

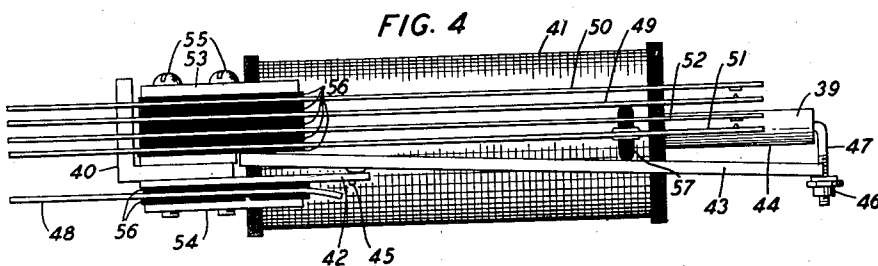
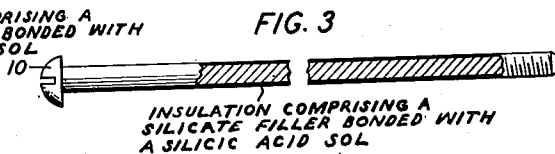
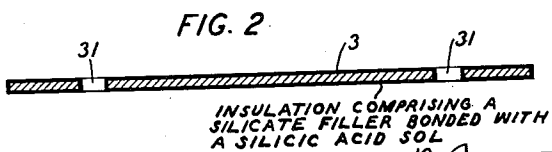
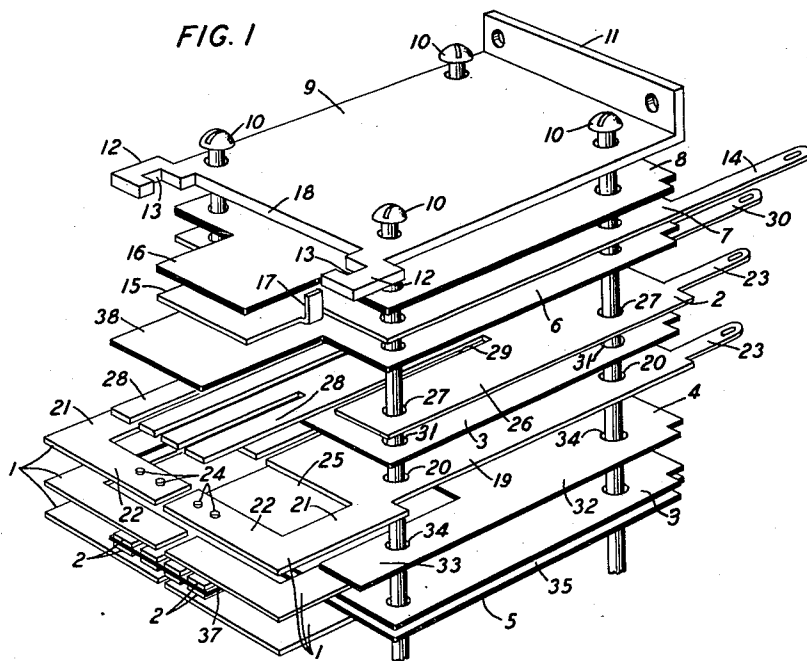
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2,347,733

SWITCHING DEVICE

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2,347,733

SWITCHING DEVICE

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3 Claims. (Cl. 106—287)

This invention relates to switching devices and more particularly to an improved means for electrically insulating the conducting members thereof from each other.

More specifically the invention relates to means for insulating the springs or contact members of relays from each other and from their supporting means.

In a relay the contact springs are usually assembled into pile-ups which are attached to the heel piece or mounting bracket by screws which extend through aligned holes in an outer clamping plate and in the springs into threaded holes in the heel piece or bracket. To insulate the springs from the heel piece or bracket, from the outer clamping plate and from each other, strips of insulating material are interposed. Such strips have heretofore been cut from phenol fibre or hard rubber. Also the clamping screws are surrounded by sleeves of hard rubber to insulate them from the contact springs through the holes in which they extend. Similar strips of insulating material are interposed between the armature and field laminations of relays of the magnetic contact type, such as is disclosed, for example, in the application of C. N. Hickman and E. Lakatos, Serial No. 367,338, filed November 27, 1940.

In a relay it is essential that the contact gap between mating springs be maintained in adjustment, otherwise faulty circuit operation over such contacts might ensue. It has been found that the fibre or hard rubber sheets from which the insulating strips are cut often vary in thickness and consequently unless a careful selection is made from the sheets, the contact gaps of assembled relays will vary in width and will thus require careful adjustment. Furthermore, fibre or hard rubber insulators are to some extent water absorbent and are thus susceptible to contraction and expansion in response to changes in temperature and humidity. As a result a contact gap which has been properly adjusted under one condition of temperature or humidity may be put out of adjustment by the contraction or expansion of the insulating strip in response to a change in atmospheric conditions. Also, most organic materials are plastic and flow under the pressure of the assembly screws thus causing the relay to lose its critical adjustment of the contacting members. Obviously an insulating strip which could be made from a material substantially unresponsive to pressure, to the atmospheric changes customarily experienced and of a dependable gauge thickness would materially and, in most cases, en-

tirely obviate the necessity for contact adjustment either following assembly or in service.

It is, therefore, the object of the present invention to provide an improved insulating medium for relays and the like whereby such devices may be assembled and prepared for service more easily and which require less maintenance while in service. This object is attained by making a composite of a metal sheet coated with a layer of insulating material comprising a binder and filler, both of inorganic nature, to form an insulating separator such as is employed for relay spring pile-ups, selector contact banks, and the like, or for insulating adjacently disposed metal elements of any switching or electrical device.

The binder in the coating material may be a composition such as silica sol which sets to a permanent gel when the solvent is evaporated. This silica sol is preferably produced by hydrolyzing an organic silicate in a suitable solvent medium. Produced in this way the silica sol has no free alkali present to give an ionic conductance to the insulating film. The hydrolyzed nitrate of aluminum, zirconium, titanium, etc., is also a suitable binder for this purpose. On evaporation of the solvent, solutions of these materials form viscous tacky bodies with marked adhesive properties. On complete drying and moderate heating, up to 600° C., water and oxide of nitrogen are driven off leaving the pure metal oxide which acts as a strong binder on the filler material.

The filler may be any of a number of stable comminuted inorganic materials such as oxides of aluminum, titanium, beryllium, zirconium, silicon, etc., or it may be a more complex compound such as a borate, silicate, phosphate, etc., for example, ground mica, talc, clay, etc.

For a fuller understanding of the invention and some of the many applications thereof to the switching art, reference may be had to the following detailed description taken in connection with the accompanying drawing in which:

Fig. 1 is a partially exploded perspective view of a relay of the magnetic contact type provided with insulating separators or laminations in accordance with the present invention;

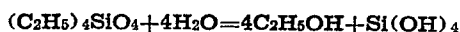
Fig. 2 is a cross-sectional view through one of the separators of Fig. 1;

Fig. 3 shows one of the clamping bolts of Fig. 1, partly in cross section having an insulating coating in accordance with the present invention; and,

Fig. 4 is a top plan view of a relay of a conventional type having spring pile-up insulators constructed in accordance with the invention.

Most inorganic cements, particularly those which cure at temperatures under 1000° C. and which might be considered for insulating coatings, make use of sodium or potassium silicate in their formulation. These alkali silicates act as binding media for the other constituents which are usually grog-like material such as silica, clay, calcined talc, alundum, etc. These cements have disadvantages in that they remain reactive, may soften under heat and, when hot, give a marked ionic conductance. Also, they are hygroscopic and take up moisture when cold, thus causing difficulty in many of their uses and restricting the extent of their application. A silicic acid sol without the presence of alkali metals has been found to give a bonding agent which possesses the desirable qualities of the alkali silicates but without the undesired characteristics. Ethyl silicate $(C_2H_5)_4SiO_4$, an ester of silicic acid which is commercially available, offers a starting material for achieving a suitable cementing or binding agent.

Water and ethyl silicate are only slightly soluble in each other. However, if these two materials are placed together in a beaker and allowed to stand, a clear amorphous silica material will solidify out. This arises from the hydrolysis of the ethyl silicate by the water and is represented by the equation



The silicic acid may then be dehydrated and forms amorphous silica according to the equation



If a coupling solvent is used, that is, one in which both ethyl silicate and water are soluble, it is possible to speed up the hydrolysis reaction and to hold the silicic acid in solution in the form of a sol. Also if the pH of the mixture is adjusted so that the solution is distinctly acid, the hydrolysis reaction is speeded up as is the common observation for the hydrolysis of organic esters. In accordance with this the following mixture has been made up:

Ethyl silicate.....	Cc. 50
0.6 normal hydrochloric acid.....	20
Ethylene glycol monobutyl ether.....	40

The resulting reaction was found to be almost immediate as indicated by the generation of heat in the mixture. On standing several days this sol sets to a stiff gel without the loss of solvent. Also, it was found that when the solvent was allowed to partially evaporate a gel was formed. On further loss of solvent, the gel layer shrinks and breaks up into small islands of gel material which after a day or two of drying become hard flakes of transparent glass-like material having considerable mechanical stability and properties desirable for a binding agent in a coating material.

The analysis of the SiO_2 content of the sol may be made by evaporating off the solvent and calcining the residue at 600° C. This analysis gives .126 gram of SiO_2 per cubic centimeter of sol. Increased heating to 1050° C. does not alter this analysis. When the silica sol is made as outlined above, there is insufficient water to completely hydrolyze the ethyl silicate and some organic matter is left coupled to the silicon, and is present in the gel which forms. When the gel is strongly calcined the organic part decomposes

and leaves a small amount of carbon dispersed in the solid gel. Heating in oxygen at 1050° C. for sixteen hours was found insufficient to remove this carbon except from a very thin film on the surface of the particles. This leads to the conclusion that the calcined solid is quite non-porous. The sol formed under conditions such that there is insufficient water to complete the hydrolysis is apparently superior to that which forms when excess water is used. When the ethyl silicate is completely hydrolyzed, it sets rather quickly to a gel. If the process of gelling proceeds to any appreciable extent before the filler is added and the mixture placed in contiguous relationship to the detail which is to be coated, the resultant coating is soft and friable and not suited to the intended purpose.

When 12 grams of 900 mesh aluminum oxide is thoroughly mixed with 20 cc. of silica sol, produced as outlined above, a mixture suitable for painting or spraying results. Iron or nichrome sheets coated with this mixture, and heated to moderate heats, up to 500° C., after the solvent has evaporated, are coated with an adherent layer of Al_2O_3 bonded with SiO_2 gel. This layer has good electrical insulating properties, and can be roughly handled without the layer flaking or chipping off. It has been found that the hardness of this layer can be improved if the surface is finally "varnished" with a layer of the silica sol without any filler.

In place of the ethylene glycol monobutyl ether any one of a number of coupling solvents may be used in the formulation of the silica sol. The viscosity of the mixture and the vapor pressure of the solvent desired will dictate the choice of solvent. As examples of other coupling solvents one might use: ethyl alcohol, isopropanol, butanol, ethylene glycol diethyl ester, diethylene glycol diethyl ether, or any one of many other solvents or mixtures of solvents. Some of these solvents have the additional advantage that they act as dispersing agents for the mineral filler and also as antifoaming agents and surface tension depressants.

The ingredients of this coating are such that the full strength of the cement will probably develop at room temperatures if sufficient time is allowed. If the material is heat-treated, the full strength develops quickly and will be stable from room temperature to 1000° C. or more. Coatings of this material have been prepared which show no ionic conductivity, even at elevated temperatures, provided care has been exercised in the selection of pure materials.

As illustrative of some of the possible applications of this coating material, reference is now made to the drawing. The relay of Fig. 1 is of the type disclosed in the application of C. N. Hickman and E. Lakatos hereinbefore referred to. Only so much of it has been disclosed as is deemed essential to show the application of my improved insulating material thereto. This relay comprises an assembly of a plurality of magnetic circuit units, for example thirty, each comprising a field lamination 1 of suitable magnetic material, such as silicon steel, an armature lamination 2 also of suitable magnetic material, such as silicon steel, and an interposed insulating separator 3. To conserve mounting space and to reduce the over-all length of the relay, the field laminations 1 of two units are reversely positioned in a single layer out of conductive engagement with each other and the armature laminations 2 of the same two units are reversely posi-

tioned in a single layer, the two layers of laminations being insulated from each other by a single interposed insulating separator 3. A plurality of such layers of units are assembled side by side and with adjacent layers back to back so that the field laminations 1 of pairs of adjacent layers are contiguous and separated from each other by insulating spacing separators 4 and that the armature laminations 2 of intermediate pairs of adjacent layers are contiguous and separated from each other by insulating spacing separators 5.

Outside of the armature laminations 2 at one end of the assembly is positioned an insulating spacing separator 6, similar to the separator 5, followed by a coil terminal lug member 7 and an outside insulating lamination 8 similar to the separator 5. A similar coil terminal lug member 7 and outside insulating lamination 8 are positioned outside of the spacing separator 4 at the other end of the assembly and the entire assembly is then clamped between two end plates 9 by bolts 10 which extend through aligned holes in all of the assembled elements.

The end plates 9 are provided with outturned angles 11 at their rear edges which serve as mounting brackets for the attachment of the relay structure to a suitable relay or apparatus rack and with forwardly extending ears 12 having notches 13 in their inner edges in which the edges of the rear spoolhead of the energizing coil may be retained.

The coil terminal lug members 7 are each provided with a rearwardly extending soldering terminal 14 to which external wiring may be connected and with a forwardly extending tongue 15 which extends through the central opening of the energizing coil and serves, with a similar tongue 16 extending forwardly from the insulating lamination 8, to support the coil. To better disclose the other elements of the relay assembly, the coil has been omitted. The tongue 15 is also provided with a soldering lug 17 extending laterally and then at right angles therefrom to which one terminal of the coil winding may be connected. This lug, when the elements of the assembly have been clamped together extends between the rear face of the spoolhead and the forward edge 18 of the clamping plate 9, but out of engagement with the plate.

Each field lamination 1 is stamped from a sheet of suitable magnetic material, such as silicon steel, and comprises one widened arm 19 which serves as a support therefor in the assembly and which is provided with two holes 20 through which two of the clamping bolts 10 extend, a narrowed base portion 21 which embraces the outside of the operating coil and a second narrow arm 22 which serves as a pole-piece and embraces the outside face of the coil. The rear arm 19 is provided with a rearwardly extending soldering terminal 23. The pole-piece arm 22 has a pair of contacts 24 welded or otherwise secured to the pole face thereof, facing the associated armature lamination 2. As previously stated two field laminations are oppositely disposed in each layer of such laminations with the inner edges of their arms 19 and 22 out of engagement and forming a rectangular space 25 between the arms and base portions 21 thereof through which the operating coil extends.

Each armature lamination 2 is also stamped from a sheet of suitable magnetic material, such as silicon steel, into an L-shape and comprises a base portion 26 which serves as a support there-

for in the assembly and which is provided with two holes 27 through which two of the clamping bolts 10 extend, and a tongue or reed portion 28. To give the tongue 28 greater length and thus greater resiliency, the base portion 26 is slotted as indicated at 29. The free end of the tongue portion is bifurcated to form two contact carrying sections to the pole faces of which, facing the associated field lamination 1, are secured contacts which cooperate with the contacts 24 carried by the associated field lamination. The rear end of the base portion 26 is provided with a rearwardly extending soldering terminal 30. As previously stated two armature laminations are oppositely disposed in each layer of said laminations with the inner edges of their tongue portions 28 out of conductive engagement.

Each insulating lamination 3, which is disposed between each layer of field laminations and each layer of armature laminations constituting a pair or layer of magnetic circuit units, is stamped from a sheet of silicon steel of the required thickness and provided with four holes 31 therethrough for the reception of the four clamping bolts. The lamination is then sprayed with a coating of insulating material of the type previously described which is baked on. As disclosed in the cross-sectional view of Fig. 2, all of the surfaces of the lamination including the walls of the holes 31 are coated.

Each insulating separator 4 is substantially C-shaped having a base portion 32 and two forwardly extending arms 33 which lie between the arms 21 of adjacent layers of field laminations 1 to give them more rigidity. Each separator is provided with four holes 34 for the reception of the clamping bolts 10. Each of these separators is also stamped from sheet steel of the required thickness and sprayed with a coating of insulating material which is then baked thereon.

Each insulating separator 5 has a substantially square base portion 35 provided with four holes therethrough for the reception of the clamping bolts 10 and with a forwardly extending tongue 37 which lies between the tongues 28 of adjacent layers of armature laminations 2 to serve as backstops therefor. These separators and the similar laminations 6 are also stamped from sheet steel of the required thickness and sprayed with a coating of insulating material which is then baked on. Since the separators 5 and laminations 6 are stamped from sheet steel, the tongues 37 and 38 thereof against which adjacent armature tongues normally rest, serve to supplement the flux paths through such armature tongues.

The clamping bolts 10, as disclosed in Fig. 3, may also be coated with the same insulating material whereby when they are inserted through the holes in the coil terminal lug 7, field laminations 1, armature laminations 2 and insulating laminations and separators 3, 4, 5 and 6 there will be no possible cross-connection through such bolts.

Insulating spacers stamped from sheet metal and coated with insulating material may as stated hereinbefore be used in the spring pile-ups of conventional relays, such for example as a relay of the type disclosed in Patent 2,178,656, granted November 7, 1939, to P. W. Swenson. A relay of this type is illustrated in Fig. 4 and comprises a core 39, the rear end of which is secured to a mounting bracket 40 and supports an operating coil 41. Hinged upon the forwardly extending arms of a hinge bracket 42, clamped to the brack-

et 40, is a U-shaped armature 43, the forward crossreach of which is attractable to the pole face 44 on the forward end of the core 39 and the rearwardly extending side arms of which are pivoted by pins 45 secured thereto which engage in holes in the arms of the hinge bracket 42. The retracted position of the armature 43 is determined by a backstop nut 46 threaded upon the backstop screw 47 secured to the forward end of the core 39.

Mounted on the opposite sides of the bracket 40 are two spring pile-ups each comprising a coil terminal lug 48 and a plurality of contact springs such as 49, 50, 51 and 52. As disclosed the springs of each pile-up are arranged in two pairs, the contacts of each pair being normally open. The terminal lug and the contact springs are clamped to the bracket 40 between the clamping plates 53 and 54 by the clamping screws 55 and are insulated from each other, from the clamping plates 53 and 54 and from the bracket 40 by interposed insulating spacers 56. These spacers may be stamped from sheet metal and sprayed with a coating of insulating material of the type previously described, baked thereon. If desired the shanks of the clamping screws 55 may be similarly coated to insulate the same from the springs through which they pass or the shanks of such screws may be surrounded with the usual hard rubber sleeves. The armature 43 when attracted toward the core operates the armature springs 49 and 51 into engagement with their mate springs 50 and 52 by the operating studs 57.

By the use of insulating laminations or spacers between the contact carrying members of relays as herein illustrated, which are stamped from sheet metal of a desired uniform gauge and

sprayed with the improved insulating coating, the contact gaps may be accurately determined by the assembling operation and no further adjustment of the gaps is required. Furthermore since such spacers are not expansible or contractible due to change in humidity and the usual ranges of temperature, the contact gaps retain their initial assembled settings without maintenance.

While the improved insulating material has been illustrated as applied to specific types of switching apparatus, it will be obvious that it could be used in any type of switching apparatus where the insulation of current conducting members is required.

What is claimed is:

1. An adherent insulating composition for insulating electrical conductors comprising an inorganic filler bonded with a silicic acid sol produced by combining approximately 45 parts of ethyl silicate, 18 parts of 0.6 normal hydrochloric acid, and 36 parts of ethylene glycol monobutyl ether.
2. An adherent insulating composition for insulating electrical conductors comprising a silicate filler bonded with a silicic acid sol produced by combining approximately 45 parts of ethyl silicate, 18 parts of 0.6 normal hydrochloric acid, and 36 parts of ethylene glycol monobutyl ether.
3. An adherent insulating composition for insulating electrical conductors comprising an aluminum oxide filler bonded with a silicic acid sol produced by combining approximately 45 parts of ethyl silicate, 18 parts of 0.6 normal hydrochloric acid and 36 parts of ethylene glycol monobutyl ether.

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