduced to a negligible minimum.

The description thus far has been limited to the utiliza-

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tion of the invention for selective charging of a xerographic plate to a positive or negative polarity. However, it is apparent that the apparatus may conveniently and expeditiously be adopted as a highly efficient device for carrying out the "multiple copy process," described above, merely by removing the shielding plate 25 from guide rail 23. When this is done, both electrodes 15 and 20 are unblocked and direct their respective positive and negative corona downwardly, simultaneously. Under these conditions, if a sheet of bond paper is placed on top of a xerographic plate having a powder image formed thereon, and the plate is placed on endless belts 9, it is passed first under positive electrode 15 to attract and electrostatically bond the powder image to the paper, and, immediately thereafter, under electrode 20 to repel the powder image from the paper and restore substantially all of the image to the xerographic plate, but leaving a residual image on the paper, as described above, whereby a complete copy can be made by a single pass through the charging stations.

In the alternate form of the invention disclosed in Fig. 3, positive and negative discharge electrodes 15 and 20 are arranged in shielding assemblies 16 and 21, respectively, that may be identical in construction to those shown in Fig. 1, except that they are arranged in back-to-back relation. The shielding assemblies 16 and 21 and assemblies 15 and 20 are supported between circular insulating discs 35 each of which is provided with a reduced hub portion 36 that is journaled for rotation in its respective bearing formed in standards 37 supported on a base plate, such as base plate 1 of Fig. 1. This arrangement is also intended for operation with a xerographic plate conveying system such as that shown in Fig. 1, and is provided with a similar power supply for energizing the electrodes.

In order to expose a xerographic plate to corona discharge from either electrode 15 or 20, selectively, one of the hubs 36 has fixed thereto a pinion 38 that is engaged by a rack member 39 that is supported in suitable guide members (not shown) and is positioned by means of a handle 40. Suitable limit stops (not shown) permit the positioning of the electrode assemblies so that either may be placed in operative position by a simple movement of handle 40.

For simplicity of illustration, the corona discharge electrodes 15 and 20 in each embodiment of the invention are shown as single wires. Obviously, when required by a particular application, the charging apparatus of the invention may be provided with the parallel strand corona wire and shielding grid of the type disclosed in the above mentioned Walkup application. Furthermore, although the invention is disclosed in an embodiment in which the xerographic plate is moved relative to the discharge electrodes, it is apparent that it may be applied equally well in a system in which the discharge electrodes are moved relative to a stationary plate. Since many other changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained herein shall be interpreted in an illustrative sense, and that the invention shall be limited only as defined in the appended claims.

What is claimed is:

1. A charging mechanism for applying positive or negative electrostatic charge selectively to xerographic plates comprising a positive corona charging station, a negative corona charging station, each of said stations including a continuously energized corona discharge electrode of corresponding polarity, conveying means for transporting a xerographic plate in spaced relation and at a predetermined speed relative to such charging stations, and means positionable selectively to block corona emission from one of said electrodes to said plate.

2. A charging mechanism for applying positive or negative electrostatic charge selectively to xerographic plates

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comprising a positive corona charging station, a negative corona charging station, conveying means for transporting a xerographic plate in spaced relation and at a predetermined speed relative to such charging stations, each of said stations including a continuously energized corona discharge electrode of corresponding polarity supported within an insulating shielding member, each shielding member having an opening to permit corona emission in the direction of the path of movement of the xerographic plate, and means positionable selectively to block corona emission from one of said electrodes to said plate.

3. A charging mechanism for applying positive or negative electrostatic charge selectively to xerographic plates comprising a positive corona charging station, a negative corona charging station, conveying means for transporting a xerographic plate in spaced relation and at a predetermined speed relative to such charging stations, each of said stations including a continuously energized corona discharge electrode of corresponding polarity supported within an insulating shielding member, each shielding member having an opening to permit corona emission in the direction of the path of movement of the xerographic plate, an insulating plate for blocking the opening of either of said shielding members, and means for positioning said plate in blocking relationship to said shielding members selectively.

4. A charging mechanism for applying positive or negative electrostatic charge selectively to xerographic plates comprising a positive corona charging station, a negative corona charging station, conveying means for transporting a xerographic plate in spaced relation and at a predetermined speed relative to such charging stations, each of said charging stations including a continuously energized corona discharge electrode of corresponding polarity supported within an insulating shielding member, said shielding members being arranged in back-to-back relationship and having diametrically arranged openings to permit corona emission from either electrode, rotatable mounting means for said shielding members, and means for selectively positioning said mounting means to place either of said electrodes in charging relationship to a xerographic plate transported by said conveying means.

5. A charging mechanism for applying positive or negative electrostatic charge selectively to xerographic plates comprising a positive corona charging device, a negative corona charging device, each of said devices including a continuously energized corona discharge electrode of corresponding polarity and either of said electrodes being movable to a charging position for effecting charging, conveying means for transporting a xerographic plate in spaced relation and at a predetermined speed relative to such charging position, and means for moving either of said electrodes into charging position selectively while the other is moved to a non-charging position.

6. A charging mechanism for applying positive or negative electrostatic charge selectively to xerographic plates comprising a positive corona charging station, a negative corona charging station, conveying means for transporting a xerographic plate in spaced relation and at a predetermined speed relative to such charging stations, each of said stations including a continuously energized corona discharge electrode of corresponding polarity supported within an insulating shielding member, each shielding member having an opening to permit corona emission in the direction of the path of movement of the xerographic plate, guide rails located intermediate said discharge electrodes and the path of movement of said plate, an insulating plate slidably mounted in said guide rails for blocking the opening of either of said shielding members, and means for positioning said plate in blocking relationship to said shielding members selectively.

7. A charging mechanism for applying positive or negative electrostatic charge selectively to xerographic plates comprising a positive corona charging station, a negative

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corona charging station, conveying means for transporting a xerographic plate in spaced relation and at a predetermined speed relative to such charging stations, each of said charging stations including a continuously energized corona discharge electrode of corresponding polarity supported within an insulating shielding member, said shielding members being arranged in back-to-back relationship and having diametrically arranged openings to permit corona emission from either electrode, rotatable mounting means for said shielding members, and means for selectively positioning said mounting means to place

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either of said electrodes in charging relationship to a xerographic plate transported by said conveying means, said last recited means comprising a pinion fixed to the shielding member mounting means and a rack for rotating said pinion.

References Cited in the file of this patent

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