

Aug. 31, 1965

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3,203,823

CELLULOSE WITH ADHESIVE SPOTS ON BOTH SIDES THEREOF IN
NON-REGISTERING RELATIONSHIP AS INSULATING MATERIAL
FOR ELECTRICAL APPARATUS

Filed Dec. 4, 1961

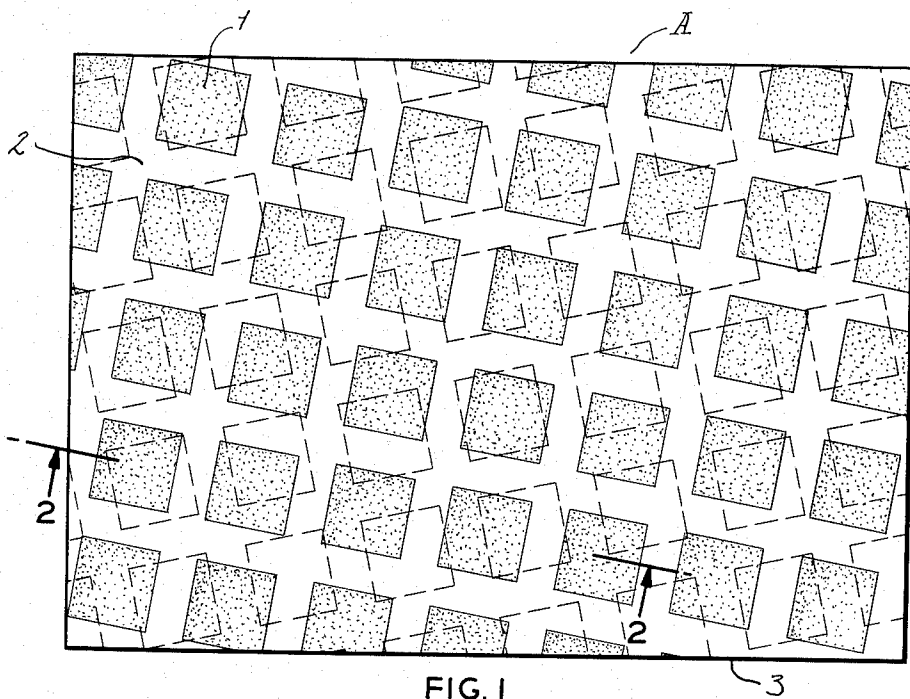


FIG. 1

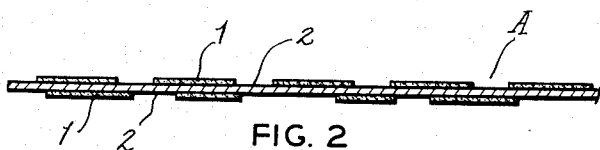


FIG. 2

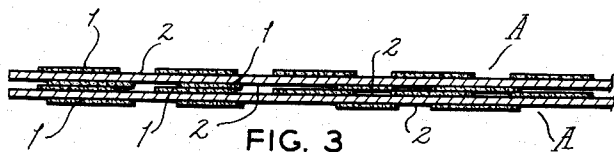


FIG. 3

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CELLULOSE WITH ADHESIVE SPOTS ON BOTH SIDES THEREOF IN NON-REGISTERING RELATIONSHIP AS INSULATING MATERIAL FOR ELECTRICAL APPARATUS

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Filed Dec. 4, 1961, Ser. No. 156,904

9 Claims. (Cl. 117—38)

This invention relates in general to dielectrics, and, more particularly, to certain new and useful improvements in insulating material for use in electrical apparatus.

It is an object of the present invention to provide insulating material for electrical apparatus, such as, electrical transformers, which is adapted to substantially eliminate "corona effect."

It is a further object of said invention to provide insulating material of cellulosic character for use in electrical apparatus, such as, electric transformers which are designed to contain liquid dielectrics, which material is adapted to provide effective and reliable adhesion between sections of said material as well as between same and electrical conductors, such as, transformer coils, to form an integrated, intimately bonded unit.

It is a further object of the present invention to provide insulating material of cellulosic sheet character for electric transformers utilizing liquid dielectrics, which material is adapted to allow for substantially complete liquid penetration in minimum time for complete saturation thereby.

It is an additional object of the present invention to provide insulating material of cellulosic sheet character adapted primarily for use with electric transformers, which material may be most economically produced; which may be efficiently and expeditiously integrated into transformers; and which has proved durable and reliable in usage.

Other objects and details of the invention will be apparent from the following description, when read in connection with the accompanying drawing in which—

FIGURE 1 is a plan view of a sheet of insulating material constructed in accordance with and embodying the present invention, showing the adhesive units on the opposite face of said sheet in dotted lines.

FIGURE 2 is a vertical transverse section taken on the line 2—2 of FIGURE 1.

FIGURE 3 is a vertical transverse sectional view taken substantially on the line 2—2 of FIGURE 1 but illustrating the union between two sheets of the insulating material of the present invention.

Referring now by reference numerals to the drawing which illustrates the preferred embodiment of the present invention, A designates a sheet or section of cellulosic insulating material adapted for use in electrical apparatus, such as, particularly, electric transformers utilizing a liquid dielectric, such as, oil. Sheet A is fabricated of kraft, wood pulp, rope, rag, or mixtures of these paper-making fibres, having a desired thickness within the range of 3 to 20 mils, and being of relatively high density. The term "high density" as used in the paper industry to qualify cellulosic material indicates an actual density or specific gravity of between .9 and 1.05.

The opposite faces, throughout their extent, of sheet A are discontinuously coated with adhesive material, such as, shellac, epoxy resins, phenolics, urethanes, polyvinyl, formal resins, etc., all of which are well known in the art, and with the coating on each such face being constituted of a multiplicity of discrete adhesive units 1 each of which is entirely surrounded by an untreated zone 2 with

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the maximum distance across such zone 2, between adjacent adhesive units 1 being less than the narrowest dimension of each such unit 1 for purposes presently appearing. The adhesive units 1 on one side of said sheet A are not in full registry alignment with the adhesive units 1 on the opposite side of said sheet A and are thus in, what might be termed, "offset relationship." However, in view of the fact that the intervening distance between adjacent adhesive units 1 on each face of sheet A is less than the narrowest dimension of such units 1 there will, understandably, be a limited or a partial overlying relationship between the units 1 on the opposite faces of each sheet A, which is critical in the present invention.

Said adhesive units 1 are applied in a predetermined pattern wherein the same are arranged in rows, the longitudinal axes of which form an angle of less than 45 degrees with the edge of the sheet extending relatively in the same general directions as the said rows, so that, for example, in FIGURE 1 the edge 3 of sheet A would be the line of reference. It will be seen that with the adhesive units so arranged the rows on one side of said sheet will tend to cross the rows on the opposite side of the sheet A to thus assure against registry. If adhesive units 1 were arranged in rows having an axis of 45 degrees with the reference edge, it is quite possible that there could result an undesired registry or alignment between adhesive units 1 on the opposite sides of the sheet. Although angles of less than 45 degrees will substantially prevent such registry, it has been found that rows which form an angle of approximately 23 degrees which the reference edge are preferable as the same provides an overlap of the adhesive units 1 on opposite sides of sheet A of about 16% when the adhesive units 1 comprise about 36% of the total area of the related faces of sheet A.

Each face of the sheet A is thus provided with untreated areas which form a grid having both longitudinally and transversely extending portions; with the same being at right angles to each other. Furthermore, the longitudinal portions extend along axes which are at acute angles to the longitudinal margins of the sheet and the transverse portions are along axes which form acute angles with the transverse margins of the sheet. Additionally, with reference to FIGURE 1, it will be noted that the longitudinal portions of the untreated grid on one face of sheet A are in intersecting relationship to the longitudinal portions of the untreated grid on the other face of said sheet A and the transverse portions of each such grid are in like relationship.

Thus, the pattern of adhesive units and the related grid on one face of sheet A are so related to the pattern and grid on the opposite face of sheet A as to prevent any undesired registration with the faces of other sheets to be laminated or otherwise secured to either face of said sheet A.

The total area of adhesive units 1 on any one face of sheet A should preferably constitute between 25 and 50% of the total area of such sheet face, although, as indicated, it has been found that coverage within the median of said range such as, between 36% and 38%, is preferable. Consonant with practices heretofore accepted in the field of transformer paper adhesives, approximately 5 pounds of the adhesive for every 3,000 square feet of surface to be coated is utilized. With sheets of the present invention, it will be seen that with 5 pounds of adhesive being utilized, the thickness of each adhesive unit 1 would be 1/2 mil for a 50% coverage and 1 mil if only 25% of the area were covered. Therefore, with coverage in the preferred median range of 36% to 38%, the thickness of each adhesive unit would be approximately 3/4 mil.

The adhesive unit 1 may be of various contours but,

for purpose of illustration only, said units 1 are illustrated in the drawing as being of square character, and, in this instance, are $\frac{3}{8}$ inch by $\frac{3}{8}$ inch, being formed on $\frac{5}{8}$ inch centers. However, it is obvious that circular, rectangular, triangular, polygonal, and other configurations may be as easily utilized. Adhesive units 1 may be applied upon sheets of paper by any suitable means but the use of gravure rollers have proved most efficient.

Sheets A are especially adapted for use in the formation of transformer cores and are incorporated therein in the customary manner whereby a plurality of such sheets A, such as the two shown in FIGURE 3, are placed in face-to-face relationship, to form a basic set, and conventional transformer coils (not shown), which have been preferably varnish coated, are applied against the outer or exposed face of each sheet of said set and then the exposed sides of the said coils have applied thereagainst a set of said sheets so that the core is built up to the extent desired by alternating sets of said sheets and transformer coils. It is, of course, to be recognized that the said sets of said sheets A may be comprised of any number of said sheets, as the two shown in FIGURE 3 are merely for purposes of illustration. Furthermore, it is to be recognized that the cores so formed may be of any desired contour, such as, square, rectangular, annular, etc., since the sheets A are equally adapted for any such design.

After the components of the core to be formed have been assembled as described above, the unit is then subjected to a baking operation with the temperature reaching approximately 300° F., and with such operation continuing for about one hour. The said baking thus effects a curing of the adhesive material used to provide adhesive units 1 for the purpose of effecting a bonding between sheets A and a bonding between the sheets and the transformer coils. The thickness of the adhesive coating, being approximately $\frac{3}{4}$ mil, allows of a relatively thick cradle-formation with respect to the wires of the transformer coils so as to bring about a positive, reliable bond between the sheets A and said coils. As indicated above, the particular adhesive may be of any well-known character such as suggested above, although a 35% shellac solution or a 50% epoxy varnish have been found in actual practice to be most satisfactory.

Subsequent to, or simultaneous with, the baking operation, the core is then subjected to evacuation for air removal, and upon termination of such procedure, the core is then immersed in an oil bath for oil penetration. The unique, novel construction of sheets A substantially prevents the development of air pockets so that the oil will penetrate the said sheets A with maximum thoroughness. Thus, with the elimination of air entrapment there is a consequent prevention of "corona effect" during operation of the transformer so that the effectiveness thereof as well as its life is measurably enhanced.

Referring now to FIGURE 3, the critical nature of the offset relationship of the adhesive units on one face of sheet A to those on the opposite face becomes quite apparent when it is recognized that each such adhesive unit 1 is confronted by a limited portion of adhesive unit or units and a substantially large untreated zone 2 on the face of the sheet applied thereagainst to form a set disposed between adjacent transformer coils. Heretofore the adhesive portions of one sheet had been applied fully, coextensively upon the adhesive areas of a companion sheet so that an adhesively treated area was not brought into face-to-face relationship with an untreated portion. By such heretofore utilized arrangement, there were expectedly formed a considerable number of air pockets which prevented full oil penetration and which were productive of "corona effect" during transformer operation. With the sheets A of the present invention, the oil is not present in areas highly resistant to penetration since the extent of adhesive unit-to-adhesive unit relationship is very small wherefore the oil may flow

readily between the opposed sheets A as well as within the sheets A between the adhesive units 1 on the opposite faces thereof so that complete saturation is achieved.

Thus, in view of the foregoing, it is apparent that the highly novel character of the discontinuous coating of the insulating material of the present invention provides the necessary, reliable bonding between insulation sheets as well as between the same and transformer coils, as well as being permissive of maximum, thorough oil saturation so that a transformer core formed therefrom will be free of "corona effect." Sheets A may be most economically produced and may be most readily incorporated in transformer cores. The said sheets A are adapted for utilization with other types of electrical apparatus but the peculiar adaptation of the same for electrical transformers has been described hereinabove for purposes only of demonstrating the uniqueness of the present invention.

It should be understood that changes and modifications in the formation, construction, arrangement, and combination of the several parts of the insulating material for electrical apparatus may be made and substituted for these herein shown and described without departing from the nature and principle of my invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. Insulating material for electrical apparatus comprising a sheet of cellulosic material, areas of each side of said sheet being treated by having applied thereon a plurality of discrete adhesive units, the untreated areas of each side of said sheet forming a grid having longitudinal and transverse portions, the longitudinal and transverse portions of said grid being at right angles to each other, the longitudinal portions being at an acute angle to the longitudinal margins of said sheet and the transverse portions of said grid being at an acute angle to the transverse margins of said sheet.

2. Insulating material for electrical apparatus as defined in claim 1 and further characterized by the adhesive units on one face of said sheet being in non-registering partial-overlying relationship with respect to the adhesive units on the opposite side of the sheet.

3. Insulating material for electrical apparatus as defined in claim 1 and further characterized by the combined area of the coated portion of each face of said sheet being between 25% and 50% of the total area of each sheet face.

4. Insulating material for electrical apparatus as defined in claim 1 wherein the adhesive units on each face of said sheet cover approximately 35% to 40% of the total area of the respective face of said sheet.

5. Insulating material for electrical apparatus comprising a sheet of cellulosic material and a plurality of discrete unconnected adhesive units applied on each face of said sheet to thereby form a discontinuous adhesive coating, the adhesive units on each face of said sheet being in spaced apart relationship with the intervening portions of said sheet being untreated, the adhesive units on one face of said sheet being in partial overlying but non-registering relationship with respect to the adhesive units on the opposite face of said sheet, the adhesive units on each face of said sheet jointly covering approximately 35% to 40% of the total area of the respective face of said sheet the untreated portion of each face of said sheet forming a grid having longitudinal and transverse portions, said longitudinal and transverse portions of said grid being at right angles to each other and at acute angles to the longitudinal and transverse margins of said sheet respectively.

6. Insulating material for electrical apparatus as defined in claim 1 and further characterized by the longitudinal and transverse portions of the grid on one side of said sheet being in intersecting relationship with the longi-

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tudinal and transverse portions respectively of the grid on the other side of said sheet.

7. Insulating material for electrical apparatus as defined in claim 1 and further characterized by the said longitudinal and transverse grid portions being at an angle of less than 45 degrees to the longitudinal and transverse margins of said sheet respectively.

8. Insulating material for electrical apparatus comprising a sheet of cellulosic material, areas of each side of said sheet being treated by having applied thereon a plurality of discrete adhesive units, the untreated areas of each side of said sheet forming a grid having longitudinal and transverse portions at right angles to each other, the longitudinal portions of each grid being at an acute angle to the longitudinal margins of the sheet, the transverse portions of each grid being at an acute angle to the transverse margins of the sheet, the adhesive units on one side of said sheet being in off-set, non-registering relationship with respect to the adhesive units on the opposite side of the sheet, the longitudinal portions of the grid on one side of said sheet being in non-parallel, intersecting relationship with respect to the longitudinal portions of the grid on the opposite side of said sheet, and the transverse

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portions of the grid on one side of said sheet being in non-parallel, intersecting relationship with respect to the transverse portions of the grid on the other side of said sheet whereby when a plurality of said sheets are applied in layer formation impregnation of said sheets is facilitated through substantial obviation of the development of air pockets.

9. Insulating material for electrical apparatus as defined in claim 8 and further characterized by the longitudinal and transverse portions of the grids on each side of said sheet being at approximately an angle of 23 degrees to the longitudinal and transverse margins respectively of said sheet.

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