An apparatus for supply of electro-insulating sheet including an electro-conductive member earthed via a DC electric source and covered by an insulator, electro-static induction on the insulator due to electro-static charge by the DC electric source causing attraction of the sheet for a precise supply of the latter.
Fig. 1

PRIOR ART

Fig. 2

Fig. 3
APPARATUS FOR SUPPLY OF ELECTRO-INSULATING SHEET

The present invention relates to an apparatus for supplying electro-insulating sheets while holding them up by utilization of an electro-static mechanism.

In the conventional holding-up system of the electro-insulating sheets, an insulating member is placed in close contact with a metallic electro-conductive member, other electro-conductive members are embedded into the insulating member in a latticework arrangement and a DC electric source is connected between the metallic electro-conductive member and the latticework electro-conductive member so as to generate static electricity for holding-up the insulating sheet.

In the case of such a system, however, the latticework structure of the electro-conductive members is accompanied by considerable operational difficulty in manufacturing and it is quite difficult to obtain a very smooth surface. In addition, due to the fact that an electrostatic attraction force is generated between the metallic electro-conductive member and the latticework electro-conductive member, the attraction force operating on the insulating sheet tends to be offset by the above-described electro-static attraction force.

When we consider the conventional supply mechanisms of such insulating sheets, they are generally accompanied by the drawbacks that precise control of the sheet supply length tends to be disturbed by slippage of the sheets caused by changes in the supply speed, the room temperature, the room humidity and sudden stoppage or starting of the supply work. For example, a measure such as a sprocket system is used in the conventional mechanism for a precise control of the supply length. In the case of such sprocket system, it is necessary to establish a somewhat loose engagement between the side holes of the sheet and the teeth of the rotational sprocket when we consider possible changes in the dimensions of the sheet caused by changes in the surrounding conditions such as temperature and humidity. This unavoidable loose engagement must degrade the precision of the supply control of the sheet. In addition, especially at the time of a sudden stoppage of the supply work, the side holes of the sheets tend to be deformed by the sprocket teeth, resulting in undesirable enlargement of the variation in the supply work.

The principal object of the present invention is to provide an apparatus for holding-up an insulating sheet by utilization of a simple and safe electro-static system while overcoming difficulties encountered in the conventional arts.

The other object of the present invention is to provide an apparatus for supply of electro-insulating sheet by the utilization of safe electro-static system which assures the precise control of sheet supply length overcoming the influence of changes in the supply speed, temperature and humidity and of sudden stoppage or starting of the supply work.

Further features and advantages of the present invention will be made more clear from the following description, reference being made to the accompanying drawings, wherein:

FIG. 1 is an explanatory sectional view of the conventional sheets holding-up mechanism,

FIG. 2 is an explanatory view for showing mechanical principle of the sheet holding-up mechanism of the present invention,

FIG. 3 is a perspective rough sketch of the principal mechanism of the sheet holding-up and supply mechanism of the present invention,

FIG. 4 is a sectional view of an embodiment of the sheet supply apparatus of the present invention.

In the arrangement of the prior art shown in FIG. 1, an insulator 2 is closely superimposed upon the first electro-conductive member 1, the second electro-conductive members 4 are embedded in the exposed surface of the insulator 2 in a selected disposition and a DC electric source 3 is connected between the electro-conductive members 1 and 4 so as to hold up an insulator sheet 5 over the exposed surface of the insulator 2. This holding-up of the insulator sheet 5 is effectuated by the electric attraction between the insulator sheet 5, which is provided with an electro-static charge by the second electro-conductive members 4, and the first electro-conductive member 1 through the insulator 2. In this connection, however, considerable difficulty and trouble are encountered when embedding the second electro-conductive members 4 in a latticework arrangement in the surface of the insulator 2 as already pointed out. In addition to this difficulty, the smoothness of the surface texture of the insulator 2 tends to be degraded by the embedding of the latticework electro-conductive members 4. Further, electric attraction between the electro-conductive members 1 and 4 tends to offset the expected electric attraction between the member 1 and the sheet 5.

In the principal arrangement of the present invention shown in FIGS. 2, an electro-conductive metallic member 6 is covered with an insulator 7 and this member 6 is earthed via a DC electric source 8 so as to impart electro-static charge to said electro-conductive member 6. When an insulator sheet 9 is mounted onto the arrangement in this construction, an electro-static charge is imparted to the member 6 and corresponding electro-static induction takes place on the part of the insulator 7 so as to generate an electro-static attraction force on the insulator sheet 9. The magnitude of this electro-static attraction force can be adjusted by changing the voltage of the electric source 8 in consideration of the type and dimension of the insulator sheet 9 to be held-up.

The principle arrangement of the apparatus for supply of the sheet in the present invention is shown in FIG. 3 in a simplified illustration. It should be noted that, in the arrangement of FIG. 3, the flat type electro-conductive member 6 in FIG. 2 is replaced by an axially rotatable roller.

In the arrangement shown in FIG. 3, a rotational drum 11 mounted on a center shaft 16 is electrically charged during its rotation via the shaft 16, which is electrically connected to an electro-conductive inner layer 22 of the drum 11. Owing to this electric charge, corresponding electro-static induction is caused on part of an insulating outer layer 21 of the drum 11. By this electro-static induction on the outer layer 21, a prescribedly tensioned sheet 18 running in surface contact with the drum 11 is attracted onto the surface of the outer layer 21 so that the sheet 18 is advanced winding partly over the drum surface. A guide roller 19 is positioned spacedly downstream of the drum 11. Being quite different from the conventional sheet advancing mechanism wherein the supply of the sheet is effectuated by a mechanical engagement between the teeth of a sprocket and corresponding holes of the
sheet, the sheet advancing mechanism of the present invention is dependent upon the electric engagement between the drum surface and the sheet to be supplied. Therefore, the supply rate of the sheet can be maintained exactly in accordance with the peripheral speed of the rotating drum without any disturbance which may possibly be caused by sudden changes in the rotational speed of the drum and changes in the surrounding conditions such as temperature and humidity. In other words, the supply length of the sheet can be very precisely controlled.

The detailed structure of a typical embodiment of the apparatus of the present invention is illustrated in FIG. 4. This arrangement is provided with the sheet supply mechanism of this invention and the conventional sheet supply mechanism of the sprocket type in combination. Rough supply of the sheet is performed by a mechanical engagement between the sprocket teeth and the holes in both sides of the sheet whereas the precise supply of the sheet is performed by the electrical engagement according to the present invention.

In the arrangement shown, the drum 11 with the outer layer 21 covering the inner layer 22 is fixedly and centrally mounted on an elongated shaft 16 via bosses 25a and 25b. The shaft 16 is rotatably mounted on a pair of bearing blocks 13a and 13b via bearings 41a and 41b and is connected to a given driving source (not shown) via a drive gear 14 fixed to one end thereof. In the case of the example shown, the gear 14 is positioned outside the bearing block 13b. Being slightly spaced from both sides of the drum 11, a pair of sprockets 12a and 12b are fixedly mounted on the shaft 16 via bosses 33a and 33b. Because of this structure, both the drum 11 and the sprockets 12a, 12b are co-rotational with the center shaft 16.

The center shaft 16 is provided with a coaxial internal bore 74 which extends from the midpoint of the shaft to the shaft end on the side opposite the drive gear 14, which bore 74 contains an elongated cord 17, suitably covered for electric insulation. The internal end of the core 17a projects into the interior of the drum 11 through a slot 75 of the shaft 16 and is electrically connected to an electro-conductive spring 24, which is disposed to a corner defined by the internal faces of the inner layer 22 and a side wall 23 of the drum 11.

The end of the shaft 16 on the side opposite the gear 14 is provided with a contact assembly 71, which includes an insulating housing 72 fixed to the end. The outer end of the housing 72 carries an electro-conductive contact shaft 73 which projects outside the housing extending from the outer end of the cord 17a. This contact shaft 73 is provided, at its outer end, with a sharp point.

Being slightly spaced sideways from the outer face of the housing 71, a terminal assembly 15 including a terminal housing 61 is carried by a stationary supporter block 62. The terminal housing 61 internally carries an insulating supporter 67 inserted over an electro-conductive cylinder 63. An electro-conductive rod 64 is slidably inserted through the cylinder 63. The outer end of the rod 64 is provided with a flanged contact disc 66 and a compression spring 65 is disposed between the cylinder and the disc. The other end of the rod 64 is suitably deformed so that the rod does not fall off the cylinder. The disc 66 is always pressed in contact with the point of the contact shaft 73 due to the resilient force of the spring 65. The cylinder 63 is connected with another cord 17b which extends outwards through the wall of the housing 61. The cord 17b is in common with the cord 17a in its configuration and nature and is connected to a given electric source.

In the above-described arrangement, an electric connection is established from the given electric source to the contact disc 66 via cord 17b, cylinder 63, rod 64 and spring 65. In other words, the contact disc 66 functions as an electric input terminal. By the point contact between this disc 66 and the contact shaft 73, an electric connection is established from this input terminal to the inner layer 22 of the drum 11 via cord 17a and spring 24. Because of the point contact between the disc 66 and the contact shaft 73, rotation of the drum 11 about the axis of the shaft 16 does not disturb the electric connection thus established. This establishment of the electric connection for corresponding electro-static charge on the part of the inner layer 22 generates a corresponding electro-static induction on the part of the outer layer so as to attract the sheet passing in surface contact therewith.

As is clear from the foregoing description, according to the concept of the present invention, the electric connection for electrically charging the drum surface can be established stably without any disturbance by the rotation of the drum on the one hand and the rotation of the drum can be carried out very smoothly without any disturbance by the establishment of the electric connection on the other hand. This is the very characteristic feature of the present invention.

The rough supply of the sheet on the apparatus of the present invention is carried out in the following manner. The side holes of the sheet 18 are placed in engagement with teeth 32a and 32b of the sprockets 12a and 12b and the sheet 18 is advanced following the rotation of the sprockets 12a and 12b. This mechanism is quite the same as the conventional arrangement, upon switching on of the electric source, the drum surface is electrically charged so as to attract the sheet thereon. At this moment, the sheet transportation work is shifted from mechanical transportation by the sprocket teeth to electrical transportation by the drum surface. Owing to this transfer of the work, the supply of the sheet can be carried out very precisely being free from possible slippage or deviation caused by a loose engagement between the sheet side holes and the sprocket teeth. Merely by switching on and off the electric source, such shifting can be effectuated very easily.

What is claimed is:

1. An apparatus for supply of an insulating sheet of insulating material comprising, in combination, a rotational shaft mechanically connected to a given driving source, a cylindrical drum fixedly mounted on said shaft and having an insulating outer layer covering an electro-conductive inner layer, a feeding mechanism for feeding the sheet onto said cylindrical drum, a terminal assembly connected to a given DC source, and means for connecting said inner layer of said drum electrically to said terminal assembly, said connecting means includes an elongated electro-conductive member which extends into said drum from outside thereof, resilient means connected to the inner end of said electro-conductive member and being conductive and adapted to bear upon said electro-conductive layer, and means for connecting the outer end of said elongated member electrically to said DC voltage source.
2. The apparatus of claim 1 wherein said means for connecting said outer end includes an electro-conductive disc resiliently urged toward a stationary shaft connected to said elongated member for establishment of an electric connection and further includes a connection between said disc and said electric source.

3. An apparatus of claim 1 further comprising one or more sprockets fixedly mounted on said shaft and spaced from said drum.

4. An apparatus for supply of an insulating sheet of insulating material comprising, in combination, a rotational shaft mechanically connected to a given driving source, a cylindrical drum fixedly mounted on said shaft and having an insulating outer layer covering an electro-conductive inner layer, a feeding mechanism for feeding the sheet onto said cylindrical drum, a terminal assembly connected to a given DC source, and means for connecting said inner layer of said drum electrically to said terminal assembly, said connecting means including an elongated electro-conductive core running through said shaft the inner end of which extends into the interior of said drum, an electro-conductive resilient member connected to said inner end and being in contact with said inner layer of said drum, and a contact shaft connected to an outer end of said core.

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