March 9, 1965 G. H. BRANDT 3,172,657

ELECTROSTATIC SHEET HOLD-DOWN

Filed Dec. 13, 1962

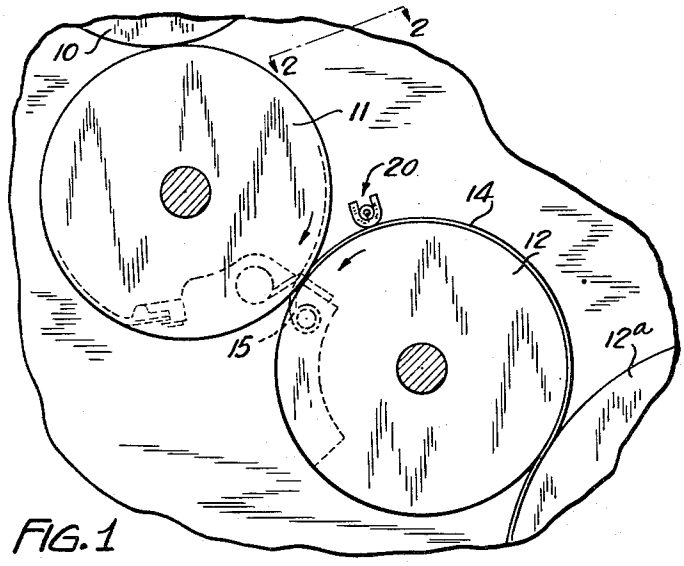


FIG. 1

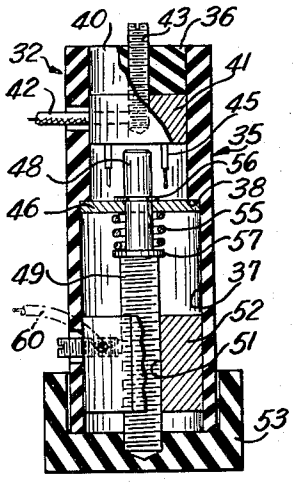


FIG. 4

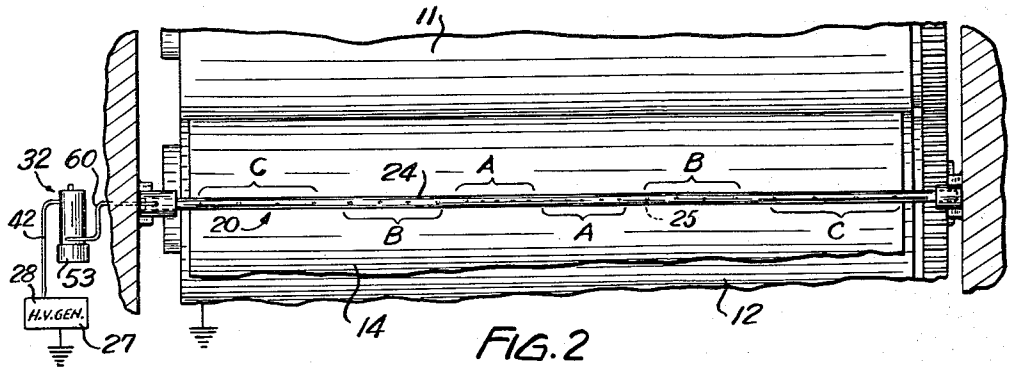


FIG. 2

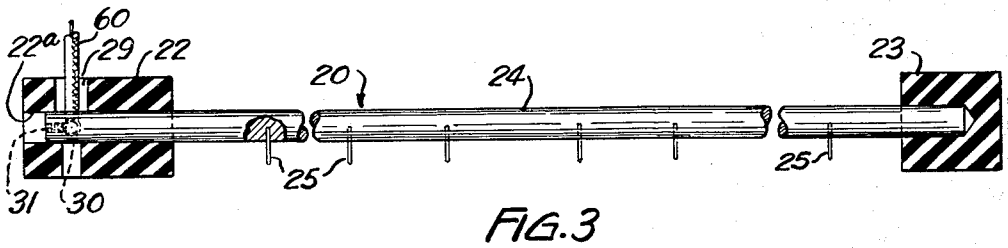


FIG. 3

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ELECTROSTATIC SHEET HOLD-DOWN

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The present invention relates to a sheet-handling machine, particularly to a printing press, wherein it is desirable to cause the sheet material to hug the cylinder with which the material moves.

In certain sheet-handling machines, such as a printing press, a sheet-carrying cylinder has grippers adapted to grip the leading edge of a sheet and to carry the sheet into and through a nip formed by the sheet-carrying cylinder and a cooperating cylinder, as the sheet-carrying cylinder is rotated. In such a machine, the sheet is gripped only at the leading edge and the tail of the sheet is free to move away from the cylinder and may flap against the cooperating nip-forming cylinder as the tail of the sheet approaches the nip. In a printing press, the sheet is carried by the impression cylinder and the cooperating cylinder is the printing cylinder of the press. If the tail flaps against the printing cylinder as it approaches the nip, smudging of the sheet will occur. Consequently, it is desirable to cause the sheet to hug the impression cylinder as it moves into and through the nip formed by the impression cylinder and the printing cylinder. Moreover, it is sometimes desirable in certain web machines to cause a web of sheet material to hug a cylinder with which it moves.

Sheet material has been caused to hug a cylinder by establishing an electrostatic field adjacent the cylinder thereby causing the material to become charged and to hug the cylinder, which is usually grounded. In this method, problems arise in applying the electrostatic field so that wrinkling of the sheet is avoided. The problem of causing a sheet to hug the cylinder without wrinkling is complicated where the cylinder carries the sheet through a nip by the fact that the sheet approaching the nip has a bubble of air thereunder. This bubble of air is caused by the fact that the nip squeezes the air out from between the sheet and the sheet-carrying cylinder as the sheet moves through the nip. If the sheet is tacked or clamped to the impression cylinder with air between the point of tacking or clamping and the nip, wrinkling will undoubtedly occur.

Patent No. 3,039,388, assigned to the same assignee as the present application, shows one structure which is adapted to apply an electrostatic field in such a manner that wrinkling is minimized or avoided. While the structure described performs satisfactorily, it is complicated by the fact that it is basically in a V-shape. Therefore, it is an object of this invention to provide a more simplified arrangement for establishing an electrostatic field adjacent the nip of two rotating cylinders to cause a sheet carried by one of the cylinders to closely hug the cylinder as the sheet moves into the nip and to accomplish this with a minimum of or no wrinkling.

Another object of the present invention is to provide a new and improved method of applying a force to sheet material to cause it to hug a cylinder and to minimize or eliminate wrinkling, in which method the force field is established between the cylinder and a plurality of electrostatic field points spaced therefrom and from each other along a line so as to minimize the wrinkling of the sheet.

Another object of the present invention is to provide a new and improved electrostatic device for establishing an electrostatic field having a novel way of regulating the strength of the electrostatic field.

Still another object of the present invention is to provide a new and improved method of electrostatically effecting sheet material hold-down in which different electrostatic forces are applied across the sheet in a manner which minimizes the wrinkling of the sheet.

A further object of the present invention is to provide a new and improved device for finely regulating the force of an electrostatic field.

In accordance with the preferred and illustrated embodiment of the invention, the electrostatic field is established along an area extending across the sheet material with the force of the electrostatic field changing as one proceeds across the material. In the preferred embodiment, the force increases when proceeding from each side of the material toward the central portion of the sheet material. An electrostatic field of this type can be applied to sheet material along an area extending across the sheet material and generally perpendicular to the side edges of the sheet.

The force of the electrostatic field is regulated, in accordance with one feature of the present invention, by an electrostatic valve which comprises a plurality of needlelike members toward which a platelike member is adjustable to vary the air gap between the points of the needlelike members and the platelike members, the device constituting a valve for controlling the voltage which establishes the electrostatic field.

Further objects and advantages of the present invention will be apparent from the following detailed description of the preferred embodiment thereof made with reference to the accompanying drawings forming a part of the present specification for all matters disclosed therein and in which:

FIG. 1 is a fragmentary view, somewhat schematic, of a printing press embodying the present invention;

FIG. 2 is a view looking in the direction of the arrow from line 2—2 of FIG. 1;

FIG. 3 is a cross-sectional view of the device for establishing the electrostatic field; and

FIG. 4 is a cross-sectional view of the valve device for controlling the electrostatic energy.

While the present invention is useful in various machines wherein it is desirable to cause sheet material to hug a rotating cylinder or moving member or to control the strength of an electrostatic field established by high voltage energy, it is particularly useful in a printing press to prevent a sheet being carried by an impression cylinder through a nip formed by the impression cylinder and a printing cylinder from slapping against the printing cylinder. Accordingly, the invention is shown as embodied in such a printing press.

Referring to the drawings, FIG. 1 illustrates a portion of a printing press having a plate cylinder **10**, a blanket or printing cylinder **11** cooperating with the plate cylinder **10** and an impression cylinder **12** which cooperates with the blanket cylinder **11**. The plate cylinder **10** is disposed above the blanket cylinder and carries the printing plate which has the image to be printed formed thereon and is inked by conventional means, not shown in the drawings, to effect a transfer of the image on the plate to the blanket cylinder **11**. The image on the blanket cylinder **11** is printed onto a sheet of material carried by the impression cylinder **12** disposed below and to one side of the blanket cylinder, the sheet passing between the impresison cylinder **12** and the blanket cylinder **11** as the cylinders are rotated. The cylinders **11** and **12** form a nip into which the sheet is carried and the sheet is printed as it is drawn between the cylinders **11** and **12**. The cylinders **10**, **11**, **12** are rotatably supported on respec-

tive shafts which extend between and are journaled in spaced side frames of the press. The sheet which is to be printed is indicated by the reference numeral **14** and is fed to the impression cylinder **12** by means shown as a conventional transfer cylinder **12***a* which may constitute part of any conventional feeding means not shown or described in the present application, or in the case of a multiunit press, the cylinder **12***a* may be the transfer cylinder between units. Suffice it to say that the impression cylinder **12** is provided with gripper fingers **15** that grip the leading edge of the sheet as it is fed to the impression cylinder and clamp the same to the impression cylinder so that the sheet will rotate therewith. The sheet **14** is transferred to the impression cylinder at a point in advance of the nip formed by the blanket cylinder **11** and the impresison cylinder **12** and the fingers **15** are operated by conventional cam means to release the sheet thereon for delivery to a delivery cylinder which cooperates with the impression cylinder or to another transfer cylinder for transferring the sheet from the printing unit shown to a succeeding printing unit, the delivery cylinder or transfer cylinder being omitted from FIG. 1 for the sake of simplicity. The cylinders **10**, **11**, **12** and **12***a* are intergeared and are rotated by conventional drive means in a manner well understood by those skilled in the art and not necessary for an understanding of the present invention. The printing press thus far described is of conventional construction and the above description will be sufficient for those skilled in the art to understand the environment of the present invention and the manner in which it functions.

When a sheet is fed to the impression cylinder **12** and the fingers **15** operated to secure the sheet thereto, some air is inevitably trapped under the sheet **14**. As the impression cylinder **12** is rotated to advance the sheet **14** so that its leading edge thereof enters the nip of the cylinders **11**, **12**, the air beneath the sheet **14** is pressed out as the sheet passes between the cylinders and builds up under the sheet and tends to form a bubble there immediately adjacent the nip. As the rotation of the impression cylinder **12** continues, air actually causes the sheet **14** to, what may be termed, "float" relative to the impression cylinder **12** and as the trailing edge of the sheet approaches the nip, the air thereunder tends to "explode" and to cause, together with centrifugal force, the trailing edge to flap against the blanket cylinder **11**. It has been found, as described in Patent No. 3,039,388, issued June 19, 1962, that this flapping may be prevented by electrically attracting the sheet to the cylinder **12**.

In accordance with the present invention, an electrostatic field is formed immediately in advance of the nip by an electrostatic device **20** which lies adjacent the outer periphery of the cylinder **12** in a plane containing the axis of the cylinder. The electrostatic device is shown in detail in FIG. 3 and, as shown therein, comprises plugs **22**, **23** of insulating material which support a bar **24** formed of electrically conductive material, such as aluminum. The insulating plugs **22**, **23** are receivable in members in the frame to support the device adjacent the cylinder **12**.

A high voltage generator **27**, having one side thereof grounded, and a high voltage terminal **28**, is provided. The high voltage terminal **28** is connected to the bar **24** through a valve device **32** and an electrostatic field is established between the impression cylinder **12** and electrically conductive needles **25** extending radially outwardly from the bar **24** toward the impression cylinder **12**, which is a grounded metal cylinder. The connection to the bar **24** is made through a radially extending opening **29** in the plug **22**. The bar **24** is drilled at **30** adjacent the opening **29** to receive the connection. A set screw **31** is threaded into the end of the bar **24** to engage the connection and clamp it in the drilled opening **30**. Access to the screw **20** is provided by an axial opening **22***a* in the end of the plug **22**.

I have found that the manner in which the sheet hugs the cylinder can be controlled by varying the average field forces established by the electrostatic device. In the preferred and illustrated embodiment, the needles **25** are spaced along the bar **24** at various distances to control the average force of the applied field. With the arrangement shown, the electrostatic field increases, in steps or otherwise, from adjacent each end of the cylinder to adjacent the midpart of the axial length of the cylinder. This arrangement has provided excellent sheet control, and wrinkling of the sheet as it is caused to hug the cylinder and pass through the nip is prevented.

As is shown in FIG. 2, the needles **25** adjacent the central portion of the axial length of the cylinder are spaced closely together as compared to the spacing of the needles at the outer ends of the cylinder. Accordingly, the electrostatic field adjacent the central part of the cylinder will have a higher intensity than the electrostatic field adjacent the ends of the cylinder. This causes the sheet to smooth out evenly and eliminates the necessity of making the electrostatic device in a V-shape as disclosed in my aforesaid patent.

In the preferred embodiment, two groups, A, of five closely spaced needles are disposed adjacent the centerline of the cylinder but on opposite sides thereof with the groups, in the illustrated embodiment, being spaced a distance slightly greater than the spacing of the needles within the groups. Then, proceeding from each group A toward each end, there is a group B of four needles with the needles spaced at a somewhat greater distance, and a third group C of four needles with the needles spaced at a still greater distance.

While the groups A in the illustrated embodiment are spaced a slightly greater distance than the needles within the groups A in order to accommodate a center support in the event one is required, the average force does increase from a minimum adjacent each end to a maximum adjacent the central portion of the axial length of the cylinder.

The electrostatic force requires rather fine adjustment since the best results are obtained when the sheet is not actually tacked or clamped to the cylinder but wherein just sufficient force is applied to cause the sheet to closely hug the cylinder. I have found that the use of an electrostatic valve device enables the adjustment of the electrostatic force to such an extent that the operation of the electrostatic holddown device is vastly improved.

The electrostatic valve device is shown in detail in FIG. 4, and, as shown therein, is comprised of a sleeve **35** of insulating material having a bore **36** therein which is counterbored to provide a counterbore **37** at the lower end of the device, as it is viewed in FIG. 4, and a shoulder **38** at the bottom of the counterbore. The outer end of the bore **36** is closed by a plug **40** of insulating material and an electrically conductive cylindrical member **41** is fixed in the bore **36** immediately adjacent the plug **40**. The cylindrical member **41** is connected to the high voltage terminal **28** by a connection **42** which passes through an enlarged opening in the side of the sleeve **35**. The connection **42** is clamped to the cylindrical member **41** by means comprising a screw **43** which threads through the plug **40**.

The cylindrical member **41** carries a plurality of spaced needles **45**, three such needles are shown in the drawing but four needles disposed at the corners of a square are preferably provided. The needles have their pointed ends extending downwardly toward a platelike conductive disc **46** disposed adjacent the pointed ends of the needles and adapted to be moved axially of the sleeve **35** toward and away from the ends of the needles so as to adjust the position of the disc **46** with respect to the needles and vary the air gap therebetween. The disc **46** is carried at one end of a stem **48** disposed in the sleeve **35** and having its other end threaded as indicated at **49** and

received in an axial opening 51 in a cylindrical member 52 in the bore 37. The member 52 is fixed against movement in the bore 37 and the opening 51 is threaded to cooperate with the threads 49 on the stem 48. The stem 48 extends through the member 52 to extend outwardly of the sleeve 35 and counterbore 37 and the outer end of the stem has a cap 53 fixed thereto. The cap loosely receives the adjacent end of the sleeve 35 and is rotatable to rotate the stem and thread it into or out of the cylindrical member 52 to adjust the disc 46 relative to the needles 45.

The disc 46 is held in position on the stem 48 by a spring 55 which urges the disc 46 against a lock ring 56 received in a groove in the stem. The spring 55 is disposed on the side of the disc 46 facing the threaded portion 49 of the stem and abuts a collar 57 formed on the stem 48 immediately adjacent the threaded portion 49. The spring 55 holds the disc 46 against the lock ring 56 until the stem is moved to engage the disc with the shoulder 38. When the disc engages the shoulder and if rotation of the cap 53 is continued to cause the stem to move downwardly the engage the inner end thereof with the cylindrical block 41, the washer or disc 46 will remain stationary on the stem and the lock ring 56 thereof will move with the stem as it moves into engagement with the block. When the stem engages the cylindrical block 41, the valve device is, in effect, shortcircuited and there is no voltage drop across the device. When the cap 53 is rotated to back the stem 48 away from the cylindrical block 41, the direct connection through the valve device is broken but ionization in the device will cause current to flow between the needles 45 and the disc 46. The spacing is such that arcing is prevented or maintained at a minimum. Moreover, any arcing which occurs will occur between the base portion of the needles and the portion of the stem 48 projecting downwardly between the needles. This means that the points of the needles will not be burned by any arc discharge which occurs. As the stem 48 is moved away from the block 41, the lock ring 56 will pick up the disc 46 and cause it to move with the stem 48 so that the position of the disc 46 may be adjusted to obtain the desired voltage drop. The position of the disc 46 may be fixed by tightening a set screw in the cylindrical member 52 to lock the stem 48. Experiments have shown that the voltage between the needles 25 and ground may be adjusted from 15 kilovolts down to 6.3 kilovolts when the voltage supply is a 15 kilovolt D.C. supply.

The cylindrical member 52 is electrically conductive and is connected to the bar 24 by a connection 60. The disc 46, then, is connected to the high voltage generator through the electrically conductive stem 48, the member 52 and the connection 60 so that the air gap between the needles 45 and the disc is in series with the high voltage generator, the electrostatic device 20, and the cylinder 12. Consequently, adjustment of the disc 46 will vary the voltage drop between the electrostatic device 20 and the cylinder and control the electrostatic field.

In operation, an individual field will exist between each of the needles 25 and the cylinder and in certain devices tested, these fields have not overlapped. Consequently, the structure shown is adapted to apply forces at a plurality of locations spaced across the sheet material and the spacing of individual fields determines the average force applied to any given portion of the line of force application. If desired, the extent of the area of the applied force lengthwise of the sheet material may be increased by using a plurality of the electrostatic devices arranged parallel to each other.

It will be appreciated by those skilled in the art that the broader aspects of the invention are independent of the particular structure utilized and that other structures different from the novel structure shown herein may be utilized to apply different but controlled electrostatic

forces to the sheet material in order to cause the latter to hug a member adjacent the material.

It can now be seen that the present invention provides a new and improved device for causing moving sheet material to hug a rotating cylinder or other adjacent member, the device causing a force to be applied to the sheet material across the width of the material and generally transversely to the side edges of the material with the force being applied in such a manner that wrinkling of the sheet is minimized. The electrostatic valve device 32 provided by the present invention greatly facilitates the adjusting of the force to that necessary to cause the sheet to hug the cylinder. Moreover, the electrostatic device, in accordance with the present invention, for establishing the electrostatic field is constructed in such a manner that it does not present a hazard to the operator even though the device is exposed as shown in the drawings.

The preferred embodiment of the present invention has been described in considerable detail and it is hereby my intention to cover all constructions, modifications and arrangements which fall within the ability of those skilled in the art and within the scope and spirit of the present invention.

Having described my invention, I claim:

1. The method of causing moving sheet material to hug an adjacent member which comprises applying an electrostatic field of different strengths to the sheet to urge the sheet toward the member with the average force of the field increasing proceeding from adjacent each side edge of the sheet toward the midpart of the sheet with respect to the side edges.

2. The method of causing moving sheet material to hug an adjacent member which comprises applying a force of different strengths to the sheet to urge the sheet toward the cylinder with the force being applied along a straight line transverse to the direction of sheet movement and with the average force increasing proceeding from each side edge of the sheet to a point adjacent the centerline of the sheet with respect to the side edges.

3. The method of causing moving sheet material to hug an adjacent member which comprises applying electrostatic forces of different magnitudes at a plurality of locations spaced across the sheet and across the direction of movement of the sheet material to urge the sheet material toward the member.

4. The method of causing moving sheet material to hug an adjacent member which comprises applying an electrostatic field of different strengths to the sheet to urge the sheet toward the member with the average force of the field increasing proceeding from adjacent each side edge of the sheet toward the midpart of the sheet with respect to the side edges with the average force of the field increasing proceeding from each side edge of the sheet material toward the central part of the material.

5. In an operation wherein sheet material is to move with a rotating cylinder, the method of causing the sheet material to hug the cylinder comprising establishing a force field between said cylinder and different locations between each end of the cylinder and the midpart of its length with the locations being spaced from the periphery of the cylinder and arranged along the length thereof with the spacing between said locations becoming less proceeding from adjacent each end of the cylinder to adjacent the midpart of the axial length of the cylinder, and rotating said cylinder to move the sheet through said field.

6. In an operation wherein moving sheet material is to hug a moving member, the method of causing the sheet material to hug the member which comprises establishing the force field between said member and different locations spaced from the periphery of said member and lying along a line substantially perpendicular to the side edges of said material with the spacing of the locations decreasing proceeding from adjacent each end of the line to the

midpart of the line and there being a plurality of said locations between the midpart of the line and each end thereof.

7. In a machine for performing an operation on sheet material, a movable member with which said sheet material is to move in one direction, and electrostatic means for causing said sheet material to hug said member comprising means spaced from said member for establishing electrostatic forces of different average magnitudes proceeding across said material transversely to the direction of movement.

8. In a machine for performing an operation on sheet material, a movable member with which said sheet material is to move in one direction, electrostatic means for causing said sheet material to hug the member comprising support means spaced from the periphery of the cylinder and extending along the length thereof, a plurality of conductive members on said support means and facing said sheet-carrying cylinder for establishing individual fields between respective conductive members and the movable member to provide electrostatic forces of different average magnitudes proceeding across said material transversely to the direction of movement.

9. A machine as defined in claim 8 wherein said conductive members lie along a straight line.

10. In a machine as defined in claim 8 wherein said conductive members are needlelike members which extend generally parallel to each other from said support means toward said member.

11. In a machine for performing an operation on sheet material, a rotatable cylinder with which said material moves, electrostatic means for causing said sheet material to hug the cylinder comprising support means extending along the length of the cylinder but spaced from the periphery thereof, means for establishing a field between spaced locations along said support means and said cylinder carrying said sheet comprising a straight rod extending axially of the cylinder adjacent the periphery thereof but spaced therefrom, a plurality of conductive needle-like elements extending from said rod toward said cylinder, the spacing of said elements decreasing proceeding from adjacent each end of said cylinder to adjacent the central part of the length thereof, and a high voltage circuit electrically connected to said conductive members and said sheet-carrying cylinder to establish a field from each conductive element to said sheet-carrying cylinder.

12. In a machine for performing an operation on sheet material, a rotatable cylinder with which said material moves, means for causing said material to hug the cylinder comprising electrostatic means disposed adjacent but spaced from said cylinder and establishing an electrostatic field between said electrostatic means and said cylinder through which the sheet material moves, high voltage generating means, connections connecting said high voltage generating means to said electrostatic means and to said cylinder to establish said electrostatic field and including a valve device connected in series with said cylinder and said electrostatic means, said device including spaced members which define an air gap in series with said electrostatic means and said cylinder and said high voltage generating means, and means for relatively adjusting said members to vary the air gap.

13. In a machine for performing an operation on sheet material, a movable member with which said material moves, electrostatic means for causing said material to hug the member comprising a plurality of parallel, laterally spaced needlelike conductive elements supported transversely of the sheet material and pointing toward said member but spaced from the periphery thereof, a high voltage generator, connections connecting said high voltage generator to said elements and to said member to establish an electrostatic field therebetween through which said material moves, said connections including a valve device connected in series with said high voltage generating means and conductive elements and cylinder and comprising spaced conductive members forming an air gap connected in series in said connections, said spaced conductive members comprising a plurality of spaced parallel needlelike members connected to one side of the generator and an adjustable member having a flat surface generally perpendicular to the axis of said needlelike members and adjustable toward and away from said needlelike members to define a variable air gap and connected to the other side of the generator.

14. In a machine as defined in claim 13 wherein said adjustable member has a projection extending past the adjacent end of and between said needlelike members to cause arcing to occur between said projection and the portion of said needlelike members inwardly of the ends thereof.

15. An electric valve device of the air-gap type comprising a plurality of spaced parallel needlelike conductive elements, a first electrically conductive member providing a flat surface spaced outwardly away from the pointed ends of said needlelike elements and generally perpendicular to the axes of the needlelike elements, said member having a projection extending from said surface between said needlelike elements, and means for adjusting said electrically conductive member toward and away from said ponted ends.

16. An electric valve device as defined in claim 15 wherein said elements are spaced equally with respect to each other and equidistantly from said projection.

17. An electric valve device as defined in claim 15 wherein said elements have base ends fixed to a second electrically conductive member and said projection is adjustable to engage said second electrically conductive member.

18. An electric valve device as defined in claim 17 wherein said first conductive member is movably disposed on a stem forming said projection and axially movable to adjust said first conductive member, an abutment on said stem and biasing means urging said first conductive member into engagement with said abutment with the latter being on the projection side of said first conductive member and said valve device includes stationary abutment means for engaging said first conductive member to limit its movement toward said elements, said biasing means yielding on engagement of said first conductive member and stationary abutment means to accommodate the continued movement of said projection to engagement with said second conductive mamber.

19. The method of causing moving sheet material to hug a member moving in one direction parallel to the side edges of the material comprising establishing an electrostatic field through which the member and the material move with the field extending across the material between the side edges and having magnitudes adjacent the side edges less than the magnitude of the field adjacent the midpart of the material between the side edges.

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