

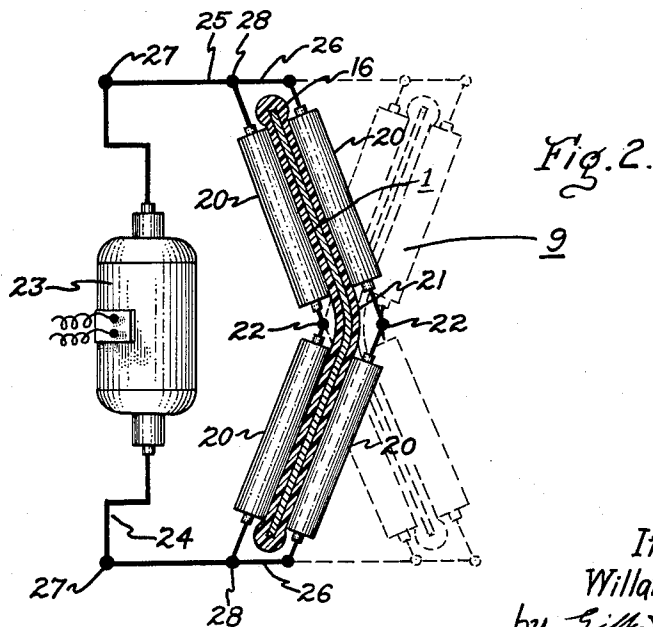
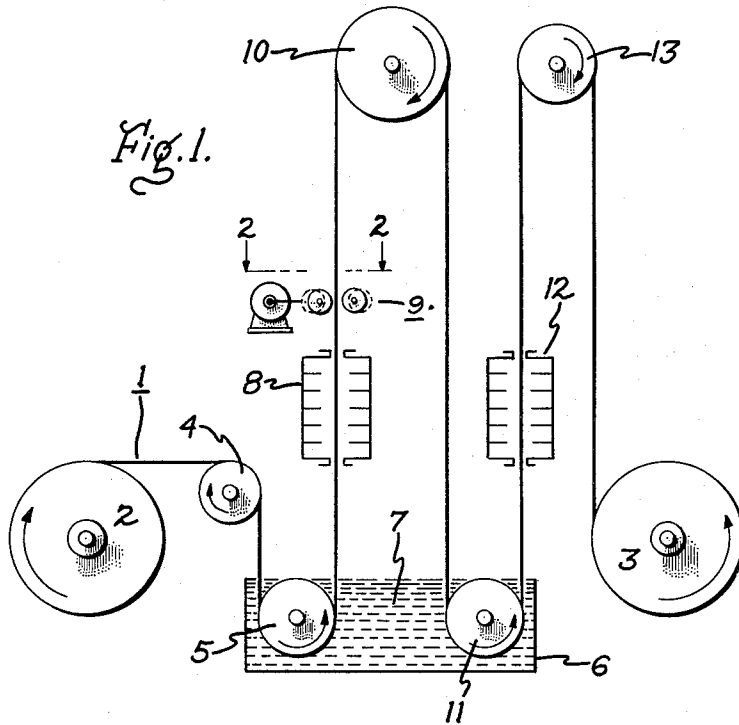
July 17, 1962

W. F. M. GRAY
EDGE COATING METHOD

3,044,892

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2 Sheets-Sheet 1



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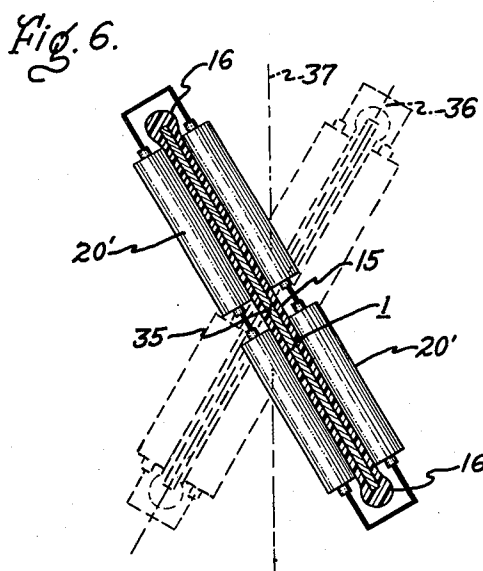
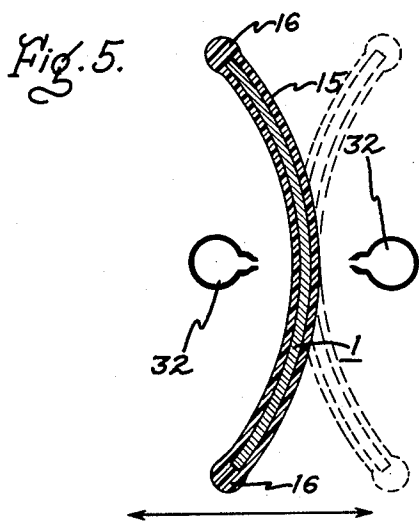
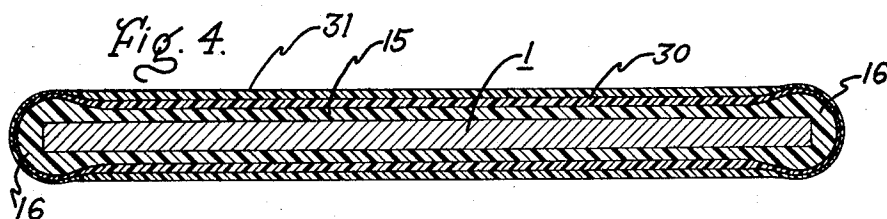
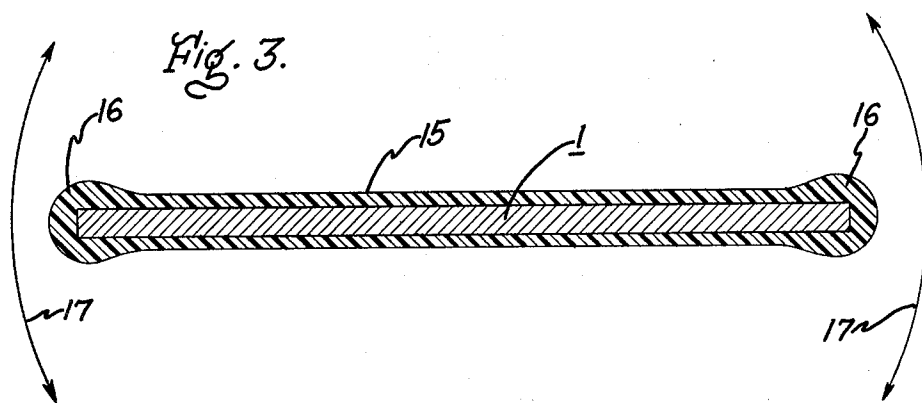
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2 Sheets-Sheet 2



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3,044,892

EDGE COATING METHOD

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9 Claims. (Cl. 117-10)

This invention relates to a method of obtaining a coating of electrical insulation or other material on the edges of foil or other substances having edges.

It is a particular object of this invention to provide an improved method of obtaining a coating of electrical insulation or other material on the edges of foil.

It is another object of this invention to provide a method of coating the edges of a substance with a coating material.

Broadly, the invention comprises forming a liquid coating on the foil and then flexing it transverse to its edges or vibrating it about a point remote from its edges so as to cause some of the liquid coating to migrate out to the edges and surround the edges in a form which is generally tear-shaped.

In prior art coating methods the surface tension of the coating liquid has prohibited obtaining good edge coverage in a single pass of the object which is being coated. In my invention it is possible to obtain a sound coating on the edges of the material which is being coated in a single pass. Furthermore, although the invention is particularly illustrated in connection with foil, it is not restricted in its applicability to foil. The invention can also be practiced in edge coating magnetic steel strip which is used to make curved magnetic cores. The invention can also be used in coating the edges of flat steel plates, and also in end coating elongated members.

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which I regard as my invention, it is believed the invention will be better understood from the following description taken in connection with the accompanying drawings in which:

FIG. 1 is a diagrammatic illustration of one form of my invention;

FIG. 2 is a diagrammatic illustration of one form of a flexing or vibrating mechanism taken as viewed from the line 2-2 of FIG. 1;

FIG. 3 is a cross-sectional view of the coated substance taken after it leaves the first curing oven of FIG. 1;

FIG. 4 is a cross-sectional view of the coated substance showing the build up of the coating material on successive passes;

FIG. 5 is a diagrammatic illustration of another form of flexing or vibrating means which can be used in practicing my invention; and

FIG. 6 is a diagrammatic illustration of still another form of flexing or vibrating means which can be used in practicing the invention.

Like reference numerals will be used throughout the various figures to indicate similar parts, and the thickness of the substance to be coated with its coating will be exaggerated for illustrative purposes. However, it will be understood that the invention is not restricted to any particular thickness of substance or coating, but is applicable to a wide thickness range.

Referring now particularly to FIG. 1, illustrated therein is an apparatus and method which can be used in obtaining a surface and edge coating on a continuous substance, such as, for example, aluminum foil 1, which is intended to be used as the primary electrical winding for an electrical apparatus such as a transformer. The foil 1 is taken off a supply reel 2 and after the coating process is completed it is rewound on a reel 3. From

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reel 2 the foil 1 passes around a guide roller 4 and then from roller 4 around a roller 5 which is immersed in a tank 6 of coating material 7 in liquid form. This is the first pass of the foil 1 through the coating liquid 7.

After the foil 1 leaves the coating tank 6 it passes through a curing oven 8. The liquid coating 7 in this example would be an electrical insulating material resin so as to put an electrical insulating material surface and edge coating on the foil 1 which will ultimately be used as an electrical conductor. The oven 8 is for the purpose of curing or setting the resin. However, it will be obvious to those skilled in the art that in some coating processes it will be possible to cure or set the liquid coating in the atmosphere, in which event oven 8 can be omitted.

After the foil 1 leaves the curing oven 8 it passes through a flexing or vibrating mechanism, indicated generally by reference numeral 9, which will be described in greater detail hereinafter in connection with FIG. 2. The flexing or vibrating mechanism 9 flexes or vibrates the foil in a transverse direction about the central portion of the foil so as to cause the liquid coating material which is deposited on the foil to migrate to and surround the foil edges before it is cured or at least before it has reached its initial set in the oven 8. In some applications it may be necessary to keep the portion of foil 1 between roller 5 and another roller 10 behind the flexing mechanism 9 under tension so as to be able to properly flex or vibrate the foil as it is passing through the oven 8. In this connection the roller 10 should be spaced sufficiently away from the flexing mechanism 9 so that the foil can be properly flexed by the mechanism 9 without binding or seizing of the foil edges on the roller 10. After this first pass of the foil 1, a sound edge coating is obtained on the foil from a mechanical and electrical point of view and a satisfactory coating is also obtained on the surface of the foil. Therefore, in some applications, it is possible to omit the second pass and re-wind the foil directly on reel 3 after it leaves the oven 8 and flexing mechanism 9. In such event the rewind reel 3 can be substituted for the reel 10. However, I prefer to increase the build of the electrical insulation on the surfaces of the foil and therefore give the foil a second pass through the tank 6.

After the foil 1 leaves the roller 10 it is passed through the coating tank 6 for a second time around a roller 11. After foil 1 leaves roller 11 it goes through a second curing oven 12 and then around a roller 13 to the rewind reel 3. It is possible to omit the roller 13 and rewind the foil 1 directly on reel 3 after it leaves the second curing oven 12. Of course, it will be understood that further passes of the foil 1 through the tank 6 may be provided to increase the build of the insulating material 7 on the foil 1.

FIG. 3 is a sectional view of the foil 1 illustrating its condition after it leaves the oven 8. It has a coating of electrical insulation 15 formed on its surfaces and also a coating 16 of electrical insulation formed along its edges. The surface coating 15 is substantially uniform in thickness and the same is true for the build of the edge insulation 16, and the insulation 16 and 15 are integral with each other. The insulation 16 is built up along the edge of the foil in the form of a generally tear-shaped drop. This is accomplished by flexing or vibrating opposite sides of the foil in a direction which is transverse to the coated edges in the direction indicated by arrows 17. That is to say, opposite edges of the foil 1 are caused to move above and below the main plane of foil 1 by flexing or vibrating opposite sides of the foil about its central portion. Stated another way, the flexing or vibrating of the foil 1 provides a reciprocal, arcuate motion of the edges of the foil about an axis, or point, in this

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case, the lengthwise or longitudinal axis of the continuous strip of foil. Such flexing of the foil causes some of the insulation 15 to migrate to and surround the edges of the foil as indicated by insulation 16. The mechanism for accomplishing this will now be described in connection with FIG. 2.

The flexing mechanism 9, indicated in FIG. 1 and illustrated in greater detail in FIG. 2, comprises two pairs of rollers 20 which are disposed along opposite surfaces of the foil 1 and also on opposite sides of the central portion 21 of the foil. The rollers are pivotally mounted at their inner ends on pivot points 22. A motor 23 is connected by a crank 24 and other appropriate linkage to the outer ends of rollers 20 so as to cause them to pivot from left to right and right to left about their pivot points 22. This flexes opposite sides of the foil about its central portion 21 in a direction which is transverse to the foil and its edges. That is to say, foil part 21 is stationary or neutral. The connection between the crank 24 and the rollers 20 to get the desired movement will not be described in great detail since this will be obvious to those skilled in the art. For instance, it may comprise a pair of links 25 and 26. The connection of link 25 to the crank 24 and the left hand rollers 20, indicated by numerals 27 and 28 respectively, can be a ball and socket type of connection whereas the connection of link 26 to the outer ends of the left and right hand rollers can be a plain pivotal connection. The position of the flexing mechanism 9 at the opposite extreme of its flexing movement is shown in dotted lines in FIG. 2.

The previously described flexing of the foil 1 is transmitted to the portion of the foil which enters and is disposed in the curing oven 8. This causes the liquid insulation to migrate to the edges of the foil as indicated by reference numeral 16 in FIGS. 2 and 3. By the time the foil leaves the oven 8 the tear-shaped insulation 16 is set and the rollers 20 are preferably made from rubber or the like so that the rollers do not damage the formed insulation. After this first pass of the foil through the tank 6 it may be desirable to increase the build of the insulation on the surface of the foil as indicated by reference numeral 30 on FIG. 4. The foil can be given any number of passes through the coating tank. In the form of the invention illustrated in FIG. 1 the foil is given a second pass to give the foil a second coat as indicated by additional insulation 30 in FIG. 4. This additional insulation will cover the surfaces of the foil as well as its edges but will build up to a greater degree along the surfaces than on the edges due to the valley formed on the foil surfaces between the tear-shaped portions 16 as well as due to the surface tension characteristics of the coating material. By giving the foil several additional passes through the tank the build of the surface insulation can be made equal to the build of the edge insulation. This is illustrated in FIG. 4 by the third layer of insulation 31, which may be coated on foil 1 in a third pass of the foil, through insulating material 7.

It will be appreciated by those skilled in the art that in some applications it may be necessary to tension the foil which is being coated between the rollers 5 and 10 so as to make the foil flex or vibrate properly. The rapidity of flexing of the foil will depend upon the material of the foil and the liquid coating. Obviously, in some applications, depending on the coating material and the physical characteristics of the substance to be coated, the rapidity of flexing will be high speed whereas in other instances it will be relatively slow. Although the theory of the invention is not clear it is believed that the inertia imparted to the liquid coating by virtue of flexing or vibrating of the foil overcomes the surface tension of the liquid coating on the flat side of the foil so as to cause it to migrate out to and build up on and surround the foil edges in the manner described. Further, it is thought that wind, caused by the flexing or vibrating of the edge, may aid in transporting the coating to the edge.

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It is believed that it would be possible to obtain a satisfactory edge coating on an isolated portion of foil by spinning it about its lengthwise axis. Centrifugal force would drive the insulation out to the edges of the foil. However, it will be obvious to those skilled in the art that spinning foil or other substances so as to drive the insulation to the edges of the substance by centrifugal force may not be practical in some processes for continuously coating continuous substances. Therefore, the invention is particularly suited to edge coating objects which cannot be spun due to their size or other considerations. In foil coating processes it is conventional to use metering means such as metering rollers between the tank and the ovens to remove excess insulation from the foil. Such means can be used in the illustrated apparatus but has not been described because it is old in the art.

Referring now to FIG. 5 of the drawings, illustrated therein is another means for transversely flexing or vibrating foil or other substances to be coated. The two members 32 which are disposed on opposite surfaces of the foil 1 represent means for directing a high pressure jet of gas alternately against opposite surfaces of the foil on its central portion. The timing or frequency of the two jets of gas is selected so that it is the same as the resonant frequency of the foil. Therefore, the foil will be caused to flex or vibrate transversely thereof with respect to the central portion. This form of foil flexing mechanism has the advantage over the form shown in FIG. 2 in that no mechanical contact is made with the foil, which minimizes the likelihood of causing any damage to the insulation formed on the foil. It has the further advantage in that it can be readily incorporated into the curing oven 8 itself or even ahead of the curing oven. This form of the invention is in effect a means for flexing or vibrating the foil at the resonant frequency of the foil without mechanically touching the coating on the foil. Once the pulsations induced at the center of the foil are equal to the resonant frequency of the foil the center of the foil will become neutral or stationary while the opposite sides thereof flex or vibrate at the resonant frequency of the foil. The opposite extremes of movement of foil member 1 are shown in FIG. 5; in full lines in one position and in dotted lines in the opposite extreme position.

Referring now to FIG. 6 of the drawing, illustrated therein is a further way of transversely flexing or vibrating a substance to be coated so as to induce the liquid coating to migrate out to the edges of the substance and surround the edges in the form of a tear-shaped drop. This form of the invention utilizes rollers 20' similar to the rollers of the FIG. 2 device. However, it differs from the FIG. 2 device in that opposite sides of the substance to be coated are not flexed in opposite directions, that is to say one side in a clock-wise direction and the other side simultaneously in a counter clock-wise direction. In this embodiment both sides are simultaneously flexed or vibrated either in a clock-wise or in a counter clock-wise direction by, in effect, transversely twisting the substance, such as the foil 1, about its neutral lengthwise axis indicated by reference numeral 35. The other position of the foil which is alternated with that illustrated in FIG. 6 is illustrated by the dot-dash line 36. The foil 1 and rollers 20' are shown in dotted lines in such second position. The normal untwisted position of the foil 1 will coincide with the position indicated by dot-dash line 37. Both of the FIG. 2 and FIG. 6 devices have the advantage that the substance to be coated can be transversely flexed or vibrated while maintaining the central portion thereof relatively stationary without regard to the resonant frequency of the substance as contrasted with the device illustrated in FIG. 5.

While there have been shown and described particular embodiments of the invention, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention, and therefore, it is intended by the appended claims to cover all such

changes and modifications as fall within the true spirit and scope of the invention.

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

1. A method of coating the edge of a substance, said method comprising forming a liquid coating on said substance and imparting a reciprocal movement to said edge about an axis of said substance by flexing said edge of said substance about said axis in directions which are transverse to said edge, to thereby cause some of said liquid coating to migrate to said edge and surround said edge, and then curing said liquid coating.

2. A method of coating the edge of a substance, said method comprising forming a liquid coating on said substance and flexing said edge of said substance about a relatively stationary portion of said substance in alternately opposite directions which are transverse to said edge, to thereby cause said liquid coating to migrate to said edge and surround said edge, and then curing said liquid coating.

3. A method of coating the edge of a substance, said method comprising forming a liquid coating on said substance and flexing said edge of said substance about a relatively stationary portion of said substance in alternately opposite directions which are transverse to said edge, by transversely bending said substance in opposite directions, about said relatively stationary portion to thereby cause some of said coating to migrate to said edge and surround said edge, and then curing said liquid coating.

4. A method of coating the edge of a substance, said method comprising forming a liquid coating on said substance, and flexing said edge of said substance about a relatively stationary portion of said substance in alternately opposite directions which are transverse to said edge by vibrating said substance at its resonant frequency, to thereby cause some of said coating to migrate to said edge and surround said edge, and then curing said liquid coating.

5. A method of coating the edge of a substance, said method comprising forming a liquid coating on said substance, and flexing said edge of said substance about a relatively stationary portion of said substance in alternately opposite directions which are transverse to said edge by transversely twisting said substance about said relatively stationary portion in opposite directions, to

thereby cause some of said coating to migrate to said edge and surround said edge, and then curing said liquid coating.

6. A method of edge coating continuous foil, said method comprising forming a coating of liquid material on said foil, and then causing the liquid material to migrate to and surround the edges of the foil by rapidly transversely flexing said edges of the foil about its central portion in alternately opposite directions while maintaining said central portion relatively stationary and then curing said liquid material.

7. A method of coating continuous foil, said method comprising forming a coating of liquid material on said foil, causing some of the liquid material to migrate to and surround the edges of the foil by rapidly flexing opposite edges of the foil in alternately opposite directions about its central portion while maintaining said central portion relatively stationary, and then curing the liquid material.

8. A method of coating continuous foil, said method comprising forming a coating of liquid material on said foil, forming a generally tear-shaped cross-sectional coating on the edges of said foil by rapidly flexing opposite sides of the foil about its central portion while said foil is maintained under lengthwise tension whereby some of said liquid material will migrate to and surround said edges, and then curing all of the liquid material.

9. A method of coating continuous foil, said method comprising passing said foil through a body of coating material which is in liquid form to deposit a liquid coating thereon, and rapidly transversely flexing opposite sides of said foil in alternately opposite directions about its lengthwise axis while said coating is in a liquid condition and while said liquid coating is being cured, whereby some of said liquid coating will be caused to migrate to and surround the edges of said foil in generally tear-shaped cross-sectional form and be cured on said edges in said form.

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