Oct. 6, 1953 W. C. HUEBNER 2,654,315

PROCESS OF MULTICOLOR ELECTRONOGRAPHIC PRINTING

Filed May 15, 1947

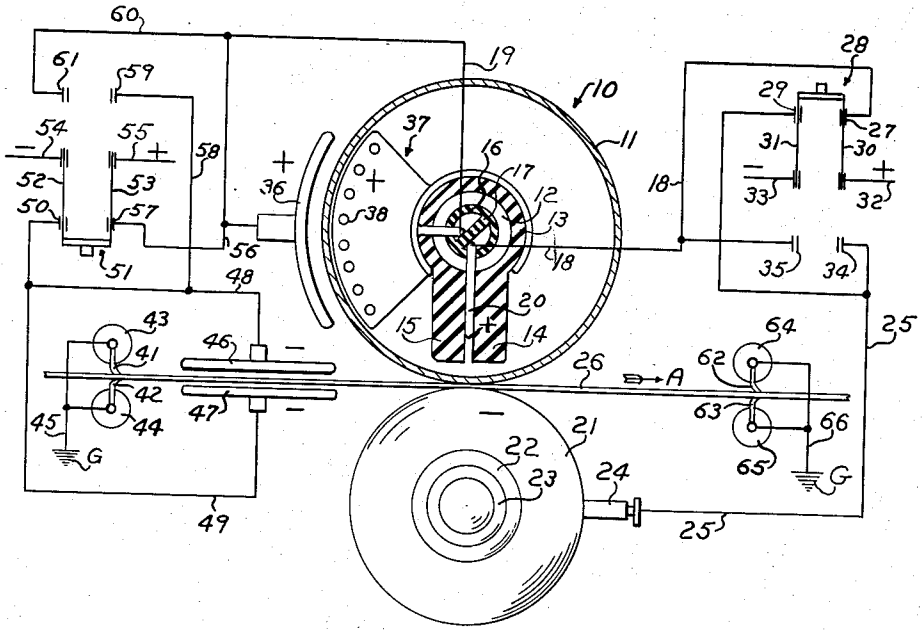


Fig. 1

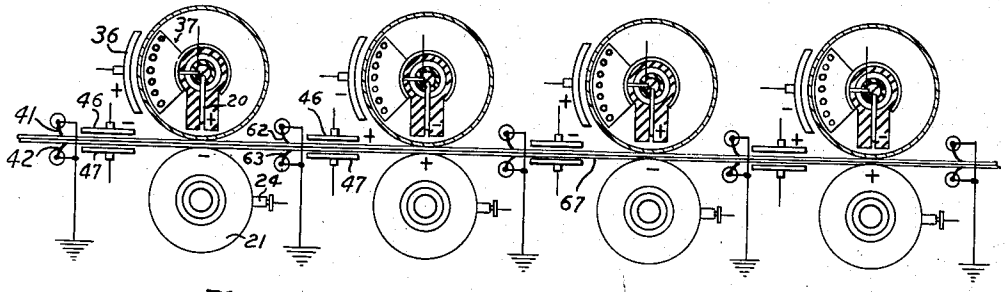


Fig. 3

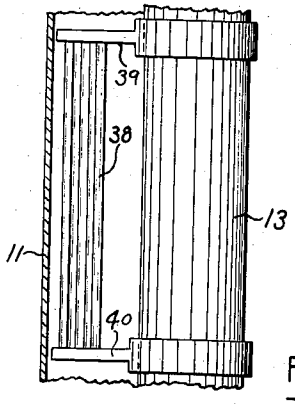


Fig. 2

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PROCESS OF MULTICOLOR ELECTRONOGRAPHIC PRINTING

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1 Claim. (Cl. 101—211)

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This invention relates to a process of and apparatus for printing wherein the ink is transferred from the inked image areas of the image carrying member of a printing couple to the surface of the print receiving material by means of electro lines of force of a field or fields of force to reproduce the image on said surface and without the use of pressure, or substantial pressure, between the image carrying member and the print receiving material, as distinguished from ordinary printing wherein the image is reproduced by the exertion of substantial printing pressure between the image carrying member of the printing couple and the print receiving material.

As defined in all dictionaries, the term "printing" involves the use of pressure between the ink carrying and ink receiving surfaces of a printing couple and there appears to be no available term in the English language which will accurately define the method of transferring ink from the ink carrying to the ink receiving surfaces of a printing couple where no printing pressure is employed. Hence, throughout the present specification where the term "printing" and related terms are employed in describing and claiming the apparatus and process it is to be understood that in employing such terms they are used as being the nearest appropriate terms.

Further, throughout the specification, the expression "field of force" is used similarly as in writings on electrical phenomena to indicate the field or zone in which electronographic forces are sufficiently active or powerful enough to effect a transference of ink from one surface to another in the manner indicated herein. The expression "lines of force" is likewise employed to indicate the forces themselves acting in a definite path or direction in effecting the transference of the ink.

As will be understood by those skilled in the art, the term "image" and related terms as used throughout the specification contemplate words, letters, delineations, drawings, pictures, illustrations and the like which may be reproduced on the print receiving material from relief, intaglio, planographic or any other known type of printing member, and such terms are used as embracing any one or any combination of such items.

It will also be understood that the term "ink" employed herein is intended to refer to ink in the ordinary sense and also to any other substance which can be employed in reproducing in color or otherwise on print receiving material an image carried by the printing member of a printing couple.

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An object of the invention is to provide a novel and improved process of and apparatus for printing by means of electro lines of force of a field of force and wherein provision is made for elimination of any existing electrical charges upon the print receiving material prior to introduction of the print receiving material into the printing zone and/or after the material has passed through the printing zone.

Another object of the invention is to provide a novel and improved process of and apparatus for printing by means of an electro field of force which effects transfer of ink from the printing member of a printing couple to print receiving material and wherein existing electrical charges upon the print receiving material are eliminated and the print receiving material is thereafter electrically precharged prior to its introduction into the printing zone.

A further object of the invention is to provide a novel and improved method of and apparatus for printing in a plurality of colors by means of a plurality of printing couples employing electro fields of force to effect transference of the ink to the print receiving material and in which the print receiving material is successively passed through the field of force for each printing couple employed, and provision is made for eliminating any existing electrical charges upon the material and thereafter providing the material with an electrical precharge prior to its introduction into the printing zone of each printing couple.

Another object of the invention is to provide a novel and improved process and apparatus of the type defined in the preceding object and in which provision is made for impressing an electrical precharge upon the ink on the printing member of each couple, the precharge impressed upon the ink on each member having a polarity which is opposite to that imparted to the print receiving member prior to introduction of the material into the printing zone of that member, and the polarity of the charge impressed upon the ink on the printing member of at least one of the printing couples being of opposite polarity to that impressed upon the ink on others of the printing members.

A still further object of the invention is to provide a novel and improved process and apparatus of the type referred to in the preceding objects and in which each printing couple comprises a discharge and attraction element for creating a field of force and in which the polarities of the discharge and attraction elements of one couple differ respectively from the polarities of the corresponding elements of other couples,

the existing charge upon the print receiving material being eliminated after passing through the field of force of the attraction and discharge element of each previous couple and prior to receiving a precharge for the next succeeding couple, which precharge is of the same polarity as that of the attraction element of the said next succeeding couple.

The invention further resides in certain novel features, details of construction, steps of procedure and combinations and arrangements of parts, and further objects and advantages thereof will be apparent to those skilled in the art to which it pertains from the following description of the present preferred embodiment thereof described with reference to the accompanying drawing in which similar reference characters represent corresponding parts throughout the several views and in which:

Fig. 1 is a somewhat diagrammatic view of a printing couple, partly in section and partly in end elevation, disclosing the present preferred form of an apparatus embodying the invention and by means of which the process may be effected;

Fig. 2 is a top plan view of the ink precharging element which is disposed within the image cylinder, a portion of the cylinder being shown in section which section is taken substantially through the diameter of the cylinder; and

Fig. 3 is a diagrammatic view of a plurality of printing couples, each similar to that illustrated in Fig. 1, and employed in sequence in accordance with this invention to effect printing of a plurality of different colors upon print receiving material.

The process and apparatus disclosed herein constitute improvements on the processes and apparatus disclosed in my copending application Serial No. 591,739 filed May 3, 1945, now Patent No. 2,483,462, issued October 4, 1949, which discloses processes and apparatus for printing wherein the ink is transferred from a movable inked imaged carrying member of a printing couple to the print receiving material by means of electro lines of a field of force, and wherein the print receiving material moves in timed relation relative to the image carrying member and is either spaced therefrom with no contact or pressure therebetween or is in contact with said member by no pressure therebetween.

In printing electronographically, wherein electro lines of force are utilized to transfer the ink from the image carrying member to the print receiving material, it is very important that the lines of force be effective to transfer all of the ink from the image carrying member to the material at the printing zone. It has been determined that any unknown charge of electricity that may be present in the print receiving material prior to reaching the printing zone may have a retarding effect upon the complete transfer of ink at the printing zone, since such a charge may have a polarity opposite to that of the attraction element of the printing couple and thus act in opposition to, and interfere with, the effectiveness of the electro lines of force passing between the discharge element and attraction element. Even where the unknown charge is of proper polarity the value thereof is not necessarily constant and hence erratically influences the transfer of the ink.

The fact that the print receiving material is subject to having created therein charges of static electricity before reaching the printing zone of the couple, the polarity of which may be difficult to control or determine, it is proposed to assure efficient ink transfer at the printing zone by first eliminating existing electrical charges and then precharging the print receiving material with the same polarity as the polarity of the attraction element of the couple, and to also precharge the ink with a polarity which is the same as the polarity of the discharge element of the couple. Further, since the print receiving material retains at least a part of the charge after passing through the printing zone it is proposed, in accordance with this invention, to provide for removal of this charge after the material has passed through the printing zone of one couple and prior to precharging the material in advance of the introduction of the material into the printing zone of a succeeding couple, thereby permitting efficient successive printing upon the same material of different colors in rapid succession and eliminating any possibility of offsetting of one color from the material during the successive printing stages or after the printing has been completed.

In Fig. 1 of the drawing, there is diagrammatically illustrated a printing couple comprising a movable image carrying member 10 shown in the form of a cylinder, the wall 11 of which is a thin section. This cylinder is rotatably mounted at its opposite ends by means of tubular supports 12 carried by the frame of the printing couple and extending into the cylinder in a manner similar to that illustrated in my prior Patent No. 2,408,144, issued September 24, 1946. The inner ends of the supports 12 are surrounded by and support an insulating sleeve 13 extending the length of the cylinder and having spaced apart insulating bars 14 and 15 extending radially therefrom. The bars 14 and 15 are shown as being formed integral with the sleeve 13 and these bars have their free ends adjacent the inner circumference of the cylinder 10. An insulating sleeve 16, extending through the cylinder, is mounted within the tubular supports 12 and its opposite ends project beyond the frame with the said sleeve 16 containing a diametrical partition 17 dividing the sleeve into two compartments. Extending through one compartment of the sleeve 16 is an electrical conductor which may comprise the inner end of a lead wire 18, and extending through the other compartment is an electrical conductor which may comprise the inner end of a lead wire 19. As shown in the previously mentioned Patent No. 2,408,144, the wall 11 of the cylinder 10 is electrically insulated from the frame of the press and from the tubular support 12.

A discharge element is contained in the cylinder 10 and is here shown in the form of a blade 20 extending longitudinally of the cylinder and located in the space between the insulating bars 14 and 15 and supported therein in any suitable manner. The inner end of the blade is electrically connected to the wire or conductor 18 while the outer end of the blade is adjacent the inner circumference of the cylinder but spaced inwardly of the outer ends of the insulating bars 14 and 15. Although the discharge blade 20 is shown in Fig. 1 as spaced some distance inwardly from the wall 11, in some instances it may be desirable to have the outer end of the blade extend outwardly with respect to the insulating bars 14 and 15 and more closely adjacent to but, nevertheless, spaced from the inner periphery of the wall 11 of the cylinder.

It will be understood that the outer wall 11 of the cylinder 10 is provided on its exterior with an image area or areas and with non-image area or areas and that the image areas may be inked with any suitable means such as inking rollers or the like while the non-image areas will not have ink applied thereto as is well known in the art. The cylinder may be adapted for intaglio, planographic or relief printing and the type of inked means employed will be in accordance with the type of printing the cylinder is to perform as is well known in the art.

The attraction element for the printing couple is located externally of the cylinder 10 and extends longitudinally thereof. In the illustrated form of the apparatus this attraction element comprises a cylindrical drum 21 of conductive material supported by an insulating sleeve 22 upon tubular supports 23, similar to the tubular supports 12, and fixedly carried by the frame in a manner similar to that illustrated in Patent No. 2,408,144. A stationary brush 24 is adapted to electrically connect the drum 21 to an electrical circuit, hereinafter described, by means of a conductor 25. As shown in Fig. 1, the cylinder 10 and the attraction element 21 are spaced apart sufficiently to receive the print receiving material 26 therebetween but without exerting any appreciable pressure thereupon and the material 26 moves in the direction of the arrow A. The cylinder 10 and attraction element or drum 21 are rotated in predetermined timed relation, by means not shown.

The discharge element or blade 20 and the attraction element or drum 21 are connected in an electrical circuit with a source of high potential direct current so that an induced electro field of force is created across the gap between the said elements with the lines of force thereof acting in a direction to transfer the ink from the ink image areas from the cylinder 10 to the adjacent surface of the ink receiving material. This is effected by connecting the wire 18 to one stationary terminal 27 of a double-pole, double-throw switch, generally designated 28, and by connecting the wire 25 to the adjacent stationary terminal 29 of the switch 28, the movable blades 30 and 31 of the switch being connected, respectively, with the power supply wires 32 and 33. Hence, with the switch 28 in the position illustrated in Fig. 1, electrical current of positive polarity is applied to the discharge element 20 while electrical current of negative polarity is applied to the attraction element or drum 21. As will hereinafter be described, it is sometimes desirable to reverse the polarities of the discharge and attraction elements and this may be effected by connecting the other set of stationary contacts 34 and 35 of the switch 28 to the wire 25 and 18, respectively. Hence when the movable blades 30, 31 of the switch are placed in contact with the stationary contacts 34 and 35 the polarities of the discharge and attraction elements are reversed.

In order to assist the transfer of the ink from the image cylinder 10 to the print receiving material 26 it has been found desirable to precharge the ink upon the cylinder 10 with a charge corresponding in polarity to that carried by the discharge element 20. This is effected in the illustrated apparatus by providing a curved terminal plate 36 externally of the cylinder 10 and intermediate the point where the image areas of the cylinder are inked and the printing zone, the latter lying between the discharge and attraction elements. The terminal 36 is preferably curved

concentrically with the circumference of the cylinder 10 and is spaced therefrom. Within the cylinder, and in alignment with the terminal 36, is mounted a stationary terminal member, generally designated 37. This member preferably comprises a plurality of longitudinally extending bars or rods 38 supported in parallel relationship and in a configuration corresponding with the curvature of the cylinder 10, but spaced therefrom, by sector shaped conductive end plates 39 and 40 (see also Fig. 2). The sector plates 39 and 40 have their inner ends supported upon the insulating sleeve 13 and the plates and rods are electrically connected with the previously mentioned conductor or wire 19 which leads to a circuit hereinafter described.

In order to eliminate any electrical charges which may be present upon the print receiving material 26, due to previous handling or to prior printing by an electronographic couple in which a precharge was imparted to the material, the print receiving material is passed between spaced conductive members which preferably take the form of longitudinally extending bars or wipers 41 and 42 located on opposite sides of the material 26 and riding upon or closely adjacent to the surfaces thereof and extending over the entire width of the material. These conductive bars or members are each supported by insulating members 43 and 44 and the members 41 and 42 are electrically connected to each other and to ground G by a conductor or conductors 45.

After the sheet material 26 has passed between the charge eliminators 41 and 42 it should then preferably be precharged with a charge having a polarity the same as that upon the attraction element or drum 21 in order to facilitate the transfer of the ink from the cylinder 10 in the printing zone. This is effected in the present instance by providing spaced terminal members 46 and 47 on opposite sides of the sheet material and located between the charge eliminators and the printing zone. These terminal members 46 and 47 are preferably spaced slightly away from the surfaces of the material 26 although the lower member 47 may act as a support for the material 26 if desired. The members 46 and 47 extend across the entire width of the material 26 and are electrically connected by wires 48 and 49 in the same circuit as that which is used to precharge the ink upon the cylinder 10. That is to say, the wires 48 and 49 are connected to each other and to a single stationary terminal 50 of a double-pole double-throw switch, generally designated 51, the movable blades 52 and 53 of which are connected, respectively, with electrical power supply wires 54 and 55 which are connected with a suitable source of electromotive force of the direct current type. The ink precharging element 36 is connected by a wire 56 to the stationary contact 57 which is adjacent the contact 50 of the switch 51. The other precharging element 37 is connected by the wire 19 with the wire 56 and hence is connected to the same terminal 57. Therefore, with the switch 51 in the position shown in Fig. 1, electrical current of positive polarity is applied to the ink precharging elements 36 and 37 while electrical current of negative polarity is applied to the material precharging elements 46 and 47.

In certain instances, as mentioned above, it is desirable to reverse the polarity of the attraction and discharge elements but whatever the polarity of these elements, the polarity of the precharge applied to ink should be the same as that em-

ployed upon the discharge element 20 while the polarity of the precharge applied to the material 26 should be the same as that applied to the attraction element 21. In order that this may be accomplished, a wire 58 is connected to the wire 48, which is in turn connected with the wire 49, and this wire 58 leads to a stationary contact or terminal 59 of the switch 51. Also, the wire 19 and the wire 56 for the ink precharging elements 36 and 37 are connected by a wire 60 to the adjacent stationary contact 61 of the switch. Hence, when the switch 51 is thrown to place the blades 52 and 53 in engagement with the stationary contacts 61 and 59, the polarities of the ink precharging elements and of the material precharging elements are, respectively, reversed to correspond with the polarities of the discharge and attraction elements when the switch 28 is moved to engage its movable contacts with the stationary contacts 34 and 35.

After the print receiving material 26 has passed through the printing zone and received the ink from the cylinder 10, by action of the lines of force of the electro field of force, the said material may, if desired, be passed through a drying zone, not shown. The material is then passed through a second charge eliminator, similar to the one previously described, and comprising a pair of conductive elements 62 and 63 located on opposite sides of the material 26 and preferably wiping over the surface thereof. These conductive elements extend over the entire width of the material 26 and are respectively supported by insulating means 64 and 65, the two conductive elements 62 and 63 being electrically connected together and to ground G by a conductor or conductors 66. The action of these charge eliminators is to neutralize or remove from the material 26 any charge remaining thereon as a result of its precharging and/or of its passage through the field of force at the printing zone, the removal of the charge being effected to prevent offsetting of the ink when the material is either rolled or otherwise arranged in successive layers or when a subsequent operation such as printing another color thereon is to be effected.

Assuming that the cylinder 10 is rotating, that the image areas thereof are supplied with ink, that the switches 28 and 51 are in the positions indicated in Fig. 1, and that the material is moving in the direction indicated by arrow A, the ink upon the cylinder or printing member receives a precharge of positive polarity and the material 26 first has any previous charge thereon neutralized and thereafter receives a precharge of negative polarity. Furthermore, an induced field of force extends between the discharge element 20 and the attraction element 21. Hence, as the print receiving material 26 passes through this field of force in the printing zone, the lines of force of the field act to transfer the ink from the image areas of the cylinder to the material. The transference action of this field of force is supplemented by the action of the precharges upon the ink and the material which has caused the ink to ionize and prepared the material for the reception thereof. It has been found that certain inks possess different ionization characteristics from those of other inks and hence there are occasions when, instead of precharging the ink with a positive polarity as shown in Fig. 1, a charge of negative polarity should be employed. When such an ink is used, both switches 28 and 51 are thrown to their reversed positions, i. e., reversed with respect to the positions illustrated in Fig. 1, so that the ink is now precharged with negative polarity and the material 26 is precharged with positive polarity, the discharge element 20 now being negative and the attraction element 21 being positive.

The potentials employed for effecting precharging of the ink and material need not be as high as those employed for establishing the electro field of force between the discharge and attraction elements and hence separate circuits are shown for these two types of elements. It will be readily apparent, however, that a single circuit may be employed, if desired, with suitable means for reducing the voltage in the precharging circuit below that in the circuit employed for producing the field of force for the printing.

Referring now to Fig. 3, there is illustrated an apparatus capable of effecting printing in successive steps. Such an apparatus is particularly useful for printing in colors and while the apparatus may be used for reproducing an image in a single color, as by successive printing of different portions thereof, the device will, for convenience be described only as it is used for printing in colors. The illustrated apparatus essentially comprises a plurality of sequentially arranged electronographic printing devices each of which is substantially the same as that illustrated in Fig. 1 and operates in the same manner. That is to say, print receiving material 26 is passed sequentially between the wipers 41, 42 of a charge eliminator, thence through precharge elements 46, 47 and through the field of force in the printing zone between the discharge element 20 and the attraction element 21 of the first printing couple which operates as above described for applying precharged ink of a certain color on the image of the printing member to the material. The material thus printed then passes through the wipers 62 and 63 of a charge eliminator after which it again passes through precharging elements such as 46 and 47 and through the field of force in the printing zone of the next succeeding printing couple whereby precharged ink of a different color on the image upon the printing member is transferred to the material 26, the spacing of the printing couples and their rates of rotation being such that the image areas on each succeeding couple are reproduced in exact registration upon the print receiving material. The print receiving material passes sequentially through succeeding charge eliminators, material precharging members, and the fields of force of other printing couples, there being as many units as there are colors to be applied to the print receiving material, and a charge eliminator being provided for the material after it has passed through the last printing zone.

During its passage through the printing couples, the material 26 may be supported upon an endless belt 67 which is mounted, and its tension adjusted, by means not shown but which may be similar to that illustrated and described in my prior Patent 2,408,143, issued on September 24, 1946. Suitable drying means, not shown, may be employed between each successive electronographic printing couple to effect drying of the ink imparted by the preceding couple before the material 26 is passed between the next succeeding charging eliminator.

In employing the apparatus illustrated in Fig. 3 it is not necessary that the polarities of the attraction and discharge elements of the several printing couples be the same. That is to say, the discharge element 20 of the first printing

couple may have a positive polarity while the discharge element of the next succeeding couple may employ a negative polarity without interfering with the operation. This is advantageous because it permits the polarities of the precharges for the different inks, employed upon the several printing members, to be selected in accordance with their individual ionization characteristics. Since, as noted before, the polarity of the discharge element should be the same as that employed for precharging the ink and the polarity of the attraction element should be the same as that applied to the material, the polarities of the discharge and attraction elements of each couple are determined by the polarity of the precharge for the ink of that couple. It is therefore desirable to employ separate electrical circuits for each unit or printing couple, the circuits being the same as illustrated in Fig. 1 for a single unit or couple.

While Fig. 3 illustrates the printing couples as having alternately different polarities upon their ink precharging elements, and hence upon their discharge elements, it will be apparent that the polarities employed for the elements of the several units may vary in any desired order as determined by the characteristics of the inks employed therewith. Moreover, the potentials employed for producing the electro fields of force and/or for effecting the precharging of the ink and material in each unit may differ from those employed for other units in accordance with the requirements of the particular ink employed. Since, the charge removers or eliminators are each connected to ground they effectively eliminate or neutralize any previously existing charge upon the material **26** prior to its being precharged for ink transfer in the field of force of a unit. Hence, any charges that may be present upon the material, due to precharging in previous units or static charges which may be introduced by handling, are removed or neutralized before the material is precharged for a printing operation and hence the precharge placed upon the material may be accurately controlled thereby resulting in a more effective and uniform transference of the ink by the fields of force of each printing couple or unit.

From the foregoing description it will have been noted that the enumerated objects and advantages of the invention are obtained effectively. As pointed out different inks and other operating conditions may require precharges of different predetermined polarities and values on the ink and print receiving material as well as transfer charges of different polarities and values on the discharge and attraction elements of the couple or couples for optimum results.

In order to obtain the desired results it is important that the print receiving material be completely free of any preexisting electrical charge before the precharge of predetermined polarity and value is applied thereto, otherwise any such preexisting electrical charge on the print receiving material would alter the value of the precharge impressed thereon, and hence affect the obtainance of the desired optimum result. As, for example, if the preexisting electrical charge on the print receiving material happened to be of the same polarity as the precharge impressed thereon and was not completely eliminated then the aggregate value of the preexisting charge and the precharge on the material would exceed the required and desired predetermined value. Conversely, if the preexisting charge was of opposite

polarity to the precharge then the latter would be diminished below the predetermined and required value.

The present invention wherein any preexisting electrical charge on the print receiving material is eliminated prior to the material having impressed thereon a precharge of predetermined polarity and value before entering the printing zone of a printing couple enables the printing of the image on the material by the couple to be accurately controlled and to produce the best results. Particularly is it important to eliminate preexisting electrical charges on the print receiving material prior to impressing thereon predetermined precharges as the material approaches the various printing couples of a multicolor press.

In the case of a multicolor press the elimination of preexisting electrical charges on the material, as referred to, not only eliminates offsetting of previously printed colors but also provides for more effective printing of the different colors by the various couples. In the case of a single couple for monocolor printing the elimination of preexisting electrical charges on the material is important as pointed out above, as is also the elimination of electrical charges remaining on the material after it has passed through the printing zone, since in the latter instance the danger of offsetting or sticking together of the material in its subsequent handling is obviated.

Although the procedure of the invention has been described with respect to the mode of operation of a specific form of apparatus, which may be employed as either a single unit, or as multiple units acting in sequence, it will be readily apparent that the process of this invention is not restricted to use of the specific apparatus shown and described. Moreover, both the process and the apparatus are susceptible of various modifications and adaptations. Therefore, the invention is not to be considered as limited to the details of procedure and apparatus herein illustrated and described but only as required by the spirit and scope of the appended claim.

Having thus described my invention, I claim:

The method of reproducing an image in color upon print receiving material and which comprises providing a plurality of printing couples arranged in sequential order and each including a printing member carrying at least a portion of the image to be reproduced, inking the image on the printing member of each of the couples with a colored ink which differs in color from that of the inks employed upon the other printing members, impressing an electrical precharge upon the ink after it is on the image carried by each member, creating an electro field of force at the printing zone for each couple, eliminating any preexisting electrical charge on the print receiving material, thereafter impressing an electrical precharge of predetermined polarity and value on said material, introducing said precharged material into the field of force of the first of said printing couples thereby effecting transfer of the precharged ink from the image to the material, eliminating the electrical charge remaining upon said material after it has passed through the field of force of said first couple; and repeating in succession for each couple the precharging of the material with an electrical charge of predetermined polarity and value, the introduction of the precharged material into the field of force of a printing couple with the

image upon the printing member of each couple aligned with the image reproduced upon the material by operation of the preceding printing couple, and then the elimination of the electrical charge remaining on said material after it has passed through the field of force of a couple; the precharging of the ink upon the printing member of each couple and the precharging of the print receiving material prior to the introduction of the latter into the printing zone of that couple being effected by charges of opposite polarity; the precharge impressed upon the ink on the printing member of at least one of the printing couples being of opposite polarity to the precharge impressed upon the ink on other of the printing members of other of the couples.

WILLIAM C. HUEBNER.

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