This invention relates to means for insulating conductors and has particular reference to a wrapping machine for insulating formed coil turns.

A commonly employed method of insulating conductors is to wrap them with a sheet or tape of an insulating cloth or paper-like material. This method is commonly employed in the insulation of formed coils designed to be fitted tightly into slots in an armature or rotor of a large electric motor or generator.

The wrapping must in such cases be very tightly applied and hence care must be taken, especially where the wrapping material has a low tensile strength, to prevent tearing or distortion of the wrapping material. While machines are preferably employed for holding the conductors and the wrapping material during the wrapping process, it is similarly desirable that the machine itself be both low in cost, as well as inexpensive to operate and maintain. In particular, it is very desirable that the machine be easy to disassemble and clean since particles of insulating material together with binder material often collect in relatively large quantities according to the type of insulating material being employed.

It is therefore an object of our invention to provide a simple and inexpensive machine for wrapping an insulator sheet about a conductor.

It is a further object of our invention to provide a coil wrapping machine which tightly wraps an insulating sheet about a coil conductor without subjecting the sheet to undue stress.

It is a further object of our invention to provide a coil wrapping machine which automatically applies pressure upon the coil as it is wrapped.

Briefer, in accordance with our invention, a jg having an elongated V-shaped groove extending along its lengthwise axis holds a straight section of the conductor being wrapped, the jg being made of non-magnetic material. A magnet positioned against the lower side of the jg with its pole pieces axially spaced is employed to attract an elongated bar made of magnetic material into the groove.

Thus, when a conductor is wrapped with an insulating sheet, the bar of magnetic material above it is forced against the conductor by the magnetic force to maintain a pressure on the conductor and keep the wrapping tightly in place as the conductor is rotated.

The features of this invention which we believe to be novel are set forth with particularity in the appended claims. Our invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing in which

Fig. 1 is a perspective view of a wrapping machine embodying our invention; and

Fig. 2 is an end view along line 2—2 of Fig. 1;

Fig. 3 is a perspective view of another wrapping machine embodying our invention;

Fig. 4 is an end view of a modification; and

Fig. 5 is a perspective view of a portion of another wrapping machine representing a modification.

Referring now to Fig. 1, a wrapping machine embodying our invention is shown having a V-shaped holder jg 1 comprising an elongated plate of brass or other non-magnetic material which is bent along a lengthwise axis to provide two planar surfaces 2 and 3 at an angle to each other, which angle may suitably be 90°. It is these facing inner sides 2 and 3 which define the working surfaces of the jg. Positioned against the outer surface of the jg is a horseshoe electromagnet 4 having its pole faces 5 and 6 axially spaced along the length of the jg. The pole faces are suitably grooved or cut away to accommodate the backside of the jg and bring the magnet pole pieces into close contact with it. As further shown in Figs. 1 and 2, each pole piece is not centered opposite the apex of the V-shaped cross section of the jg but instead more of the iron of the pole pieces is positioned against the side 3 of the jg thus concentrating the magnetic flux on that side of the center groove of the jg. The magnet is preferably bolted to the jg, the head of each bolt being flush with an inner side of the jg and extending therethrough and through the respective legs of the electromagnet core. A support 8, suitably comprised of brass or other non-magnetic metal rod, is brazed to the underside of one end of the jg and extends therefrom in a generally axial direction to a supporting surface such as a workbench (not shown). A winding 9 on the electromagnet is connected by leads 10 to a direct current voltage source 11 through a circuit breaker 12, which may suitably take the form of a foot activated switch. To prevent fouling of the electromagnet leads 10 with a coil to be wrapped, they are preferably taped to the jg support rod 8 as shown on the drawing.

To provide pressure on the coil or other conductor placed in the groove of the jg a member or bar roller 13 made of magnetic material is placed in the jg on the conductor. This bar roller preferably takes the form of a smooth cylinder of steel the length of the jg and having a diameter small enough to permit the cylinder to be contained within the jg when it is resting upon a coil turn. Due to the magnetic field established by the electromagnet 4 when energized, the bar roller 13 is held firmly in the V-shaped groove by magnetic attraction toward the pole faces 5 and 6 to thus exert pressure upon a conductor underneath it. It should be noted that the cylinder will apply pressure along the entire length of the jg, properly positioned by the V-block effect. While the weight of the bar roller itself provides some pressure on a coil turn within the groove, the force exerted is preferably made to be many times that due to the weight of the bar and can be removed at will by opening the foot switch 12.

In operation of the machine of Figs. 1 and 2, a conductor assembly 14 which may suitably take the form of a group of formed conductors comprising a turn of an armature coil for a dynamo-electric machine is placed in the bottom of the groove of the jg. In the examples shown in Figs. 1 and 2, this conductor group has a rectangular cross section and it is the straight portion of the armature turn that is to be insulatingly wrapped.

Accordingly, a sheet of insulating material 15, which material may suitably be paper impregnated or covered with a high dielectric material, is provided having a width sufficient to extend over the length of the conductor to be insulated and having a length adequate to provide the number of layers of wrapping desired for the particular application. One end of the insulating sheet is fastened to one surface of the conductor with a suitable adhesive and the conductor with the sheet fastened to it is placed against side 2 of the jg and slid along that face until it rests against the bottom of the groove formed by the junctions of sides 2 and 3. It is not necessary that the
steel bar roller 13 be removed since it can be easily dis-
placed upward by the entrance of the conductors provid-
ing that the switch 12 is open.

After the conductor is in place, the foot switch 12 is
closed to energize the electromagnet and force the roller
13 tightly against the coil form. The coil is then rotated
about its lengthwise axis to wind the insulation upon the
conductors. Due to the pressure caused by the roller 13,
the insulating sheet is pressed firmly and tightly against
the core and the preceding insulation layers. No tension
on the sheet 15 is therefore required which is a very sub-
stantial advantage of our machine when insulating wraps
of low tensile strength are employed. In the case of the
rectangular cross section coil turn shown in Figs. 1 and 2,
it may be seen that the roller 13 not only rolls over the
surface of the coil turn as the coil is rotated within the
jig but the roller is also displaced in directions transverse
to its lengthwise axis. This displacement is maintained
along the side 3 of the jig due to the concentration of the
magnetic field on that side as mentioned in a preceding
paragraph describing the unbalanced pole piece construc-
tion. In this way, when the partially formed coil turn
14 has a rectangular cross section deforming substantially
from a circular shape, the roller does not shift from side to
side of the groove but instead slides or rolls along the side 3
to thus provide a steady pressure to the sheet 15 at its
line of contact with the wound portion of the coil. Due
to the greater distance of the roller 13 from the magnetic
pole pieces when the long side of the armature turn rests
against the groove side 2, the flux leakage between the
pole pieces increases and the force that the roller exerts
upon the coil is accordingly decreased. This, however,
is generally desirable since the rectangular cross section
coil turns are designed to be forced into an armature slot
and must therefore have the insulation against the longer
sides very tightly compressed against them while at the
same time the insulation wrapping across the short sides
of the conductor must not be made so tight as to unduly
stress the insulating material.

As may be seen, the wrapping machine is very simple
and lends itself to the wrapping of different size conduc-
tors without adjustment of the machine. Of course, the
length of the jig 1 must be as long as the length of the
conductor to be wrapped and in the case of the generally
U-shaped armature coils shown in Fig. 1, the length of
the jig is preferably not much greater than the straight
sides of the coil in order that the coil may be adequately
wrapped and that it may be wrapped without obstruction.

Referring now to Fig. 3, another embodiment of a coil
wrapping machine in accordance with our invention is
shown therein. In this case, the V-shaped coil wrapping
jig 16 has one of its sides extended and bent over to pro-
vide an off-duty holder 17 for the pressure bar roller 18.
Such a cross section of the jig assembly may suitably be
described as W-shaped. The V-shaped shelf portion or
holder 17 is especially useful when the magnetic attract-
ion force is provided by a permanent horseshoe magnet
19 corresponding in position and function to the electro-
magnetic core of Fig. 1. When a conductor 14 is to be
wrapped with an insulating sheet 15, the bar roller 18 is
placed in the V-shaped groove and the coil slid under it
as with the machine of Fig. 1. However, depending upon
the amplitude of the magnetic force, it may be desirable
to leave the bar roller 18 in the holder 17 until the coil
form is positioned. While the force exerted by the perma-
nent magnet cannot be conveniently dispelled by merely
opening a switch, this structure advantageously emp-
loys the presence of an external energy source is not
desired or feasible.

The end view of the machine of Fig. 4 corresponds to
the machine of Fig. 3 except that the use of a straight-
sided bar 20 is illustrated in this case. Its generally rec-
tangular cross section is rounded in the area of develop-
ment contact with the rotating coil form, and the flat sides
provide a larger surface contact and hence more pressure
with respect to both the side 26 of the jig groove against
which the bar slides and to the side of the coil being
wound. The permanent magnet 27 therein is shown in
an off-center position with respect to the apex of the V-
shaped groove so that most of the magnetic pressure is
exerted through the side 26 of the jig. Other variations in
the pressure bar configuration may be made, of course,
to accommodate either the shape of the groove or of the
conductor being wrapped.

Fig. 5 illustrates another V-shaped jig 28 made of a
non-magnetic material such as brass and having iron or
other magnetic material inserts 29 secured therein oppo-
site the location of the pole faces of the magnet 30. To
provide off-center magnetic force, the iron inserts may
suitably be confined to one side of the jig 28. These iron
inserts increase the holding power of a given magnet
since the length of the low permeability portion of the
flux bar is greatly reduced or eliminated thereby. When
the wrapping bar is slid under holder 28 where such in-
serts are employed in combination with the permanent
magnet, the inserts together with the bar provide a keeper
for the magnet.

It is obvious that, while the generally V-shaped groove
has been shown in the jig embodiment illustrated herein,
the groove may be generally rounded or the angle of the
groove may be increased or decreased depending upon
the particular size of the coil to be wrapped. It is fur-
ther apparent that in each of the embodiments described,
insulation particles and binding materials may be very
easily removed from the jig since the wrapping bar can
be easily lifted out.

While we have shown particular embodiments of our
invention, it will be understood, of course, that we do
not wish to be limited thereto since many modifications
may be made, and we, therefore, aim by the appended
claims to cover any such modifications as fall within the
true spirit and scope of our invention.

What we claim as new and desire to secure by Letters
Patent of the United States is:

1. A device for wrapping a conductor with insulating
material and comprising a jig having a non-magnetic V-
shaped member having inner surfaces large enough for
accommodating a length of said conductor to be insu-
lated and outer surfaces, a magnet means having pole
pieces of opposite polarity adjacent to said outer surfaces
of said jig, and a member of magnetic material arranged
to be placed within said jig on said conductor and said
insulating material in the field of said magnetic means
for urging said insulating material against said conductor.

2. A device for wrapping a conductor with a sheet of
insulating material and comprising a jig having a non-
magnetic V-shaped member having inner surfaces large
enough for accommodating a length of said conductor
to be insulated and an outer surface, a magnet mean-
having pole pieces of opposite polarity adjacent to said
outer surface of said jig, a V-shaped cross section, and a roller of
magnetic material arranged within said jig on said con-
ductor and said insulating material in the field of said
magnet means for urging said insulation material against
said conductor.

3. A device for wrapping a conductor with a sheet of
insulating material and comprising a jig having a non-
magnetic V-shaped channel member having inner surfaces
large enough for accommodating a length of said con-
ductor to be insulated and an outer surface, a magnet
means having pole pieces of opposite polarity positioned
along the axis of and adjacent to said outer surface of
said V-shaped section, and a roller of magnetic material
adapted to be positioned within said jig on said conductor
and said insulating material in the field of said magnet
means for urging said insulation material against said
conductor.

4. A device for wrapping a conductor with a sheet of
insulating material and comprising a jig having an inner
surface for supporting said conductor and said insulation
material and having an axially uniform V-shaped member opening upward, an electromagnet having pole pieces of opposite polarity positioned along the axis of said conductor, and a cylindrical roller of magnetic material adapted to be arranged within said jig on said conductor and said insulating material in the region of said magnet for urging said insulation material against said conductor when current is applied to said electromagnet.

5. A device for wrapping a straight portion of a U-shaped conductor with a sheet of insulating material and comprising a roller of magnetic material, a jig having a non-magnetic V-shaped channel portion for supporting said straight portion of a conductor, said insulation material and said roller during the wrapping operation, said channel portion having one side being extended and bent to form a concave shelf portion for supporting said roller during the loading and unloading operations, and a magnet means having pole pieces of opposite polarity positioned along the axis of and adjacent to and below said channel portion so that said roller urges said insulation material against said conductor.

6. A wrapping machine for insulating a straight portion of a conductor assembly with an insulating sheet without subjecting the sheet to undue stress, comprising a horseshoe magnet having its poles extended upwardly, a bar of magnetic material, and a holding jig of nonmagnetic material bent along a lengthwise axis to provide two planar surfaces extending upward from said axis, said jig being secured to said magnet so that said poles are positioned along said axis of said axis, said jig being of a size sufficient to accommodate the conductor assembly and said bar lying on top thereof while the conductor assembly is being rotated to wrap the sheet thereon.

7. A wrapping machine for insulating the straight side of a partially formed coil turn of a dynamosoelectric machine with an insulating sheet without subjecting the sheet to undue stress, comprising a horseshoe permanent magnet having its poles extending upwardly, a bar roller made of magnetic material, said roller being of sufficient length to act as a keeper for said magnet, and a holding jig of nonmagnetic material bent along a lengthwise axis to provide two planar surfaces extending upward from said axis, said jig being secured to said magnet so that said poles are positioned along said axis of said jig, said jig being of a size sufficient to accommodate the coil side with said bar roller lying on top thereof while the coil side is being rotated to wrap the sheet thereon.

8. A wrapping machine for insulating the straight side of a partially formed coil turn of a dynamosoelectric machine with an insulating sheet without subjecting the insulating sheet to undue stress, comprising a horseshoe electromagnet having its poles extending outwardly, a bar roller of magnetic material, said roller being of sufficient length to carry flux between said poles, a holding jig of nonmagnetic material bent along a lengthwise axis to provide two planar surfaces extending upwardly from said axis, said jig being secured to said magnet with the poles of said magnet adjacent to said axis, and said jig being of a size sufficient to accommodate the coil side with said bar roller lying on top thereof while the coil side is being rotated to wrap the sheet thereon.

9. A wrapping machine for insulating the straight side of a partially formed coil turn of a dynamosoelectric machine with an insulating sheet without subjecting the sheet to undue stress, comprising a horseshoe permanent magnet having its poles extending upwardly, a bar made of magnetic material, said bar being of sufficient length to act as a keeper for said magnet, a holding jig of nonmagnetic material bent along a lengthwise axis to provide two planar surfaces extending upward from said axis, said jig being secured to said magnet so that said poles are positioned along said axis of said jig, said jig being of a size sufficient to accommodate the coil side with said bar lying on top thereof while the coil side is being rotated to wrap the sheet thereon, and a pair of inserts of magnetic material placed in said jig in contact with said poles to increase the holding power of said magnet.

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