

April 6, 1937.

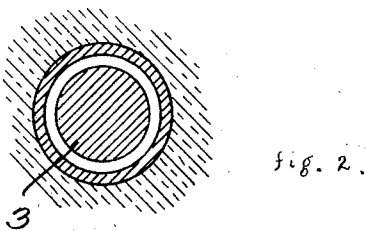
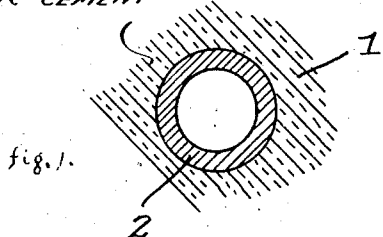
A. H. MAUDE

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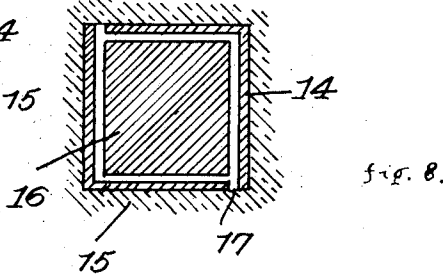
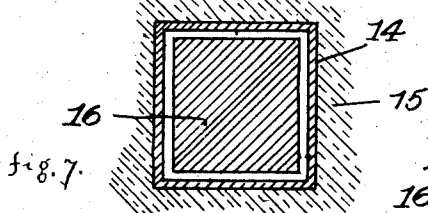
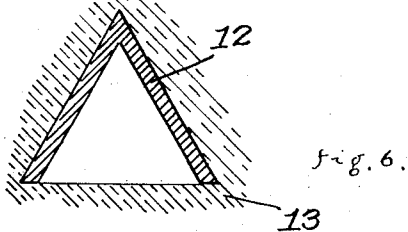
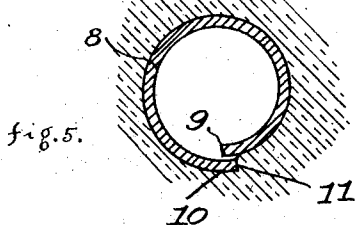
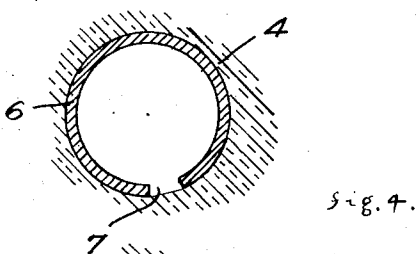
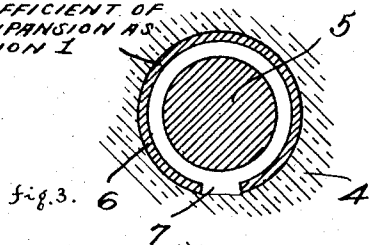
CONDUCTOR

Filed April 6, 1932

VITREOUS ENAMEL OR
INORGANIC CEMENT



SAME COEFFICIENT OF
THERMO-EXPANSION AS
INSULATION 1



INVENTOR.

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UNITED STATES PATENT OFFICE

2,075,906

CONDUCTOR

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7 Claims. (Cl. 173-264)

This invention relates to improvement in conductors for use with electrical apparatus and more particularly to those conductors employed in electric motors and electromagnets, transformers, generators, or the like.

An important object of this invention is to provide a conductor which will permit expansion or contraction of the same under varying temperature changes while in use.

Another important object of this invention is to provide a conductor which will permit the same to be used in coils and embedded in an insulating material whereby the latter is unaffected by varying temperature changes.

Another important object of this invention is to provide a conductor for use with electrical apparatus and which is adapted to be insulated with a vitreous enamel or inorganic cement whereby the same can be used at a high temperature without affecting the insulation due to the expansion or contraction of said conductor.

A further object of this invention is to provide a conductor having an insulation thereon formed of a material having a thermal expansion less than that of the conductor element.

A still further object of this invention is to provide a conductor of the above character which is of simple construction, easily manufactured and which may be produced at a reasonable cost.

These and other objects and advantages will be apparent throughout the course of the following description and drawing; in which

Fig. 1 is a cross sectional view of a conductor constructed of a tube or tubular sheath embedded in insulation;

Fig. 2 is a cross sectional view of a tubular conductor sheath similar to that disclosed in Fig. 1, and having a solid conductor therein, having line contact with said tubular conductor;

Fig. 3 is a cross sectional view of a conductor similar to that disclosed in Fig. 2 with the tubular conductor sheath split longitudinally to permit circumferential expansion of said tubular conductor;

Fig. 4 is a cross sectional view similar to Fig. 3 with no solid conductor;

Fig. 5 is a cross sectional view similar to that disclosed in Fig. 4 in which the free edges of the tubular conductor are overlapped;

Fig. 6 is a view similar to Fig. 4, the conductor element being inverted V-shaped in cross section;

Fig. 7 is a modification of the invention disclosed in Fig. 2 in which the tubular and solid conductor members are substantially rectangular in cross section; and

Fig. 8 is a modification of the construction shown in Fig. 7 in which the tubular casing is split longitudinally at diametrically opposite points whereby to permit additional expansion of the conductor sheath.

Referring in detail to the drawing, 1 designates insulation which is preferably formed of a vitreous enamel or inorganic cement as distinguished from an insulation which contains organic matters such as cotton or varnish. The dominant characteristic of this insulation is such that it has a thermal expansion less than that of the conductor with which the same is to be used.

A hollow or sheath like conductor element 2 is embedded in the insulation 1 and is adapted to receive a solid conductor element 3. The conductor element 3 as shown in Fig. 2 is solid in cross section and is loosely disposed within the conductor sheath 2 so as to provide a space between the circumference of the conductor 3 and the conductor sheath 2. That is, the solid conductor is poked through the tube of sheath. There is at least line contact between these elements, or frequent point contact between the sheath and the solid conductor.

The modifications as shown in Figs. 3 and 4 comprise an insulation 4, a conductor element 5 and a conducting sheath 6 having a longitudinal slit or opening as at 7.

In the modification shown in Fig. 5 a conductor sheath 8 is provided with a longitudinal slit similar to that shown in Figs. 3 and 4 and the opposed free edges of the sheath 8 and 10 adjacent the slit are overlapped, one free edge being embedded in the insulation as at 11 and the other free edge being so arranged as to permit the same to move in continuous overlapping relation in either direction when the sheath is contracted or expanded due to temperature changes.

In the modification shown in Fig. 6 a conducting sheath 12 of substantially inverted V-shaped formation in cross section is embedded in insulation 13 and is adapted for use with or without a solid conductor element (not shown). The form of the invention shown in Fig. 7 is similar to that disclosed in Fig. 2 with the exception that the tubular conductor sheath 14 is of substantially rectangular formation in cross section and is embedded in insulation 15 and is adapted to receive a solid conductor element 16 of substantially rectangular formation in cross section, said conductor element 16 being spaced upon all sides interiorly of the sheath 14.

The form of the invention disclosed in Fig. 8 is similar to that disclosed in Fig. 7 with the ex-

ception that the sheath 14 is longitudinally slit at diametrically opposite points as at 17 so as to permit the sections of the sheath to move relative to the conductor under varying temperature changes.

Under certain conditions the solid conductor may be eliminated, and the current carried by the sheath alone.

In proceeding in accordance with the present invention, a length of soft annealed copper having a cross section similar to Fig. 2 is covered with asbestos paper and then wound into the form of a coil. This coil is then impregnated with a sodium silicate solution, following which it is slowly dried and baked, the sodium silicate serving to cement the turns of the coil together.

In the form shown in Fig. 7 a helical coil of soft annealed copper is formed with mica strips separating the turns. When the first layer is completed it is enameled with a readily fusible vitreous enamel. Successive layers are then wound over the first layer and each successive layer is then enameled until the coil is completed.

A coil may be constructed of aluminum having a cross section similar to diagram 2 being heavily coated on the outside of the tubular portion of the conductor with an oxide or phosphate. The space between the coils is then impregnated with a readily fusible vitreous enamel by vacuum and/or pressure.

A still further manner of practicing the invention may consist of placing a plurality of lengths of copper of square cross section within thin walled tubes of rectangular cross section formed of a nickel iron alloy externally plated with copper. The tubes are then enameled on the exterior surface and placed in the position which they will occupy in the finished coil. This formation is then heated to a temperature at which the enamel flows together to form a continuous binding. The ends of the pieces are then connected in any suitable way to form a continuous conductor. This method is particularly suitable where a large portion of the coil is composed of parallel straight lengths having a cross-sectional area of $\frac{1}{8} \times \frac{1}{8}$ inches or more. The space between the copper rod or conductor and the alloy tube should be sufficient to allow for the expansion of said rod. A coil so constructed is capable of withstanding extremely high temperatures, the limiting temperature being that which would soften the enamel coating or binding.

In any of the foregoing examples of coil construction the completed coil may be strengthened by placing a jacket around the same composed of a material having a coefficient of expansion substantially equal to that of the insulating material of the coil.

In operation, a hollow sheath which may be formed of conducting material is covered with an inorganic insulation having a coefficient of expansion not greater than the sheath. A conducting element of a small diameter is then placed within said sheath so as to provide a space circumferentially about the conductor between the latter and the sheath, whereby to permit expansion of the conductor and the sheath and insulation under varying temperature changes to prevent the cracking or splitting of the insulation. This arrangement further permits movement of the conducting element in all directions within the protecting or conducting sheath without maiming or damaging the insulation.

It is to be understood that the foregoing ex-

amples of coil construction are merely a few of the ways by which the invention may be practiced and is not to be construed in any way as limiting the uses to which the invention may be placed.

Additional legends on the drawing are merely by way of illustration and they are not to be construed as limiting the disclosure in any way.

Having thus described my invention, what I claim, is:

1. An electrical conductor comprising a solid conducting element, and insulating material surrounding and spaced from said element, and a relatively thin conducting sheath held to said insulating material and loosely surrounding said element and normally having line contact therewith, said sheath being constructed of material having substantially the same coefficient of expansion as that of said insulating material, said solid conducting element being constructed of material having any reasonable coefficient of expansion whatever.

2. An electrical conductor comprising a solid conducting element, and insulating material which will withstand a temperature of 150 degrees centigrade surrounding and spaced from said element, and a relatively thin conducting sheath held to said insulating material and loosely surrounding said element and normally having line contact therewith, said sheath being constructed of material having substantially the same coefficient of expansion as that of said insulating material, said solid conducting element being constructed of material having any reasonable coefficient of expansion whatever.

3. An electrical conductor comprising a solid conducting element, and insulating material consisting of a vitreous enamel surrounding and spaced from said element, and a relatively thin conducting sheath held to said insulating material and loosely surrounding said element and normally having line contact therewith, said sheath being constructed of material having substantially the same coefficient of expansion as that of said insulating material, said solid conducting element being constructed of material having any reasonable coefficient of expansion whatever.

4. An electrical conductor comprising a solid conducting element, and insulating material consisting of an inorganic cement surrounding and spaced from said element, and a relatively thin conducting sheath held to said insulating material and loosely surrounding said element and normally having line contact therewith, said sheath being constructed of material having substantially the same coefficient of expansion as that of said insulating material, said solid conducting element being constructed of material having any reasonable coefficient of expansion whatever.

5. An electrical conductor in the form of a coil comprising a solid conducting element, and insulating material surrounding and spaced from said element, and a relatively thin conducting sheath held to said insulating material and loosely surrounding said element and normally having line contact therewith, said sheath being constructed of material having substantially the same coefficient of expansion as that of said insulating material, said solid conducting element being constructed of material having any reasonable coefficient of expansion whatever.

6. An electrical conductor comprising a solid internal conducting portion, a thin conducting portion surrounding and spaced from said in-

ternal portion and normally having line contact therewith to permit normal expansion of said internal portion, said thin conducting portion being insulated with an inelastic material on its exterior surface, said material having a thermal expansion so close to that of said thin conducting portion and thermal stability so high that no injury occurs when exposed to a temperature of 150 degrees centigrade.

10 7. An electrical conductor comprising a solid internal conducting portion, a thin conducting portion surrounding and spaced from said internal portion and normally having line contact therewith to permit normal expansion of

said internal portion, said thin conducting portion being insulated with an inelastic material on its exterior surface, said material having a thermal expansion so close to that of said thin conducting portion and thermal stability so high that no injury occurs when exposed to a temperature of 150 degrees centigrade, said thin conducting portion and said insulating material having approximately the same coefficient of thermal expansion, said solid internal portion being constructed of material having any reasonable coefficient of expansion whatever.

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