The present invention relates to means for applying metal foil to paper or other insulating material in strip form (referred to hereafter in this specification and claims comprehensively as "paper strip") such a combination being especially, although not necessarily exclusively, applicable in the manufacture of capacitors. In using a composite strip of this nature, it is frequently desired that, while the paper strip shall be continuous, the metal foil applied to it shall be in predetermined lengths separated by gaps. It is the main object of the present invention to produce such a composite strip from rolls of paper strip and of metal strip by a continuous operation.

According to the invention, there is applied to a continuously fed paper strip a strip of metal foil wound off from a roll, rotation of this roll being arrested when a predetermined length of metal foil has been wound off whereby the metal foil is severed, such stoppage being maintained over a sufficient period of time to produce the required gap between successive lengths of foil applied to the paper strip. The most convenient way of effecting periodical stoppage of the roll of metal foil is by mounting it between two plates which are in proximity to the sides of the roll, but, when the latter is required to rotate to feed the foil, do not touch it. When, however, it is desired to stop the unwinding of the metal foil so that it is severed, one of the plates is moved toward the other so that the coil is gripped between them and the required stoppage thereby effected.

This lateral movement of one of the side plates is most readily carried out by means of a solenoid which is periodically excited to attract an armature and hold it in its attracted position during a period of time wherein the paper strip travels over a distance equal to the desired gap between the strips of foil applied to it. The solenoid is then de-energized, the roll of foil released and application of a fresh length of foil to the paper strip commences. The required periodical excitation of the solenoid is most conveniently effected by causing the composite strip to co-operate with an electrical contact, the position of which is adjustable relatively to that of the roll of metal foil. Thus, as a length of foil is applied to the strip, it travels toward this contact, and as soon as it establishes electrical contact therewith the solenoid is excited, the roll of foil is gripped thereby severing the foil at the point at which it has just come into contact with the paper strip, and further feeding of the foil is prevented during the predetermined period in order to produce the required gap between successive lengths of foil. Ultimately, the solenoid having been de-energised owing to the formation of the gap, the roll of metal foil is released and a fresh length is applied to the paper strip, the cycle of operations being then repeated.

After passing the above electrical contact, the composite strip is wound on to a winding-off roll, both this roll and a roller over which the paper strip is wound at the point at which the metal foil is applied to it being positively driven. The arrangement is such that the member on which the winding-off roll is mounted is of approximately the same diameter and is driven, through a slipping clutch, at substantially the same speed as the above roller located at the metal foil roll. The winding-off roll being fitted around the above member, the radius at which the composite strip is wound on to it is necessarily greater than that of the roller at the metal foil roll. By this means, the composite strip is maintained taut in its passage from the metal foil to the winding-off roll; the slipping clutch incorporated in the drive of the latter makes allowance for the difference in peripheral speed between the two driven members which would otherwise be present.

In order that the invention may be clearly understood and readily carried into effect, it will now be described more fully with reference to the accompanying drawings which illustrate one form of machine in accordance therewith and wherein:

Figures 1 and 2 are respectively side and plan views of the machine,

Figure 3 is a plan view, to an enlarged scale, of the metal foil roll and the means for controlling it,

Figure 4 is a diagram of connections,

Figure 5 is a fragmentary plan view showing another position of the apparatus in Figure 3 caused by the solenoid in action when excited, and

Figures 6 and 7 are respectively side and plan views of the adjustable contacting members,

Referring to figures 1 and 2, the continuous paper strip is wound off from rolls 1 and 2, paper being taken from either of the rolls or from both of them and combined to form a single paper strip. These rolls are reversibly mounted on a suitable support 3 and a base or bed plate 4 which also serves to support the other elements of the apparatus; the mounting of the rolls 1 and 2 does not constitute a feature of the present invention and will not therefore be further de-
scribed, except to state that the spool or the like on which each roll is mounted is provided with braking mechanism so as to ensure that, as the paper strip is wound off from each roller, it is maintained taut. The paper strip, from either of the rollers 1, 2 or from both rolls as the case may be, is led around an idler roller 6 and then around a power-driven roller 7, from whence it is led to a winding-off roller 8 mounted, by means of a slipping clutch 9, on a spindle 10 which is also power driven. For the purpose of driving the roller 7 and spindle 9, power is supplied in any suitable manner through a shaft 11 mounted in a bearing 12 carried by the frame 4, the shaft being provided with a set of cone pulleys 13 connected by means of a belt 13 with a set of driven cone pulleys 14, mounted on a spindle 15 which carries the roller 1. On the spindle 15 there is also mounted a pulley 16, which serves, by means of a crossed belt 17 and pulley 18, to drive the spindle 8 in the direction required to wind on the paper strip 5. The spindles 15 and 10 revolve at substantially the same speed and the spool or the like which supports the winding-off roller 8 is of such a size that the least radius at which the winding-off operation is carried out is greater than that of the roller 7, the difference of peripheral speeds which would thus normally occur being allowed for by the slipping clutch through which the roller 8 is driven. This action ensures that the length of paper strip 5 between the roller 7 and the winding-off roller 8 shall be maintained taut.

The application of the metal foil strip to the paper strip 5 is by means of a roll 19 of the metal foil strip mounted on a suitable spool or the like (see Figures 3 and 5) between face plates 21 and 22, the spool being provided with trunnions 23 which extend through slots 24 in the plates 21 and 22. Thus the metal foil roll 19 is mounted immediately above the roller 7 and is in contact with the paper strip, the roll being caused to bear on the paper strip 5 as it passes over the roller 7 with sufficient pressure by means of fingers 25 which rest on the trunnions 23. The fingers 25 are fixed to a spindle 26 which is mounted so as to be capable of rocking in vertical plates 27 and 28, the spindle 26 being at its further end bent at right angles as indicated and fitted with a weight not shown, the effect of which is to cause the fingers 25 to exert downward pressure on the trunnions 23 and to maintain the required pressure of the roller 19 on the paper strip 5. Owing to the fact that, by means constituting no part of the present invention, and therefore not shown in the drawings, the paper strip 5 has been previously coated with a suitable adhesive, the free end of the metal foil becomes attached to and carried along with the paper strip, becoming unwound from the roll 19.

For the purpose of determining the length of metal foil strip 29 to be applied to the paper strip 5, the latter with the foil strip 29 on its upper surface is passed between two rollers 30, 31 (see Figures 1, 2, 6 and 7) carried by a bridge contact member 32 mounted on two parallel bars 33 which are supported at one end by a member 34 extending from the plate 27 and at the other end by a member 35 supported from the bed plate 4. The bridge contact member 32 is so constructed that it may be adjusted in position to any point along the bars 33. Of the fingers 30 and 31 of the bridge contact 32, the roller 30 is of metal and so is adapted to make electrical contact with the metal foil strip 29, whereas the roller 31 is of insulating material and serves to ensure that the above electrical contact shall be satisfactorily effected. As soon as the forward edge of the metal foil strip 29 carried by the paper strip 5 reaches the contact 30, an electrical circuit is completed, this circuit being illustrated in Figure 4. Direct-current power supply for this circuit is applied to terminals 36, one of which, as shown, is connected to a brass contact 37 which bears on the peripheral surface of the metal foil roll 19. The other terminal 36 is connected to one pole of a solenoid 38, the other pole of which is connected by a flexible lead and a slip-ring contact not shown to the roller 8. Thus, as soon as contact is made as above described between the metal foil strip 29 and the roller 30, the solenoid 38 is excited and serves to arrest rotation of the roll 19. By this action and by reason of the fact that the foil on the paper strip is secured thereto by the adhesive and the paper strip continues to move with the paper strip, the foil tear or is ruptured along a line immediately beneath the roller 19 at the initial line of contact between the paper and the foil, where the foil is no longer supported by the roller and, being of aluminum and very weak, owing to its thickness being of the order of 0.000025 in., it is found that the lengths of foil are consistent to within 1/4 in. inch.

The mechanism whereby this action is performed is shown most clearly in Figures 3 and 5; the solenoid 38 is mounted in a suitable frame fixed to the plate 21, through which and through the plate 29 there extend rods 39 in such a manner as to be capable of longitudinal reciprocation through the plates 21 and 28. Astride these rods and pinned thereto is a bridge piece 40 to which an armature 41 for the solenoid 38 is riveted. When the solenoid is unexerted this armature is held away from it by the action of springs 42, which surround the rods 39, the possible movement of the armature 41 and therefore of the rods 39 being determined by adjustment of a set-screw 43, threaded in the plate 28. To the ends of the rods 39 which extend through the plate 21 the plate 22 is attached, and accordingly, on excitation of the solenoid 38, this plate is moved to bear on the metal foil roll 19, which is thereby gripped between the plates 21 and 22, as seen in Figure 5, thereby effecting the desired arrest of its movement, and causing the metal foil strip to be severed, whereby the length thereof applied to the paper strip 5 is determined. This action, however, breaks the solenoid circuit as above established, with the result that the armature 41 would be withstood released and rotation of the metal foil roll 19 would immediately restart so that a new length of metal foil strip would begin to be applied to the paper strip 5 with the intervention of a very small gap. In order that an adequate gap may be formed, there is connected across the solenoid a capacitor 44 which, on establishment of the above circuit, becomes charged, but when the circuit is broken by severance of the metal foil strip 29 the capacitor 44 discharges through the solenoid 38, thus maintaining it excited during the time determined period according to the value of the capacitor, and correspondingly increasing the length of the gap. In order to provide for variation in the length of gap, further capacitors 45, each provided with a switch 46, may be connected across the terminals of the solenoid 38 so that, by varying the total capacity in series across the solenoid, the time that the latter remains excited will be correspondingly varied and
a gap of the desired length secured. Variation in the gap length may also be effected by altering 
the rate of travel of the paper strip 5 by means of the conical drive 12, 14, 16. By a combina-
tion of these methods practically any gap length, 
within the limits of the apparatus, is obtainable.

In order to allow for the application of metal 
foil strip of various widths, the plate 21 is made 
adjustable relatively to the plate 22. For this 
purpose the former plate is carried by two rods 
41 extending through the plates 21 and 28, the 
portions extending through the latter plate being 
screw-threaded as shown. On these portions 
there are fitted nuts 48 which bear on the plate 
28 on the side remote from the plate 27. These 
nuts being fitted with chain-wheels 43 connected 
by a chain 50. Further, one of the nuts is pro-
vided with a hand-wheel 51, whereby both the 
nuts may be rotated in synchronism. The nuts 
48 are maintained in contact with the plate 28 
owing to the action of springs 52 which bear 
respectively on the plate 28 and on collars 53 
fitted to the rods 41. By this mechanism, the 
position of the plate 21 relatively to the plate 22 
may be so adjusted that, when the solenoid 38 is 
not excited, the roll 19 is free to revolve, but, 
on attraction of the armature 41 by the solenoid 38, 
rotation of the roll 19 is prevented owing to 
its being gripped between the plates 21 and 22 as 
above described. Means for mounting rolls 1 
and 2 of paper strip 5 of various widths may be 
provided, such means not forming part of the 
present invention and it therefore being unnec-
essary to give description thereof. As regards 
the passage of the composite strip over the 
rollers 20 and 31, of the bridge contact 32, these 
rollers are made sufficiently wide to allow of the 
passage of the widest strip with which the machine 
is called upon to deal.

Corresponding to the above means for dealing 
with paper and metal foil strip of various widths, 
means is provided for adjustment of the brush 
contact 31, bearing on the metal foil roll 19. For 
this purpose the brush contact 31 is supported 
by a pivoted arm 54 of sufficient weight to supply 
the required bearing pressure of the contact 31 
on the roll 19. As indicated in Figure 3, the arm 
54 is bent at right angles and extends through 
plates 55 which are pinned to a rod 56 extend-
ing through the plates 27 and 28 and capable of 
longitudinal adjustment therein. On this rod 
there is a flat surface 57 upon which there bears 
a set-screw 58 threaded in the plate 27, whereby 
the rod 56 is held in any position to which it is 
adjusted. By this means the position of the 
brush contact 31 may be adjusted transversely 
across the surface of the roll 19, so as to bear 
thereupon whatever may be the width of the 
metal foil strip composing the roll. Electrical 
connection to the brush contact 31 is effected 
by means of a lead sweated into a socket 59 at-
tached to the pivoted arm 54.

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

1. A method of applying successive lengths of 
metal foil to a single length of paper strip, com-
prising the steps of winding the metal foil off 
from a roll on a continuously fed paper strip 
while maintaining a pressure contact between the 
roll and the strip, arresting rotation of the roll 
when a predetermined length of metal foil has 
been wound off to effect severance by rupture of 
the metal foil along the line of said pressure con-
tact, releasing the roll and feeding a further 
length of metal foil on to the paper strip.
with adhesive comprising a source of said paper strip, means for drawing said coated paper strip continuously from said source, a roll of said metal foil in contact with said continuously fed paper strip, said contact being operative to rotate said roll and unwind said foil on to said paper strip, means for arresting rotation of said roll whereby said foil is severed by tearing along the line of contact between the roll and the coated strip and subsequently releasing said roll for further rotation, said arresting and releasing device comprising face plates mounted on opposite sides of the roll for movement relative to one another for engagement of the roll therebetween whereby rotation of the roll is permitted or is arrested by pressure of the face plates on its sides, an electric solenoid operated means for effecting the said relative movement of the face plates toward one another for arresting rotation of the metal foil roll, and means for automatically exciting said solenoid to cause movement of one of the face plates toward the other, comprising mechanism operative when a strip of metal foil of predetermined length has been applied to the said length of paper strip, said mechanism including an electrical contact member with which the forward end of the metal foil strip last applied to the said length of paper strip makes contact in the normal course of travel of the composite strip.

10. Means as set forth in claim 9, wherein the said electrical contact member is adjustable relatively to the metal foil roll in the direction of the path of travel of the composite strip.

11. Means for applying successive lengths of metal foil to a single length of paper strip coated with adhesive comprising a source of said paper strip, means for drawing said coated paper strip continuously from said source, a roll of said metal foil in contact with said continuously fed paper strip, said contact being operative to rotate said roll and unwind said foil on to said paper strip, means for arresting rotation of said roll whereby said foil is severed by tearing along the line of contact between the roll and the coated strip and subsequently releasing said roll for further rotation, said arresting and releasing device comprising face plates mounted on opposite sides of the roll for movement relative to one another for engagement of the roll therebetween whereby rotation of the roll is permitted or is arrested by pressure of the face plates on its sides, an electric solenoid operated means for effecting the said relative movement of the face plates toward one another for arresting rotation of the metal foil roll, and means for automatically exciting said solenoid to cause movement of one of the face plates toward the other, comprising mechanism, operative when a strip of metal foil of predetermined length has been applied to the said length of paper strip, and means for maintaining said excitation during a predetermined period of time comprising at least two capacitors electrically connected in parallel with said solenoid, and a switch in series with at least one of said capacitors.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Number</th>
<th>Name</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,569,765</td>
<td></td>
<td></td>
</tr>
<tr>
<td>918,813</td>
<td>Armstrong</td>
<td>Apr. 20, 1909</td>
</tr>
<tr>
<td>1,173,170</td>
<td>Cartlidge</td>
<td>Feb. 29, 1916</td>
</tr>
<tr>
<td>1,860,691</td>
<td>Richard</td>
<td>May 31, 1932</td>
</tr>
<tr>
<td>2,205,171</td>
<td>Kile et al.</td>
<td>June 18, 1940</td>
</tr>
<tr>
<td>2,255,498</td>
<td>Babillis</td>
<td>Sept. 9, 1941</td>
</tr>
<tr>
<td>2,610,071</td>
<td>Prisch</td>
<td>Feb. 2, 1943</td>
</tr>
</tbody>
</table>