Oct. 12, 1954 W. C. HUEBNER 2,691,343

METHOD AND APPARATUS FOR PRINTING OR COATING

Filed March 17, 1949

6 Sheets-Sheet 1

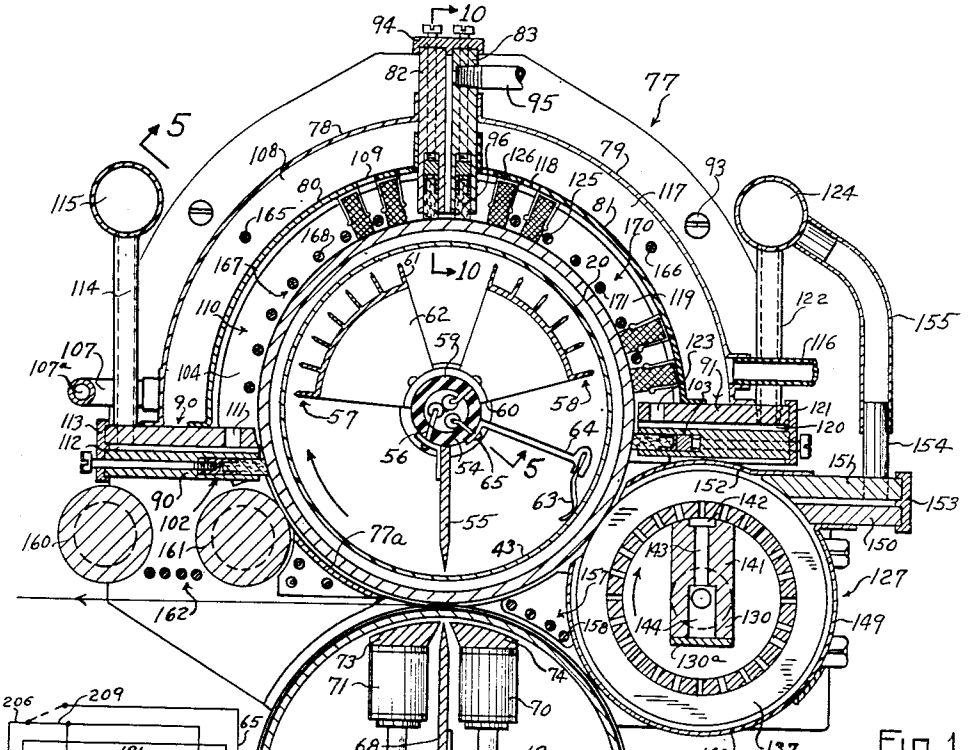


Fig. 1

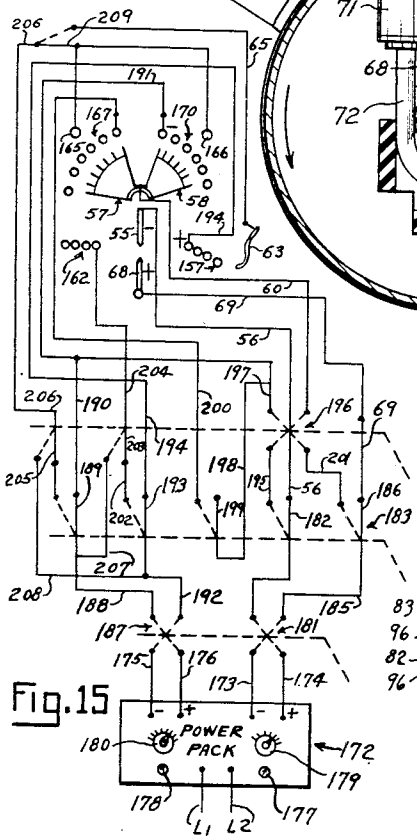


Fig. 15

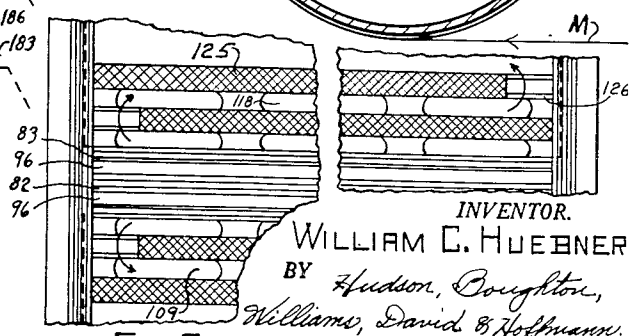


Fig. 9

INVENTOR.
WILLIAM C. HUEBNER
BY Hudson, Boughton, Williams, David & Hoffmann.
ATTORNEYS

Oct. 12, 1954 W. C. HUEBNER 2,691,343

METHOD AND APPARATUS FOR PRINTING OR COATING

Filed March 17, 1949

6 Sheets-Sheet 2

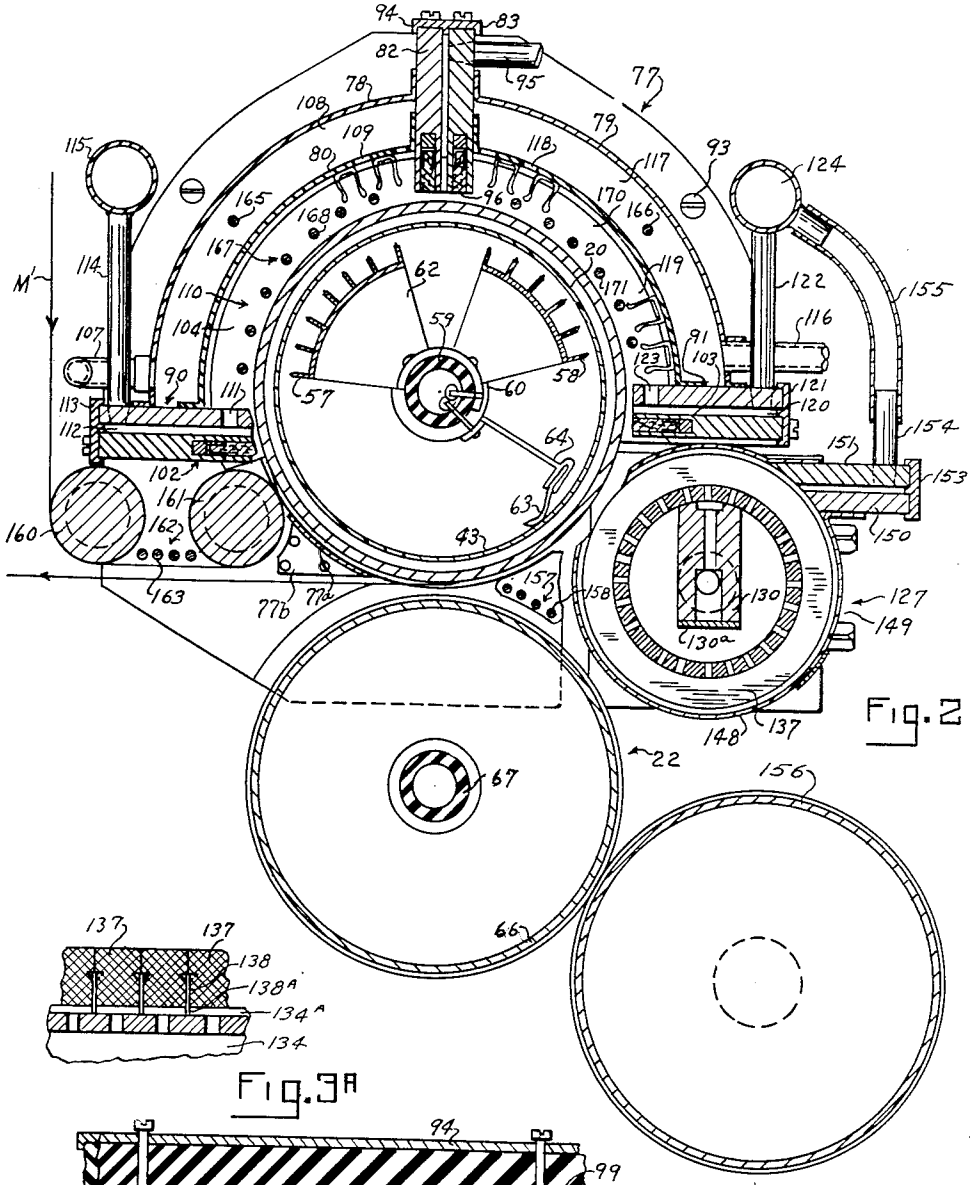


Fig. 2

Fig. 3A

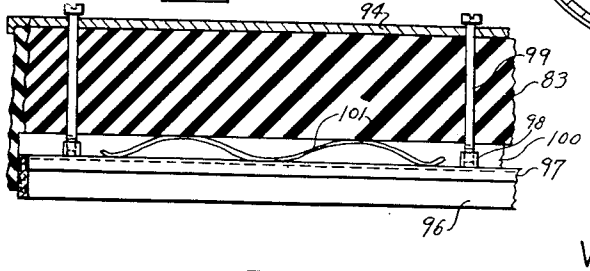


Fig. 1D

INVENTOR.
WILLIAM C. HUEBNER
BY Hudson, Boughton, Williams, David & Hoffmann.
ATTORNEYS

Oct. 12, 1954 W. C. HUEBNER 2,691,343

METHOD AND APPARATUS FOR PRINTING OR COATING

Filed March 17, 1949 6 Sheets-Sheet 3

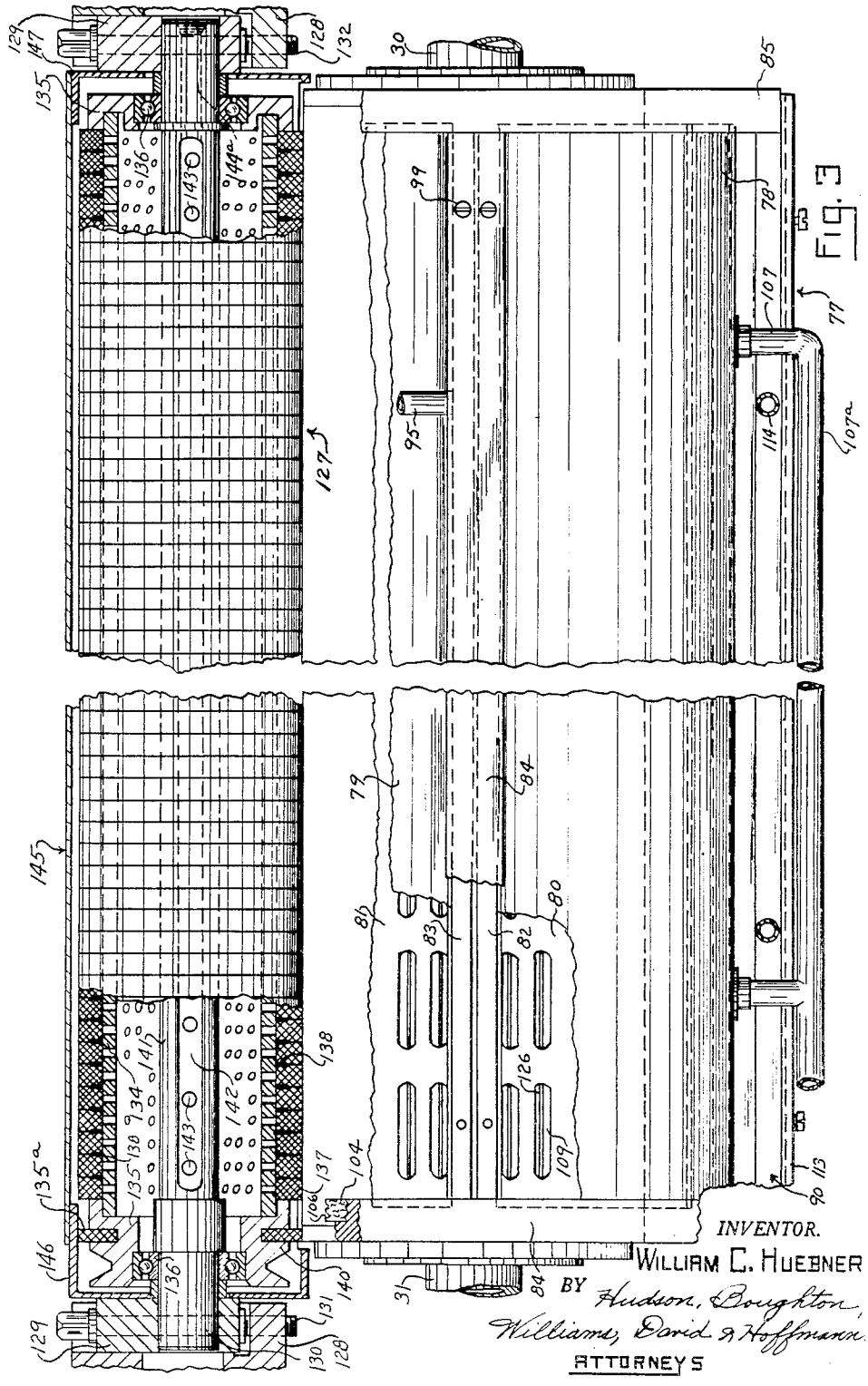


FIG. 3

INVENTOR.
WILLIAM C. HUEBNER
BY Hudson, Boughton, Williams, David & Hoffmann
ATTORNEYS

Oct. 12, 1954 W. C. HUEBNER 2,691,343

METHOD AND APPARATUS FOR PRINTING OR COATING

Filed March 17, 1949

6 Sheets-Sheet 4

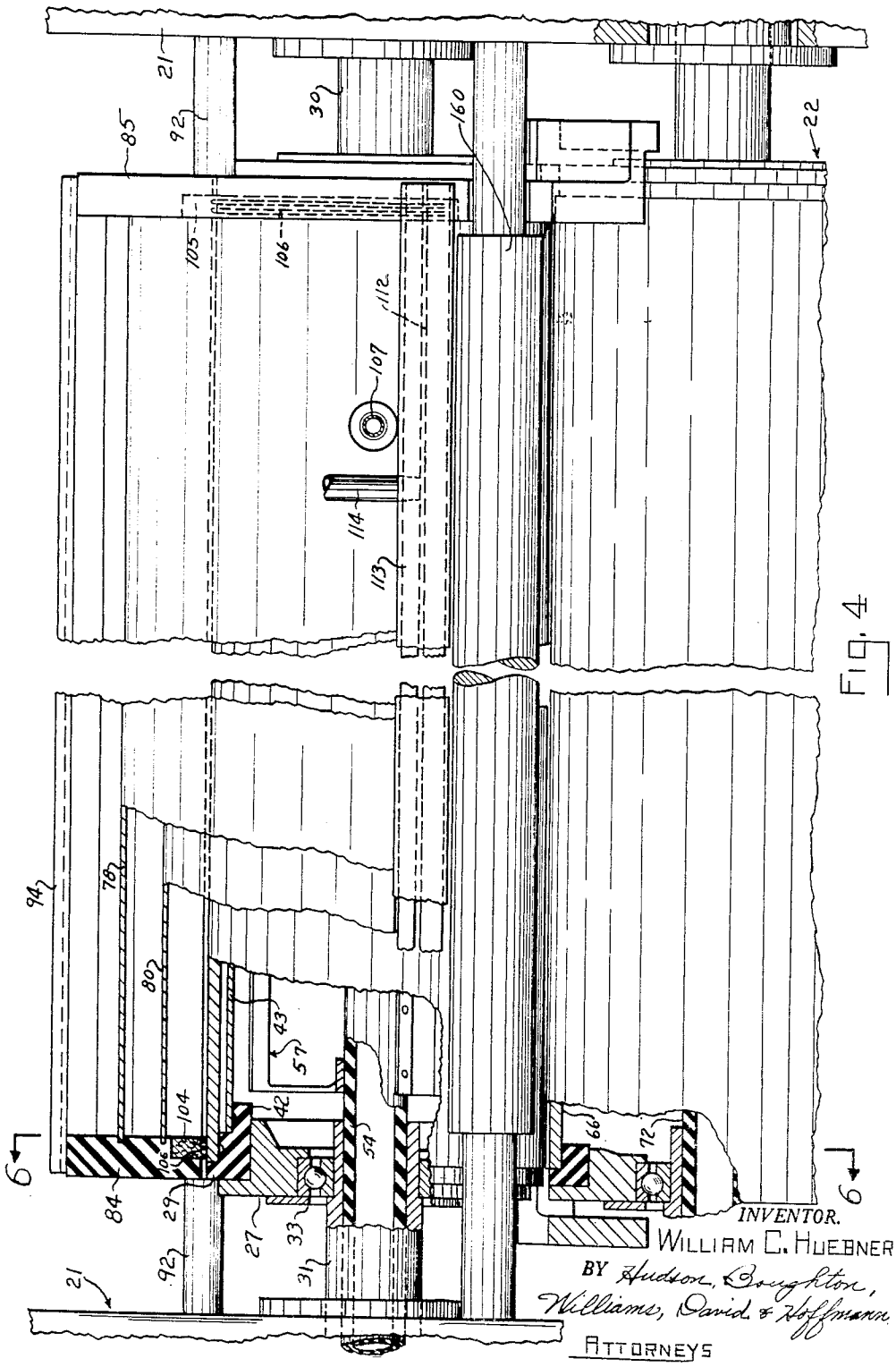


FIG. 4

INVENTOR.
WILLIAM C. HUEBNER
BY Hudson, Boughton, Williams, David & Hoffmann
ATTORNEYS

Oct. 12, 1954 W. C. HUEBNER 2,691,343

METHOD AND APPARATUS FOR PRINTING OR COATING

Filed March 17, 1949

6 Sheets-Sheet 5

Fig. 6

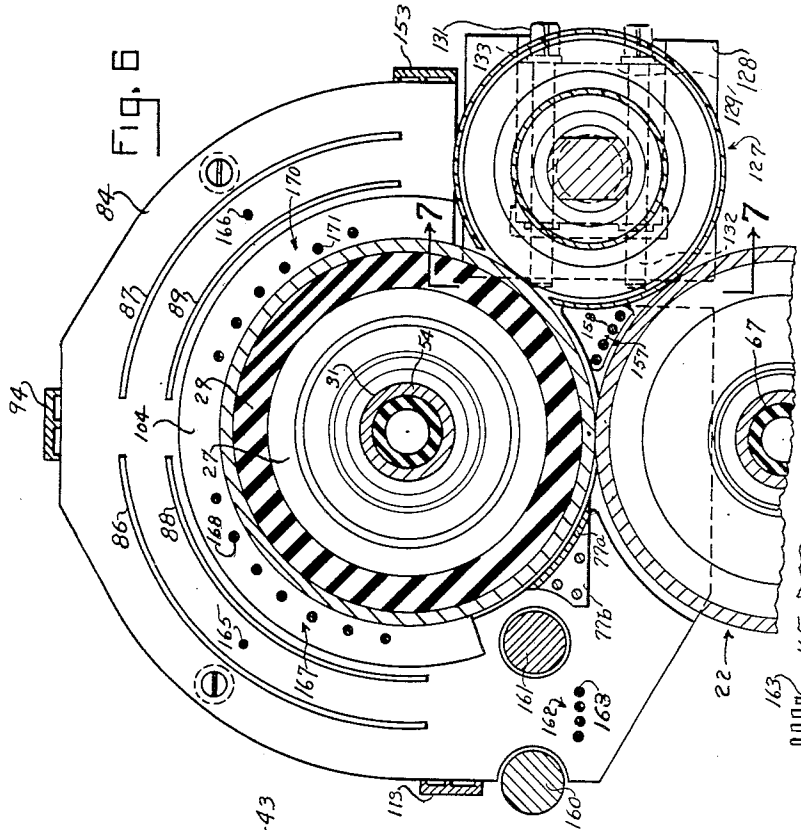


Fig. 8

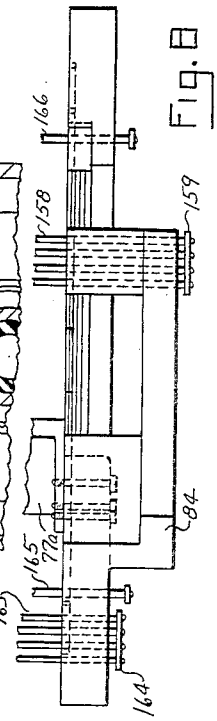


Fig. 5

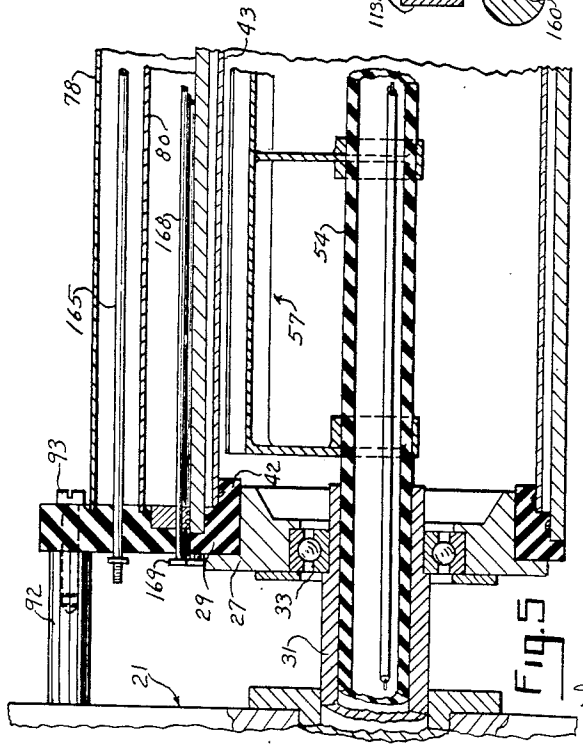
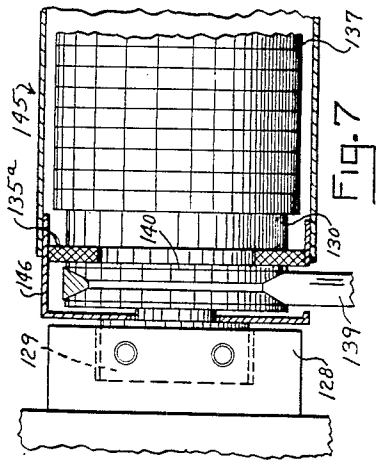


Fig. 7



INVENTOR.
WILLIAM C. HUEBNER
BY Hudson, Boughton, Williams, David & Hoffmann.
ATTORNEYS

Oct. 12, 1954 W. C. HUEBNER 2,691,343

METHOD AND APPARATUS FOR PRINTING OR COATING

Filed March 17, 1949 6 Sheets-Sheet 6

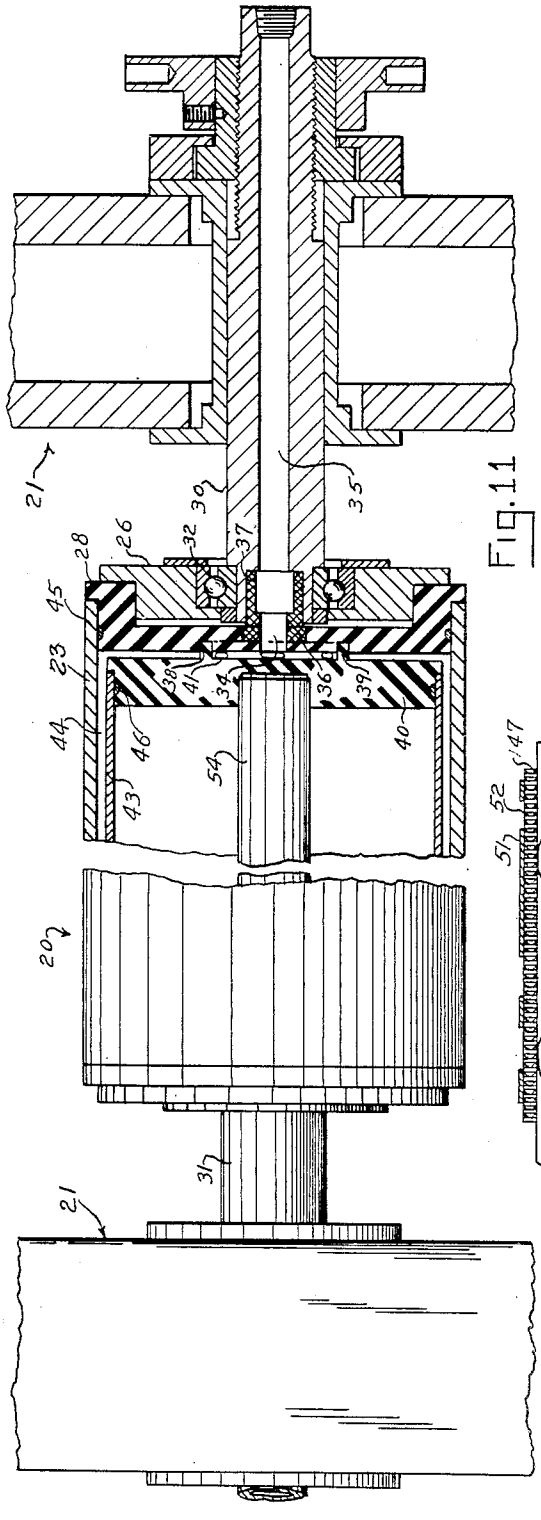


Fig. 11

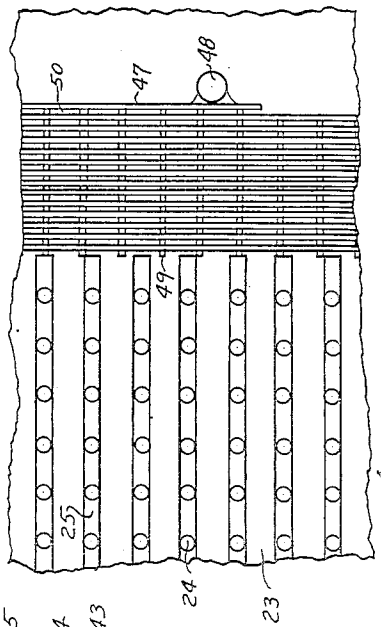


Fig. 12

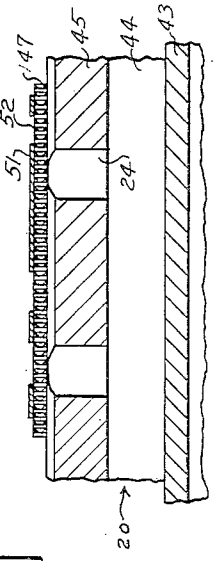


Fig. 13

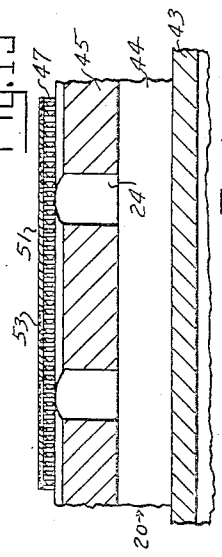


Fig. 14

INVENTOR.
WILLIAM C. HUEBNER
BY Hudson, Boughton, Williams, David & Hoffmann
ATTORNEYS

Patented Oct. 12, 1954

2,691,343

UNITED STATES PATENT OFFICE

2,691,343

METHOD AND APPARATUS FOR PRINTING OR COATING

William C. Huebner, New York, N. Y., assignor to The Huebner Company, Dayton, Ohio, a corporation of Ohio

Application March 17, 1949, Serial No. 81,866

54 Claims. (Cl. 101—116)

1

This invention relates to a method and apparatus for printing or coating sheet or web material, and, more particularly, to a method and apparatus employing an electrostatic field of force to effect transfer of printing or coating substance or substances to web or sheet material.

An object of the invention is the provision of a universal apparatus capable of utilization for the production of a coating or an image upon sheet or web material by the use of a substance or substances, which are in the form of liquid, semi-liquid, gaseous, suspensions in a liquid or gas, or combinations thereof, the substance or substances being transferred to the sheet or web material by an electrostatic field of force.

Another object of the invention is the provision of a novel procedure and apparatus for coating or printing upon sheet or web material wherein two substances, at least one of which is in liquid or semi-liquid form, are supplied to opposite sides of a member at least a portion of which is perforate, one of the substances exuding through the member to unite with the other substance and the substances after thus uniting being transferred to sheet or web material to form a coating or an image thereon.

An additional object of the invention is the provision of a novel procedure and apparatus for coating or printing upon sheet or web material as defined in the preceding object and wherein the transfer of the substances, after uniting, on a single surface of the member are transferred to the sheet or web material by an electrostatic field of force.

A further object of the invention is the provision of a universal apparatus capable of selective utilization for effecting printing or coating by the use of products of partial combustion, liquids, suspensions, or the like, or combinations of these substances, by relatively simple adjustments and/or removal and replacing of parts in the apparatus whereby a single apparatus may be readily adapted for effecting a plurality of different modes of printing or coating.

A still further object of the invention is to provide a universal type apparatus for printing or coating sheet or web material wherein gases, liquids, suspensions in either a gas or a liquid, or combinations of such substances are employed with an electrostatic field of force to effect the printing or coating by: expulsion of such substances through pervious regions of a member cooperating with the sheet or web material; transfer of the substances from the impervious surface of a member cooperating with the sheet

2

or web material; or by depositing the substances upon sheet or web material interposed between the coating or printing substances and a cooperating member which may be either perforate or imperforate.

A still more specific object of the invention is the provision of a universal apparatus for printing or coating web material wherein a rotatable cylinder is provided with a housing about a portion of its periphery, which housing is adapted to enable the use of either gaseous or liquid substances, suspensions in gases or liquids, or combinations thereof for effecting the printing or coating on sheet or web material, the said material either passing about the said cylinder and through said housing or passing in close proximity with a portion of said cylinder exteriorly of said housing.

Another more specific object of the invention is the provision of an improved apparatus of the type mentioned in the preceding object and wherein the cylinder has at least a portion of its curved periphery perforate so that print or coating forming substances may be supplied to the sheet or web material from within the said cylinder, transfer being effected by an electrostatic field of force which effects movement of the substance or substances through the perforate portions of the cylinder onto the sheet or web material.

Another specific object of the invention is the provision of an improved apparatus of the type mentioned and wherein an imperforate cylinder is employed to effect the printing or coating, the substance or substances for producing an image or coating being supplied to said cylinder from the exterior thereof and transferred from the cylinder to the material by electrostatic fields of force.

An additional object of the invention is to provide an apparatus of the type mentioned above and wherein novel wiping means are provided to remove surplus image forming substances from the non-image areas of a printing cylinder and to effect better distribution of the said substances in the image areas.

The invention also contemplates the provision of an improved apparatus as defined in the preceding object and wherein the sheet or web material passes around the major portion of the cylinder with the image or coating producing substance or substances introduced into the housing on the outer side of said sheet or web material, the said substance or substances being trans-

ferred to and/or penetrating the material under the influence of an electrostatic field of force.

An additional object of the invention is the provision of a universal apparatus of the type mentioned above and wherein a plurality of separate electrodes are employed within said cylinder and housing and interconnected by an electrical circuit to a power source for supplying electrical energy for effecting precharge of the sheet or web material and of the substances employed as well as producing an electrostatic field of force to transfer and/or effect penetration of the image forming or coating substances to the sheet or web material, switching means being provided to facilitate ready interchange of the polarities and/or functions of certain of the precharge and transfer electrodes.

The invention further resides in certain novel steps of procedure, features of construction and combination and arrangements of parts of the apparatus, 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 described with respect to the accompanying drawings in which similar reference characters represent corresponding parts in the several views and in which:

Fig. 1 is a transverse sectional view through an improved apparatus constructed in accordance with this invention, the frame being omitted and certain portions being shown in elevation for the sake of clarity of illustration;

Fig. 2 is a view similar to Fig. 1 but illustrating the manner in which the apparatus may be adapted for use with web material passing around the image or coating cylinder for effecting printing or coating on the material;

Fig. 3 is a view principally in top plan with portions of the housing broken away and the rotatable wiping means illustrated partly in elevation and partly in longitudinal section through the axis thereof;

Fig. 3*a* is an enlarged fragmentary sectional view of a portion of the rotatable wiper illustrating the manner in which a permeable wiping surface is provided thereon;

Fig. 4 is a front elevational view, with portions broken away and others shown in section, the view being taken from the left of Fig. 1;

Fig. 5 is a fragmentary sectional view taken substantially on the section line 5—5 of Fig. 1;

Fig. 6 is a sectional view taken substantially on the line 6—6 of Fig. 4;

Fig. 7 is a fragmentary sectional view taken substantially on the line 7—7 of Fig. 6;

Fig. 8 is an elevational view of one of the end plates of the apparatus as seen from the bottom thereof;

Fig. 9 is a fragmentary view of the housing with the cylinder removed and as viewed in a direction looking upwardly within the housing from the normal location of the cylinder;

Fig. 10 is a fragmentary sectional view taken substantially on the line 10—10 of Fig. 1;

Fig. 11 is a fragmentary view partly in elevation and partly in section illustrating a portion of the image or coating cylinder with the housing and electrodes removed and showing the manner in which the cylinder is supported in the frame together with the passages for supplying printing or coating substances to the interior of the cylinder;

Fig. 12 is an enlarged fragmentary plan view of a portion of the periphery of the image or coating cylinder illustrating the manner in which a perforate or pervious surface is provided thereon;

Fig. 13 is a fragmentary sectional view to a greatly enlarged scale through a portion of the image or coating cylinder and illustrating the manner in which spaced imperforate areas corresponding to non-image areas are provided on the cylinder;

Fig. 14 is a view similar to Fig. 13 illustrating the manner in which the perforate areas intermediate the imperforate areas may be filled with an insulating material thereby providing an entirely imprevious cylinder to effect one particular group of printing or coating operations; and

Fig. 15 is a simplified, schematic wiring diagram illustrating the manner in which the several electrodes of the apparatus are connected to an electrical power pack or source of electrical energy for providing both precharge potentials and transfer potentials for the various modes in which the apparatus is used, the figure illustrating the switching means employed to select the potentials applied to the various electrodes and the polarities thereof.

In accordance with this invention the novel process and apparatus for printing or coating employ substances which may be gases, liquids, suspensions in gases or liquids, or combinations thereof, the printing or coating substances being transferred to and penetrated into the fibers of sheet or web material by means of an electrostatic field of force extending through the material. When the lines of the field of force are substantially uniform, a coating or substantially uniform deposit is formed upon the material, whereas if the lines of force are arranged in a pattern in accordance with an image, the substance or substances are transferred to the sheet or web material in a manner which forms an image thereon. It will be understood that in either case, namely coating or image formation, the substance or substances are transferred to and penetrate the sheet or web material without the use of pressure, or substantial pressure, between the material and the member from which the image or coating substances are transferred. This is an important distinction from ordinary printing or coating procedures and apparatus wherein the image or coating is formed on the web material by the exertion of substantial pressure and contact between the image or coating member and the web material. Hence, while the terms "printing" and "coating" are employed in this application, it is to be understood that in using such terms they are employed in their nearest appropriate terms, since there appears to be no available term in the English language which will accurately define the processes of transferring a coating or image producing substance or substances from a carrying surface to a web material where no pressure is employed to effect the transfer.

Furthermore, throughout the specification and claims, the expression "field or force" is used similarly as in writings on electrical phenomena to indicate the field or zone within which electrostatic forces are sufficiently active or powerful enough to effect a transfer of a coating or image forming substance or substances to sheet or web material in the manner indicated herein. Also, the term "image" and related terms, as used hereinafter, contemplate words, letters, delineations, drawings, pictures, illustrations and the like and the term is intended to embody all such matters or combinations thereof.

For the sake of brevity, the term "smoke" is hereinafter used to cover gaseous printing, image forming, or coating producing substances and is to be considered as covering finely divided gaseous suspended particles produced as the result of a partial burning or combustion, whether this combustion be effected at the time of utilization in the process and apparatus or prior thereto and stored in suitable containers or the like for subsequent use. The term "smoke" is also to be considered as covering gaseous suspensions of finely divided particles of solid substances and atomized liquids which resemble smoke, or mixtures of such substances with the usual components of smoke.

The term "liquid" likewise refers to liquid, or semi-liquid, such as ink or the like, and liquid suspensions or solutions of pigments, dyes, powders, metallic dusts and the like. The term "liquid" is likewise to be understood as covering not only substances which themselves provide an image or coating but also those which assist other substances in forming such images or coatings, such as solvents, adhesives, and the like.

An apparatus constructed in accordance with this invention comprises a coating or image producing cylinder, generally designated 20, which is rotatably supported upon a suitable framework 21, the said framework also rotatably mounting a second cylinder 22 which provides a web supporting action in certain modes of use of the apparatus. The cylinders 21 and 22 may be adjusted towards and away from each other by any conventional means, not shown, but which are well known in the art. As will hereinafter appear, however, the cylinders 21 and 22 are not in pressure engagement with each other as in conventional printing cylinders but are simply either lightly touching web material therebetween or spaced so that only the image or coating cylinder touches such material.

The cylinder 20 is hollow and has a perforate surface, the cylinder, being, for example constructed substantially as shown and described in my Patent No. 2,615,389 entitled "Universal Printing Process Cylinder and Method of Making the Same." For the purposes of this disclosure it is sufficient to note that the cylinder 20 may comprise a cylindrical shell 23 which is provided with a plurality of openings or ports 24 of relatively small diameter at spaced points about its periphery, these openings being interconnected on the outer surface of the shell by longitudinally extending grooves such as 25, see Figs. 11 through 14. The ends of this shell are removably supported upon end plates or members 26 and 27, see Figs. 4, 5 and 11. Between the shell 23 and the members 26, 27 are provided suitable insulating members 28 and 29 so that the shell 23 is insulated from the end plates. The end plates 26 and 27 are rotatably mounted upon non-rotatable tubular members 30 and 31 by means of anti-friction bearings such as 32, 33, the shafts 30 and 31 being supported in the frame 21.

The insulating member 28 preferably has an integral disk-shaped portion providing a seal for the adjacent end of the shell 23 and this member has a centrally located bore or opening 34 which extends coaxially and is in communication with the bore 35 extending through the tubular member 30. The adjacent faces of the end plate 26 and the member 28 are counterbored and provided with packing means which, in the illustrated embodiment, comprise suitable packing material 36 received in the member 28 and a packing nut or gland 37 supported in the tubular member 30. The member 26 is provided on its inner face with an annular groove 38 coaxial with the bore 34 and within this groove is received a cylindrical boss 39 provided upon an insulating member or disk 40, the diameter of which is less than the internal diameter of the shell 23. The adjacent faces of the members 28 and 40 are spaced from each other and the boss or cylindrical portion 39 has a plurality of circumferentially spaced openings 41 therethrough, thereby providing a communication between the bore 34 and the space between the two members 28 and 40 exteriorly of the boss 39.

The insulating member 29 at the other end of the cylinder is provided with a reduced diameter inwardly directed extension 42 on which is supported an imperforate cylindrical shell 43, the other end of the shell 43 being supported upon a reduced diameter portion of the insulating member or disk 40, see Figs. 4 and 11. There is thus provided a space 44 intermediate the shells 23 and 43 which communicates with the previously-mentioned space between the members 28 and 40, and hence with the bore 35. Suitable sealing means 45 and 46 are provided intermediate either end of the cylindrical shells 23 and 43 and the cooperating end members therefor to prevent leakage of fluids therebetween. Consequently, fluids such as gases or liquids may be introduced from the exterior of the apparatus through a connection applied at the threaded outer end of the stationary tubular member 30. The said fluid thus supplied passes through the bore 35 and the openings 41 to the annular chamber 44, and thence flows outwardly through the perforations such as 24 and groove 25 and is distributed over the outer surface of shell 23 by the grooves 25.

Disposed upon and forming a covering for the outer surface of shell 23 is a helically wound, ribbon-like member or strip 47 which has its ends secured to the imperforate end portions of the shell 23 by soldering, welding, or the like to pin members such as 48. As shown in Fig. 12, the ribbon or strip member 47, which may be formed from wire, preferably has one side substantially planar and the other side provided with spaced protuberances or bosses such as 49, so that when the strip is wound upon the drum, the protuberances 49 of one convolution abut the planar face of the next convolution, the protuberances 49 being so spaced with respect to the circumference of the drum that the resulting spaces between adjacent protuberances are preferably in staggered relationship in adjacent convolutions. The strip-like member 47 is wound over substantially the entire surface of the shell 23 in this manner, thus providing a plurality of capillary type openings 50 which communicate with the grooves 25 and the openings 24 to permit exuding or flowing of fluid from the interior of the cylinder to the outer surface of the wire or strip 47. The width of the strip-like member 47, and of the openings formed between the said protuberances, are so small and numerous that fluid flowing or exuding outwardly from the several elongated openings such as 50 therethrough can merge on the outer surface providing a substantially continuous film thereover. When the fluid is a liquid the exuding or flow is such that the result-

ing film upon the cylinder does not readily drip or flow therefrom. By way of example, a strip or wire member 47 having a height of about .016", a thickness of approximately .005" and protuberances of about .0015" has proved satisfactory in practice. However, strip-like members of any suitable dimension may be used, depending upon the type of fluid used within the cylinder. It will be evident that the outer surfaces of the convolutions of the wire or strip 47 are initially not flat but will be rounded somewhat, which facilitates use of the cylinder when a coating is to be formed upon web material, since it facilitates union of the separate portions or drops of the coating producing substance exuding through the openings 50.

When the cylinder is to be used for image production, selected areas of the wire or strip 47, representative of the non-image portions in the image to be produced are covered by an imperforate material such as a copper shell. This may be effected as is fully described in my above-mentioned Patent No. 2,615,389 or by other suitable means which do not per se form a part of this invention, and hence need not be here described in detail. For the present purpose, it is sufficient to note that a thin metallic shell 51 is formed in the non-image areas of the cylinder with the image areas left open, as indicated at 52, in Fig. 13, so that fluid supplied to the interior of the cylinder may now move outwardly only through the image areas 52.

As hereinafter described, a cylinder such as mentioned above may also be utilized as an imperforate cylinder for printing or coating in accordance with the procedures disclosed in my copending application Ser. No. 74,822 filed February 5, 1949, and entitled "Combustion Precipitronic Process and Apparatus." In such a process the entire surface of the strip member 47 is covered and no fluid is emitted from the interior thereof. When a coating is to be formed the entire surface of the strip or wire 47 is preferably provided with a conductive shell such as copper or the like. When an image formation is desired, the image areas of the cylinder are provided with conductive portions such as the previously mentioned portions 51, and the previously mentioned spaces 52 are now filled with an electrically insulating material 53 of suitable type, the entire cylinder then being subjected to a light surface grinding to render the surface smooth.

A cylinder of the type described may also be employed to effect the formation of an image or a coating by supplying the image or coating producing material to the outer surface of the cylinder. For utilization in this manner, the entire outer surface of the strip or wire member 47 is covered with a metallic covering or shell. When a coating is to be produced the said metallic covering or shell preferably has the entire surface lightly etched in a network of lines to assist in proper distribution of the coating substance over the surface of the cylinder and retention thereon until transfer is effected. When an image is to be produced, the image areas may be formed by forming recesses in the covering shell in the image areas thereof as by etching or depressing the shell in such areas.

The hollow tubular support 31 for the lefthand side of the cylinder 20, as viewed in Figs. 3 and 4, has a tube of insulating material 54 extending therethrough, the inner end of this tube being received in a recess provided in the insulating end member 40, see Fig. 11. The insulating tube 54 is therefore stationary and provides a support for electrode means within the cylinder 20 which electrode means include both electrodes for effecting transfer of printing or coating substances and electrodes for precharging such substances. As hereinafter described, certain of these electrodes are utilized for one function in one type of operation and for a different function in a different type operation.

As is shown in Fig. 1, the insulating tube or member 54 has a transfer electrode 55 supported thereon and extending radially therefrom and towards the cylinder 22. This electrode 55, which is preferably of the blade type, extends longitudinally within the cylinder 20 and has an electrical connection with an insulated conductor 56. The latter extends through the interior of the member 54 to a position exteriorly of the apparatus and is connected in a suitable circuit, as shown in Fig. 15, for supplying electrical energy to the electrode. Also supported upon the insulated member 54 are arcuately shaped electrode members 57 and 58 which are connected together by semi-circular conductive portions such as 59, the latter in turn being connected by a wire 60 to the previously mentioned electrical circuit. The electrode members 57 and 58 each comprise a plurality of longitudinally extending blade-like projections 61 extending radially in spaced relationship from integral segmental portions such as 62 which are either connected to, or formed integral with, the previously mentioned semi-circular portions 59.

Also disposed within the cylinder 20 is a resilient contact member 63 which has a sliding contact upon the inner surface of the inner shell 43, the contact being stationarily supported upon a radially extending arm 64 which is mounted upon the member 54, the arm 64 being electrically connected to an insulated conductor 65 which is also connected in the previously mentioned electrical circuit illustrated in Fig. 15.

The lower cylinder 22 is preferably formed similar to that described in Patent No. 2,408,144 issued to William C. Huebner on September 24, 1946. For the purpose of this disclosure it is sufficient to note that this cylinder comprises a shell 66, see Fig. 1, which is formed of conductive material and is insulated from the endplates and bearings for the cylinder. Disposed within the cylinder 22 is an insulating tubular member 67 upon which is mounted a transfer electrode 68. This electrode is preferably plate-like in form and extends longitudinally of the cylinder, the electrode being electrically connected to an insulated conductor 69 which extends through the member 67 to the exterior of the apparatus and is connected in the previously-mentioned electrical circuit as shown in Fig. 15. Also supported upon the insulating tube or sleeve 67 is a magnetic shielding means for confining the electrostatic field of force existing between the electrodes 55 and 68 when the latter are supplied with electrical energy. This magnetic shielding means comprises a plurality of electromagnets 70, 71 mounted adjacent the ends of U-shaped armature members 72, the ends of the U-shaped members being provided with suitable pole pieces 73 and 74. The U-shaped members 72 and hence the electromagnets and pole pieces are all supported upon the insulating sleeve or tube 67 by means of insulating brackets 75 which are carried by the sleeve member 67; see the previously mentioned Patent 2,408,144. Also, as described in

this patent, the electromagnetic shielding means may be adjusted towards and away from the shell 66 by means of adjusting screws 76 to thereby regulate the action of the magnetic fields produced thereby upon the electrostatic field, it being understood, however, that in no case are the pole pieces brought into contact with the interior surface of the shell 66. The cylinder 22 is adapted to be rotated in timed relationship with cylinder 21, when the parts are in the positions shown in Fig. 1, by means similar to that disclosed in Patent No. 2,408,144.

Supported upon the framework 21, and adapted to surround a portion of the periphery of the cylinder 20, is a housing generally designated 77. This housing is preferably formed in two arcuate portions each comprising outer arcuate walls 78, 79, respectively, and inner arcuate walls 80 and 81, respectively. The inner and outer walls have a curvature such as to be substantially coaxial with the cylinder 20 and extend in spaced relationship longitudinally thereof. The adjacent edges of the outer walls 78, 79 of the two arcuate portions have integral upturned flanges which are respectively secured to longitudinally extending, vertically disposed, elongated members or plates 82 and 83. Likewise, the inner walls 80 and 81 of the housing have their adjacent edges provided with integral upturned flanges also secured to the elongated plate members 82, 83. The ends of the housing 77 are provided by end plate members 84 and 85, see Figs. 1 to 6 and 8, which are formed of insulating material and are provided with arcuate grooves such as 86, 87, 88 and 89 in which the ends of the arcuate walls 78, 79, 80 and 81 are adapted to be inserted. This arrangement of parts likewise closes the ends of the space between the vertical members or plates 82, 83, the width of that space being determined by the spacing of the arcuate grooves 86 to 89.

The lower ends of the walls 78, 79, 80 and 81 are each provided with integral flange portions. These lower flange portions of the walls 78, 80 are secured to a longitudinally extending, horizontally disposed member 90. Likewise, the lower ends of the walls 79, 81 are secured to a longitudinally extending, horizontally disposed member 91. The members 90 and 91 are also secured to the end walls 84, 85, thereby retaining the parts in their aforementioned relationships and providing a unitary housing which is supported from the framework 21 by suitable posts and cooperating screws 92 and 93, respectively; see Figs. 4 and 5.

The upper edges of the vertically extending members 82 and 83 are provided with a cap or top closure 94 which extends over the tops of these members and is suitably secured thereto, thus defining a closed space or well between the members and extending longitudinally of the cylinder 20, this space or well being adapted to supply a liquid to the exterior surface of the cylinder. For this purpose one of the members 82, 83, in this case the member 83, is provided with an opening in which is secured a conduit 95 for conducting a liquid into the said space. In order to regulate the quantity of liquid supplied to the cylinder, the lower edges of the members 82, 83 are provided with adjustable sealing means adapted to be selectively placed in engagement with the surface of the cylinder 20 or to be spaced therefrom any desired amount to thereby regulate the application of liquid to the cylinder 20. These sealing means are identical and

therefore a description of one is a description of both.

As shown in Fig. 10, the sealing means comprises a strip of leather or composition material 96 which is adapted to extend longitudinally of the cylinder 20, the upper edge thereof being secured in a substantially U-shaped support member 97. The support member 97 is provided on its upper surface with a plurality of integral threaded bosses 98 adapted to receive the threaded lower ends of screws 99. The members 96 are fitted into longitudinally extending grooves in the lower end of the vertically extending members 82 and 83 with the screws 99 extending upwardly through suitable openings therein and having their heads disposed above the member or cap 94. Intermediate the upper surface of each support member 97 and the upper portion of the groove, such as 100, in which the sealing means are provided, is inserted a suitable resilient means which, in the present form, is illustrated as a flat curved spring 101 bearing upon both the member 83 and the member 97 for exerting force in a direction tending to effect engagement of the strip 96 with the surface of the cylinder 20.

Ordinarily, the heads of the screws 99 are spaced slightly above the plate or cap member 94 so that the sealing strips 96 remain in engagement with the surface of the cylinder 20 under the action of the springs 101, thereby insuring a good contact with automatic compensation for wear of the strips being effected by the action of the spring 101. If it be desired to retract the lower edges of the strip members 96 from contact with the cylinder 20, as for example, when it is desired to apply a film of liquid to the cylinder 20 for the purpose of coating or the like, or when web material is wound about the cylinder 20 as hereinafter described, the screws 99 are threaded inwardly into the bosses 98 whereupon the heads of the screws engage the cap member 94 compressing the spring member 101 and withdrawing the members 96 from engagement with the cylinder 20. The limit of this withdrawing action is substantially that indicated in Fig. 2 from which it will be seen that the members 96 can be withdrawn to a position such that their lower edges are substantially aligned with the lower edges of the members 82, 83, the limit being determined by engagement of the upper faces of the bosses 98 with the upper surface of the grooves 100.

The members 90, 91 are each provided with sealing means, generally designated 102 and 103, which sealing means are constructed in the same manner and operate upon the same principles as the members 96 to 101 which have just been described. These sealing means are adapted to cooperate with the surface of the cylinder 20 when the screws 99 are in their positions indicated in Fig. 1 thereby providing a substantially fluid tight seal for the spaces or compartment between the walls 80, 81, and the cylinder 20. The sealing strips 96 of the sealing means 102, 103 may, however, be withdrawn from engagement with the cylinder 20 in the manner previously described to permit passage of web material about the cylinder 20, the position of the parts at this time being indicated in Fig. 2.

Sealing is also provided between the arcuate portions of the inner edges of the end plates or members 84, 85 and the cylinder 20 adjacent the outer ends of the latter. This sealing means is in the form of arcuately shaped strips 104, 105, formed from leather or suitable composition,

which are respectively supported in recesses provided in the inner edges of the plates 84 and 85. The sealing strips or members 104, 105 have their inner arcuate surfaces extending into engagement with the cylinder 20 and these said inner arcuate faces are provided with a plurality of spaced circumferentially extending grooves such as 106. In the illustrated form, each of the strips 104, 105 has two such spaced grooves 106, thereby providing three spaced lands in engagement with the cylinder 20. These sealing means 104 and 105 prevent any flow of fluids from the housing 77 longitudinally of the cylinder 20.

In order to supply a fluid in the nature of smoke or smoke mixed with vaporized liquids to the apparatus, a plurality of conduits 107 are connected to the outer shell 78 of the housing, the interiors of the conduits communicating with the space or compartment 108 intermediate the shells 78, 80. The several ducts 107 are preferably connected to a common longitudinally extending conduit 107a. The inner shell 80, which forms one wall of this compartment 108 is provided with a plurality of spaced openings 109, see Figs. 1, 2, 3 and 9, so that communication is provided between the space or compartment 108 and the space or compartment 110 intermediate the shell 80 and the surface of the cylinder 20. The longitudinally extending member 90 at the lower edges of the shells 78, 80 is provided with interconnected openings or ducts 111, 112, the latter extending substantially horizontally through member 90 from the exterior of the housing to a point adjacent the periphery of the cylinder 20 while the duct or opening 111 communicates with the duct 112 and with the compartment or space 110. The outer end of the conduit or duct 112 is preferably closed by an end plate 113 suitably secured in place, the duct or passage 112 being in communication with a suitable conduit or conduits 114 which lead to a means for creating a partial pressure or vacuum, not shown. Preferably, there are a plurality of conduits 114 extending substantially vertically at spaced points from the member 90 and united with a single horizontally extending duct or conduit 115 for communication with the aforementioned means to produce a partial pressure or vacuum. It will be apparent from the construction described that smoke or gaseous suspensions introduced through the conduits 107a and 107 will circulate through the space or compartment 108, thence through the openings 109 into the compartment 110 and through the latter adjacent the cylinder 20 to and through the openings 111 and 112 to the exhaust conduit 115 under influence of the partial vacuum in the latter. The end of the opening or duct 112, adjacent the cylinder 20, prevents escape of smoke or the like from between the cylinder and the housing at this point.

The construction just described is repeated for the portion of the housing represented by the shells 79, 80 and member 91. That is to say, a plurality of conduits or ducts 116 communicate with a space or compartment 117 intermediate shells 79, 81 and the inner shell 81 has openings 118 providing communication between the space or compartment 117 and a space or compartment 119 between the shell 81 and the cylinder 20. Likewise, the member 91 is provided with a substantially horizontally extending opening or duct 120, the outer end of which is closed by a plate 121, the duct being connected to a plurality of vertically extending pipes or conduits 122, and the inner end of the opening or passage 120 communicating with the compartment or space 119 through a laterally extending opening 123 in the member 91. Likewise, the pipes or conduits 122 are connected to a horizontally extending conduit 124 similar to the conduit 115 and these two pipes or conduits 115, 124 are preferably united together for convenience in applying the partial pressure or vacuum thereto. Smoke, vapor or the like introduced through conduits 116 will circulate through the space or compartments 117, openings 118, and space or compartment 119 to and through the exhaust openings 120 and 123 to the conduit 124 under the influence of the partial vacuum in the latter. The end of the opening 120 adjacent the cylinder 20 prevents the escape of smoke or vapor at this point.

Disposed within the compartments 110 and 119 for cooperation with the periphery of the cylinder 20 are a plurality of wiping means. In the present embodiment, the wiping means are shown as being removable and comprise spaced longitudinally extending strips of felt, or the like, 125 which are removably supported in substantially U-shaped clips 126 secured to the shells 80 and 81. The clips 126 may, if desired, be made somewhat resilient to facilitate the insertion and removal of the wiping material 125 and to properly retain the latter in position therein. Any appropriate or desired number of wipers may be utilized but the illustrated number and position of wipers has been found advantageous. As will be seen in Fig. 9, the wipers 125 preferably are slightly shorter than the distance between the end plates 84, 85 of the housing and adjacent ends of the wipers are staggered as shown in Fig. 9 to facilitate circulation of smoke or vapor in certain modes of utilization of the apparatus as will hereinafter appear.

In addition to the wiping means within compartments 110 and 119, a rotatable wiping means, generally designated 127, is rotatably supported on the frame 21 exteriorly of the housing 77 and adjacent the member 91. The rotatable support for the wiping means 127 is preferably so constructed that the axis of the wiping means may be moved towards and away from the axis of the cylinder 20 to thereby selectively effect contact of the wiping means with the cylinder 20 or to disengage these members. For this purpose the frame 21 is provided with a pair of brackets 128, see Figs. 3 and 6, adjacent opposite ends of the cylinder, the adjacent faces of the brackets being provided with rectangularly milled openings in which are slidably mounted rectangular bearing blocks 129 in which the cylindrical ends of a conduit member 130 are non-rotatably supported. The blocks 129 are each provided with a pair of parallel extending openings through which pass screws 131 and 132, the inner ends of the screws being threadably received in threaded openings of the brackets 128. The screws 131 and 132 are provided with flange portions or collars 133 on either side of the bearing blocks 129 so that rotation of the screws effects movement of the bearing blocks within the brackets, thereby shifting the shaft 130 with respect to the frame 21 and hence relative to the cylinder 20. Also, by completely removing the screws 131, 132 from the brackets 128, the bearing blocks 129 and hence the entire rotatable wiping means 127 may be readily removed from the apparatus.

The wiping means 127 comprises a perforate shell 134 having inwardly directed flanges 135 at

the ends thereof which are journalled upon the cylindrical portions of the conduit member 130 by antifriction bearings 136. Disposed upon the outer surface of the perforate member 134 is a permeable wiping surface which, in the present embodiment, is shown as constructed of a plurality of annular washers 137 formed of felt or other suitable material, see Fig. 3a. Interposed between adjacent felt washers 137 are washers or disks 138 which are preferably formed of metal and have a lesser outside diameter than the felt washers 137. Preferably, the side surfaces of the washers or disks 138 are provided with outwardly extending projections or protuberances which embed in the sides of the felt washers 137. The disks or washers 138 are keyed to the perforate member 134, by integral lugs or key portions 138a on the former engaging in a keyway 134a on the latter, and the washers 137 and 138 are held in side engagement by suitable means, not shown, so that the felt washers are caused to rotate as a unit with the perforate cylinder 134. The cylinder 134 is rotated by suitable means such as a belt 139 which is connected from a source of power, not shown, and extends around a pulley 140 provided on or formed integrally in the portion 135 of the cylinder 134.

The conduit member 130 has a radial portion 141 extending longitudinally intermediate the end portions 135 of the perforate member or cylinder 134. The outer edge of the portion 141 extends closely adjacent the inner surface of the shell 134 and is arcuately curved concentric therewith. The outer arcuate face of the portion 141 has a longitudinally extending groove or recess 142 therein adapted to successively communicate with the perforations in the shell 134 as the latter rotates therepast. The groove 142 communicates with a plurality of radially extending openings or passages 143 which in turn communicate at their lower ends with a central opening or chamber 144 in the member 130. The opening or chamber 144 may be formed by a milling or other suitable operation, the lower side of the completed chamber being closed by a plate 130a. The central opening or chamber has an axial extension formed by a bore 144a extending to one of the ends of the member 130. The outer end of this bore 144a is threaded and hence is adapted to be connected with a pipe or conduit, not shown, communicating with a source of fluid pressure such as compressed air.

It should now be apparent that, when the rotatable wiping means 127 has been adjusted into operative engagement with the cylinder 20, and is rotated in the opposite direction to the rotation of cylinder 20, the liquid wiped by the former from the latter, and normally absorbed into the felt, is removed therefrom by the air or other fluid under pressure issuing from the opening or groove 142 as the portions of the wiper pass thereover. To withdraw this removed liquid and prevent it from being deposited upon other portions of the apparatus, the rotatable means 127 is substantially enclosed by a housing or shield 145 communicating with a region of reduced fluid pressure, such as a chimney or a chamber provided with an air exhaust fan. This shield may be made in several parts and is shown as comprising substantially cup-shaped end portions 146 and 147 connected with the aforementioned bearing blocks 129. The cup portions 146, 147 are connected with arcuate portions 148, 149 extending longitudinally of the wiper and removably secured to the cup portions. The longitudinally extending arcuate portion 149 has its upper edge provided with an outwardly extending flange portion which is connected with a plate 150. A second plate 151 is supported in spaced relationship with the plate 150 and has an outwardly extending flange of an arcuate shield portion 152 connected thereto. The shield portion 152 is, like the portions 148 and 149, removably secured to the cup members 146 and 147, sufficient space being provided intermediate the edges of the arcuate portions 149 and 152 to permit cooperation of the wiping means with the cylinder 20. The space between the plates 150 and 151 is closed at the outer end by a member 153 and the sides of this opening are likewise sealed, thereby providing a duct or passageway which is connected with upstanding ducts or conduits 154, the latter in turn being connected to the previously mentioned conduit 124 which, it will be remembered, is in communication with a region of reduced fluid pressure. The connections between each conduit 154 and the conduit 124 preferably includes a flexible portion 155 to permit movement of the wiper mechanism 127 and its shield relative to the housing 77 and the conduit 124, Figs. 1 and 2 showing respectively the two extreme positions of the wiping mechanism 127 while the latter remains mounted in the machine. Intermediate the pulley 140 and the felt washers 137, the shell or cylinder 134 is provided with a circumferentially extending groove in which a sealing washer 135a is mounted for cooperation with the shield 145 to prevent fluid leakage at this point. The directions of rotation of the wiping means 127 and of the cylinder 20 are indicated by arrows in Fig. 1 from which it will be observed that these two elements are rotated in opposite directions.

It will be apparent from the construction just described that, when the wiping mechanism 127 is in engagement with the cylinder 20, liquid is removed by the wiping mechanism from the cylinder and this liquid is in turn removed from the felt washers 137 by the fluid pressure emitted from the groove or opening 142 as successive portions of the washers 137 pass thereover. The liquid thus displaced by the fluid pressure, being in the form of a vapor or spray, is readily withdrawn through the conduits 154, 155 and 124 due to the partial vacuum or reduced pressure maintained therein. When the rotary wiper 127 is moved out of operative relationship with the cylinder 20 to a position such as indicated in Fig. 2, it need no longer be rotated and the fluid pressure supplied thereto is terminated. The partial vacuum applied through the conduits 154, 155 may be also terminated, if desired, or may be left in operative relationship.

Web material may be introduced into the apparatus and into cooperative relationship with the cylinder 20 in either of two ways in accordance with the type of coating or printing to be effected thereon. As shown in Fig. 1, the web material M comes from a source of supply, not shown, and is led around an idler or direction-changing cylinder 156 which is suitably supported in the frame 21 adjacent the cylinder 22 and spaced therefrom sufficiently to permit passage of the material M. The web material after passing about a portion of the cylinder 156, then passes around a portion of the cylinder 22 and between the latter and the cylinder 20, the material continuing therefrom to a suitable takeup mechanism not shown. The cylinder 22 forms a support for the material to maintain the latter close-

ly adjacent the cylinder 20, but no pressure is exerted between these latter two cylinders since the coating or printing upon the material M is effected by transfer of the printing or coating substances from the cylinder 20 by an electrostatic field of force as contrasted with pressure as in conventional procedures.

In order to provide an electrical precharge upon the web material M before the latter passes adjacent the cylinder 20 and through the electrostatic field of force utilized for transfer of the coating or printing substance, the said material passes adjacent an electrode means generally designated 157. This electrode means comprises a plurality of spaced rods or wires 158 which extend longitudinally between the end plates 84, 85 and are supported in the latter, the rods or wires 158 being disposed in a somewhat arcuate configuration concentric with the axis of the cylinder 22 when the latter is in its position shown in Fig. 1. The outer ends of the electrode wires or rods 158 extend beyond the outer faces of the end plates 84, 85 and are electrically connected together by soldering, welding, or the like to a conductive strip 159, see Fig. 3.

Web material may also be introduced into cooperative relationship with the cylinder 20 in the manner shown in Fig. 2 from which it will be observed that the material such as M', coming from a source of supply not shown, passes around idler rollers or cylinders 160 and 161 which are supported upon the frame 21 and extend through suitable cutout portions of the end plate members 84, 85 of the housing. The web material M', after passing around the rollers or cylinders 160, 161, then passes through the housing 77 by being wrapped around the periphery of the cylinder 20 and is led therefrom tangentially between the cylinder 20 and the cylinder 22. When the material is fed in this manner, the rotatable wiping means 127 and the cylinder 22 are normally moved to positions where they are spaced from the cylinder 20, as indicated in Fig. 2, and the stationary wipers such as 125 are removed from the housing, while the sealing means carried by the members 82, 83 and 90, 91 are retracted from engagement with the cylinder by operation of the screws 99, the position of these parts in their retracted position likewise being illustrated in Fig. 2.

In order to provide a precharge for the web material M' before the latter is conducted about the cylinder 20, an electrode means 162 is provided intermediate the rollers 160, 161. This electrode means is constructed similar to that designated 157 and likewise comprises a plurality of longitudinally extending rods or wires 163, the ends of which are supported in the end plates 84, 85, the rods or wires 163 being disposed in a plane adjacent the path of the material between the rollers 160, 161. The ends of the wires or rods 163 which extend beyond the sides of the end plates 84, 85 are electrically connected together as by welding or the like to connecting strips 164.

In addition to the electrode means just described, electrode means are also provided to supply an electrical precharge to smoke or other fluid entering the apparatus through the conduits 167 and 116 and circulating through the compartments 108, 119 and 117, 119 respectively. For this purpose an electrically conductive rod or wire 165 extends through the space or compartment 109 intermediate the walls 78, 80, the ends of this rod being supported in the end walls 84, 85 with at least one end of the rod extending sufficiently beyond the end wall for connection of an electrical conductor thereto; see, for example, Fig. 5. A similar electrically conductive rod or wire 166 is provided in the compartment 117 extending therethrough between the end plates 84, 85 for precharging smoke or other fluids passing through the compartment 117 prior to its introduction adjacent the surface of the cylinder 20.

Electrode means are also provided in the compartments or spaces 118 and 119. These electrode means likewise comprise a plurality of electrically conductive rods or wires extending longitudinally of the housing and secured at their ends in the end plates or walls 84, 85. Thus, the electrode means in the compartment 118, designated 167, comprises spaced rods or wires 168, the outer ends of which extend through the end wall of the housing and are electrically connected together by a conductive strip 169, see Fig. 5. Likewise, the electrode means in the compartment 119, generally designated 170, comprise spaced rods or wires 171 electrically connected together by a common connecting strip. The wires 168 and 171 are disposed in arcuate configurations about the surface of the cylinder 20 and spaced therefrom and these wires, being opposite the blade edges of the electrodes 57, 58, may be used for either precharging substances on the surface of the cylinder 20 when the electrodes 55, 60 are used for transfer of the substances, or may themselves be used for effecting the transfer of substances when the web material such as M' is wrapped around the cylinder 20 as indicated in Fig. 2.

In addition to the features of construction just mentioned, an arcuate shield 77*a* extends longitudinally of the housing 77 adjacent the surface of the cylinder 22 intermediate the cylinder 22 and the roller 161. This arcuate shield or plate 77*a* is secured to the end plates 84, 85 by angular portions or brackets 77*b* which are held by means of screws or they may be otherwise connected to the end plates. As will be observed from Fig. 2, this shield 77*a* substantially closes the portion of the surface of the cylinder 20 which is not covered by the web material M' when the latter is conducted about the cylinder 20 as shown in Fig. 2. Consequently, when the machine is used in the manner indicated in Fig. 2, and as hereinafter more fully described, smoke or other fluid admitted to the interior of the cylinder 20 cannot freely flow from openings in the cylinder at the portion intermediate the rollers 161 and cylinder 22 and which is not covered by the web material M'.

Fig. 15 illustrates a simplified form of electrical circuit for interconnecting the previously mentioned electrodes. As shown therein, power lines L1 and L2 conduct electrical current from a commercial source of supply to a conventional power pack or supply unit 172. This unit is adapted to provide direct current of two different potential differences, the potential difference provided at the output wires 173 and 174 being, for example, in the order of twice that between the output wires 175 and 176. The higher voltage or potential difference at the wires 173, 174 is employed for the transfer electrodes to establish the electrostatic field of force therebetween which effects transfer of substances to the web material, while the lower voltage or potential difference between the wires 175 and 176 is connected with the precharge electrodes to supply the web material and

the printing or coating substances with electrical charges prior to their being subjected to the electrostatic field of force. The power supply unit or pack 172 is preferably provided with adjusting means operated by knobs, such as 177 and 178, to control the voltages applied to the leads 173, 174 and 175, 176, respectively. The power pack or unit 172 is also preferably provided with indicating meters 179 and 180 to indicate the potential differences or voltages supplied to the two sets of output leads. Since the power supply unit 172 is of conventional construction, the details thereof need not be described.

The output lead 173 is connectible through a reversing switch 181 to the previously mentioned wire 56 which, as previously mentioned, is connected with the transfer electrode 55, this connection being effected when a movable blade 182 of a multipole, double-position switch, generally designated 183, is positioned as indicated in full lines in Fig. 15. The wire 174 is connectible through a second portion of the reversing switch 181 to a wire 185 which is in turn connected through the movable blade 186 of the switch 183, when in its full line position of Fig. 15, to the previously mentioned wire 69 connected to the transfer electrode 68. In addition, the switch 183, when in the position indicated in full lines in Fig. 15, has the output terminal 175 of the precharge voltage connected through a reversing switch 187 to a wire 188 which is in turn connected by the movable blade 189 of the switch 183 to the wire 190, the latter being connected by a wire 191 to the precharge electrode 170 located within the chamber 119. The output wire 176 of the precharge voltage is at the same time connected through the reversing switch 187 to a wire 192 and thence through the movable blade 193 of the switch 183 to a wire 194 which is in turn connected to the precharge electrode 157 for the web material M. The polarities of the potential differences or voltages applied to the electrodes 55 and 68 and to the electrodes 157 and 170 may be reversed simultaneously by simultaneous operation of the switches 181 and 187, these switches being preferably ganged together for common actuation, as indicated in the drawing. Consequently, the polarity of the charge supplied to the web material is kept the same at all times as that applied to the electrode 68 and the polarity of the potential applied to the electrode 170 is the same as that applied to the transfer electrode 55, the polarities being reversed as indicated when the coating or printing substance is such that it more readily receives a charge of one type than of the other.

With the switch 183 in its broken line position indicated in Fig. 15, the wire 173 is now connected through blade 182 to a wire 195 which is in turn connected through a reversing switch 196 to a wire 197, the latter being connected to the wire 191 and hence to the electrode 170. The wire 197 is also connected by a wire 198 with a movable blade 199 of the switch 183 which now closes a circuit to the wire 200 connected with the electrode means 167 within the compartment 110 of the housing. The movable blade 186 of the switch 183 has now closed a circuit to a wire 201 which is in turn connected through the reversing switch 196 to the wire 60 for the electrode means 57, 58 located within the cylinder 20. The switch blade 193, of switch 183, in the broken line position of Fig. 15, closes a circuit to a wire 202 and through a switch blade 203 and a wire 204 to the precharge electrode 162 for the web material M'. The switch blade 189 of the switch 183 would then close a circuit to a switch blade 205 and from the latter this circuit extends through a wire 206 and a switch blade 209 to the electrodes 165 and 166 in the compartments 108 and 117, respectively. The switch blades 203 and 205 are connected for common actuation along with the reversing switch 196 and, hence, when the switch 196 has been moved to reverse the previously described connections extending therethrough, the switch blades 203 and 205 are then moved to their broken line positions illustrated in Fig. 15. In those positions, the switch blade 203 closes a circuit between the wire 204 and a wire 207 connected with the wire 188 and the blade 205 completes a circuit from the wire 206 to a wire 208 and thence to the wire 192. The previously mentioned switch having the movable blade 209 is adapted to connect the wire 206 to the electrodes 165, 166, as before mentioned. However, when the switch blade 209 is thrown to its broken line position shown in Fig. 15, a circuit is completed from the wire 206 to the wire 65 and hence to the contact 63 riding in engagement with the interior of shell 43 of the cylinder 20. The manner in which the circuit illustrated in Fig. 15 is employed to perform the various operations of coating or printing upon web material will be more fully apparent in the hereinafter described operation of the machine, in conjunction with the present preferred modes of utilizing the latter.

OPERATION

I

The apparatus illustrated and described may be employed for forming an image upon web material by means of a liquid printing or coating substance supplied directly to the exterior surface of the cylinder 20. When employed in this manner the apparatus is in substantially the condition illustrated in Fig. 1, wherein it will be observed that the web material M is fed over the idler cylinder or roller 156, thence about a portion of the cylinder 22 and between the latter and the cylinder 20. The stationary wiping means 125 and the rotatable wiping means 127 are in position, as indicated, and the cylinder 20 employed has the surface thereof provided with recesses or depressed areas in the image portions. These recesses or depressed areas may be provided, for example, by employing a cylinder 20 such as illustrated in Fig. 13 wherein it will be observed that the copper shell or covering 51 occurs only in the non-image areas and the image areas therebetween are in the form of pockets or recesses or the cylinder may have a complete shell over the strip or wire member 47 with the image areas provided by depressions or recesses in this shell as by etching or the like. The substance to be employed for forming the image, being in liquid or semi-liquid form, is supplied through the pipe or conduit 95 into the space between the elongated members 92, 93 so that it is applied to the exterior surface of the cylinder 20, excessive flow from the source of supply onto the cylinder being prevented by the previously mentioned members 96 carried by the members 92 and 93.

At this time the electrical circuit will be conditioned as shown in Fig. 15 so that the switch 183 has the blades thereof in their full line positions as are also the switch blades 203, 205 and 209, the reversing switches 181, 187 having been thrown to a position so that the polarities sup-

plied to the various electrodes are in accordance with the electrical characteristics of the material employed. Therefore, the transfer potential difference between the wires 173 and 174 is supplied to the electrodes 55 and 68 through the switch blades 182 and 186 respectively, while precharge potentials are applied to the electrodes 157 for the web material and 170 for the liquid, these connections being effected through the switch blades 193 and 189.

The liquid, as supplied to the exterior surface of the cylinder 20, fills the depressed or recessed image portions or areas thereon, the liquid upon the non-image areas being wiped therefrom by the stationary wiping means 125 as the cylinder rotates and any remaining liquid upon the non-image areas being removed by the rotary wiping means 127. In addition to removing the liquid from the non-image areas, the wiping means perform the further function of assisting in filling any small image areas which might normally not be filled with the liquid, especially when the latter is somewhat viscous. As the cylinder, now supplied with liquid in only the image areas and precharged by passage past the electrode means 167, comes adjacent the web material, precharged by the electrode means 157, transfer of the precharged liquid to the precharged web material is effected by the electrostatic field of force between the electrodes 55 and 68. This transfer occurs whether or not the magnetic field provided by the electromagnets 70, 71 is utilized, the latter being employed simply for the purpose of confining the lines of force in the electrostatic field and thereby effecting a somewhat sharper image upon the web material.

If, instead of employing depressed image areas upon the surface of the cylinder 20, the surface be substantially uniform, a coating may be applied to web material M by slightly raising the sealing means 96, by removing the stationary wipers 125 and moving the wiping means 127 away from the surface of the cylinder 20. A uniform film of liquid will then be supplied to the cylinder which film will receive a precharge from the electrode means 170 and this precharged liquid will be transferred to the precharged web material M by the transfer potential difference between the electrodes 55 and 68. When effecting coating it is normally unnecessary to employ the electromagnetic shielding means. In effecting coating in this manner, it is preferable to employ an imperforate shell of conductive material upon the cylinder 20 which shell is lightly etched or otherwise provided with a network of fine lines or grooves to facilitate distribution of the liquid over the surface thereof and to facilitate the formation of a uniform layer or coating on the web material. While the wiping means such as 125 and 127 are normally removed from engagement with the cylinder 20 when producing a coating, as just described, wipers such as 125, but with their lower edges spaced from the cylinder 20 and/or adjustment of the wiping means 127 adjacent to but spaced slightly from the surface of the cylinder 20, will remove excess liquid from the cylinder 20 but will leave a layer thereon which is subsequently transferred to the web material as a coating. This mode of operation is useful where the liquid is relatively viscous and tends to be unevenly distributed over the surface of the cylinder.

II

A second mode of employing the apparatus is to utilize a cylinder 20 having perforate portions in the surface thereof corresponding to image areas and imperforate portions representing non-image areas, the surface of the cylinder then being similar to that shown in Fig. 13. With such a cylinder in place and the apparatus otherwise constructed as shown in Fig. 1, liquid is supplied to the interior of the cylinder 20 through the bore or passageway 35 in the shaft 30 and exudes outwardly through the perforate areas, any liquid which may come upon the non-image areas being removed by the wiping means which also serve to distribute the liquid into such image areas as, due to their small dimensions, are not perforate through the cylinder. The circuit for the several electrode means is the same as previously described for the first-mentioned operation and hence the liquid receives a precharge by means of the electrode wires 171 of the electrode means 170. The web material is electrically precharged by the electrode 157 and the liquid within the image areas is transferred by the electrostatic field of force extending between the electrodes 55 and 68 as the image areas pass therebetween due to rotation of the cylinder. As before mentioned, the magnetic field provided by the electromagnets 70 or 71 may be employed, if desired, this depending upon the characteristics of the web material and the image producing substance as well as upon the sharpness of the image desired.

If the cylinder 20 have its entire surface perforate and the wiping means 125 and 127 be removed from cooperative relationship with the cylinder, the apparatus being otherwise conditioned as just described, liquid supplied to the interior of the cylinder exudes from the entire surface thereof, is precharged and transferred to the precharged web material as a uniform coating, this transfer being effected by the electrostatic field between the electrodes 55 and 68. Likewise, as mentioned under Operation I above, wiping means such as 125 and 127 may be positioned adjacent the surface of the cylinder but spaced slightly therefrom to ensure a uniform layer of liquid on the surface of the cylinder when using the latter to coat with a liquid fed from within the cylinder.

III

In some instances, when ink or other liquid is supplied from within the cylinder 20, it is desirable to supply a second liquid such as a solvent to facilitate entry of the liquid such as the ink into small image areas which, due to their size do not have perforations thereunder, and hence have no means of direct supply of ink from the interior of the cylinder, this condition occurring especially when very fine image work is desired. In such an event, the apparatus is employed in substantially the same manner as previously described above under Operation II, except that the solvent or other second liquid is introduced through the conduit 95 and applied to the exterior surface of the cylinder, while the ink or image forming substance proper exudes through the cylinder from the interior thereof. These two liquids, being compatible, mingle on the outer surface of the cylinder and hence the solvent thins the ink or other liquid coming from within the cylinder sufficiently to permit the latter to easily fill image areas which are imperforate but which are recessed or depressed

below the larger non-image areas, this action being effected by the wipers as the cylinder is rotated therepast. The liquid upon the surface of the cylinder is precharged as is also the web material as previously described under Operation II and the transfer of the mingled substances to the web material is again effected by the electrostatic field of force between the electrodes 55 and 68.

Coating may likewise be effected by employing two compatible liquids supplied respectively from the interior and exterior of the cylinder 20 by removing the wipers 125 and the rotating wiping means 127 from cooperative relationship with the cylinder 20, and by slightly raising the sealing strip 96 carried by the member 83. In this case, the cylinder 20 has substantially its entire surface perforate so that a liquid supplied from the interior thereof exudes throughout the periphery and mingles with the second liquid introduced as a film upon the exterior surface. These mingled liquids are precharged and transferred to the precharged web material M in the same manner as previously described for coating under the second form of operation described above. Likewise, as mentioned above under Operation I and II, wiping means adjacent to but spaced from the surface of the cylinder 20 may be used at times to facilitate forming a uniform thickness of mingled liquids on the surface of the cylinder prior to transfer to the web material.

IV

Instead of employing the ink or other printing or coating substance from within the cylinder 20 and a solvent supplied to the exterior of the cylinder, the mode of supplying two liquids may be reversed so that the solvent is supplied from the interior of the cylinder and the ink supplied directly to the exterior surface of the cylinder. The operations are otherwise the same as described above under III and either printing or coating may be performed in the same manner.

V

In employing smoke, vapor, gaseous suspensions, or the like, to form an image upon web material, the apparatus is conditioned substantially as shown in Fig. 2, from which it will be observed that the stationary wipers 125 have been removed, the rotatable wiping means 127 has been moved away from the cylinder 20, and cylinder 22 has likewise been lowered so as to proide a greater space between it and the cylinder 20. The web material M' is introduced into the apparatus by passing it around the guide rollers or cylinders 160, 161, thence around the cylinder 20, and finally leading it from the machine substantially parallel with the incoming portion of the web. The sealing means 192 and 193 have the strips 96 thereof positioned in spaced relationship with respect to the cylinder 20 sufficiently to permit free passage of the web material M' therepast as are also the sealing strips 96 carried by the members 82 and 83. The circuit for the apparatus is then conditioned by throwing the switch 183 to dispose its blades in their broken line positions. The circuit for the apparatus is then such that the precharge electrode 162 is now connected through the wire 204, switch blade 203, wire 202, to and through the reversing switch 187 to wire 176 of the precharge voltage supply. Likewise, the precharge electrodes 165 and 166 are connected through the switch blade 209 to the wire 206, through the switch blades 205 and 189, wire 188 to the reversing switch 187 and wire 175 connected to the other side of the precharge voltage supply. Therefore, the smoke due to its circulation through the compartments 108 and 117 receives a precharge from the wires 165 and 166 while the web material M' is precharged by passing near electrode 162. These precharges are of opposite polarities, which polarities may be selected in accordance with the type of materials utilized by proper positioning of the reversing switches 184, 187. The electrodes 57 and 58 within the cylinder 20 are now connected through the wire 69, switch 196, wire 201, switch blade 185, wire 185 and switch 181 to one side of the source of transfer voltage. The electrode means 167 is connected by the wire 200, switch blade 199, wires 198 and 197, switch 195, wire 195, switch blade 182, and switch 181 to wire 173 connected to the other side of the transfer voltage supply. Finally, the electrode means 170 is connected through the wire 191 to the wire 197 and thence to the said other side of the voltage supply through the connections just described. Hence the electrode means 167 and 170 are connected together and together form the discharge electrode of the electrostatic field employed for transferring or depositing the precharged smoke or the like circulating through the compartments 110 and 119 upon the web material.

In employing the apparatus in this manner, the cylinder 20 will have its surface substantially as shown in Fig. 14, that is to say, the image areas will be formed of conductive material whereas the non-image areas are formed of non-conductive or insulating material. The smoke entering through the conduit 107 flows through the compartment 102 intermediate the inner and outer walls 78, 80, thence through the openings 109 and the compartment 110 intermediate the inner wall 80 and the web material M', smoke being withdrawn through the opening 111, and any smoke attempting to leak exteriorly of the housing past the member 80 being withdrawn through the duct 112 extending adjacent the surface of the web material. Likewise, smoke may also be introduced through the conduit 116 and flows serially through the chambers or passages 117 and 119, being removed through the opening 123 and the conduit 124.

The precharged smoke circulating past the electrode means 167 and 170 is transferred or disposed upon the web material due to the action of the field of force between the said last-mentioned electrodes and the electrode 57, 58 within the cylinder. This field of force will be sequentially arranged in accordance with the image upon the cylinder 20 as successive conductive portions of the surface of the latter, representing the image, move through the field of force. Hence, smoke or the like will be deposited upon the web material only in the areas thereof opposite image portions of the cylinder with the result that an image is formed thereon in accordance with that on the cylinder; see my above-mentioned copending application Ser. No. 74,822 for a more complete description of this mode of printing or coating and the broad claims thereto.

If it be desired to produce a coating upon web material by the use of smoke or fluid suspensions similar to smoke, this may be readily effected by substituting for the cylinder having an image surface, one having a conductive shell over the

entire periphery. The apparatus is otherwise the same as just described for image formation and is utilized in the same manner except that now the smoke or the like is deposited as a uniform layer or coating on the web material.

VI

Yet another way of employing the apparatus is to utilize smoke, gaseous suspensions, or the like introduced through the conduits such as 107 and 116 together with a liquid such as an adhesive or the like introduced through the interior of the cylinder 20 and exuding through the perforations therein. When employed in this manner, the apparatus will be conditioned substantially as shown in Fig. 1 with the cylinder 20 having perforate image areas and imperforate non-image areas similar to that shown in Fig. 13. The web material M is led over the roller or cylinder 156 and over a portion of cylinder 22 to pass between the latter and the cylinder 20. The wipers 125 and the rotary wiping means 127 are in cooperative relationship with the cylinder 20, and at least in this instance, the stationary wipers 125 have opposite ends thereof staggered with respect to the end plates or walls 84, 85 of the housing, see Fig. 9. This provides a devious path for the smoke or the like coming into the inner compartments 110 and 119 through the openings 109 and 118 thus permitting flow of the smoke or the like while at the same time providing the necessary wiping action upon the surface of the cylinder.

The circuit for the several electrodes will be the same as described above for operations such as I, II, III, and IV. Hence the electrode means 157 provides a precharge upon the web material M and the electrode means 170 provides a precharge upon the mingled smoke and liquid upon the surface of the cylinder, it being understood that the liquid exuding through the perforations of the cylinder is compatible with the smoke and hence will pick up portions of the smoke circulating thereabout so that the smoke and liquid are mingled on the cylindrical surface. This mingled smoke and liquid are confined to the image areas by action of the wiping means 125 and 127 which remove any mingled fluid and liquid from the non-image areas and hence the mingled fluid and liquid are transferred to the web material in the form of an image as the image portions of cylinder 20 and the web material pass through the electrostatic field existing between the electrodes 55 and 68, as before described. The polarities employed upon the several electrodes may be reversed, if necessary, depending upon the nature of the substances employed.

Coating may likewise be performed with mingled gas and liquid by employing the apparatus as just described except that the cylinder 20 has substantially the entire surface thereof perforate so that liquid exudes throughout the entire periphery and the wiping means are removed or spaced from the surface of the cylinder 20 sufficiently so that they permit a layer of mingled liquid and fluid to be carried around to the electrostatic field as previously described.

VII

The apparatus disclosed may be employed for forming an image or coating upon web material by means of smoke, gaseous suspensions, or the like, exuding through openings in the surface of the cylinder. For a printing operation in this manner the cylinder 20 will be formed substantially as shown in Fig. 13 with perforate image areas and imperforate non-image areas. The apparatus will be conditioned substantially as shown in Fig. 2 and as described above with respect to Operation V. That is, the wipers 125 are removed, the wiping means 127 is positioned out of engagement with respect to the cylinder 20, and the cylinder 22 is lowered slightly with respect to the cylinder 20. The web material M' is brought into the apparatus over the rollers or cylinders 160, 161 and is passed around the periphery of the cylinder within the housing, as shown in Fig. 2.

The circuit is prepared by moving the switch 183 to dispose the blades thereof in their broken line positions, the switch blades 203, 205 are disposed in their broken line positions and the switch 196 is simultaneously actuated to reverse the connections therethrough. In addition, the switch blade 209 is moved to its broken line position. Therefore, a circuit is completed for energization of the electrode means 162 through the wire 204, switch blade 203, wires 207 and 188, and the reversing switch 187 to the wire 175 connected to one terminal of the precharge voltage supply. A precharge for the smoke, or the like, which now flows into the interior of the cylinder through the bore 35 of the shaft 30, is provided by charging the inner shell 43 of the cylinder 20. This is effected through the contact 63 which rides upon the said inner shell and is now connected by the wire 65, switch blade 209, wire 206, switch blade 205, wires 208 and 192, and the reversing switch 187 to the wire 176 connected with the other terminal of the precharge voltage supply. The electrode means 167 is connected through the wire 200 and switch blade 199 to the wires 198 and 197, thence through the reversing switch 196, wire 201, switch blade 186, wire 185, and reversing switch 181 to wire 174 connected to one of the terminals of the transfer voltage supply. Likewise, the electrode means 170 is connected to the same terminal of the transfer voltage supply by means of wires 191, 197, switch 196, etc. The electrode means 57 and 58 are connected to the other terminal of the source of transfer voltage through the wire 60, switch 195, wire 195, switch blade 182, reversing switch 181 and wire 173. Consequently, the electrodes 167, 170 form the attraction electrodes for effecting transfer of the smoke to the web material, while the electrodes 57, 58 form the discharge electrodes for this purpose, it being observed that the polarities applied to the smoke and web material are in the proper relationship for cooperation with the electrostatic field since the precharge upon the web material is now applied on the opposite side thereof from that on which the image is formed rather than on the same side, as in the prior operations.

In operating in accordance with this procedure, smoke, or the like, introduced into the interior of the cylinder is precharged as it passes the inner shell 43 and this smoke exudes through the perforate areas of the cylinder, being transferred to and deposited upon the precharged web material, wrapped around the cylinder 20, under the influence of the electrostatic field of force between the electrode means such as 167, 57 and 170, 58. Any smoke which might tend to exude through the uncovered portion of the cylinder and thereby escape from the housing is substantially blocked by the shield 77*a*.

Coating may be effected in accordance with the operation just described by simply omitting the imperforate covering or portions of the cyl-

inder 20 so that substantially the entire surface area of the cylinder is perforate, the apparatus being otherwise constructed and operating in the manner just described. In addition to employing smoke in this manner, coatings may also be formed by employing a liquid or liquids or liquid vapor mixed with smoke or the like.

VIII

The apparatus may likewise be employed for forming either an image or coating upon web material by employing smoke supplied from the interior of the cylinder and a liquid compatible therewith, such as an adhesive supplied to the cylinder 20 from the outside thereof. The apparatus employed in this manner is set up in the manner described above with respect to Fig. 1 and Operation III. The operation is substantially the same as that described under III above except that it is now smoke rather than ink or the like which exudes from the perforate portions of the cylinder 20 and mingles with the liquid, which in this case may be an adhesive, supplied to the surface of the cylinder from between the members 82 and 83. The mingled fluid, such as smoke and liquid, are transferred to the web material M by the electrostatic field between the electrodes 55 and 68, precharges being supplied to the mingled liquid and smoke by the electrode means 170 and to the web material M by the electrode means 157. Since the operation is otherwise the same as described above under III, a detailed description thereof need not be repeated.

IX

The apparatus may likewise be utilized for forming an image or coating by using smoke, or other gaseous suspensions, by introducing the latter through the conduits such as 107, 116 as previously described under Operation V above. In the instant case, however, a suitable compatible liquid such as an adhesive is vaporized or atomized and mixed with the smoke to provide a composite coating or image formation upon the web material. The apparatus is conditioned for employment, however, the same as described above under V and hence the description need not be repeated.

OTHER OPERATIONS

Other methods of using the disclosed apparatus will readily appear to those skilled in the art to which it pertains after a study of the above description and the accompanying drawings. Without attempting to exhaust all such possibilities, it may be further noted that, in addition to the above, coating may be effected by employing smoke or liquid in vapor form supplied to only the left side of the housing, as viewed in Fig. 2, through the conduit 107 with a compatible liquid such as a solvent or adhesive in liquid form introduced through the conduit 95. In this operation the web material M' will be led into the apparatus and about the periphery of the cylinder 20, the cylinder having a conductive material over its entire surface. The electrode means 162 will be connected for precharging the web material and the electrode means 165 is connected to precharge the smoke or vaporized liquid. The electrode means 167 and 57 will be connected to the source of transfer voltage so that the smoke or vaporized liquid circulating through the left side of the housing, as viewed in Fig. 2, is transferred to the web material by the electrostatic field between the electrode means 167 and 57, the operation in this respect being similar to that described with respect to Operation V. The liquid enters the apparatus, as mentioned before, through the conduit 95 and is supplied from between the members 82 and 83 as a thin film or layer by adjusting the sealing means or member 83, carried by the vertical plate member 83, slightly upwardly out of contact with the cylinder 20. This liquid will then be disposed as a coating or layer on top of the web material M' and superimposed upon the vaporized liquid which was transferred to the web material and imbedded therein during the passage through the electrostatic field existing between the electrode means 167 and 57. The said liquid layer may be firmly united with the web material and the previously applied vaporized liquid by the action of the electrostatic field present between the electrode means 170 and 58 and through which the web material with the coating substances thereon pass.

A coating of a liquid may also be applied to web material such as M' passing about the cylinder 20 by employing the apparatus as described above, and as shown in Fig. 2, except that neither smoke nor vaporized liquid is introduced through the conduit 107. In such a situation liquid is simply supplied through the conduit 95 and the layer or coating thus applied to the web material as it passes around the cylinder is firmly united or driven into the said material by the electrostatic field of force between the electrodes 170 and 58.

In addition to the above modes of operation of the apparatus and methods which may be effected by using the same, others may be devised by those skilled in the art. Likewise, the apparatus as shown and described may have portions thereof varied and other conventional devices may be added thereto to facilitate the operations. As an example of the latter, static eliminators of conventional type may be provided for cooperation with the web material such as M and M' before the latter is conducted past the precharge electrodes such as 157 and 162 and/or after the material emerges from the apparatus. Also, heating and/or drying devices may be employed for cooperation with the web material either prior to passage of the latter through the apparatus, subsequent to such passage, or both. For example, static eliminators and heating or drying means may be employed in conjunction with the web material in a manner similar to that indicated in my copending application Ser. No. 74,822 filed February 5, 1949. See also Huebner Patent 2,445,271 issued on July 13, 1948, which illustrates static eliminating means for cooperation with web material in electronographic printing or coating processes.

In view of these and other modifications that may be effected in the apparatus and procedure disclosed, it will be understood that the invention is not to be considered as limited to the exact details of procedure and apparatus described and shown, but that these illustrations and descriptions are only representative of practical embodiments of the invention.

Having thus described the invention, I claim:

1. The method of producing a deposit on a material which comprises providing a perforate body, supplying a first fluid to one side of said body in a manner such that the said fluid exudes to the other side of said body, supplying a second fluid compatible with the first fluid to the said other side of said body so that the fluids mingle on the said other side, bringing the material

adjacent the said other side of the body, and establishing an electrostatic field of force extending through the said body and the material on which the deposit is to be formed whereby the said mingled fluids are simultaneously transferred to the said material by the said field of force.

2. The method of produding a deposit on web material which comprises providing a hollow rotatable cylinder having a perforate periphery, supplying a first fluid to the interior of said cylinder in a manner causing the said fluid to exude through the periphery thereof, supplying a second fluid compatible with the first fluid directly to the exterior periphery of said cylinder so that the said fluids mingle on the surface of the cylinder, providing an electrostatic field of force extending through a portion of the side wall of said cylinder, and moving web material through said field of force and adjacent the surface of said cylinder while rotating the latter whereby the said mingled fluids are simultaneously deposited upon the web material by the said field of force.

3. The method of producing an image on a material which comprises providing a body having perforate areas corresponding with image areas of the image to be produced and imperforate areas corresponding with non-image areas, supplying a first fluid to one side of said body in a manner such that the fluid exudes through the said perforate areas, supplying a second fluid compatible with the first fluid directly to the said other side of said body, wiping the non-image areas to remove the said second fluid therefrom and confine the said second fluid to the image areas whereby the said fluids are mingled in said image areas, and establishing an electrostatic field of force extending through said body and the material on which the image is to be produced whereby the said mingled fluids are deposited upon said material in the form of an image corresponding with that upon the said body.

4. The method of producing an image on web material which comprises providing a hollow rotatable cylinder the periphery of which comprises imperforate portions corresponding with non-image areas and perforate portions corresponding with image areas of the image to be produced, supplying a first fluid to the interior of said cylinder in a manner such that the said fluid exudes through the said perforate portions, supplying a second fluid compatible with the first fluid directly to the exterior periphery of said cylinder, wiping the non-image portions of said cylinder to remove the said second fluid therefrom and confine said second fluid to the image portions whereby the said fluids are mingled in said image portions, providing an electrostatic field of force extending through a portion of the periphery of said cylinder and moving web material through said field of force and adjacent the surface of said cylinder while rotating the cylinder whereby the said mingled fluids are deposited upon said web material in the form of an image corresponding with that upon the cylinder.

5. An apparatus of the character described comprising a rotatable cylinder having recesses in the surface thereof representative of image areas to be produced on web material, a stationary housing surrounding a portion of the periphery of said cylinder, means in said housing adapted to supply a liquid to the surface of said cylinder, means in said housing extending axially adjacent the surface of said cylinder and cooperating with the liquid supply means to regulate the quantity of liquid supplied to the cylinder, wiper means in said housing extending axially of said cylinder in cooperative relationship with the curved surface of said cylinder to remove at least a part of the liquid from the non-image areas, rotatable wiping means adapted to cooperate with the periphery of said cylinder to remove liquid from the non-image areas, means for guiding web material adjacent the surface of said cylinder exteriorly of said housing, means cooperating with said web material to provide an electrical precharge thereon prior to passage of said web material past said cylinder, and means for creating an electrostatic field of force extending through the said web material, the last-mentioned means including first electrode means within said cylinder and a second electrode means externally of said cylinder and spaced from the surface thereof, whereby the liquid on the said image areas of the cylinder is transferred to said material by the said electrostatic field of force.

6. An apparatus of the type defined in claim 5 and further comprising electrode means within said housing adjacent the surface of said cylinder to impart an electrical precharge to the liquid on the said cylinder.

7. An apparatus of the type defined in claim 5 wherein the said rotatable wiping means comprises a cylindrical wiping surface rotatable about an axis extending parallel with the axis of said cylinder, and means to move the axis of said wiper towards or away from the axis of said cylinder.

8. An apparatus of the character described comprising a rotatable cylinder, a stationary housing surrounding a portion of the periphery of said cylinder, means in said housing adapted to supply a liquid to the surface of said cylinder, rotatable wiping means adapted to cooperate with the periphery of said cylinder and remove excess liquid therefrom, a housing substantially surrounding said wiping means and having a longitudinally extending opening adjacent said cylinder through which a portion of said wiping means is adapted to extend into engagement with said cylinder, fluid pressure means cooperating with said wiping means to remove therefrom liquid which is wiped from said cylinder, means for guiding web material adjacent the surface of said cylinder exteriorly of the first-mentioned housing, and means for creating an electrostatic field of force extending through the said web material including a first electrode means within said cylinder and a second electrode means externally of said cylinder and spaced from the surface thereof, whereby the liquid remaining on said cylinder surface is tranferred to said material by the said electrostatic field of force.

9. An apparatus of the type defined in claim 8 wherein the said wiping means comprises a cylindrical wiping member mounted to rotate about an axis extending parallel with the axis of said cylinder, and the said fluid pressure means for removing liquid from said wiping means includes means to apply fluid pressure longitudinally of the said wiping member from the interior thereof.

10. An apparatus of the type defined in claim 8 wherein the said wiping means comprises a hollow cylindrical member having a permeable wiping surface rotatable about an axis extending parallel with the axis of said cylinder, and

the said means for removing the liquid from said wiping means includes conduit means extending within the interior of said cylindrical wiping member and connected to a source of fluid pressure to thereby blow liquid from said wiping surface and means to subject the exterior of said wiping surface to a region of reduced fluid pressure to withdraw the liquid removed therefrom.

11. An apparatus of the character described comprising a hollow rotatable cylinder having passages therein adapted to conduct a liquid from within said cylinder to the exterior surface thereof, a stationary housing surrounding a portion of the periphery of said cylinder, wiping means adapted to cooperate with the curved exterior surface of said cylinder to remove excess liquid therefrom, means for guiding web material in a path closely adjacent a portion of the surface of said cylinder, and means for creating an electrostatic field of force extending through the said web material including a first electrode means within said cylinder and a second electrode means externally of said cylinder and spaced from the surface thereof to effect transfer of the liquid remaining on said cylinder to said web material.

12. An apparatus as defined in claim 11 and wherein the said cylinder has raised portions on the periphery thereof corresponding to non-image areas of an image to be produced and the said wiping means are so positioned as to remove liquid from the said raised non-image areas and assist in distributing the liquid in the image areas.

13. An apparatus of the character described comprising a hollow rotatable cylinder having passages adapted to conduct a fluid from within said cylinder to the exterior surface thereof, means for conducting a fluid into said cylinder, a stationary housing surrounding a portion of the periphery of said cylinder, means in said housing adapted to supply a liquid directly upon the exterior surface of said cylinder, wiping means adapted to cooperate with the curved exterior surface of said cylinder to remove excess mingled fluid and liquid therefrom, means for guiding web material in a path closely adjacent a portion of the exterior surface of said cylinder, and means for creating an electrostatic field of force extending through the said web material including a first electrode means within said cylinder and a second electrode means externally of said cylinder and spaced from the surface thereof to effect transfer of the mingled fluid and liquid remaining on the exterior of said cylinder to said web material.

14. An apparatus of the character described comprising a hollow rotatable cylinder having passages therein adapted to conduct a fluid from within said cylinder to the exterior surface thereof, means for conducting a fluid into said cylinder, a stationary housing surrounding a portion of the periphery of said cylinder, means in said housing adapted to supply a liquid directly to the exterior surface of said cylinder, means in said housing adapted to support wipers in cooperative relationship with the curved exterior surface of said cylinder to remove excess mingled fluid and liquid therefrom, rotatable wiping means adapted to cooperate with the curved exterior surface of said cylinder, means for guiding web material in a path closely adjacent a portion of the surface of said cylinder, and means for creating an electrostatic field of force extending through the said web material including a first electrode means within said cylinder and a second electrode means externally of said cylinder and spaced from the surface thereof to effect transfer of the liquid remaining on said cylinder to said web material.

15. The combination as defined in claim 14 and wherein the said cylinder has impervious raised portions on the surface thereof corresponding with non-image areas in the image produced upon said web material by transfer of the liquid from the cylinder to the web material by the said electrostatic field of force.

16. An apparatus of the character described comprising a hollow rotatable cylinder having passages therein adapted to conduct a fluid from within said cylinder to the exterior surface thereof in areas representative of image areas of an image to be produced on web material, a stationary housing surrounding a portion of the periphery of said cylinder, means in said housing adapted to supply a liquid to the surface of said cylinder, means in said housing adapted to support wipers in cooperative relationship with the curved exterior surface of said cylinder to remove excess mingled fluid and liquid from the non-image areas thereof, rotatable wiping means adapted to cooperate with the non-image areas of the surface of said cylinder, means for guiding web material in a path closely adjacent a portion of the surface of said cylinder, means cooperating with said web material to provide an electrical precharge thereon prior to passage of said web material past a portion of said cylinder, means for creating an electrostatic field of force extending through the said web material including a first electrode means within said cylinder and a second electrode means externally of said cylinder and spaced from the surface thereof, and means for imparting an electrical precharge to said fluid and liquid before they are subjected to the electrostatic field of force.

17. An apparatus of the character described comprising a rotatable cylinder at least a portion of the curved surface of which is formed by electrically conductive material, means to guide web material in a path extending around at least a portion of said cylinder, a stationary housing enclosing a segment of the curved surface of said cylinder and of the web material guided thereabout, sealing means adjacent the edges of said housing and cooperating with said cylinder to prevent the escape of a fluid, the said housing including spaced inner and outer walls with the inner wall spaced from the surface of said cylinder and provided with an opening therethrough, means to conduct smoke into said housing intermediate the said inner and outer walls thereof and at a point remote from the said opening in said inner wall, means to withdraw smoke from the space between said inner wall and said cylinder at a point remote from said opening to thereby cause the smoke to circulate between said walls and between said inner wall and said web material, and means for creating an electrostatic field of force extending through said web material while the latter passes intermediate said housing and cylinder to effect depositing of components of the smoke upon the web material.

18. The combination as defined in claim 17 and wherein the said conductive material on said cylinder has a configuration representative of an image to be produced upon the web material, the non-image areas on said cylinder being formed of electrical insulating material.

19. An apparatus of the character described comprising a rotatable cylinder at least a portion of the curved surface of which is formed by electrically conductive material, means to guide

web material in a path extending around at least a portion of said cylinder, a stationary housing enclosing a segment of the curved surface of said cylinder and of the web material guided thereabout, sealing means adjacent the edges of said housing and cooperating with said cylinder to prevent the escape of a fluid, the said housing including spaced inner and outer walls with the inner wall spaced from the surface of said cylinder and provided with an opening therethrough, means to conduct smoke into said housing intermediate the said inner and outer walls thereof and at a point remote from the said opening in said inner wall, means to withdraw smoke from the space between said inner wall and said cylinder at a point remote from said opening to thereby cause the smoke to circulate between said walls and between said inner wall and said web material, and means for creating an electrostatic field of force extending through said web material including a first electrode means within said cylinder and a second electrode means supported by said housing intermediate said inner wall and said cylinder whereby components of the smoke are deposited upon the web material by the action of said electrostatic field as the material passes through said housing.

20. The combination as defined in claim 19 and further comprising electrode means supported by said housing exteriorly thereof and cooperating with said web material to impart an electrical precharge thereto prior to passage of said material around said cylinder.

21. The combination as defined in claim 19 and further comprising electrode means disposed within said housing intermediate said inner and outer shells thereof for imparting an electrical precharge to said smoke.

22. The combination as defined in claim 19 and further comprising electrode means cooperating with said web material to impart an electrical precharge thereto prior to passage of said material around said cylinder, and electrode means for imparting an electrical precharge of opposite polarity to said smoke prior to introduction of the latter into the space between said inner shell and said cylinder.

23. An apparatus of the character described comprising a hollow rotatable cylinder having passages therein adapted to conduct a liquid from within said cylinder to the exterior surface thereof, means to conduct a liquid into said cylinder, a stationary housing surrounding a portion of the periphery of said cylinder, sealing means intermediate said housing and cylinder providing a substantially fluid tight seal therebetween, means for conducting smoke into said housing and through a portion thereof adjacent the curved surface of said cylinder, means adapted to guide web material in a path closely adjacent a portion of the surface of said cylinder exteriorly of said housing, and means for creating an electrostatic field of force extending through the said web material including first electrode means within said cylinder and a second electrode means externally of said cylinder and spaced from the surface thereof, whereby components of said smoke are mingled with the liquid on the surface of said cylinder and the resulting composite substance is transferred to said web material by the said electrostatic field of force.

24. The combination as defined in claim 23 and wherein the said cylinder has pervious portions in the curved surface thereof representative of image areas in an image to be produced upon the web material, and impervious portions representative of non-image areas.

25. An apparatus of the character described comprising a hollow rotatable cylinder having portions of the curved surface thereof pervious and other portions impervious, the said pervious portions representing the configuration of an image to be produced on web material, means to conduct a liquid into the interior of said cylinder, a stationary housing surrounding a portion of the periphery of said cylinder, sealing means intermediate said housing and cylinder providing a substantially fluid tight seal therebetween, means for conducting smoke into said housing and through a portion thereof adjacent the curved surface of said cylinder, means adapted to guide web material in a path closely adjacent a portion of the surface of said cylinder exteriorly of said housing, means cooperating with said web material to provide an electrical precharge thereon prior to passage of said web material past a portion of said cylinder, means for creating an electrostatic field of force extending through the said web material including first electrode means within said cylinder and a second electrode means externally of said cylinder and spaced from the surface thereof, and means for imparting an electrical precharge to said smoke and liquid before they are subjected to the electrostatic field of force, whereby components of the smoke are mingled with the liquid on the surface of said cylinder and the resulting composite substance is transferred to said web material by the said electrostatic field of force.

26. An apparatus of the character described comprising a hollow rotatable cylinder having portions of the curved surface thereof pervious and other portions impervious, the said pervious portions representing the configuration of an image to be produced on web material, means to conduct a liquid into the interior of said cylinder, a stationary housing surrounding a portion of the periphery of said cylinder, sealing means intermediate said housing and cylinder providing a substantially fluid tight seal therebetween, means for conducting smoke into said housing and through a portion thereof adjacent the curved surface of said cylinder, wiping means cooperating with the impervious portions of said cylinder, means adapted to guide web material in a path closely adjacent a portion of the surface of said cylinder, means cooperating with said web material to provide an electrical precharge thereon prior to passage of said web material past a portion of said cylinder, means for creating an electrostatic field of force extending through the said web material including first electrode means within said cylinder and a second electrode means externally of said cylinder and spaced from the surface thereof, and means for imparting an electrical precharge to said smoke and fluid before they are subjected to the electrostatic field of force, whereby components of the smoke mingle with the liquid on the surface of said cylinder and the resulting composite substance is transferred to said web material by the said electrostatic field of force producing an image thereon.

27. The combination as defined in claim 26 and wherein the said wiping means include stationary wipers removably supported in said housing.

28. The combination as defined in claim 26 and wherein the said wiping means include a rotatable wiper supported exteriorly of said housing.

29. An apparatus of the character described

comprising a rotatable cylinder at least a portion of the curved surface of which is pervious to a liquid, means to conduct a fluid into the interior of said cylinder, a stationary housing enclosing a segment of the curved surface of said cylinder, sealing means adjacent the edges of said housing and cooperating with said cylinder to substantially prevent the escape of a fluid, the said housing including spaced inner and outer walls with the inner wall spaced from the surface of said cylinder and provided with an opening therethrough, means to conduct smoke into said housing intermediate the said inner and outer walls thereof and at a point remote from the said opening in said inner wall, means to withdraw smoke from the space between said inner wall and said cylinder at a point remote from said opening to thereby cause the smoke to circulate between said walls and between said inner wall and said cylinder, means adapted to guide web material in a path closely adjacent a portion of the surface of said cylinder exteriorly of said housing, and means for creating an electrostatic field of force extending through said web material including a first electrode means within said cylinder and a second electrode means supported exteriorly thereof and spaced therefrom.

30. An apparatus of the character described comprising a rotatable cylinder having portions of the curved surface thereof pervious and other portions impervious, the said pervious portions representing the configuration of an image to be produced on web material, means to conduct a liquid into said cylinder, a stationary housing enclosing a segment of the curved surface of said cylinder, sealing means adjacent the edges of said housing and cooperating with said cylinder to substantially prevent the escape of a fluid, the said housing including spaced inner and outer walls with the inner wall spaced from the surface of said cylinder and provided with an opening therethrough, means to conduct smoke into said housing intermediate the said inner and outer walls thereof and at a point remote from the said opening in said inner wall, means to withdraw smoke from the space between said inner wall and said cylinder at a point remote from said opening to thereby cause the smoke to circulate between said walls and between said inner wall and said cylinder so that components of said smoke are mingled with the liquid exuding from said cylinder, means adapted to guide web material in a path closely adjacent a portion of the surface of said cylinder exteriorly of said housing, and means for creating an electrostatic field of force extending through said web material including a first electrode means within said cylinder and a second electrode means supported exteriorly thereof and spaced therefrom.

31. An apparatus of the character described comprising a rotatable cylinder at least a portion of the curved surface of which is pervious to smoke, means to conduct smoke into said cylinder from the exterior thereof, means to guide web material in a curved path extending around the major portion of the curved surface of said cylinder, means cooperating with said cylinder to substantially prevent the escape of smoke from the pervious portions of said cylinder which are not covered by the web material, and means creating an electrostatic field of force extending through said web material including a first electrode means within said cylinder and a second electrode means supported exteriorly of said cylinder adjacent the surface thereof but spaced therefrom so that smoke introduced into said cylinder exudes through the said pervious portions thereof and is transferred to the said web material by the electrostatic field of force.

32. The combination as defined in claim 31 and further comprising means for electrically precharging the smoke before it issues from said cylinder, and means for electrically precharging the said web material before the latter reaches said cylinder.

33. The combination as defined in claim 31 and wherein the said curved surface of said cylinder has both pervious and impervious portions with the pervious portions corresponding in configuration with the image areas of an image to be formed on web material and the impervious portions corresponding to non-image areas.

34. An apparatus of the character described comprising a hollow rotatable cylinder, a stationary housing surrounding a portion of the periphery of said cylinder, sealing means intermediate said housing and cylinder providing a substantially fluid tight seal therebetween, means in said housing adapted to supply a liquid to the external surface of said cylinder, means in said housing adapted to support wiping means in cooperative relationship with the curved surface of said cylinder to remove excess liquid therefrom, means adapted to conduct smoke into said housing and through a portion thereof adjacent the curved surface of said cylinder, rotatable wiping means supported exteriorly of said housing and adapted to cooperate with the curved surface of said cylinder, means for guiding web material closely adjacent at least a portion of the surface of said cylinder, electrode means supported by said housing and adapted to impart an electrical precharge to the web material prior to the guiding of said web material adjacent a portion of said cylinder, means for creating an electrostatic field of force extending through the said web material including a first electrode means within said cylinder and a second electrode means externally of said cylinder and spaced from the surface thereof, and means supported by said housing for imparting an electrical precharge to said smoke and liquid before they are subjected to the said electrostatic field of force.

35. An apparatus as defined in claim 34 and wherein the said rotatable wiping means is cylindrical with its axis extending parallel with the axis of said cylinder and means to adjust the axis of said rotatable wiping means towards or away from said cylinder.

36. An apparatus as defined in claim 34 and further comprising means for applying a fluid pressure to said rotatable wiping means to withdraw excess liquid therefrom.

37. An apparatus as defined in claim 34 and wherein the said means in said housing for supporting wiping means include resilient clip means extending longitudinally of said cylinder whereby wiping means may be readily applied and removed.

38. An apparatus as defined in claim 34 and wherein the said housing includes spaced inner and outer walls with the inner wall spaced from the surface of said cylinder and provided with an opening therethrough, the said means to conduct smoke into said housing comprising conduit means extending therein from the exterior of the housing to a point intermediate said inner and outer walls and remote from the said opening in the said inner wall, and means to withdraw

smoke from the space between said inner wall and said cylinder at a point remote from said opening to thereby cause the smoke to circulate between said walls and adjacent said cylinder.

39. An apparatus as defined in claim 34 and wherein the means to supply a liquid to the said cylinder comprise a pair of spaced plates supported by said housing and extending longitudinally of said cylinder with their inner edges adjacent a portion of the surface of said cylinder, means to conduct a liquid to the space between the said plates, and means adjacent the inner edges of said plates cooperating with the surface of said cylinder to prevent excessive lateral flow of the liquid over the surface of said cylinder.

40. An apparatus as defined in claim 34 and wherein the said housing includes two arcuate portions extending longitudinally of said cylinder with adjacent edges of the two portions spaced from each other and with the said means for supplying liquid to the said cylinder extending between the said arcuate portions and secured thereto.

41. An apparatus as defined in claim 34 and wherein the said housing includes two arcuate portions extending longitudinally of said cylinder with adjacent edges of the two portions spaced from each other, and the said means for supplying liquid to the exterior of said cylinder includes a pair of elongated members extending longitudinally of said cylinder in spaced relationship and secured to the adjacent edges of the said two arcuate portions.

42. An apparatus as defined in claim 34 and wherein the means for imparting an electrical precharge to said smoke and liquid before they are subjected to the said electrostatic field of force include electrode means supported by said housing adjacent said cylinder, and other electrode means supported within said cylinder and insulated from the said first electrode means.

43. An apparatus as defined in claim 34 and further comprising an electrical circuit interconnecting the several said electrode means and switch means in said circuit for effecting reversal of the polarities of the electrical potentials supplied to said electrode means.

44. An apparatus as defined in claim 34 and further comprising an electrical circuit interconnecting the said electrode means for producing an electrostatic field of force to a source of direct current electrical energy and for interconnecting the said electrode means for producing precharges to a source of direct current electrical energy of lower potential than that applied for creation of said field of force, and switch means in said circuit for interchanging the said interconnections of the electrode means to the sources of electrical energy to selectively change the polarity and potentials of said electrode means.

45. In an apparatus of the character described, a housing adapted to surround a portion of a cylinder, the said housing comprising two arcuate portions each including two spaced walls extending longitudinally with adjacent edges of the two portions spaced from each other, a pair of interconnected elongated members extending longitudinally of said housing in parallel spaced relationship, the adjacent edges of each of the walls of said arcuate portions being secured to one of the said elongated members respectively, means closing the ends of said arcuate portions and the ends of the space between said elongated members, sealing means carried by said housing and adapted to cooperate with the cylinder about which it is placed, means adapted to supply a liquid to the space between said pair of elongated members, means adjacent the lower edges of said elongated members adapted to cooperate with the adjacent surface of a cylinder to regulate the quantity of liquid supplied to the surface of the cylinder from the liquid retained between said elongated members, means in said housing adapted to cooperate with the surface of said cylinder to remove excess liquid therefrom, electrode means supported in said housing adjacent the surface of the cylinder, means to provide a flow of smoke through said housing adjacent at least a part of the surface of a cylinder about which the housing is positioned and through the region of said electrode means, and electrode means carried by said housing and adapted to precharge said web material prior to movement thereof adjacent said cylinder.

46. The combination as defined in claim 45 and wherein the means within said housing for removing excess liquid from a cylinder positioned therein comprise a plurality of clip members mounted on the inner walls of said housing in spaced relationship and adapted to removably support longitudinally extending wiping means in cooperative relationship with the surface of said cylinder.

47. An apparatus of the character described comprising a first hollow rotatable cylinder, a plurality of separate electrode members stationarily supported in said cylinder and extending longitudinally therein in angularly spaced relationship and insulated from each other, a second hollow cylinder rotatably supported adjacent said first cylinder with the axes of said cylinders extending parallel, an electrode member stationarily supported in said second cylinder in a position substantially opposite one of said electrode members in said first cylinder, a housing surrounding a portion of said first cylinder, sealing means between said housing and said first cylinder, means carried by said housing and adapted to supply a liquid to the surface of said first cylinder throughout substantially the entire length thereof, wiping means supported by said housing and cooperating with the surface of said first cylinder to remove excess liquid therefrom, means adapted to supply a fluid to the interior of said first cylinder, electrode means supported in said housing adjacent the surface of said first cylinder, means to provide a flow of smoke through said housing adjacent at least a part of the surface of said first cylinder and through the region of said last-mentioned electrode means, means to selectively guide web material through said housing and about said first cylinder or between said first and second cylinders without passing through said housing, electrode means carried by said housing and adapted to precharge said web material prior to movement adjacent said first cylinder, and means to selectively connect certain of said electrode means to a source of high potential direct current electrical energy to provide an electrostatic field between said certain electrodes capable of transferring fluids and depositing them upon web material and to selectively connect others of said electrodes to a source of direct current electrical energy of lower potential to provide electrical precharges on said web material and said fluids.

48. The combination as defined in claim 47 and wherein the means to effect selective con-

nections of said electrode means includes an electrical circuit and switch means in said circuit, the said circuit further comprising reversing switches for effecting reversal of the polarities of the electrical energy supplied to said electrode means.

49. An apparatus of the character described comprising a first hollow rotatable cylinder, a plurality of separate electrode members stationarily supported in said cylinder and extending longitudinally therein in angularly spaced relationship and insulated from each other, a second hollow cylinder rotatably supported adjacent said first cylinder with the axes of said cylinders extending parallel, an electrode member stationarily supported in said second cylinder in a position substantially opposite one of said electrode members in said first cylinder, a housing surrounding a portion of said first cylinder, the said housing comprising two arcuate portions each including two spaced walls extending longitudinally of said first cylinder with adjacent edges of the two portions spaced from each other, a pair of elongated members extending longitudinally of said first cylinder in parallel spaced relationship, the adjacent edges of each of the walls of said arcuate portions being secured to one of the said elongated members respectively, sealing means between said housing and said first cylinder, means adapted to supply a liquid to the space between said pair of elongated members, means adjacent the lower edges of said elongated members to regulate the quantity of fluid supplied to the surface of said first cylinder from the fluid supplied between said elongated members, wiping means supported by said housing and cooperating with the surface of said first cylinder to remove excess liquid therefrom, means adapted to supply a fluid to the interior of said first cylinder, electrode means supported in said housing adjacent the surface of said first cylinder, means to provide a flow of smoke through said housing adjacent at least a part of the surface of said first cylinder and through the region of said last-mentioned electrode means, means to selectively guide web material through said housing and about said first cylinder or between said first and second cylinders without passing through said housing, electrode means carried by said housing and adapted to precharge said web material prior to movement adjacent said first cylinder, and means to selectively connect certain of said electrode means to a source of high potential direct current electrical energy to provide an electrostatic field between said certain electrodes capable of transferring fluids and depositing them upon web material and to selectively connect others of said electrodes to a source of direct current electrical energy of lower potential to provide electrical precharges on said web material and said fluids.

50. An apparatus as defined in claim 49 and wherein the means to provide a flow of smoke through said housing includes conduit means adapted to introduce smoke into the space between said inner and outer walls at a point spaced from an opening through said inner wall, and means to withdraw smoke from the space between said inner wall and the surface of said cylinder, the last-named means being located at a point remote from the said opening through said inner wall.

51. An apparatus as defined in claim 50 and further comprising electrode means in said housing intermediate said inner and outer walls and selectively connectible to a source of electrical energy to provide an electrical precharge on the smoke prior to its introduction into the space adjacent said cylinder.

52. An apparatus of the character described comprising a first hollow rotatable cylinder, a plurality of separate electrode members stationarily supported in said cylinder and extending longitudinally thereon in angularly spaced relationship and insulated from each other, a second hollow cylinder rotatably supported adjacent said first cylinder with the axes of said cylinders extending parallel, an electrode member stationarily supported in said second cylinder in a position substantially opposite one of said electrode members in said first cylinder, a housing surrounding a portion of said first cylinder, the said housing comprising two arcuate portions each including two spaced walls extending longitudinally of said first cylinder with adjacent edges of the two portions spaced from each other, a pair of elongated members extending longitudinally of said first cylinder in parallel spaced relationship, the adjacent edges of each of the walls of said arcuate portions being secured to one of the said elongated members respectively, sealing means between said housing and said first cylinder, means adapted to supply a liquid to the space between said pair of elongated members, means adjacent the lower edges of said elongated members to regulate the quantity of fluid supplied to the surface of said first cylinder from the fluid supplied between said elongated members, means in said housing adapted to removably support wiping means for cooperation with the surface of said first cylinder to remove excess fluid therefrom, means adapted to supply a fluid to the interior of said first cylinder, rotatable wiping means supported exteriorly of said housing and selectively engageable with said first cylinder to remove surplus liquid therefrom, electrode means supported in said housing adjacent the surface of said first cylinder, means to provide a flow of smoke through said housing adjacent at least a part of the surface of said first cylinder and through the region of said last mentioned electrode means, means to selectively guide web material through said housing and about said first cylinder or between said first and second cylinders without passing through said housing, electrode means carried by said housing and adapted to precharge said web material prior to movement adjacent said first cylinder, and means to selectively connect certain of said electrode means to a source of high potential direct current electrical energy to provide an electrostatic field between said certain electrodes capable of transferring fluids and depositing them upon web material and to selectively connect others of said electrodes to a source of direct current electrical energy of lower potential to provide electrical precharges on said web material and said fluids.

53. The combination as defined in claim 52 and wherein the said rotatable wiping means includes a hollow cylindrical member rotatably supported exteriorly of said housing with the axis of said member extending parallel with the axis of said first cylinder, means providing a fluid permeable wiping surface on said cylindrical member, and means to apply fluid pressure to the interior of said cylindrical member to force from said wiping surface the liquid removed thereby from said first cylinder.

54. The combination as defined in claim 53 and further comprising a means for removing liquid

displaced from the said rotatable wiping means by the fluid pressure applied thereto.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
21,080	Nichols	Aug. 3, 1858
1,082,586	Georges et al.	Dec. 30, 1913
1,668,322	Kessler	May 1, 1928
1,703,015	Ratingnier	Feb. 19, 1929
1,820,194	Huebner	Aug. 25, 1931
2,049,495	Freuder	Aug. 4, 1936
2,169,641	Gurwick	Aug. 15, 1939
2,224,391	Huebner	Dec. 10, 1940
2,267,901	Duncan	Dec. 30, 1941
2,272,406	Gurwick	Feb. 10, 1942
2,408,144	Huebner	Sept. 24, 1946
2,451,288	Huebner	Oct. 12, 1948

FOREIGN PATENTS

Number	Country	Date
513,260	France	Oct. 29, 1920
605,012	Great Britain	July 14, 1948