

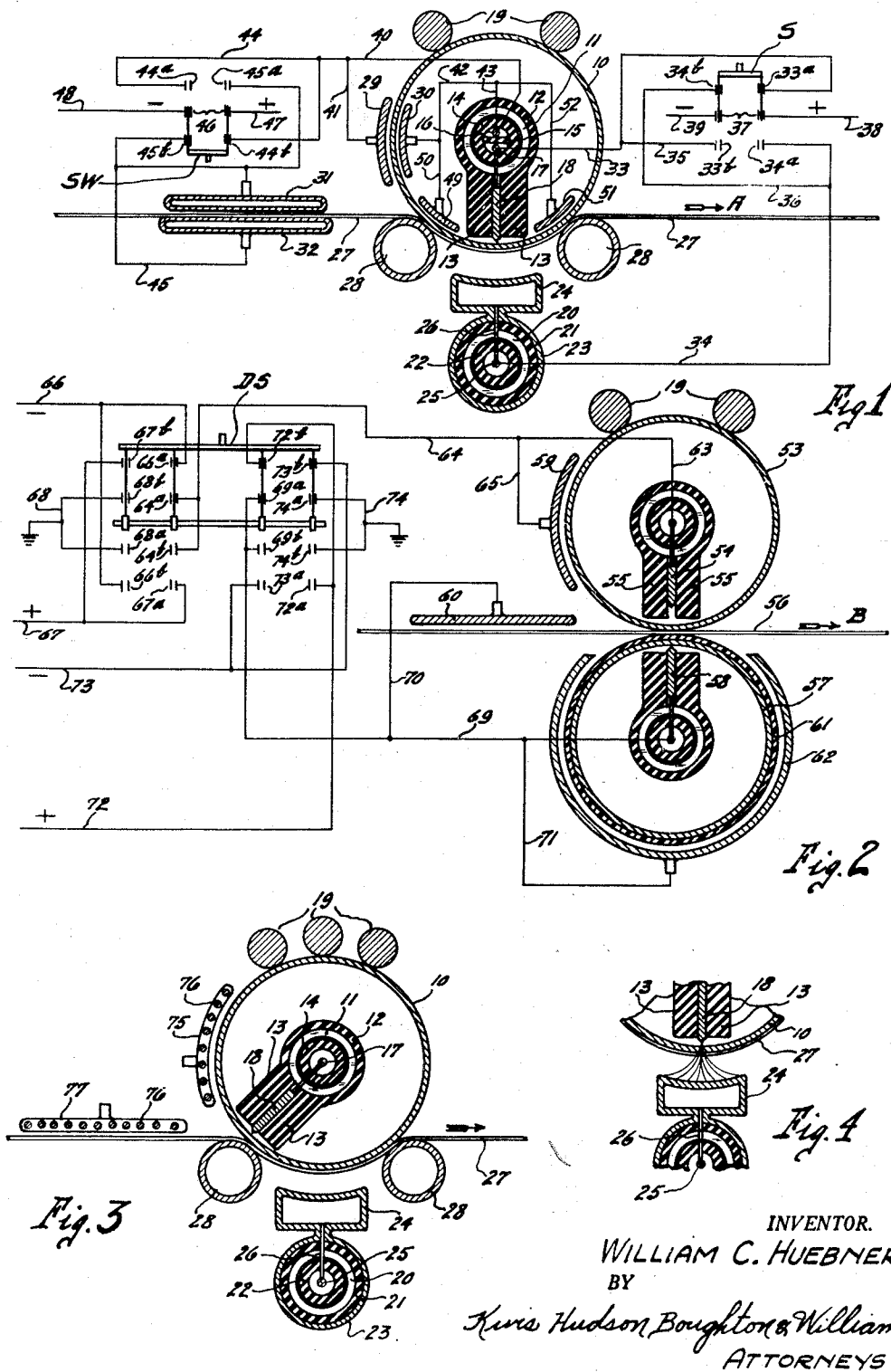
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PROCESS AND APPARATUS FOR ELECTRONOGRAPHIC PRINTING

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PROCESS AND APPARATUS FOR ELECTRONOGRAPHIC PRINTING

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This invention relates to a process of and apparatus for printing and 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 on the print receiving material by the exertion of substantial printing pressure and contact 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 using such terms they are used as 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 within 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. Such lines of force are measurable in direction and amount and their effects, even though the theoretical explanation of what produces these effects may not be entirely clear or certain.

As will be understood by those skilled in the art, the term "image" and related terms as used throughout the specification contemplates 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

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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.

An object of the invention is to provide an improved and novel process of and apparatus for printing by means of electro lines of force of a field or fields of force and wherein the reproduced or printed image will be clear and sharply defined and have improved characteristics.

Another object of the invention is to provide a process of and apparatus for printing by means of electro lines of force of a field or fields of force and wherein interference to the transfer of the ink from the inked image carrying member to the print receiving material is eliminated and thus improved printing results are obtained.

A more specific object is to provide in a method of and apparatus for printing by electro lines of force of a field or fields of force means for impressing upon the ink and upon the print receiving material an electrical charge or charges of such polarities that the detrimental effect of any undesired static charges in the material is overcome and the lines of force of the ink transferring field of force are assisted in causing the ink to be transferred from the inked image carrying member to the print receiving material.

A still further object is to provide in a process of and apparatus for printing by means of electro lines of force of a field or fields of force an arrangement for utilizing electrical currents of high intensity but at the same time avoiding arcing, short-circuiting or the formation of coronas.

Another object is to provide in a process of and apparatus for printing by electro lines of force of a field or fields of force an arrangement for conditioning the electrical polarities of the ink and print receiving material and the field or fields of force to facilitate the transference of the ink from the inked image carrying member to the print receiving material by the said electro lines of force and wherein the polarities to which the ink and print receiving material and the field or fields of force are conditioned can be in accordance with predetermined ionization characteristics of the particular ink employed in the printing operation.

Another object is to provide a printing couple wherein the ink is transferred from the image carrying member to the print receiving material by electro lines of force and which lines of force are so distributed as to prevent any offsetting of

previously deposited ink back from the material to the member.

Further and additional objects will become apparent during the description of embodiments of the invention which are illustrated in the accompanying drawing and wherein,

Fig. 1 is a diagrammatic view of a printing couple disclosing one form of apparatus embodying the invention and by means of which the process can be effected.

Fig. 2 is a diagrammatic view of a printing couple disclosing a different form of apparatus embodying the invention and by means of which the process can be effected.

Fig. 3 is a view similar to Fig. 1 but illustrating a different arrangement for the discharge blade of the ink transfer field of force and different form of terminals for precharging the ink and print receiving material.

Fig. 4 is a fragmentary detached diagrammatic view illustrating the conical configuration of the ink transfer field of force between the discharge and attraction elements of Fig. 1.

The process and apparatus disclosed herein constitute improvements on the processes and apparatus disclosed in my prior Patents 1,820,194, issued August 25, 1931; 2,224,391, issued December 10, 1940; and 2,408,144, issued September 24, 1946. In my said patents there are disclosed processes and apparatus for printing wherein the ink is transferred from the movable inked image carrying member of the printing couple to the print receiving material by means of the electro lines of force 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 but with no pressure therebetween. The process and apparatus of the present invention constitute improvements over the processes and apparatus shown in said patents in that improved control and more sharply defined printing on the print receiving material is obtainable and inks having different ionization characteristics can be used. The improved results occurring from practicing the process and using the apparatus embodying the present invention are attributable primarily to the arrangement whereby the ink on the movable image carrying member and the print receiving material prior to reaching the printing zone have impressed thereon electrical charges of high intensity and of opposite polarities corresponding respectively to the polarities of the ink discharge element and the ink attraction element. These electrical charges on the ink and print receiving material act in association with the electro field of force at the printing zone and extending between the discharge element and the attraction element of the printing couple to facilitate and insure complete and proper transference of the ink by the lines of force from the image carrying member to the print receiving material.

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 charge of static electricity which may be present in the print receiving material prior to reaching the printing zone may have a retarding effect on the complete transfer of the ink at the printing zone, since such static charge

may act in opposition to and thus interfere with the effectiveness of the electro lines of force passing between the discharge element and the attraction element. This interference is especially objectionable where the polarity of the static charge on the print receiving material is not in agreement with the polarity of the attraction element of the printing couple. 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 and the polarity of which may be difficult to control or determine, it is proposed to assure efficient ink transfer at the printing zone by precharging the ink with the same polarity as the polarity of the discharge element of the couple and to precharge the print receiving material with the same polarity as the polarity of the attraction element thereof, thus overcoming the effects of any repelling static charge in the material and producing a harmonious condition at the printing zone to achieve the full ink transferring effect of the lines of force passing between the discharge element and the attraction element. It is proposed to include provision whereby the polarity of the precharged ink and the discharge element and the polarity of the precharged material and the attraction element can be reversed readily and in accordance with the ionization characteristics of the particular ink being employed for a particular printing job. In this connection it has been determined that certain inks will ionize better with a negative precharge than with a positive precharge or vice versa.

Referring to Fig. 1, there is illustrated diagrammatically a printing couple comprising a movable image carrying member 10 shown in the form of a cylinder the wall of which is of thin section. This cylinder is rotatably mounted at its opposite ends on tubular supports 11 carried by the frame of the printing couple and extending into the cylinder. The inner ends of the supports 11 are surrounded by and support an insulating sleeve 12 extending the length of the cylinder and having connected thereto radially extending parallel but spaced apart insulating bars 13 which may be formed integral with the sleeve 12 and have their free ends adjacent the inner circumference of the cylinder 10. An insulating sleeve 14 extending through the cylinder is mounted within the tubular supports 11 and its opposite ends project beyond the frame and said sleeve 14 contains a diametral partition 15 dividing the sleeve into two compartments. Extending through one compartment of the sleeve 14 is an electrical conduit 16 and extending through the other compartment is an electrical conduit 17. The cylinder 10 is electrically insulated from the frame of the press and from the tubular support 11 in the manner disclosed in my said Patent 2,408,144 and hence this aspect of the construction can be readily understood without further description herein, particularly since it forms no part of the present invention.

A discharge element is contained in the cylinder 10 and is in the form of a blade 18 extending longitudinally of the cylinder and located in the space between the insulating bars 13 and supported therein in any suitable manner and with the inner end of the blade electrically connected to the conduit 17 while the outer end of the blade is adjacent to the inner circumference of the cylinder. Although the discharge blade 18 is shown in Fig. 1 as extending to adjacent the inner circumference of the cylinder 10 it will

later be pointed out that in some instances it may be desirable to have the outer end of the blade spaced inwardly from the inner circumference of the cylinder, depending on the position of the attraction element of the printing couple.

It will be understood that the cylinder 10 is provided on its exterior with image areas and with non-image areas and that the image areas may be inked with any suitable means, such as the inking rollers 19, 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 inking means employed will be in accordance with the type of printing the cylinder is to perform as is well known in the art.

The ink attraction means of the printing couple is located externally of the cylinder 10 and extending the longitudinal length thereof and comprises tubular supports 20 similar to the tubular supports 11 and fixedly carried by the frame. An insulating sleeve 21 surrounds and is supported by the ends of the supports 20 while a second insulating sleeve 22 is located within the sleeve 21 and extends internally of the supports 20. The attraction means also includes a supporting portion illustrated in the form of a sleeve 23 mounted on the insulating sleeve 21 and having integrally connected therewith a substantially rectangular box-like portion 24 constituting the attraction element proper. The upper wall of the portion 24 is shown in this instance as curved concentrically to the curvature of the cylinder 10, although said upper wall may be differently shaped if desired.

In Fig. 1 the upper wall of the attraction element 24 is shown as spaced from the circumference of the cylinder 10 and from the print receiving material later to be referred to. An electrical conduit 25 extends through the inner insulating sleeve 22 and said conduit is electrically connected to the attraction element 24 by leads 26 extending radially of the insulating sleeves.

It will be understood that the attraction element 24 is electrically insulated from the cylinder 10 and from the frame of the printing apparatus, similarly to the attraction element described in my said Patent 2,408,144.

The print receiving material 27 moves in the direction of the arrow A in Fig. 1 and passes over idler rollers 28 so disposed relative to the cylinder 10 as to be slightly spaced from the circumference thereof and to cause the material intermediate said rollers to follow the circumference of the cylinder 10 in contact therewith.

It will be observed that although the material moves in contact with the cylinder 10 no pressure is exerted on the material, the rollers being spaced from the cylinder a slightly greater distance than the thickness of the material.

It will be understood that the discharge element or blade 18 and the attraction element 24 are connected in an electrical circuit with a source of high potential electricity 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 inked image areas of the cylinder 10 to the adjacent surface of the print receiving material, as clearly described in my said issued patents. The electrical circuit in which the discharge and attraction elements are connected will later be described.

In order to overcome the retarding effect of the

static electrical charges which may exist in the print receiving material to the transference of ink from the cylinder to said material by the lines of force the invention contemplates precharging the ink and the print receiving material in the manner now to be described.

A curved plate terminal 29 is located externally of the cylinder 10 and intermediate the point where the image areas of the cylinder are inked by the rolls 19 and the printing zone. The terminal 29 is preferably curved concentrically to the circumference of the cylinder and is spaced therefrom. A similar although somewhat smaller terminal 30 is located within the cylinder 10 and spaced from the inner surface thereof and in alignment with the terminal 29. It will be understood that in some instances it may be desirable in precharging the ink to employ both the terminals 29 and 30, while in other instances it may be desirable to omit one or the other of said terminals.

In order to precharge the print receiving material before it reaches the printing zone so as to eradicate the effect of any static electrical charge which may be in the paper, a terminal 31 is positioned in spaced relation but adjacent to the surface of the print receiving material which is to receive the printed image, while a similar but somewhat larger terminal 32 is shown positioned in contact with the opposite surface of the print receiving material. It will be understood that in certain instances it may be desirable to position the terminal 31 in contact with the material and the terminal 32 in spaced relation to the material or both terminals may be spaced from the material. It will be understood that in some instances it is desirable to employ both the terminals 31 and 32 for precharging the material, while in other instances it may be desirable to omit one or the other of said terminals. The terminals 29, 30, 31 and 32 are supported by suitable means carried by the frame of the printing press or by the support for the discharge element 18 and are insulated therefrom and from the discharge and attraction elements.

In Fig. 1 the terminals 29, 30, 31 and 32 are shown as included in an electrical circuit which, in this instance, may be called the precharging circuit, while the discharge element 18 and the attraction element 24 are indicated as in a separate electrical circuit which, in this instance, may be designated the transfer circuit.

It is proposed to precharge the ink to the same polarity as that of the discharge element and to precharge the print receiving material to the same polarity as that of the attraction element. In this way not only is the effect of any static charge in the print receiving material overcome but the precharges impressed upon the ink and the material assist or supplement the transfer field of force in causing the ink to be transferred from the inked image areas of the cylinder 10 to the print receiving material.

The discharge element 18 and attraction element 24 are electrically connected in the transfer circuit now to be described. The electric conduit 17 connected to the discharge element 18 is electrically connected by a wire 33 to the contact 33a of a double pole double throw switch S. The attraction element 24 is connected to the conduit 25 and said conduit is connected by a wire 34 to the contact 34a of the switch S. The wire 33 is connected also to the contact 33b of the switch by a wire 35, while the wire 34 is electrically connected by a wire 36 to the contact 34b of the

switch. The switch blades of the switch S are pivoted at 37 and are electrically connected respectively by a wire 38 to the positive side of a source of supply of high potential electricity and by a wire 39 to the negative side thereof. It will be seen that when the switch blades are thrown to the operative position indicated in Fig. 1 and are engaged with the contacts 33a and 34b of the switch, the discharge element 18 is electrically connected to the positive side of the circuit while the attraction element 24 is electrically connected to the negative side thereof. It will also be seen that when the switch blades are thrown to their opposite operative position the discharge element 18 and the attraction element 24 will be connected, respectively, to the negative and the positive sides of the circuit; in other words, the polarities of the discharge and attraction elements can be reversed by throwing the switch S to one or the other of its two operative positions.

The ink precharging terminal 29 is connected to a wire 40 by a wire 41. The wire 40 extends to the conduit 16 and the latter is connected interiorly of the cylinder 10 to the terminal 30 by the wires 42 and 43. The wire 40 is electrically connected by a wire 44 with the contact 44a and the contact 44b of a double pole double throw switch SW.

The terminals 31 and 32 for precharging the print receiving material are electrically connected to a wire 45 which in turn is electrically connected to the contacts 45a and 45b of the switch SW. The switch blades of the switch SW are pivotally mounted at 46 and are electrically connected, respectively, by wires 47 and 48 with the positive and negative sides of a source of high potential electricity.

It will be seen by reference to Fig. 1 that the terminals 29 and 30 for precharging the ink are shown therein as connected to the positive side of the circuit while the terminals 31 and 32 for precharging the printing receiving material are connected to the negative side of the circuit. It will be understood that when the switch blades of the switch SW are thrown from the operative position of Fig. 1 into their other operative position the terminals 29 and 30 will be connected to the negative side of the circuit and the terminals 31 and 32 to the positive side thereof.

When the switch SW is closed and the terminals 29 and 30 are electrically connected to the source of high potential electric energy the ink on the image areas of the cylinder 10 is ionized at a polarity depending upon the position of the switch SW as, for instance, in Fig. 1 the ink will be ionized with a positive charge. In view of the fact that various inks possess different ionization characteristics there may be occasions when instead of ionizing the ink with a positive charge, as shown in Fig. 1, a negative charge will be employed for such purpose. The terminals 31 and 32 when connected to the source of high potential electric energy by closing the switch SW act to impress a charge on the print receiving material which, of course, is of opposite polarity from the charge used to ionize the ink. It will be understood that the polarities of the discharge element 18 and the attraction element 24 by means of the switch S are maintained in harmony respectively, with the polarities of the ink precharging terminals 29 and 30 and of the material precharging terminals 31 and 32.

Assuming that the cylinder 10 is rotating and the image areas thereof are inked by the rollers 19 and that the switches S and SW are in the

positions indicated in Fig. 1, then the ink is being precharged with a positive charge and the material precharged with a negative charge, while an induced field of force extends across the gap between the discharge element 18 and the attraction element 24, with the lines of force thereof acting to transfer the ink from the image areas of the cylinder to the print receiving material. The transference action of this field of force is supplemented by the action of the precharges of opposite polarity on the ink and the material. When the material comes into contact with the ink on the surface of the cylinder 10 the ionized ink has a tendency to transfer the precharged material. Thus the precharging of the ink and the print receiving material acts not only to overcome the repelling effect of any static electrical charge which may be in the print receiving material before it reaches the printing zone, but also functions cumulatively with the field of force between the discharge and attraction elements to effectively, efficiently and completely transfer the ionized ink from the image areas of the cylinder to the print receiving material.

It may be desirable to employ a terminal 49 similar to the terminal 30, but possibly of smaller size, and located within the cylinder 10 and adjacent to the point where the print receiving material first contacts the cylinder. The terminal 49 is connected by a wire 50 to the wire 42 that extends to the terminal 30. The terminal 49 supplements the action of the terminals 29 and 30 in ionizing the ink and thus facilitates the transference of the ink from the image areas to the print receiving material.

Also it is advantageous to employ within the cylinder 10 a terminal 51 like the terminal 49 but located adjacent to the point where the print receiving material moves out of contact with the cylinder. The terminal 51 is connected in the electrical circuit with the terminals 30 and 49 by a wire 52. The purpose of using the terminal 51 is to maintain the charge on the ink which has been transferred from the cylinder to the print receiving material at the printing zone and thus to overcome any tendency of the ink to offset from the material back onto the printing cylinder past the printing zone and prior to the material passing out of contact with the cylinder.

When the print receiving material runs in contact segmentally with the cylinder 10, as shown in Fig. 1, the function of the terminals 49 and 51 is important, particularly where the printing couple constitutes one couple of a multicolor press, since the charges impressed by the terminals on the ink deposited on the print receiving material by a previous couple or by the instant couple prevent any tendency of such ink to offset back from the material onto the cylinder. Consequently when printing couples such as shown in Fig. 1 are combined in a multicolor press said couples can be positioned closely together since the material need not be traversed back and forth over idler rollers for drying purposes, thus reducing the overall size of the press and making it unnecessary to employ ink drying devices intermediate the couples. Also the material can be fed through the press at greater speeds as no drying time for the ink is required.

In Fig. 2 there is disclosed a different form of apparatus embodying the invention and whereby the novel process of printing can be practiced. In this apparatus the printing cylinder 53 is similar to the printing cylinder 10 previously de-

scribed, while the discharge element 54, the insulating bars 55 and the support and insulation for said element and bar correspond to the similar parts of the apparatus described in connection with Fig. 1. It should be noted, however, that the free end of the discharge element 54 is substantially spaced radially inwardly from the inner circumference of the cylinder 53, as distinguished from the location of the free end of the discharge element 18 in the previously described form.

In the form of apparatus shown in Fig. 2 the print receiving material 56 instead of contacting a segmental portion of the printing cylinder 53 extends tangentially to the outer circumference of said cylinder and is supported in contact therewith by a supporting cylinder 57. The printing cylinder 53 and the supporting cylinder 57 are insulated from each other and from the frame of the apparatus and also are insulated from the discharge element 54 and the attraction element 58 that is located within the supporting cylinder 57. The attraction element 58 is similar to the discharge element 54 and is mounted in the cylinder 57 in a corresponding manner, except it should be noted that the free end of the attraction element 58 is closely adjacent to the inner circumference of the cylinder 57 to provide the predetermined gap or space between the ends of the aligned elements. As in the previously described form the attraction and discharge elements extend the axial length of the interior of the cylinders.

In order to reduce or eliminate friction between the print receiving material and the supporting cylinder 57 the latter preferably will rotate in timed relation to the rotation of the printing cylinder 53 and to the movement of the print receiving material in the direction of the arrow B.

In order to ionize the ink with the proper polarity a curved terminal 59 is located adjacent the outer circumference of the printing cylinder 53 and in advance of the printing zone, so that as the cylinder rotates the ink on the image areas thereof will be ionized before reaching the printing zone. The terminal 59 extends the length of the printing cylinder and is curved concentrically to the cylinder and spaced therefrom. If desired, a similar terminal may be employed within the cylinder in accordance with the arrangement of Fig. 1. The terminal 59 is supported by and insulated from the frame.

In order to impress a precharge of the proper polarity on the print receiving material before it reaches the printing zone, a terminal 60 is mounted in and insulated from the frame of the press and overlies said material and is spaced therefrom and extends the transverse width of said material. In order to impress a precharge of corresponding polarity on the opposite surface of the print receiving material the following arrangement may be employed:

The supporting cylinder 57 mounts exteriorly a suitable blanket 61 which may be formed of plastic, rubber or other suitable material and which blanket is coextensive with the circumference of the cylinder. Surrounding the blanket 61 and spaced radially outwardly therefrom is an arcuate terminal 62 that extends the longitudinal length of the cylinder 57 and blanket 61 but has its opposite ends segmentally spaced apart as is clearly indicated to provide an opening which includes the printing zone, wherefore the cylinder and blanket support the print re-

ceiving material in tangential contact with the printing cylinder at the printing zone. The terminal 62 is for the purpose of electrically charging the blanket 61 and the blanket in turn running in contact with the print receiving material at the printing zone impresses said charge on the under surface of said material, it being recalled that the upper or printing surface of said material has impressed thereon a charge by the terminal 60. It will be understood that the polarities of the charges impressed on the opposite surfaces of the print receiving material will be the same and will correspond to the polarity of the attraction element. It will also be understood that the polarities of the discharge element 54 and the terminal 59 will correspond but will be opposite to the polarities of the terminals 60 and 62 and the attraction element 58.

As distinguished from the arrangement disclosed in Fig. 1, in Fig. 2 the discharge element 54 and the terminal 59 for ionizing the ink are included in one electrical circuit, while the attraction element 58 and the terminals 60 and 62 for precharging the print receiving material are included in a separate electric circuit.

The discharge element 54 is electrically connected by a wire 63 to a wire 64, while the terminal 59 is connected to the wire 64 by a wire 65. The wire 64 is connected to the contacts 64a and 64b of a multiple double contact switch DS. A wire 66 extends from the negative side of a source of high potential electrical energy to the contacts 65a and 65b of the switch DS. A wire 67 extends from the positive side of said source of high potential electrical energy to the contacts 67a and 67b of said switch. The contacts 68a and 68b are grounded by a wire 68. As indicated in Fig. 2 the discharge element 54 and the terminal 59 are connected to the negative side of the source of high potential electrical energy while the positive side thereof is grounded. It will of course be understood that this arrangement can be reversed, by throwing the switch DS to its other operative position.

The attraction element 58 is connected by a wire 69 to the contacts 69a and 69b of the switch DS, while the terminals 60 and 62 are connected to the wire 69 by wires 70 and 71 respectively. A wire 72 extends from the positive side of a second source of high potential electrical energy to the contacts 72a and 72b of the switch DS. A wire 73 extends from the negative side of said second source of high potential electrical energy to the contacts 73a and 73b of said switch DS. A wire 74 grounds the contacts 74a and 74b of the switch DS.

As shown in Fig. 2, this attraction element 58 and the terminals 60 and 62 are electrically connected to the positive side of this second source of high potential electrical energy, while the negative side thereof is grounded through the switch DS.

As already explained, various inks have different ionization characteristics such that in some cases a positive charge on the ink will be more effective, while in other cases a negative charge thereon will be more effective. The arrangement shown in Fig. 2 assumes the latter situation, but it will be understood that where the first mentioned situation exists the switch DS is thrown to its other operative position, whereupon the discharge element 54 and the terminal 59 will be connected to the positive side of the first source of high potential electrical energy, while the attraction element 58 and the terminals 60 and 62

will be connected to the negative side of the second source of high potential electrical energy, while the opposite side of each source will be grounded.

It will be seen that the polarity of the discharge element 54 always corresponds with the polarity of the terminal 59 while the polarity of the attraction element 58 always corresponds with the polarities of the terminals 60 and 62. It will also be seen that by throwing the multiple switch DS from one operative position to its other operative position the polarities of the discharge element 54 and the terminal 59 and the polarities of the attraction element 58 and the terminals 60 and 62 can be reversed.

Experiments have shown that with certain inks more effective transfer of the ink from the image areas of the printing cylinder to the print receiving material is obtained when the discharge element is negative and the attraction element is positive and corresponding precharges are impressed respectively on the ink and print receiving material, while with other inks the reverse arrangement produces more satisfactory results. Therefore provision is made in the constructions shown in both Figs. 1 and 2 for readily reversing the polarities of the discharge and attraction elements and the terminals for precharging the ink and the print receiving material.

It will be understood that if desired a terminal similar to the terminal 59 can be mounted within the printing cylinder 53 in a manner corresponding to the terminal 30 of the first described form of apparatus and also if desired that terminals such as the terminals 49 and 51 of the first described form might be employed in the cylinder 53, although since the print receiving material has tangential contact with the cylinder 53 such use of additional terminals can be omitted.

Referring to Fig. 3, it should be understood that this view is intended to embody the features shown in Fig. 1, except for certain differences which will be pointed out. Insofar as the parts disclosed in Fig. 3 are identical with those disclosed in Fig. 1 the same reference characters will be employed.

The first difference existing in the arrangement shown in Fig. 3 over that shown in Fig. 1 resides in the location of the discharge element 18, it being noted that said element is angularly displaced from the vertical position shown in Fig. 1 and is not in alignment with the attraction element 24. When the arrangement shown in Fig. 3 is utilized the lines of force of the field of force between the discharge and attraction elements travel in part along the wall of the cylinder and then across the gap to the attraction element. The arrangement of Fig. 3 widens the printing zone of the transfer field of force and the angular displacement of the discharge element can be varied to vary the width of this printing zone. It will also be noted that in place of terminals of the type of terminals 29, 30, 31 and 32, as shown in Fig. 1, a curved ink charging terminal 75 is illustrated and which includes a plurality of spaced bars or rods 76, while a flat material precharging terminal 77 is shown located above the upper surface of the material and said terminal also includes the spaced bars or rods 76. It will be understood that a second flat terminal similar to the terminal 77 can be supported beneath the material, similar to the terminal 32 of Fig. 1. Likewise it will be understood that a terminal or terminals similar to terminal 75 may

be employed within the printing cylinder as are the terminals 30, 49 and 51 of Fig. 1.

In Fig. 4 there is diagrammatically illustrated a configuration of the field of force extending between the discharge and attraction elements of the type shown in Fig. 1. The field of force between these elements is indicated by the light lines and is of conical formation, with the point of the cone at the tip of the discharge element 18. It will be seen that the print receiving material running in contact segmentally with the printing cylinder passes through the field of force closely adjacent to the narrowest point of the cone, and hence the most effective point, since all of the lines of force are concentrated in a narrow zone. It will be understood that it is important to have the print receiving material pass through the transfer field of force adjacent to the narrowest part thereof in order to obtain the concentrated effect of the lines of force. The location of the print receiving material relative to the discharge and attraction elements will be correlated to obtain this desired result and will vary according to the type of discharge and attraction elements employed and the type of printing desired.

In my prior patents the print receiving material is disclosed as being in spaced relation to the printing cylinder. This spaced relation does not position the material at the narrowest zone of the field of force, and hence does not obtain the benefit of the concentrated lines of force of the field in transferring the ink from the cylinder to the material when very sharply defined printing is desired.

Although the print receiving material is disclosed herein as in contact with the printing cylinder, it will be understood that no printing pressure is applied between the material and cylinder and hence the printing cylinder, the rollers 28 and the supporting cylinder 57 are of light weight construction as they are not subject to strains or stresses incident to the creation of pressure as in the usual pressure printing apparatus.

In this connection it should be noted that attraction elements such as shown in Figs. 1, 3 and 4 constitute the subject matter of copending application Serial No. 643,344 filed January 25, 1946.

As previously stated any static electrical charge in the print receiving material may have a repelling or retarding effect on the transference of the ink from the printing cylinder to the material by the field of force depending upon the polarity of said static charge. However, in accordance with the present invention where the ink is ionized with a polarity corresponding to the discharge element and the print receiving material is precharged to a polarity corresponding with the attraction element, such retarding effect is eliminated and the ionization of the ink and the precharging of the material cumulatively assist the field of force in transferring the ink from the cylinder to the material. Therefore improved printing can be obtained without the necessity of using extremely high voltages in the creation of the field of force and thus danger of arcing or the creation of coronas is minimized.

In addition, it will be recalled that the discharge elements 18 and 54 are located intermediate insulator bars 13 or 55 and which bars extend to a point closely adjacent the inner circumference of the printing cylinder. The insulating bars, therefore, also function to prevent arcing or the formation of coronas. Therefore

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the combination of ionizing the ink and pre-charging the print receiving material with the use of the insulator bars eliminates any tendency toward arcing or the creation of coronas.

Although several embodiments of the invention have been illustrated and described herein, it will be understood that the invention is susceptible of various modifications and adaptations within the scope of the appended claims.

Having thus described my invention, I claim:

1. The method of reproducing upon print receiving material an image carried by a printing member of a printing couple and which comprises inking said image, impressing upon the ink on the image an electrical precharge, impressing an electrical precharge on the print receiving material, introducing said precharged print receiving material to the printing zone, and creating an electro field of force at the printing zone to transfer the precharged ink from the inked image to the precharged print receiving material.

2. The method of reproducing upon print receiving material an image carried by a printing member of a printing couple and which comprises inking said image, impressing upon the ink on the image an electrical precharge of certain polarity, impressing an electrical precharge of opposite polarity on the print receiving material, and then bringing the precharged material into close proximity to the precharged ink in a printing zone and therein transferring by electro lines of force the precharged ink from the image to the precharged material.

3. The method of reproducing upon print receiving material an image carried by a printing member of a printing couple and which comprises creating an induced electro field of force in the printing zone, inking said image while outside the printing zone, impressing upon the ink on the image an electrical precharge of certain polarity and while the ink is outside the printing zone, impressing an electrical precharge of opposite polarity on the print receiving material, and then introducing the material to the printing zone to bring the precharged ink and precharged material into close proximity to each other, wherefore the electro lines of force between the precharged ink and precharged material assist the lines of force of said induced electro field of force to transfer the ink from the image to the material.

4. The method of reproducing upon print receiving material an image carried by a printing member of a printing couple and which comprises inking said image, creating an induced electro field of force in the printing zone, introducing the material to the printing zone so the lines of force of said field of force can act to transfer the ink from the image to the material, and impressing upon the transferred ink beyond the printing zone an electrical charge which acts to cause the ink to adhere to the material and thus prevents offsetting of the transferred ink from the material to the printing member.

5. The method of reproducing upon print receiving material an image carried by a printing member of a printing couple and which comprises inking said image, impressing upon the ink on the image an electrical precharge of certain polarity, impressing an electrical precharge of opposite polarity on the print receiving material, then bringing the precharged material into close proximity to the precharged ink in a printing zone and therein transferring by electro lines

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of force the precharged ink from the image to the precharged material, and maintaining the transferred ink beyond the printing zone electrically charged with the same polarity as the precharged ink to prevent offsetting of the transferred ink from the material to the printing member.

6. The method of reproducing upon print receiving material an image carried by a printing member of a printing couple and which comprises creating an induced electro field of force in the printing zone, inking said image while outside the printing zone, impressing upon the ink on the image before it reaches the printing zone an electrical precharge of certain polarity, impressing an electrical precharge of opposite polarity on the print receiving material, then introducing the precharged material to the printing zone to bring it and the precharged ink into close proximity to each other wherefore the electro lines of force between the precharged ink and precharged material assist the lines of force of said induced electro field of force to transfer the ink from the image to the material, and maintaining on the transferred ink beyond the printing zone an electrical charge of the same polarity as the precharged ink to prevent offsetting of the transferred ink from the material to the printing member.

7. The method of reproducing upon print receiving material an image carried by a printing member of a printing couple and which comprises inking said image, impressing upon the ink on the image an electrical precharge of certain polarity, impressing on both sides of the print receiving material corresponding electrical precharges which are of opposite polarity to the precharge on the ink, and then bringing the precharged material into close proximity to the precharged ink in a printing zone and therein transferring by electro lines of force the precharged ink from the image to the precharged material.

8. The method of reproducing upon print receiving material an image carried by a printing member of a printing couple and which comprises inking said image outside the printing zone, impressing upon the ink on the image before it reaches the printing zone an electrical precharge of certain polarity, impressing on one side of the print receiving material before it is introduced to the printing zone an electrical precharge of opposite polarity, then bringing the material into the printing zone and into close proximity to the precharged ink and transferring by electro lines of force the precharged ink to the precharged material and simultaneously impressing on the opposite side of the material an electrical charge of said opposite polarity.

9. The method of reproducing upon print receiving material an image carried by a printing member of a printing couple and which comprises creating an induced electro field of force in the printing zone, inking said image while outside the printing zone, impressing upon the ink on the image before it reaches the printing zone an electrical precharge of certain polarity, impressing on one side of the print receiving material before it reaches the printing zone an electrical precharge of opposite polarity and then introducing the material to the printing zone to bring the precharged ink and the precharged material into close proximity to each other and simultaneously therewith impressing upon the other side of said material an electrical charge of said opposite polarity, wherefore the electro

lines of force between the precharged ink and the charged material assist the lines of force of said induced electro field of force to transfer the ink from the image to the material.

10. In a printing couple, an image carrying printing member adapted to have printing relationship with print receiving material at the printing zone, means for inking the image on said member, means for impressing an electrical precharge of certain polarity on the ink in advance of the printing member and the material being brought into printing relationship, means for impressing an electrical precharge of opposite polarity on the print receiving material before the same is introduced to the printing zone, means for creating at the printing zone an electro field of force the lines of force of which extend from said member to said material, and means for supporting the print receiving material in printing relationship to said member in the printing zone and wherein the precharged ink and the precharged material are in close proximity to each other, whereupon the lines of force passing therebetween act to transfer the ink from the printing member to the material.

11. In a printing couple, an image carrying printing member adapted to have printing relationship with print receiving material at the printing zone, means for inking the image on said member, means for impressing an electrical precharge on the ink in advance of the printing member and the material being brought into printing relationship, means for impressing an electrical precharge on the print receiving material in advance of the same being introduced to the printing zone, discharge and attraction elements operatively associated with said printing member and electrically connected to a source of high potential electricity for creating at the printing zone an induced field of force the lines of force of which act to transfer the ink from said member to said print receiving material, and means for holding the print receiving material in contact with said member at the printing zone.

12. In a printing couple, an image carrying printing member adapted to have printing relationship with print receiving material at the printing zone, means for inking the image on said member, means for impressing an electrical precharge of certain polarity on the ink in advance of the printing member and the material being brought into printing relationship, means for impressing an electrical precharge of opposite polarity on the print receiving material in advance of the same reaching the printing zone, discharge and attraction elements located at the printing zone and spaced apart to have said member and the print receiving material interposed therebetween, means electrically connecting said discharge element to that side of a high potential electrical circuit corresponding in polarity to the polarity of the precharge impressed on the ink and the attraction element to that side of a high potential electrical circuit corresponding in polarity to the polarity of the precharge on the material, wherefore a field of force is induced between the discharge and attraction elements with the lines of force thereof acting to transfer the ink from said member to the print receiving material, and means for holding the print receiving material in contact with said member at the printing zone.

13. A printing couple as defined in claim 12 and including the provision of switch means for changing the polarities of the electrical pre-

charges on the ink and the material and the polarities of the discharge and attraction elements.

14. In a printing couple a movable image carrying printing member, means for supporting print receiving material in printing relation to said member at the printing zone, means for inking the image on said member, means for impressing an electrical precharge of certain polarity on said ink prior to reaching the printing zone, means for impressing an electrical precharge of opposite polarity on said material in advance of the same reaching the printing zone, discharge and attraction elements located at the printing zone and spaced apart to have said member and the print receiving material interposed therebetween, means electrically connecting said discharge element to that pole of a high potential electrical circuit corresponding to the polarity of the precharged ink and the attraction element to that pole of a high potential electrical circuit corresponding to the polarity of the precharged material, wherefore a field of force is induced between the discharge and attraction elements with the lines of force thereof acting to transfer the ink from said member to the print receiving material, and means for maintaining on the transferred ink beyond the printing zone an electrical charge corresponding in polarity to the polarity of the precharged ink to prevent offsetting of the transferred ink from the material to said member.

15. In a printing couple, a movable image carrying printing cylinder, means for supporting print receiving material in printing relationship to said cylinder at the printing zone, a discharge element within said cylinder at the printing zone and spaced from the wall of the cylinder, an attraction element exteriorly of said cylinder at the printing zone and spaced from said cylinder, means electrically connecting said discharge element to one pole of a high potential electrical circuit and said attraction element to the opposite pole of a high potential electrical circuit, means for inking the image on said cylinder, an electrical terminal operatively associated with said cylinder intermediate the inking means and the printing zone for impressing an electrical precharge on the ink of the same polarity as the discharge element, and an electrical terminal operatively associated with the print receiving material in advance of the same reaching the printing zone for impressing on said material an electrical precharge of the same polarity as the attraction element.

16. In a printing couple a movable image carrying cylinder, means for supporting print receiving material in printing relationship to said cylinder at the printing zone, a discharge element within said cylinder in the printing zone and spaced from the wall thereof, an attraction element in the printing zone located exteriorly of said cylinder and spaced therefrom, said elements being electrically connected to opposite polarities of a source of high potential electrical energy, means for inking the image on said cylinder, electrical terminals operatively associated with said cylinder interiorly and exteriorly thereof intermediate said inking means and the printing zone and acting to impress on the ink an electrical precharge of the same polarity as the polarity of the discharge element, and electrical terminals operatively associated with the opposite sides of the print receiving material in advance of the printing zone and acting to impress on said ma-

terial an electrical precharge of the same polarity as the polarity of the attraction element.

17. In a printing couple, a movable image carrying cylinder, means for supporting print receiving material in printing relationship to said cylinder at the printing zone, a discharge element within said cylinder at the printing zone and spaced from the wall thereof, an attraction element exteriorly of said cylinder at the printing zone and spaced therefrom, means electrically connecting said elements to opposite polarities of a source of high potential electricity, means for inking the image on said cylinder, means for impressing on the ink before it reaches the printing zone an electrical precharge of the same polarity as that of the discharge element, means operatively associated with one side of the print receiving material in advance of the printing zone for impressing on said one side of said material an electrical precharge of the same polarity as that of the attraction element, and means operatively associated with said print receiving material for impressing on the opposite side thereof at the printing zone an electrical charge of the same polarity as that of the attraction element.

18. In a printing couple, a movable image carrying member, discharge and attraction elements operatively associated with said member at the printing zone and spaced apart to provide a gap, means electrically connecting said elements respectively with the opposite poles of an electrical circuit to induce an electro field of force between said elements with the lines of force thereof acting to transfer ink from the image on said member to print receiving material, means for inking the image on said member, an electric terminal operatively associated with said member intermediate said inking means and the printing zone, an electric terminal operatively associated with the print receiving material in advance of the same entering the printing zone, means electrically connecting said terminals respectively with the opposite poles of an electrical circuit, wherefore precharges of opposite polarity will be impressed upon the ink on said image and on said material, and means for supporting the print receiving material in printing relationship to said member in the printing zone and within said gap between said elements.

19. In a printing couple, a movable image carrying printing member, means for supporting print receiving material in printing relationship to said member at the printing zone, discharge and attraction elements located at the printing zone and spaced apart to have said member and material extend therebetween, means for inking the image on said member, an electrical terminal operatively associated with said member intermediate said inking means and the printing zone, an electrical terminal operatively associated with the print receiving material in advance of the same entering the printing zone, means electrically connecting said discharge element and said first named terminal to one pole of an electrical circuit, the other pole of which is grounded, and means electrically connecting said attraction element and said second named terminal to the opposite pole of another electrical circuit the other pole of which is grounded, wherefore said terminals impress electrical precharges on the ink

and the material of opposite polarities while a field of force is induced between said elements with the lines of force thereof acting to transfer the precharged ink to the precharged material at the printing zone.

20. In a printing couple, an image carrying printing member, means for supporting print receiving material in printing relationship to said member, a discharge element operatively associated with said member and having its free edge adjacent one side of the member, and an attraction element operatively associated with said member and having its free edge located on the other side of the member with said material located between the free edges of said elements, the free edges of said elements being located in separate offset planes in the zone wherein the print receiving material is in printing relationship to said member, and means for electrically connecting said elements to a source of high potential electrical energy to create an electro field of force between said elements.

21. A printing couple as defined in claim 10 and wherein the means for impressing electrical precharges on the ink and the print receiving material comprise electric terminals that include supports and series of spaced rods with the rods of one terminal equally spaced from the printing member and the rods of another terminal equally spaced from the print receiving material.

22. A printing couple of the type wherein the ink is transferred from the image of the printing member to the print receiving material by electro lines of force comprising a movable image carrying printing cylinder, means for supporting print receiving material in printing relationship to said cylinder at the printing zone and including a supporting cylinder having a blanket surrounding its periphery and adapted to contact said material, means for inking the image on said printing cylinder, means for impressing an electrical precharge of certain polarity on the ink before it reaches the printing zone, and a segmental terminal electrically charged to the opposite polarity and embracing said supporting cylinder and acting to impress an electrical charge on the print receiving material through the medium of said blanket.

23. The method of reproducing upon print receiving material an image carried by a printing member of a printing couple and which comprises inking said image, introducing the material to the printing zone and therein transferring the ink from said image to said material and then beyond the printing zone impressing upon the transferred ink an electrical charge which acts to cause the ink to adhere to the material and thus prevents offsetting of the transferred ink from the material to the printing member.

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