This invention relates to an electrical mat switch of the type commonly employed for energizing door operating apparatus and similar control equipment; in particular, the invention contemplates a new and different mat switch and electrode core characterized by lightweight and improved resistance to fatigue stresses. A novel method for making the invention is also within the purview of this invention.

Mat switches have been in use for quite some time. Heretofore they have been constructed of thin flexible metal electrode plates that are held apart by either a plurality of compressible insulating discs or by a perforated resilient dielectric sheet. Suitable leads are provided from each of the plates to the external circuit requiring the device; closure of the electrical contacts is effected by the imposition of sufficient weight upon the plates to cause flexing of the upper plate resulting in the touching of one plate on the other. The plates are generally contained in a molded outer casing or mat having a suitable tread surface and adapted for positioning in the line of traffic.

While such mats have been satisfactory for many purposes it has been found that they are subject to rather significant limitations because of their inherent design. For example, the solid conductor plates therein must be sufficiently thick to resist constant flexing and resulting fatigue stresses. This means that in steel electrode mat switches they generally run into a thickness of from 14 to 24 gauge resulting in an individual mat weight of from 65 to 100 pounds. Besides the excessive weight and relatively high cost of the mats, they are prone to breakage and damage. Mat switches made with aluminum electrodes do not have as great a weight problem but are still subject to breakage and damage. For example, when such a mat is dropped on its corner the conductor plates generally protrude through the molded casing and destroy the electrical integrity of the mat besides subjecting it to the elements. Fatigue failures also are inevitable with such construction as repeated stresses upon the tread surface thereof cause eventual failure of the plates. The plates themselves are very costly as they must be fabricated of high quality accurately finished steel and aluminum plate and sheet obtainable from the mills only on special order. In addition to being inconvenient and costly to fabricate, electrical mats employing solid electrode plates present storage problems because of their weight and are more costly to ship and transfer from one place to another.

It is therefore a primary object of this invention to provide an improved electrical mat switch that will overcome to a large extent the foregoing disadvantages and objectionable features.

Another object of this invention is to provide an improved method for making electrical mat switches of the type described.

Another object of this invention is to provide a new and improved electrode core for use in electrical mat switches of the type described.

Another object of this invention is to provide a novel method for making electrode cores of the type described.

Still another object of this invention is to provide an improved electrical mat switch characterized by lightness in weight, ease of manufacture and adapted for fabrication from readily available materials.

Yet another object of this invention is to provide a new and improved inner construction for an electrical mat switch of the type described that is superior in resistance to fatigue stresses, waterproof and easier to handle and store.

A further object of this invention is to provide in an electrical mat switch of the type described, an improved electrode core assembly that is self-contained and functionally independent of the outer shell enclosing the same.

Yet another object of this invention is to provide in an electrode core assembly in an electrical mat switch novel means for imparting rigidity thereto without sacrificing other desired functional attributes.

Another object of this invention is to provide in an electrode core used in an electrical mat switch novel means for sealing the core electrically and protecting it from the elements.

Another object of this invention is to provide a novel method for fabricating electrode plates characterized by a minimum of steps yet resulting in a product superior to those currently in use.

These and other objects and advantages of the invention will become more fully apparent from a consideration of the following detailed specification and accompanying drawing wherein is shown an embodiment of the invention by way of illustration and not by way of limitation.

In the drawings:

FIGURE 1 is a view in perspective, with parts peeled away, showing the invention;

FIGURE 2 is an enlarged fragmentary view in section taken substantially along the line 2--2 of FIGURE 1;

FIGURE 3 is an enlarged fragmentary perspective view, with parts peeled away, of the electrode core forming part of the invention;

FIGURE 4 is a view in perspective of a mold adaptable for use in one of the steps in the invention;

FIGURE 5 is an enlarged fragmentary sectional view illustrating the manner in which the screen employed as an electrode member in the invention is treated with a layer of plastic material;

FIGURE 6 is an enlarged fragmentary sectional view showing the electrode core assembly before the bonding of the edges thereof with plastic cement;

FIGURE 7 is a view similar to FIGURE 6 illustrating the electrode core assembly after the edges thereof have been bonded with plastic cement;

FIGURE 8 is a diagrammatic view of typical apparatus used in carrying out the process of the invention on a continuous basis; and

FIGURE 9 is a perspective schematic view illustrating the manner in which the components of the invention are assembled to form a completed structure.

Referring to FIGURE 1 of the drawings, the invention, designated in its entirety by the reference character A, comprises a molded outer casing 10 having a suitable tread surface 12 adapted for use in doorways, traffic areas, and the like. Terminal leads 14 are provided which connect to an electrical circuit that is energized in response to traffic pressure on the surface 12 of mat A.

Casing 10 is preferably formed of molded poly vinyl chloride plastic material although other suitable materials such as rubber may be used. Enclosed within and bonded to casing 10 is an electrode core assembly B which comprises the main operative and inventive feature of the switch, as will be described. Core assembly B is of the same variety as a general purpose automotive type switch or circuit breaker, having features that, when operated, open the electrical circuit and in which the mechanism is such that it may be employed separate and distinct from casing 10 or it may be used integral with mat A, as will become apparent from that which follows.

Electrode assembly B, shown also in detail in FIGURES 2, 3 and 6, is comprised of a pair of woven wire electrode members 14 and 16 that are disposed in a parallel
spaced arrangement and separated from each other by a perforated dielectric member 18. Further provided is a thin layer of plastic material 20, 22 which overlies and is formed upon the outer surfaces 24, 26 of electrode members 14 and 16, respectively, in such a manner as to make said outer surfaces 24 and 26 imperforate. In addition to plastic material, other materials such as epoxy resin, fiber glass and the like could be used to coat electrode members 14 and 16. The coatings 28 and 22 do not extend through the mesh of electrode members 14 and 16 thereby leaving the inner surfaces thereof electrically conductive and spaced so as to close a circuit whenever they touch each other. The edges of the resulting sandwich type construction of electrode core assembly B are stitched as at 28 in a quilted manner, i.e., a cross-criss pattern is employed to prevent displacement of layers 20 and 22 with respect to each other. It is then sealed along the edges thereof with a vinyl plastic seal 30 to make core assembly B waterproof and shock resistant. It should be noted that inner dielectric 18 extends slightly beyond electrode members 14, 16 and their plastic coatings 20 and 22, as shown at 19 in FIGURE 6. This permits plastic seal 30 to bond firmly to the plastic of layers 20, 22 and dielectric 18 as these materials are compatible and will bond under certain temperature conditions. FIGURE 7 illustrates the resulting bond of the vinyl seal 30, the electrode member plastic coatings 20 and 22, and the urethane foam plastic dielectric member 18. The entire electrode core assembly B is equipped with suitable terminal connections 14 and 16 and encased in molded casing 10.

FIGURE 3 sets forth clearly the structural features of electrode core assembly B. As shown, the electrode members 14 and 16 are fabricated from woven wire cloth or screen made of a suitable conductive material such as stainless steel, copper or non-corrosive aluminum. Carried partially within the interstices of screens 14 and 16 and covering the outer surfaces thereof is a film of plastic material such as plastic or the like which may be sprayed thereon, as will be explained during the discussion of the method forming part of this invention. The inner member 16 may be fabricated of a sheet of urethane or other thin resilient plastic dielectric sheet material that has been perforated with holes 32. Holes 32 may be approximately 3″ in diameter and should be closely spaced so as to allow for the facile and intimate contact of the inner surfaces of electrode members 14 and 16 in response to traffic pressure imposed thereupon. As explained, inner member 18 extends beyond the edges of electrode members 14 and 16 a distance of approximately 1/4″. A beaded edge 30 of vinyl material is bonded under a temperature of about 400 ℉ to core assembly B to make the same an integral resilient electrode core assembly that may be self-contained and used independently, if desired. The molded outer casing 10, which may be applied to inner electrode assembly B, bonds to assembly B, as they are compatible materials and functionally quite independent thereof and any damage to it will not adversely affect the electrical or mechanical properties of core assembly B.

The method of making the foregoing resilient shockproof electrical mat will now be described; although no particular apparatus need be used to perform the method of this invention, exemplary apparatus for continuously producing components of the invention in quantity along with the construction of apparatus that may be employed to produce the invention at a limited production rate will be described to aid in understanding the complete method. The following steps and apparatus relate to the latter or limited quantity method of making the invention. In both of these processes the steps are essentially the same; FIGURE 9 represents the steps necessary to assemble the invention after the initial preparation of the electrode members is accomplished.

The electrode members 14 and 16 are selected from suitable screen material such as that pointed out previously. It is then flattened and cut to the proper size or the cutting could be done after the coating or curving step.

A sheet of urethane or similar dielectric resiliently compressible material is cut and perforated with suitable holes to provide the dielectric member 18. Dielectric member 18 may also be molded to size with the spaced holes therein. Thickness, i.e., the gauge size, of electrode members 14 and 16 can vary according to the type and frequency of the traffic passing over the mat, which, however, has been found that wire cloth of the weight and mesh size used in Fourdrinier process paper machines is entirely suitable. The thickness of dielectric member 18 may vary between 1/16″ to 1″ depending upon the sensitivity requirements and speed of the mat, 1/16″ to 1″ being suitable for most automatic door applications. A suitable primer is applied to electrode members 14 and 16 to prepare their outer surface so that the sprayed on plastisol will firmly adhere thereto.

The woven wire electrode members 14 and 16 are then placed in a silicon rubber fiber die or mask C (shown in FIGURE 4) having therein a series of complementary crossed grooves or indentations 34 which receive and support the wire elements 15 thereof so that approximately half of the wire diameter extends above the surface of the die C. Pre-heating and curving of the primer on the screen is then accomplished in an infra red or other suitable type of oven until a temperature of about 250 F is reached. In the next step, the screens are sprayed while in the die with a plastic material such as plastisol and then placed in an oven for a period of about one minute to cure at a temperature of 350–400 F. The resulting intimate bond of plastic film 20 to wires 15 of screen 14 is shown in FIGURE 5. It is, of course, possible to accomplish the foregoing by use of a travelling die or mask member suitably grooved to accommodate any length of screen and adapted to pass through heating ovens in a continuous cycle, as will be explained. The primer coat applied to screen 14 causes the wires 15 thereof to bond to the plastic film 20. The plastic film 20 will not bond to the silicone mask C as they are not compatible; the mask serves only as a base upon which to form the plastic coat or film 20.

The screens 14 and 16 are then removed from die C, sanded to insure a positive electric contact between the spaced inner surfaces thereof and then placed in either one of the urethane sheet 18 and stitched together with no core cord. The stitching is done in a cross-criss fashion so that the screen elements 14 and 16 do not float while they are curing. Vinyl cement is then applied at a temperature of about 400 F along the edges thereof to seal and chemically bond the entire assembly into an electrode core. The electrode core being sandwiched is placed in a suitable mold which is then filled with liquid plastisol and subsequently cured at a temperature of approximately 375 F in a heat transfer bath, electric oven or open air oven depending upon the choice available. Terminal leads 14 may be molded in the final step or they may be inserted at an earlier stage in the process. Embossing or other steps necessary for individual mat applications are then incorporated in the mold itself.

Referring to FIGURES 8 and 9 of the drawings, FIGURE 8 shows apparatus that may be used for the continuous production of electrode members 14 and 16. Included in this apparatus is a supply roll 40 adapted to carry a roll of wire mesh cloth or screen 45 that is of the proper size and weight for the purpose intended. Powered delivery rolls 44 guide screen 42 under primer coating roll 46 and an infra red primer cure oven 48 where primer coated screen 42 is subjected to a temperature of about 250 F. It is then passed onto the surface of an endless belt 50 of silicone rubber which has been scored with a continuous female die pattern that is complementary to the mesh configuration of screen 42. Screen 42 is caused to reside as it passes over belt 50 in the scored
grooves of belt 50 so that only the upper diametral surface of the wires thereof are exposed. A spray nozzle 52 delivers liquid plastisol to the treated upper surface of screen 42 as it resides upon belt 50 and fills the upper diametral portion of the interstices of screen 42 besides coating the upper surface thereof to form an upper sheath or thin imperforate coat of plastisol firmly thereupon. The coated screen 42 then passes under an infra red oven 56 which is maintained at a temperature of about 350-400° F. where curing of the plastisol takes place. After leaving the area under oven 56, screen 42 passes under a pressure roller 60 which forces it under the correct pressure upon sanding roller 62. This removes the primer from the undersurface thereof to insure the electrical conductivity of the contact surface. Shears 58 then cut the coated and prepared screen 42 into individual electrode members 14 and 16.

In FIGURE 9 the final assembly of electrode core assembly B and mat A is outlined. Electrode members 14 and 16 are placed in spaced juxtaposed relation to each other and dielectric member 18 is placed therebetween, as indicated in view E of FIGURE 9. Dielectric member 18 is slightly longer and wider than electrode member 14 and 16, as previously explained. The three layer assembly is then stitched together with thread as shown in view F. The threading pattern should extend across electrode members 14 and 16 so that shifting thereof during subsequent steps is eliminated. Dielectric member 18 is positioned so that its outer edge 19 extends slightly beyond the edges of electrode members. The cementing of the edges of the resulting laminated structure B is the next step as shown in view G of FIGURE 9. A polyvinyl cement 30 is used that is compatible with both the plastisol of electrode members 14, 16 and the foam plastic dielectric member 18. Terminal leads 14' may be attached to electrode assembly B at this stage by means of suitable lead connectors (not shown) that are attached at spaced intervals to screen 42.

If desired the electrode assembly B is then placed in a suitable mold (view H) and liquid plastisol is introduced into the mold cavity. Curing of the liquid plastisol is accomplished in a suitable oven at a temperature of 350-400° F. and the resulting product, mat A, is removed from the mold as shown in view I of FIGURE 9. The leads 14' of mat A which are molded in the last step of the operation, are attached to the lead connectors previously referred to.

The resulting electrode core assembly B may be used separately or incorporated in the outer casing 10 depending upon the ultimate use intended. The use of plastisol has been referred to as a material for use in the above method it should be understood that no limitation in this regard is intended as any suitable material may be used.

The resulting mat switch is entirely suitable for the use described. It is about one-half the weight of conventional mat switches employing solid contact plates. The likelihood of failure of the wire mesh electrode members 14 and 16 due to continuous and repeated cyclic stresses is obviated by the plastic film that is intimately bonded to the wires 15 forming the warp and weft of the screen 42 used therein. Structural rigidity is gained without greatly adding to the weight of the mat and without affecting the electrical properties of the conducting elements used therein.

It will be apparent that the process or method of the invention does not in every case require all of the steps described hereinabove, and while the invention itself has been described in the degree of particularity it is to be understood that no limitation is intended thereby. Therefore, the various inventive features are to be construed from the recitations of the several appended claims.

1 claim:

1. An electrical mat switch for energizing a circuit comprising a pair of woven wire electrode screens, said screens being vertically spaced from each other, a resilient perforate dielectric member between said screens adapted to yieldably hold said screens apart in a normally open position and permit the opposed inner surfaces of said screens to come into reposable contact with each other at the perforations thereof, a plastisol coating chemically bonded to the outer non-contacting surface of each of said screens, said plastisol coating being carried within the interstices between the wires of said screens to approximately half of the diameter of the wires in said screens, and a resilient mat molded around said screens and said dielectric member.

2. An electrical mat switch adapted to close an electrical circuit in response to weight imposed thereon consisting of an upper electrode member in electrical communication with an outside power line, said upper electrode member being fabricated of wire cloth, a lower electrode member identical to said upper electrode member and complementary therewith, said electrode members being spaced from each other and adapted to close an electrical circuit whenever their inner surfaces contact each other, plastic dielectric means between said electrode members adapted to permit the reposable contact of the inner surfaces of said electrode members, plastisol coating intimately bonded to each of said electrode members in such a manner to render the same imperforate without disturbing the electrical conductivity of the inner surfaces thereof, and chemically compatible sealing means bonding said electrode members and said dielectric means into a self-contained flexible unit, and a resilient compressible mat enclosing said aforementioned structure.

3. A lightweight flexible electrode assembly for mat switches and the like comprising a pair of spaced perforate electrical conductors, said conductors each consisting of a sheet of woven wire cloth, a sheet of perforated resiliently compressible plastic insulating material interposed between said conductors, a thin coating of thermoplastic material intimately bonded to each of said conductors, said coating extending from the external non-contacting surface of said conductors into the space between the wires thereof a distance sufficient to make said conductors imperforate and resistant to fatigue failure but not sufficient to cause a degradation in the electrical conductivity of the inner surfaces thereof, and a thermoplastic bonding agent chemically compatible with said thermoplastic material and said insulating material enclosing said assembly.

4. The method of making electrical mat switches including the steps of priming the exterior surface of a pair of wire cloth electrodes, spraying plastic material on the exterior surface of each of said electrodes while in a female die to render the same imperforate without harming the electrical conductivity of the inner surfaces thereof, curing said sprayed electrodes by subjecting them to a temperature in excess of 300° F., assembling said cured electrodes in spaced parallel relation with a resilient perforate dielectric material therebetween, binding said resulting assembly along the edges thereof, placing said assembly in a mold, filling said mold with liquid plastic material, and curing said liquid plastic material at a temperature in excess of 300° F. whereby to result in a one-piece molded mat switch.

5. The method of manufacturing electrode cores for mat switches and the like consisting of the steps of of of 250° F. a pair of electrically conductive wire fabric electrodes to size, perforating a sheet of resiliently compressible plastic insulating material, laying each of said electrodes on a mold adapted to receive approximately one-half of the diametral area of the wires in said fabric, preheating each of said electrodes to a temperature of at least 250° F. spraying the exposed surface of each of said electrodes with plastisol, curing said sprayed electrodes, binding said electrodes in spaced parallel relation with said insulating material therebetween, and chemically bonding the edges of said electrodes and said insulating material.

6. The method of making electrode cores for electrical
mat switches including the steps of cutting a pair of wire cloth electrodes into the proper size for a given mat, cutting a perforated plastic dielectric material to accommodate said electrodes, placing each of said electrodes in a travelling mold so that at least one-half of the diametral area of the wire therein is exposed, preheating each of said electrodes to a temperature of at least 300°F., spraying each of said electrodes while in the mold with plastisol to chemically bond the same thereto, curing the resulting plastisol coated electrodes at a temperature of at least 300°F., assembling said cured electrodes in spaced parallel relation with said dielectric material therebetween, binding said assembly together and chemically bonding the edges of said assembly.

7. The method of making electrical mat switches including priming one surface of a continuous woven wire conductor, spraying the primed surface of said conductor with liquid plastisol, curing said plastisol by heating to a temperature of at least 300°F., removing said plastisol from the unprimed surface of said conductor, cutting said conductor into electrode members, assembling a pair of said electrode members into a juxtaposed position in register with each other with the unprimed surfaces thereof in face to face relationship, placing a resiliently compressible insulating member having spaced contact permittity areas therein between said pair of electrode members, stitching said three layer structure together, chemically bonding the edges of said structure with a plastic material that is chemically compatible with said sprayed plastisol and said dielectric member, attaching terminal leads to each of said electrode members, and molding around said three layer structure an outer housing to contain the same.

8. In a mat switch, the combination comprising a first woven wire electrode, a second woven wire electrode, said electrodes being generally identical and having interstices between the wires forming the body thereof, a perforate sheet of dielectric plastic material between said electrodes, a coating of plastisol material covering the outer non-contacting surfaces of said electrode member and extending into the interstices thereof a distance sufficient to coat the internal surfaces of the wires in said electrode members without disturbing the electrical conductivity of the inner face to face surfaces thereof, said coating being intimately bonded to said electrode members, and a plastisol seal enclosing the outer periphery of said switch, said seal being chemically bonded to said coating on said electrode members and to said dielectric plastic material therebetween.

9. The switch of claim 8 wherein said assembly is stitched together with a thin elongated stitching material adapted to bind said assembly together without interfering with the electrical properties of the same.

10. In the method of continuously producing electrical mat switch components, the steps comprising spraying a sheet of woven wire material with priming material, curing the resulting coated woven wire by subjecting the same to a temperature of at least 200°F., spraying said cured woven wire with a coating of plastic material so that only one surface is coated therewith while leaving the other surface thereof unaffected by said material, curing said plastic coated surface by subjecting the same to a temperature of at least 300°F., and cutting said woven wire material into lengths suitable for use as conductors in electrical mat switches.

11. The method of claim 10 including the additional step of sanding the surface of said woven wire material unaffected by said coating step to increase the electrical conductivity thereof.

12. The method of making electrical mat switches including the steps of cutting a pair of woven wire electrode members to proper size, applying a coat of primer material to one surface of said electrode members, curing said primer material on said electrode members, placing each of said electrode members in a moving female die so that the primed surface thereof is exposed, while in said die applying a thin coating of plastisol to the exposed surfaces of said electrode members, curing said plastisol coating upon said electrode members to intimately bond the same, removing said electrode members from said die, sanding the non exposed surfaces of said electrode members, placing a sheet of plastic perforate material between said electrode members so that the non exposed surfaces of said electrode members are in contact with said plastic material and face to face with each other, stitching said resulting assembly into a sandwich type unit, applying to said sandwich type unit a border coating of plastic material chemically compatible with said plastisol and said plastic perforate material, placing said sandwich type unit in a mold, filling said mold with liquid plastisol, curing said assembly, and removing said assembly from said mold.

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