July 7, 1936. A. R. SWOBODA 2,046,707

ELECTRIC CONDUCTOR

Filed Dec. 23, 1932

FIG. 1

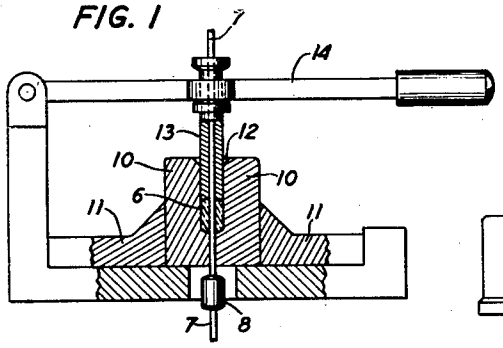


FIG. 2

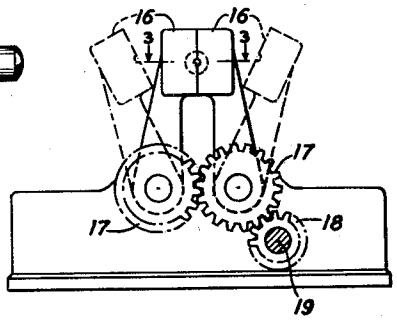


FIG. 4

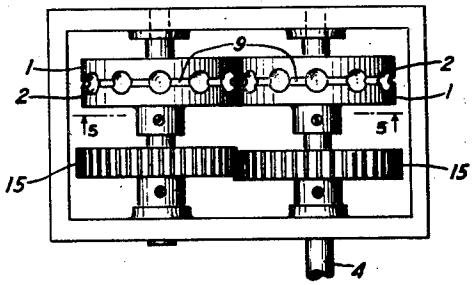


FIG. 3

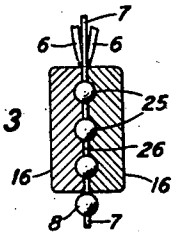


FIG. 6

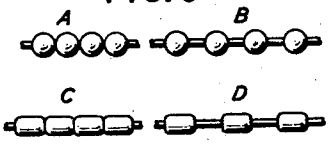


FIG. 5

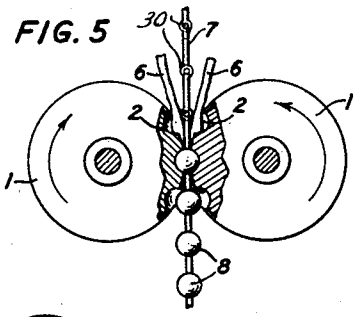


FIG. 7

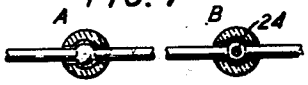


FIG. 8

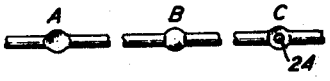
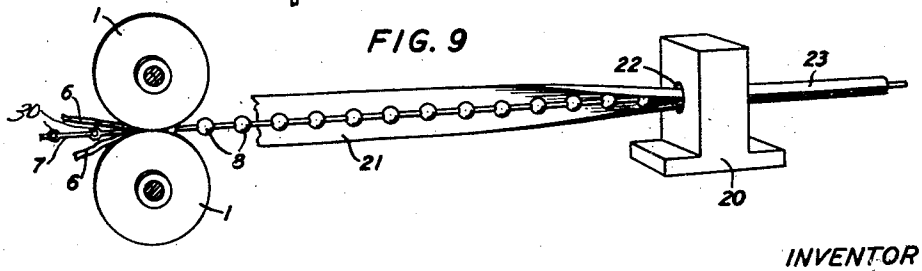


FIG. 9



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ELECTRIC CONDUCTOR

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Application December 23, 1932, Serial No. 648,671

5 Claims. (Cl. 173—264)

This invention relates to improvements in electric conductors.

It is an object of this invention to provide an electric wire conductor with an improved, flexible, heat-resistant insulation affixed to the wire.

Another object of this invention is to provide an electric wire conductor with an improved electromagnetic loading arrangement.

Still another object of this invention is to furnish a machine for manufacturing an electric wire conductor having members formed and/or localized on the wire.

A further object of this invention is to supply a coaxial concentric conductor, having an inner conductor surrounded by an outer tubular conductor, with an improved arrangement for holding the inner conductor in the center of the tubular conductor for the purpose of providing an insulating medium having a low dielectric loss.

An additional object of the invention is to furnish a machine for manufacturing an improved type of coaxial concentric conductor.

There is a need for an improved type of insulation for that class of electric wire conductors which in use are subjected to heat, such as lead wires from resistors. Rubber insulation is undesirable because it is decomposed by heat, aging, and oxidation. Other types of insulation are undesirable either because they have poor dielectric properties or else because they detract from the flexibility of the wire conductors. Some use has been made of beads composed of insulating and heat-resistant material preformed and then loosely strung on the wire conductors. This arrangement enables the wire to retain its flexibility. However, if the wire ends are disconnected, the loosely strung beads will be apt to slide off.

In accordance with this invention an electrically conductive wire is passed through a progressive forming die comprising two rotatable discs having contiguous cylindrical surfaces. The cylindrical surfaces of the discs have depressions therein at spaced intervals. The depressions in the cylindrical surface of one disc are preferably in alignment with those in the cylindrical surface of the other disc. At the same time that the wire is passed through the die certain material is likewise passed between the contiguous cylindrical surfaces of the discs. The compressing action of the die will cause the certain material to form into members, or beads, corresponding in shape and location to the depressions in the cylindrical surfaces of the discs. Since the wire also passes between the discs, the beads will be formed on the wire. Due to the comparatively rough surface of the wire, the beads will usually stick to the wire and be localized thereon without the aid of a locking arrangement. However, if it is thought desirable, roughening of the surface of the wire or any suitable localizing device may be used.

The certain material may be any suitable insulating and/or heat-resistant material that is desired. It may be thermoplastic or not depending upon the requirements of a particular case. For engineering reasons, it may consist of low dielectric loss material, such as quartz or Pyrex glass. The material should be introduced into the forming die in a plastic form, such as plastic strips, gobs, or as a paste. The electrostatic capacity of the material may be further reduced by forcing bubbles of air or gas into it.

If desired for electromagnetic loading, the certain material which is used may consist of magnetic material. If this magnetic material consists of iron or permalloy dust, it would be advisable to add binding material, such as asphalt, to it. If this is done, the members which are then formed upon the wire will serve as loading members instead of insulating members.

The invention is also broad enough to include a core portion composed of any desired material other than an electrically conductive wire. For this reason, in most of the statements which follow, the term "core" is used instead of "wire".

An improved type of coaxial concentric conductor may be manufactured by means of the procedure described above. After the wire has passed through the progressing forming die and the beads have been formed upon the wire, the next step is to pass the beaded wire through a drawing die. At the same time, a band of conductive covering material is also passed through the drawing die. By means of the drawing action of the die, the band of conductive covering material will be drawn into a tubular sheath surrounding the beaded wire. This sheath will be separated and insulated from the wire by the beads which will maintain a concentric air-space of low dielectric loss between the wire and the tubular sheath.

The invention will now be described with reference to the drawing in which:

Fig. 1 represents one type of machine for forming members upon a core;

Fig. 2 represents another type of machine for forming members upon a core;

Fig. 3 is a top view of a cross-section of a portion of the machine shown in Fig. 2 as taken along line 3—3 of Fig. 2 and illustrates the manner of operation of this machine;

Fig. 4 represents a preferred type of machine for forming members upon a core;

Fig. 5 is a side view of a cross-section of a portion of the machine shown in Fig. 4 as taken along line 5—5 of Fig. 4 and illustrates the manner of operation of this machine;

Fig. 6 shows several different shapes of the formed members;

Fig. 7 shows two different types of formed members;

Fig. 8 shows several different types of localizing arrangements; and,

Fig. 9 illustrates the method of, and apparatus for, manufacturing an improved type of coaxial conductor.

As stated above, a preferred type of machine is shown in Fig. 4. It comprises essentially a pair of co-acting wheel dies, or progressive forming die, comprising two wheels 1—1, or discs, having contiguous cylindrical surfaces having depressions 2—2 therein at spaced intervals. The depressions 2—2 in the cylindrical surface of one disc 1 may, if desired, be in adjacent locations as those in the cylindrical surface of the other disc 1. It should be noted that depressions 2—2 are connected by grooves 9—9. The purpose of grooves 9—9 is to provide space for the passage of core material 7 through discs 1—1. The wheel dies may be caused to rotate by any desired arrangement, such as by means of co-acting gears 15—15 and driven shaft 4 connected to a source of power supply (not shown).

Fig. 5 shows a portion of Fig. 4 taken along line 5—5 of Fig. 4. Certain material, such as plastic pyrex glass, shown in the form of plastic strips 6—6, is fed between the two wheel dies 1—1. The core portion 7, such as an electric wire conductor, is also fed between the two wheel dies 1—1 at the same time that the plastic strips 6—6 are fed through. The compressing action of the wheel dies 1—1 causes strips 6—6 to form units 8—8, or beads, on core portion 7 corresponding to the shape and location of depressions 2—2 in the cylindrical surfaces of discs 1—1.

Beads 8—8 will probably be composed of material which will not have the same coefficient of expansion as the material making up core portion 7. Therefore, if core 7 is later to be subjected to external or internal heat, such as by the passage of electric currents through it, it might become heated more rapidly than beads 8—8 and might expand sufficiently to crack beads 8—8. In order to prevent beads 8—8 from cracking and consequently dropping off core 7, it might be advisable to heat core 7 to a temperature greater than that of beads 8—8 at the time of their application to core 7 by the forming die.

If this is done, the core might later cool and contract sufficiently to break away from the beads. The beads would then become loose upon the core and would not be localized thereon. To remedy this undesirability, it is advisable to use one of the localizing arrangements shown in Fig. 8. These localizing arrangements comprise distortions of the core at spaced intervals. A flat type of localizing arrangement is shown at A, an upset arrangement is shown at B, and a perforated arrangement is shown at C. The advantage of the arrangement shown at C resides in perforation 24 through the core as this allows a portion of the certain material, from which the beads are formed, to pass through. This forms a sort of spindle thereby preventing a bead from turning around on the core. The arrangements shown at A and B will serve to localize beads upon the core even if the beads are held there loosely. Since the arrangement shown at C in Fig. 8 is preferred, wire 7 in Fig. 5 is illustrated as having perforated enlargements 30—30 for nonrotatably localizing the beads 8—8.

In Fig. 7 the bead shown at A is illustrated as being localized by means of the arrangement shown at B in Fig. 8 whereas the bead shown at B in Fig. 7 is illustrated as being non-rotatably localized by the arrangement shown at C in Fig. 8.

The shape of beads 8—8 depends upon the shape of depressions 2—2 in the cylindrical surfaces of the wheel dies 1—1. Likewise the location and spacing of beads 8—8 depend upon the location and spacing of depressions 2—2 in the peripheries of the wheel dies 1—1.

Fig. 6 shows beads having a variety of shapes and locations. Contiguous spherical beads are shown at A, spaced spherical beads are shown at B, contiguous cylindrical beads are shown at C, and spaced cylindrical beads are shown at D. The shape and spacing of the beads which are used for a given case depend upon the requirements to which the particular structure is to be put.

Another type of forming machine is shown in Fig. 1 and is shown to consist essentially of a divided block 10—10 held together by a holding arrangement, such as braces 11—11. It can be seen that divided block 10—10 has an aperture 12, or chamber, therein. A plunger 13 is adapted to travel in and out of aperture 12 by any desired means, such as handle lever 14.

In operating the machine shown in Fig. 1, core 7 is passed through chamber 12 in divided block 10—10 and out through its bottom. The certain material which is used in this case, such as glass 6, is introduced into chamber 12. Upon forcing plunger 13 down by means of handle lever 14, material 6 is compressed into a bead 8 which is formed around core 7. When handle lever 14 is withdrawn, plunger 13 is pulled out of aperture 12. Braces 11—11 are removed and divided block 10—10 is taken apart in order to allow core 7 with its newly formed bead 8 to be moved downward. To make this machine ready for the forming of another bead 8, divided block 10—10 should be put together and held closed by means of braces 11—11. More material 6 should be introduced into chamber 12. The forming operation may now be repeated by forcing plunger 13 down.

Still another type of machine is shown in Fig. 2. This machine consists essentially of a pair of jaws 16—16 which are adapted to open and close. Jaws 16—16 are operated by some such means as gears 17—17 which may be driven by any desired arrangement, such as gear 18 attached to driven shaft 19 connected to a source of power supply (not shown). Jaws 16—16 are shown to be closed in Fig. 2 with their open position indicated by dotted lines.

The manner of operation of the machine shown in Fig. 2 is illustrated in Fig. 3 which is a top view of a cross-section of a portion of this machine as taken along line 3—3 of Fig. 2.

It can be seen that the faces of jaws 16—16 contain depressions 25 and 26 therein similar to depressions 2 and 9 in the cylindrical surfaces of the wheel dies 1—1 used in the machine shown in Fig. 4. As in the machine shown in Fig. 1, core 7 and the certain material 6 pass through the machine of Fig. 2 in a series of steps whereas they pass through the machine of Figs. 4 and 5 in a continuous process of operation. When jaws 16—16 are closed by gears 17—17 and 18, the resulting compressing action will cause material 6 to be formed into beads 8—8 around core 7 as in the other types of machines. When jaws 16—16 are opened (as shown by the dotted lines in Fig. 2), core 7 and material 6 should be moved along one step. The operation described above may then be repeated.

Under certain conditions, the use of loading coils, as such, is sometimes undesirable. Thus, in submarine cables, continuous loading is provided by means of permalloy tape. According to this invention, a loading arrangement may be utilized which employs beads 8—8 composed of any desirable magnetic material, such as loading coil iron dust. Preferably, this material should include some desirable binding material, such as asphalt or shellac. When this material is used in place of the other material 6, such as glass, loading members will be formed upon core 7 instead of insulating members. These members like the others described above, can be of any shape and have any spacing that is desired.

As shown in Fig. 9, a new improved type of coaxial concentric conductor may be made in accordance with this invention. After beads 8—8 have been formed upon core 7 by any one of the several machines described above, such as the one shown in Fig. 4, core 7 with beads 8—8 formed thereon is then passed through drawing die 20. At the same time, a band of conductive covering material 21 is also passed through drawing die 20. Drawing die 20 has a conical aperture 22 therein so that the band of conductive covering material 21 can be formed into a tube, or sheath 23 surrounding core 7 and beads 8—8. Tubular sheath 23 will be separated and insulated from core 7 by beads 8—8 which will maintain a coaxial dielectric air-space of low loss between core 7 and tubular sheath 23. Beads 8—8 may be of any of shapes shown in Fig. 6 and may have any desired spacing. Since it is preferred to non-rotatably localize the beads 8—8 by means of the arrangement shown at C in Fig. 8, wire 7 in Fig. 9 is illustrated as having perforated enlargements 30—30. If it is thought necessary or desirable, sheath 23 may be passed through a soldering bath (not shown) after coming out of drawing die 20.

The arrangements shown in the drawing are illustrative of the operation of the invention and will serve to assist in interpreting the claims. The claims are not to be restricted to the precise construction described above, but are intended to include all changes and modifications employing the principles and features of operation of the invention.

What is claimed is:

1. An electric conductor comprising an electrically conductive wire having flattened portions at spaced intervals, each flattened portion having a hole therein, and a plurality of beads formed upon the wire, each bead being formed around one of the flattened portions of the wire and having a portion of its material disposed in one of the holes in the wire for forming a spindle whereby each bead is non-rotatably localized upon the wire.

2. A coaxial concentric conductor comprising an electrically conductive wire having flattened portions at spaced intervals, each flattened portion having a hole therein, a plurality of beads of insulating material formed at spaced intervals upon the wire, each bead being formed around one of the flattened portions of the wire and having a portion of its material disposed in the hole in that flattened portion of the wire for forming a spindle whereby each bead is non-rotatably localized upon the wire, and an electrically conductive tube formed around the beads whereby an air-space is provided between the wire and the tube.

3. A coaxial concentric conductor comprising an electrically conductive wire having flattened portions at spaced intervals, each flattened portion having a hole therein, a tubular sheath of conductive material formed around the wire, and spacing means for equidistantly spacing the wire from the tube, said means comprising uniformly shaped beads of insulating material formed at spaced intervals upon the wire, each bead being formed around one of the flattened portions of the wire and having a portion of its material disposed in the hole in that flattened portion of the wire for forming a spindle whereby each bead is non-rotatably localized upon the wire.

4. An electric conductor comprising an electrically conductive wire having flattened portions at spaced intervals, each flattened portion having a hole therein, and a plurality of uniform loading members composed of magnetic material and formed upon the wire, each member being formed around one of the flattened portions of the wire and having a portion of its material disposed in one of the holes in the wire for forming a spindle whereby each member is non-rotatably localized upon the wire.

5. An electric conductor comprising an electrically conductive wire having enlargements at spaced intervals, and a plurality of beads formed upon the wire, each bead being formed around one of the enlargements of the wire whereby each bead is localized upon the wire.

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