

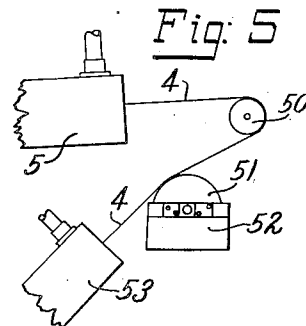
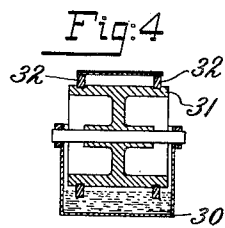
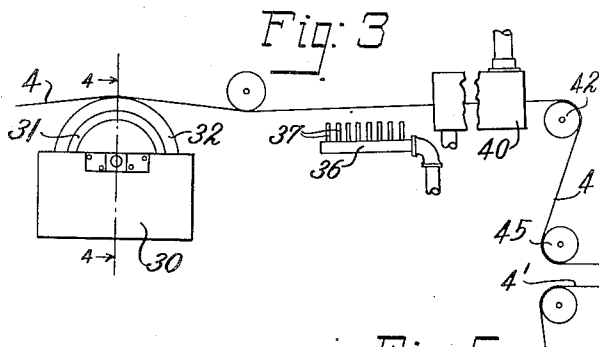
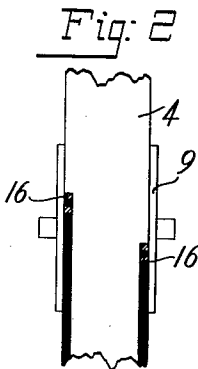
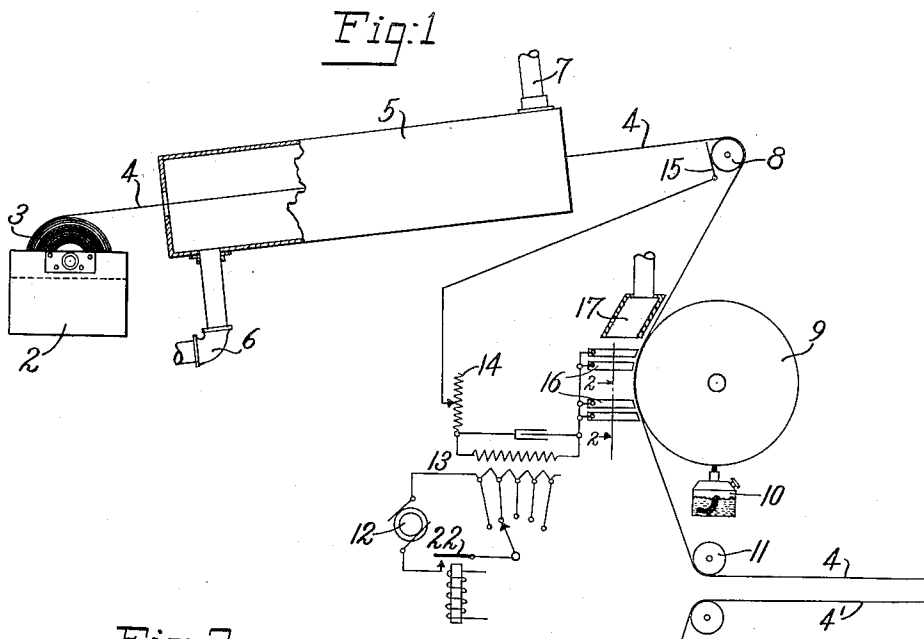
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ELECTRICAL CONDENSER

Filed March 29, 1929



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UNITED STATES PATENT OFFICE

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ELECTRICAL CONDENSER

Application filed March 29, 1929. Serial No. 350,882.

The present invention relates in general to electrical condensers, and more particularly to the manufacture of insulated foil for use in condensers of the wound or rolled type.

5 Briefly stated, my invention contemplates a condenser constructed in the usual way by rolling up two long strips of metallic foil which are insulated from each other. A common method followed in making rolled foil
10 condensers is to alternate layers of paper with the layers of foil. Paper, however, is not entirely satisfactory as a dielectric, especially for high voltages. Another process which has been used to some extent dispenses with
15 the separate strips of foil and uses instead strips of paper on which metallic coatings have been deposited on one side. The methods followed in producing the metallic coatings, however, necessarily result in very thin
20 coatings which have a high electrical resistance and which are rather easily damaged. It has also been suggested that the insulating material in the form of some kind of enamel could be applied directly to a metallic foil.
25 This process has the disadvantage that enamel coatings are likely to be thin at the edges of the foil, which renders condensers made of enameled foil subject to breakdown if this condition is not taken care of. Except for
30 the point mentioned, the process which makes use of insulated foil is very advantageous. It is simple and it permits the use of excellent insulating materials.

35 In my improved condenser I use foil which is coated with an insulating material, and I have devised a novel and highly effective method of eliminating the "edge effect" difficulty. Among the features of my invention
40 are the following:

A new and improved insulating compound which is especially adapted for coating condenser foil.

45 A new and improved arrangement for applying the insulating coating to one side only of a continuous strip of condenser foil.

A novel method and apparatus for removing the edges of a strip of insulated condenser foil without damaging the insulation.

50 The foregoing and other features will be

described hereinafter with reference to the accompanying drawing, in which:—

Fig. 1 is a side elevation of a complete layout of apparatus for producing my new and improved insulated condenser foil. 55

Fig. 2 is another view of the edge-removing apparatus shown in Fig. 1, being a section along the line 2—2.

Fig. 3 is a side elevation which shows a modified form of edge-removing apparatus. 60

Fig. 4 is a section along the line 4—4, Fig. 3.

Fig. 5 shows a form of apparatus used to deposit a protective coating of shellac or similar material.

Referring to Fig. 1, the reference character 65 2 indicates a tank or other container for the insulating compound, which is used in liquid form. The reference character 3 indicates a roll of foil which has been placed in position on a shaft or spindle mounted transversely of
70 the tank. The strip of foil coming from the roll is indicated by the reference character 4. This foil first passes through a drier 5, which has an inlet pipe 6 for dry heated air and an outlet pipe 7 leading to a condenser. After
75 leaving the drier the insulated foil 4 passes over a metallic roll 8 and thence over a larger roll 9. The roll 9 is a cooling roll, forming part of the edge-removing equipment. As the roll 9 is in contact with the insulated side
80 of the foil, it is preferably constructed of glass or provided with an enameled surface to prevent sticking. As an additional precaution against sticking, the oil reservoir 10 is provided, which carries a wick in contact
85 with the surface of the cylinder 9. A good grade of transformer oil may be used. The edge-removing apparatus co-operating with the cooling roll 9 is electrical in character and comprises a generator 12, a transformer
90 13, and a plurality of electrodes 16, which are positioned in close proximity to the edges of the foil, as indicated more clearly in Fig. 2. After passing the roll 9, the insulated foil
95 passes underneath the roll 11. It is then combined with a similar insulated foil 4' coming from a similar machine, and the two strips of foil then pass to the condenser-winding machine.

In Fig. 3 there is illustrated a different 100

form of edge-removing apparatus, operating chemically rather than electrically. Referring to this figure, the reference character 30 indicates a tank or other receptacle containing some chemical such as an acid which is capable of attacking the foil. The reference character 31 indicates a wheel which carries two rings 32 of asbestos felt, as shown in Fig. 4. The wheel 31 is mounted on a shaft supported in the sides of the tank in such a position that the rings 32 dip below the surface of the liquid contained therein. The reference character 36 indicates a water pipe which has a plurality of spray nozzles 37. The pipe 36 and its nozzles constitute a washing device. The reference character 40 indicates a drier which may be similar to the drier indicated in Fig. 1 by the reference character 5.

Having described briefly the apparatus shown in the drawings, the various aspects of the invention will be gone into more in detail with a view to fully explaining the materials used and the methods which are followed in producing the complete insulated condenser foil. The insulating compound may first be considered.

This insulating compound is a solution of asphalt and rubber in carbon tetrachloride with gum dammar added as a hardener. The asphalt used is preferably a very pure, translucent asphalt which has been recently placed on the market. It has been found that in coating the foil direct with the insulation in liquid form, it is very advantageous to use a coating which is transparent or substantially so. A transparent coating shows up defects such as a lack of homogeneous nature, dust particles, and other undesirable defects much more readily than a black or opaque insulation would. Now, this translucent asphalt is at room temperature somewhat soft and tacky, so in order to correct this a small amount of gum dammar is added as a hardener. In order to give the coating the required flexibility and tensile strength, a certain amount of rubber is used also. Carbon tetrachloride is a solvent for all of these materials and is quite desirable, being readily volatilized, entirely safe to use, and having besides a specific hardening action on the asphalt.

The proportions in which the different materials are used in making up the solution depend on the various conditions and particularly upon the type of condensers to be manufactured. It is understood that in the manufacture of condensers, the thickness of the insulation will vary in accordance with the voltages to which the condensers are to be subjected. Usually the thickness varies between one-thousandth and five-thousandths of an inch. Other factors being equal, the thickness of deposit of the liquid insulation may be varied by altering the concentration

of solid matter in the liquid insulation and also by variations in the viscosity which is controlled by adding a larger or smaller percentage of rubber. The rubber also gives a highly desirable colloidal character to the liquid insulation, which results in a film free from pinholes.

A typical solution which may be relied on to give very satisfactory results will be described by way of example: A solution of #1 transparent asphalt is first made, using one part of asphalt to three parts of carbon tetrachloride. Next, a solution of gum dammar is made up, using three pounds of gum dammar to fifteen pounds of carbon tetrachloride. The complete insulating compound is now made up using three parts of the asphalt solution and three parts of the gum dammar solution, adding two and one-half parts of #6 rubber cement. The thickness of the deposit can be varied within considerable limits by using more or less of the rubber as a component of the compound.

It will be understood from what has been said already that the insulating compound in the form of a liquid solution is applied directly to the foil from the tank or other receptacle as the foil is unrolled. It has been found that this produces a very uniform and perfect deposit. Efforts have been made to apply a coating to a foil after it has been unwound from the original roll, but this is very difficult, because after the foil is once unwound from the roll it is likely to contain wrinkles and ridges which make it almost impossible to produce a uniform deposit. It is also difficult to apply the insulating compound to only one side of the foil after it has been unrolled. My improved method of depositing the insulation produces a perfectly even deposit on only one side of the foil, the other side being left absolutely clean.

Referring to Fig. 1, the solid compact roll of foil 3 is supported on a shaft in the tank or receptacle 2 in such a position that the roll projects below the surface of the insulating compound contained therein, as indicated by the dotted line. The insulating material, of course, coats the entire outside of the roll as it is rotated, but in view of the fact that the foil is rolled up very tight the compound does not penetrate between the different layers of the roll. It will be seen that the outside surface of the foil is in contact with the solution and will, therefore, receive a coating, but since the under surface of the foil leaves the roll at the top side thereof where it is out of the solution, it does not receive any coating. It is understood that I contemplate insulating the foil by a continuous process, preferably making the finished foil directly into condensers as it is manufactured. This means that the foil 4, indicated in Fig. 1, will be in continuous motion

through the apparatus shown, except for short intervals of time during which the operator of the winding machine is taking off the finished condensers.

5 The drier 5 may be of any well-known construction and will not require any particular description beyond what has already been given. It may be mentioned, however, that the outlet pipe 7 is preferably taken to a condenser, which is provided for the purpose of salvaging the carbon tetrachloride.

10 The operation of the edge-removing apparatus depicted in Fig. 1 may now be considered more in detail. As mentioned hereinbefore, this apparatus is electrical in character and removes the edges of the foil by a sparking or arcing process which takes place between the electrodes 16 and the foil itself. There are two pairs of electrodes 16 which are lined up at the opposite edges of the foil as it passes over the cooling roll 9, as can be seen more clearly in Fig. 2. These electrodes are adjusted so that the ends thereof are spaced perhaps one-fourth of an inch from the foil. One side of the secondary winding of the transformer 13 is connected to the electrodes, while the other side of the secondary winding is connected by a conductor 14 to the brush 15 which bears on the metallic roll 8. The roll 8 is in contact with the bare side of the foil and consequently the circuit of the secondary winding of the transformer is completed except for the space between the foil and the electrodes 16. The voltage is adjusted by means of the tapped primary winding to a point where it is just sufficient to readily establish an arc between the ends of the electrodes and the tin foil directly beneath the ends of the electrodes. This arc, of course, immediately extinguishes itself as soon as the foil is consumed to a point a little beyond the electrodes, for this action increases the length of the air gap, but since the foil is continuously moving, the arc is re-established promptly when a fresh section of foil passes beneath the electrodes. The arcing or sparking which takes place in the manner described entirely removes the tin foil for a short distance along each edge, leaving a clean surface of insulating material extending beyond the metallic foil at each edge of the strip, as shown clearly in Fig. 2. It will be understood that the amount of edge material removed is exaggerated somewhat in Fig. 2 for the sake of clearness. For low voltage condensers it is sufficient in practice to remove the edge for a distance of 1/64 of an inch. This distance may be increased up to perhaps 1/8 of an inch for high voltage condensers. The position of the electrodes is adjusted in accordance with the amount of material to be removed.

15 In order to avoid contamination of the air due to the volatilization of the relatively large amount of foil occurring in the course

of the continuous operation of the machine for some length of time, a suction device is provided for drawing off the gases. This device is indicated by the reference character 17 and is positioned with the open end just above the ends of the electrodes.

While not strictly necessary, it is advisable to provide an automatic switch 22 in the primary circuit for shutting off the current when the machine is stopped. This switch may be controlled automatically by a connection with the winding machine, so that whenever the winding machine is stopped the switch will be opened.

20 The roll 9 may be more particularly described as having the function, among other things, of positioning the foil accurately in front of the electrodes so that these may be maintained at a constant distance from the foil. The roll 9 also provides for maintaining the insulation relatively cool during the arcing process. Some heat is generated by the action of the arc and this might result in unduly softening the insulating material. The latter, however, is in contact with the cool roll 9 and thus undue heating is avoided. The roll 9 may be kept cool by circulation of water which can be introduced through the bearings of the shaft in a well-known manner, or it may be cooled very effectively by means of an air blast which is directed against the roller at a point opposite the electrodes. The surface of the roller 9 is covered at all times with a fine film of oil deposited from the oiler 10, which effectively prevents the insulation from sticking to the roller. Some of this oil is, of course, deposited on the insulation and is effective to prevent the insulation from having a tendency to stick to the roller 11. The small amount of oil which adheres to the insulation does no harm, since it is a good insulator. I have found also that glycerine is very effective in preventing the insulation from sticking to the roller. It may be applied in the same way as oil.

25 Referring now to Fig. 3, an explanation will be made of the modified arrangement for removing the edges which is there shown. It will be understood that the apparatus shown in Fig. 3 is used in connection with the insulating and drying apparatus shown in Fig. 1 and replaces the electrical edge-removing apparatus there shown. As the insulated foil comes from the drier it passes over a wheel 31, which is provided with two asbestos felt rings spaced apart a distance equal to the width of the foil. The construction of the wheel 31 and the rings 32 is shown clearly in Fig. 4. The wheel 31 is mounted on a shaft secured to the sides of the receptacle 30, which latter contains the chemical substance which is used to attack or eat away the foil along the edges of the strip. A chemical solution which gives good results may be

formed by mixing two parts of concentrated nitric acid with one part of saturated solution of salt in water. The wheel 31 is preferably made of hard rubber or some other substance that will not be attacked by the acid. The rings 32 are preferably made of asbestos for the same reason. In the operation of the apparatus, the insulated foil 4 moves along with the edges of the foil on the uncoated side thereof in contact with the asbestos rings 32. The wheel 31, therefore, rotates and fresh acid is constantly applied to the foil as it moves along. This acid is sufficiently strong to promptly eat away the foil wherever it is applied. As a result, a short distance past wheel 31 the foil will be completely eaten away along both edges of the strip substantially as has been described previously in connection with Fig. 2.

From the acid-applying device, the moving foil 4 passes to a washing apparatus which comprises a pipe 36 and a series of nozzles 37. These nozzles are preferably staggered so that the sprays produced are in two lines directly opposite the edges of the foil. Sufficient nozzles should be provided so that by the time the foil has passed the last one, all traces of acid will be completely washed away.

The washing operation, of course, leaves the foil wet, which necessitates the inclusion of an additional drying apparatus, indicated by the reference character 40. This drier may be of any usual construction and need not be specifically described. Suffice it to say that after passing through the drier 40 the completed foil passes over the rolls 42 and 43 and thence to the winding machines along with a similar foil 4', substantially as described in connection with Fig. 1.

There may arise conditions in the manufacture of this condenser which would make it highly desirable to use an interrupted process, which means that the insulated foil must be wound up or rolled up on a reel before going to the condenser winding machine. It is understood that this temporary winding or storing will have to be done without interfering with the final object, which is to form a condenser in which the layers will ultimately adhere and form, so to speak, by itself a condenser block.

Now, I have found by experiment that this may be accomplished by giving the insulation a very fine coating of quick-drying lacquer, such as shellac varnish. The shellac is dissolved in alcohol and this lacquer may be applied without any noticeable softening of the insulation. It is extremely quick-drying. Aside from this fact, shellac has a very good dielectric strength and good specific inductive capacity, at least a capacity higher than paper or paraffin. The shellac is applied directly after the drying of the insulation proper and may be applied by a stationary

brush or by contact with a roller carrying the varnish. After this is dried and the product given, if necessary, a fine coating of talcum powder, the insulated foil may be rolled up and stored in this form.

Fig. 5 shows diagrammatically an arrangement of apparatus for applying a coating of lacquer to the insulated foil. This figure may be considered as a modification of Fig. 1. Reference character 5 indicates the drier, as in Fig. 1. The insulated foil 4 first passes over a roll 50 which reverses the foil so as to bring the insulated side underneath. From roll 50 the foil passes over a roll 51, which is supported properly in a receptacle 52 containing the shellac varnish. The roll 51 rotates as the foil is drawn along and deposits on it a coating of varnish. The foil is then passed through another drier 53, from which it passes to a machine (not shown) which winds it up for storing until wanted.

Having described my invention, what I consider to be new and desire to secure by Letters Patent will be pointed out in the appended claims.

What is claimed is:

1. An apparatus for removing a portion of the metal along the edge of a moving strip of insulated foil comprising a stationary electrode positioned adjacent the edge of the foil, a conductor in electrical contact with the foil, and a source of current connected between said electrode and said conductor so as to strike an arc between said electrode and the foil.

2. An apparatus for removing a portion of the metal along the edge of a moving strip of insulated foil, said apparatus comprising an electrode, means for directing the foil past the electrode but out of contact therewith, and means for establishing an arc between the electrode and the foil.

3. An apparatus for removing a portion of the metal along the edge of a strip of foil which is insulated on one side, said apparatus comprising a receptacle containing an acid bath, means for applying acid from the bath to the foil as the latter is moved past the receptacle, and means for washing off the surplus acid from the foil.

4. The process of making a strip of metal foil having an insulating coating on one side which extends beyond one edge of the strip, which consists in first applying an adherent coating to the foil and in then removing the metal foil for a short distance back from one edge.

5. Apparatus for treating a strip of metal foil insulated on one side only, said apparatus comprising a plurality of electrodes, means for directing the strip past said electrodes but out of contact therewith, said means including a metal roller with brushes connected thereto in contact with the metal foil side of said insulated strip, and means

including said metal roller and brushes for completing a circuit from said electrodes to said metal foil for burning off a portion of said foil.

6. In combination, a variable primary circuit, a source of current, a switch for controlling said source of current in said primary circuit, a secondary circuit, a plurality of electrodes in said secondary circuit, means for directing a strip of metal foil past said electrodes but out of contact therewith, means for completing a connection from said electrodes to said metal foil, and means responsive to a current flow in said primary circuit for causing a current flow in said secondary circuit of sufficient strength to establish an arc between said electrodes and said metal foil.

7. An apparatus for removing a portion of metal foil along the edge of a moving strip of metal foil insulated on one side only, said apparatus comprising a primary circuit, a source of current for establishing a current flow in said primary circuit, a secondary circuit, a plurality of electrodes connected to one end of said secondary circuit and said moving metal foil connected to the other, means for directing said foil past said electrodes but out of contact therewith, and means responsive to a current flow in said primary circuit for causing a current flow in said secondary circuit of sufficient strength to establish an arc between said electrodes and said metal foil.

8. In an apparatus for treating a moving band of insulated metal foil, an electrode, a plurality of rollers for directing the insulated foil past said electrode but out of contact therewith, said plurality of rollers including a metal roller in contact with the metal foil side of said band, a conductor connected to said metal roller and said electrode, and means for establishing an arc between said electrode and said band to remove a portion of the metal foil along the edge.

9. An apparatus for removing a portion of foil along the edge of a strip of foil insulated on one side, said apparatus comprising a series of rollers over which the foil is drawn, one roller being in contact with the insulated side of the foil and a second roller being in contact with the bare side of the foil, an electrode positioned adjacent the edge of the foil opposite said first roller, a brush in contact with the second roller, and a source of current connected between said electrode and said brush for the purpose of producing an arc between the electrode and the foil, whereby the edge of the foil is progressively burned away as the foil moves along.

10. The process of making a strip of metal foil having an insulating coating on one side which extends beyond one edge of the strip, which consists in applying an adherent coating to the foil, and in subjecting the metal

foil for a short distance back from one edge to a chemical action which converts the foil to a fluid.

11. The process of making a strip of metal foil having an insulating coating which extends beyond one edge of the strip, which consists in applying an insulating coating to the foil, in hardening the coating, and in applying a reducing agent to the foil for a short distance back from one edge.

In witness whereof, I hereunto subscribe my name this 27th day of March, A. D. 1929.

GODFREY STEERUP.

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