

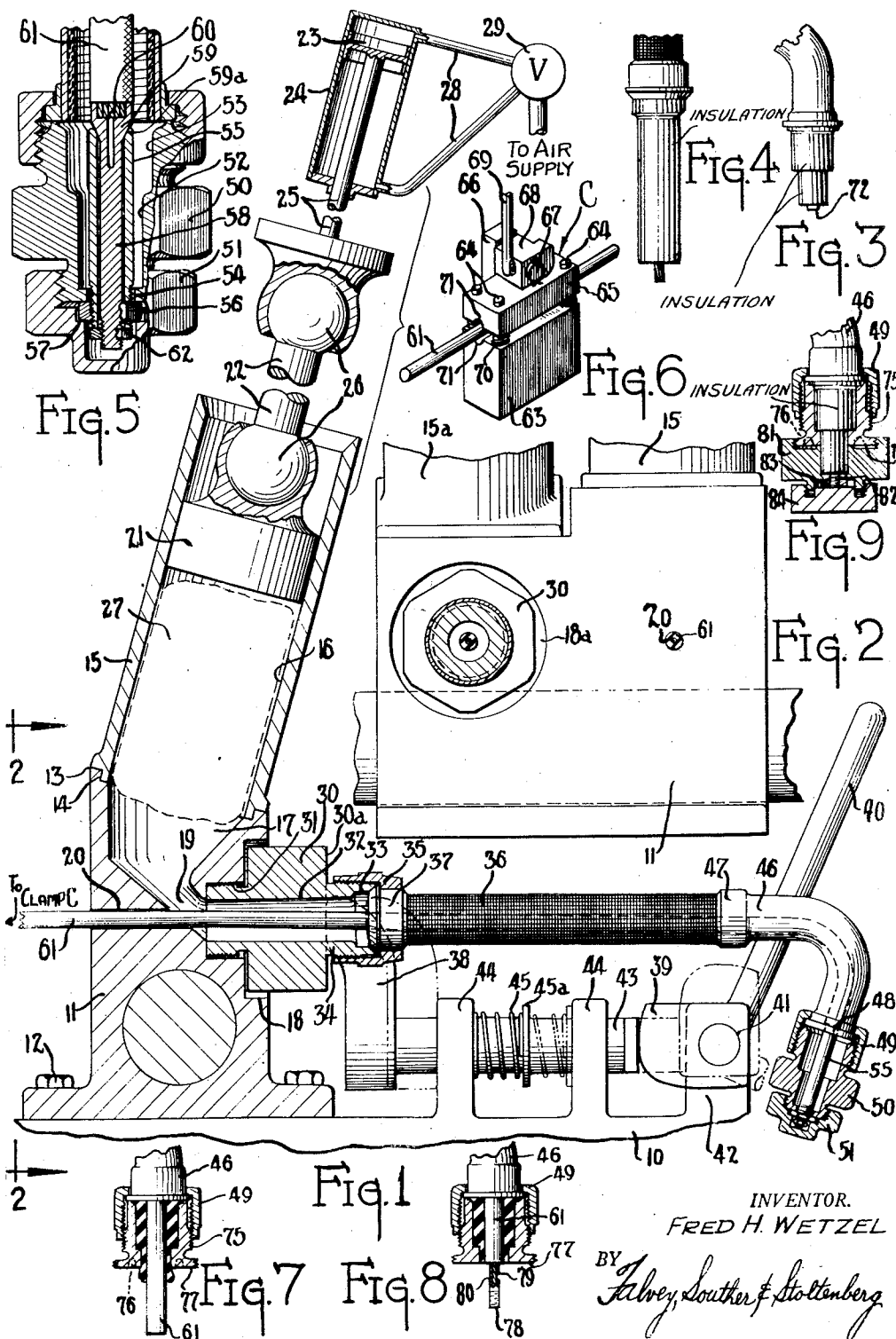
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SHIELDED IGNITION LEAD

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## SHIELDED IGNITION LEAD

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This invention relates to ignition systems, more particularly to shielding for ignition systems for aircraft including high tension leads between the spark plugs and the source of high electrical tension, such as a magneto or the like.

The use of shielding in the form of tubing in connection with high tension electrical leads in ignition systems for aviation engines is old in the art and has been attended with difficulties which cause breakdowns in the ignition systems of the engines with which the shielding systems are used. These difficulties usually are caused by moisture condensation in the shielding tubes in the space between the insulated wire positioned on the inside of the tube and the interior of the tube itself, the moisture being carried into this space by "breathing" usually caused by changes in temperatures or pressures due to sudden changes in altitude. To overcome these difficulties, it has been suggested to fill the space between the insulated wire and the shielding tubing with a viscous fluid or compound similar to a heavy oil.

This method of obviating the difficulties pointed out above is subject to several objections inasmuch as it is practically impossible to completely fill the space with this viscous compound. Even if the tubes are filled completely under a given condition of pressure and temperature, when the airplane is taken to high altitudes the pressure and temperature conditions are subject to wide variations which will cause the viscous compound which is essentially a fluid to expand or contract, giving rise to air bubbles in the system. When the viscous compound expands, some of the compound will be forced out through small leaks in the system which will extrude some of the compound which, in turn, aggravates the situation upon return to normal conditions. Upon contraction of the viscous compound, voids will be created in the system which usually result in air bubbles and defeat the purpose for which the viscous compound is positioned in the tubing.

The present invention provides a method of obviating these difficulties by positioning an elastic body, such as rubber or the like, between the insulated wire and the shielding tubing. The elastic compound is extruded into position around the insulated wire and preferably extends beyond the ends of the shielding tube where it is formed to a predetermined contour by means of molds and the whole shielding tube, including the molds, is then subject to a curing process which will polymerize the compound which has been extruded into position into a permanent rubber-

like body of a unitary composition positioned between the wire and the shielding tube. Terminal portions may be attached to the ends of the wire at any convenient time in the process. This may be accomplished at an intermediate step, such as prior to the extruding step, or it may occur at the end of the extruding step and before the curing takes place.

The shielded ignition lead made in accordance with the present invention consists in its completed form of an insulated wire positioned in a metallic shielding tube which may, or may not, include an elbow with the ends of the wire positioned in centered relation with the ends of the tubing and the space between the insulated wire and the metallic shielding tube completely filled with an elastic rubber-like compound including projections extending from each end of the shielding tube to facilitate the making of connections in an electrical circuit. The shielding tubing is provided with the usual nipples so that convenient mechanical connection may be made with either a spark plug or a shielding manifold.

It is, therefore, a principal object of this invention to provide a method of positioning an elastic body between an insulated conductor and a metallic shielding tube, the elastic body having projecting ends and consisting of a unitary body cured in position.

It is a further object of this invention to provide a method for positioning an elastic insulating body between an electric conductor and a metallic shielding tube provided with an elbow, which consists of first positioning an insulating body about the conductor, then inserting the insulated conductor into the shielding tube, providing molds at the ends of the shielding tube for holding the insulated conductor in centered relation with the tubing and extruding the elastic compound into the assembly through one of the molds positioned on the ends of the shielding tube to completely fill the space in the tubing and both molds and thereafter curing the elastic compound in position in the assembly.

It is a further object of this invention to provide a method of completely filling the space between an insulated conductor and a metallic shielding tube provided with an elbow which will center the ends of the insulated conductor with reference to ends of the shielding tube.

It is a further object of this invention to provide a method of positioning an insulated wire into a shielding tube provided with an elbow, by surrounding the wire with an elastic body of insulating compound to completely fill the space

between the wire and the shielding tube and to provide projecting ends of a predetermined contour integral with the elastic body to facilitate connecting the wire in an electric circuit.

Other objects and advantages of this invention relating to the arrangement, operation and function of the related elements of the structure, to various details of construction, to combinations of parts and to economies of manufacture, will be apparent to those skilled in the art upon consideration of the following description and appended claims, reference being had to the accompanying drawing forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

Fig. 1 is an elevational view, partly in section, of a mechanism used in carrying out the invention.

Fig. 2 is an elevational view, taken along the line 2—2 of Fig. 1.

Fig. 3 is an elevational view of one of the projecting ends of a completed spark plug lead.

Fig. 4 is an elevational view of another projecting end of a completed spark plug lead.

Fig. 5 is an enlarged sectional elevation of a mold.

Fig. 6 is a perspective view of a clamping device for use with the mechanism shown in Fig. 1.

Figs. 7 and 8 are sectional elevations of portions of another mold type.

Fig. 9 is a sectional elevation of the complete mold, shown in part in Figs. 7 and 8.

Referring to the drawing, particularly to Fig. 1, an elevational view of an extruder is shown which is used to carry out this invention. The extruder is provided with a base 10 to which is attached a cylinder support 11 by means of bolts 12. The upper surface of the cylinder support 11 is cut obliquely at 13 and provided with a recess 14 into which fits the lower end of a cylinder member 15 which projects upwardly at a slight angle to the vertical. The bore 16 of the cylinder member is in communication with a recess 17 formed in the cylinder support 11 which, in turn, communicates with a stepped circular recess 18 by means of a throat 19. The stepped recess 18 is concentric with a bore 20 which extends from the throat 19 through the cylinder support 11 to the forward side opposite from the stepped recess 18.

A piston 21 is provided to fit snugly into the bore 16 of the cylinder, the piston being reciprocated by means of a connecting rod 22 connected to a second piston 23 of an air cylinder 24 by means of a piston rod 25. An articulated connection is provided between the piston rod 25 and the piston 21 by means of a pair of ball and socket joints 26 which allow the piston 21 to be removed completely from the bore 16 so that plastic insulating compound 27 (shown in phantom) may be inserted into the bore 16 to load the extruder apparatus for use. The cylinder 24 is adapted to move the piston 23 upwardly or downwardly and is in communication with a source of air pressure by means of conduits 28 which are under control of a main valve 29 to allow an operator to selectively move the piston 21 upwardly or downwardly in order to operate the extruder.

Two cylinders 15 and 15a may be mounted on the cylinder support 11 as is clearly shown in Fig. 2. The cylinders are mounted so that they extend upwardly in a divergent angle and the stepped recesses 18 and 18a are positioned on opposite sides of the cylinder support 11.

The stepped recesses 18 and 18a are adapted to cooperate with mold members 30 which have

threaded projections 31 fitting into the smaller portion of the stepped recess. The mold cavity is in the form of a bore 32 extending longitudinally of the mold 30, being provided at its inner end with a flared portion 33 and being in communication with throat 19 at its outer end. The inner end of the mold adjacent the flared portion 33 is provided with a threaded extension 34, to which is attached a threaded nipple 35 of a shielding tube 36. The threaded nipple 35 is attached to the shielding tube 36 by means of a flanged collar 37 which is preferably soldered or otherwise conveniently attached to the tube.

The mold 30 is positioned in the stepped recess 18 by the manual operation of an operator and is held in position in the recess by means of a clamping member 38 which reciprocates longitudinally under the action of a cam member 39 under manual control of a manual lever 40 which is adapted to rotate the cam member about a journal 41 positioned in an upstanding ear 42 preferably integral with the base member 10. The cam member 39 reciprocates a horizontal bar 43 sliding through apertures in a pair of spaced ears 44 preferably integral with the base member 10. A spring 45 is provided to embrace the rod, being anchored against an ear 44 and acting against a flange 45a on the rod to urge the same against the face of the cam member 39. Mounted on the forward end of the rod 43 are the clamping members 38 in the nature of fingers to contact the face 30a of the mold member 30 to urge the mold member into the recess cavity 18.

The shielding tube 36 may be provided in various lengths and sizes, depending upon the purpose for which it is to be utilized. On the free end of the shielding tube 36 an elbow 46 may be provided, being soldered or otherwise attached to the tube by means of an enlarged collar 47 which embraces the outer part of the tube 36. The elbow 46 is provided with a flanged collar 48 to cooperate with a threaded nipple 49 which is used for the purpose of attaching the shielding tubing to a spark plug. The threaded nipple 49 is utilized also for the purpose of attaching a mold member 50 to the end of the elbow 46. The mold member is provided with a closure cap 51 for purposes which will be described hereinafter.

The details of the mold member 50 are shown on an enlarged scale in Fig. 5 where the cavity of the mold 50 is shown as a bore 52 and a counter-bore 53. The floor of the mold cavity is provided with an aperture 54 through which projects a threaded tubular member 55 which terminates adjacent the upper portion 53 of the mold cavity. The threaded portion of the tube 55 cooperates with a nut 56, which abuts against the lower side of the floor of the mold member, and is clamped against it by the floor of a recess 57 formed in the closure cap 51. Positioned on the interior of the tubular member 55 a threaded stud 58 is provided which has, at its upper end, a hollow enlarged portion 59 with a conical lower face 59a cooperating with the end of the tubular member 55 forming a clamp which is adapted to grip the conductor end 60 of an insulated lead 61. The method of positioning the conductor end 60 of the insulated lead 61 into the clamp will be described in greater detail hereinafter.

The threaded end of the stud 58 cooperates with a nut 62 which abuts against the lower end of the threaded sleeve 55 and pulls conical section of the enlarged portion 59 against the open end of the tube for the purpose of closing in the clamp to grip firmly the conductor end 60 of the lead 61.

Referring again to Fig. 1, the insulated lead 61 extends to the left to cooperate with a clamp C, the details of which are shown in perspective in Fig. 6. The clamp C is preferably attached to the base member 10 in any convenient manner by its base block 63, which has four upwardly projecting pins 64 threading aligned apertures in a movable member 65. The base member 63 is provided with an upwardly projecting lug 66 to extend above the upper surface of the movable member 65 where a journal pin 67 is positioned to project over the upper surface thereof. Mounted on the journal pin 67 is a cam block 68 which is actuated by means of a manual lever 69 to urge the movable member downwardly. Springs 70 are positioned about the pins 64 to contact the upper surface of the base block 63 and the lower surface of the movable member 65 to urge them apart to allow ready insertion of the insulated lead 61, and by the manual manipulation of the lever 69 the movable member 65 may clamp the insulated lead 61 against the base block 63 to prevent longitudinal movement of the lead. The cooperating surface of the base block 63 with the lower face of the movable member 65 may be recessed at 71 to prevent localization of pressure on the insulated lead which might otherwise damage the insulation thereof.

The longitudinal axis of the recesses 71 is in alignment with the aperture 20 in the cylinder support 11 so that the insulated lead 61 may be conveniently positioned first between the clamping members and then into the aperture 20, through the throat 19 into the mold member 30, through the shielding tube 36 into the elbow 46 and finally into the lower mold member 50 at the free end of the shielding tubing 36. At this point the insulation is removed for a short distance from the conductor end which is then positioned into the clamp 59 and the nut 62 is tightened until the clamp 59 grips the free ends 60 firmly. The closure member 51 is then positioned onto the end of the mold 50 so that the tubular member 55 is held in centered relation with the mold cavity and firmly held in position therein against longitudinal movement by having the nut 56 on the tubular member 55 clamped between the recess 57 in the closure member 51 and the floor of the mold member 50. The insulated conductor 61 is then pulled toward the left to place it under tension (Fig. 1) and the clamp member C is tightened to hold the wire in position. By this means the insulated lead 61 is substantially centered in the two mold cavities.

The positioning of the insulated conductor 61 has been described above as being positioned within the assembly including the mold member 30, the shielding tubing 36, the elbow 46 and the mold 50 which has already been mounted in the extruder substantially as shown in Fig. 1, where the mold member 30 is held firmly in the stepped recess 18 by means of the clamping fingers 38 under the influence of the cam member 39. It is to be understood however that this operation may be accomplished by using wires cut to predetermined length so that the operation may be accomplished separate from the extruder and then the completed assembly positioned on the extruder, as has already been described, with the clamping operation of the clamp C on the conductor being the last operation in the sequence. The first method is to be preferred inasmuch as it allows the insulated conductor 61 to remain in position on a supply reel (not shown) positioned beyond the clamp C and thereby a wastage of

wire during the operation is substantially obviated.

With the shielding tube 36 and its attached mold members 30 and 50 in assembled relation with the insulated conductor 61, all mounted in position on the extruder substantially as shown in Fig. 1, an operator may direct air pressure into the upper end of the cylinder 24 to move the piston 23 downwardly to actuate the piston 21 so that the viscous insulating compound 27 will be forced downwardly into the throat 19, thence into the mold cavity 32, thence through the shielding tubing 36 into the elbow member 46 and finally into the cavity of the mold 50 to completely fill all the space between the insulated conductor 61 and the shielding tubing 36 and both molds. The air in the assembly will be forced out ahead of the insulating compound through small leaks so that no air bubbles will be formed at any place. This will result in a unitary body of insulated compound extending from the terminus of the throat 19 to the floor in the cavity of the mold 50. Air pressure is then directed to the lower side of the cylinder 24 moving the piston 23 upwardly to retract the piston 21. The manual lever 40 is then actuated to release the fingers of the clamping member 38 which will allow removal of the complete assembly from the extruder. The insulated lead 61 will be pulled out toward the right, as shown in Fig. 1, and will be cut off adjacent the end of the mold member 30 and a closure cap will be positioned over the threaded end 31. The whole assembly is then subjected to a process which will cure the viscous insulating compound while it is in position in the assembly. This curing process is well known in the art and need not be described in detail.

After the curing process is complete, the mold members are detached from the ends of the shielding tubing 36 by unscrewing the nipples 35 and 49 which will leave the projecting tips of the cured compound in substantial conformation as shown in Figs. 3 and 4. The conformation shown in Fig. 3 is the result of the cavity of the mold 50 while the conformation shown in Fig. 4 is the result of the cavity of the mold 30. The mold 50, due to the positioning of the tube 55 (Fig. 5), will have a void into which may be positioned a conducting member having characteristics suitable for making connection with a spark plug and, if desired, a resistor 72 of predetermined value may be positioned in the cavity. Terminal caps may be attached to the ends of the conductors in the well known manner.

The conductor 61 is preferably covered with insulation which has corona resistant qualities and is fully adequate to isolate the conductor when placed in the shielding tube 36, notwithstanding the additional insulating compound that is extruded into the tube from the cylinder 15 of the extruder. The insulating compound 27 extruded into the tube 36 is preferably selected from neoprene stock having corona resistant qualities and which is, when cured, a self-sustaining body having elastic properties.

Figs. 7, 8 and 9 disclose another type of mold which may be used in place of mold 50 on the free end of the shielding tube. This mold is preferably made in three parts (Fig. 9), the upper portion 75 being attached to the end of the elbow 46 by means of the nipple 49 substantially as described above with reference to the mold member 50. The mold cavity in this type of mold is of similar conformation to the cavity

of mold 50, however, a parting line is provided in this type in the lower portion of the projecting portion adjacent the terminus of the mold member 75 as is most clearly shown in Fig. 7. The mold member 75 is first attached to the nipple 49 by means of a spanner wrench (not shown) cooperating with apertures 76 formed in the lower face 77 of the mold member 75. With the mold member 75 in position, a complete assembly is attached to the extruder in the manner similar to that already described and the extrusion of the viscous molding compound continues until the operator observes the molding compound being ejected from the aperture of the mold member 75 substantially as shown in Fig. 7. The insulated lead 61 is held by the clamp C so that the free end projects a substantial distance from the mold cavity of the mold member 75 substantially as shown.

At this time the operator removes the assembly from the machine and cuts away the extruded insulated compound from the face 77 of the mold member 75 and also cuts away the insulation of the lead 61 so as to be able to position a hollow terminal member 78 about the bare metallic conductor 79 substantially as shown in Fig. 8. With the terminal member 78 in position, the upper end thereof is crimped at 80 to hold it in permanently assembled relation with the lead 61. The second mold member 81 (Fig. 9) is then positioned on the mold member 75, left-handed threads being provided to form a cooperative relation between the two mold members which allows the use of a wrench to attach the second mold member 81 in position on the first mold member 75. The terminal member 78, which is attached to the bare conductor 79, extends through an aperture 82 formed in the floor of the now completed mold cavity and is provided with a nut 83 on the exterior to hold the parts together in fixed relation. Inasmuch as the extruded insulating compound was cut off at the face 77, a small portion of insulated compound is now positioned in the mold cavity formed in the mold member 81 before it is attached to the mold member 75. The smaller portion of insulating compound contacts the main portion at the parting line. The third portion 84 of the mold is then mounted in position in a threaded relation with the mold portion 81 and prevents the terminal member from moving longitudinally with reference to the mold member 81 by abutting against the nut 83 substantially as shown.

The complete assembly is then removed from the extruding machine and treated in the same manner as the previous one already described including the curing step which unifies the small portion of molding material with the main portion so as to form a unified body of cured insulating compound extending through the whole assembly. In this construction, the projecting end formed by the mold 30 is substantially the same as the one previously described whereas the projecting portion formed by the mold 75 has the same outer contour but is not provided with a cavity as the one previously described. The threaded terminal tip 78 projects slightly from the end of the terminal substantially as shown in Fig. 9. Terminal tips may again be applied if desired.

The mold members are now removed in this modification in the same manner as that already described and the parts are reassembled for a new cycle of operation.

It is to be understood that the above detailed description of the present invention is intended to disclose an embodiment thereof to those skilled in the art, but that the invention is not to be construed as limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawing, since the invention is capable of being practiced and carried out in various ways without departing from the spirit of the invention. The language used in the specification relating to the operation and function of the elements of the invention is employed for purposes of description and not of limitation, and it is not intended to limit the scope of the following claims beyond the requirements of the prior art.

What is claimed is:

1. The method of positioning a unitary body of insulating compound in a shielding tube, housing an insulated wire comprising, positioning threaded nipples on each end of the length of tubing, attaching mold members by a threaded relation with the nipples to each end of the tubing, placing an insulated wire from a continuous strand in the tube and attaching the free end thereof to one of the mold members, holding the continuous strand of wire adjacent the other mold, extruding an insulating compound into the tube through the last mentioned mold to completely fill the spaces between the insulated wire, the molds and tubing with a continuous piece of insulating compound, severing the wire contained in the assembly from the continuous strand of wire adjacent the holding means and thereafter curing the insulating compound in position.

2. The method of positioning a unitary body of insulating compound in a shielding tube, housing an insulated wire comprising, positioning threaded nipples on each end of the length of tubing, attaching mold members by a threaded relation with the nipples to each end of the tubing, placing an insulated wire from a continuous strand in the tube and attaching the free end thereof to one of the mold members, holding the continuous strand of wire adjacent the other mold, extruding an insulating compound into the tube through the last mentioned mold to completely fill the spaces between the insulated wire, the molds and tubing with a continuous piece of insulating compound, severing the wire contained in the assembly from the continuous strand of wire adjacent the holding means, curing the insulating compound in position and thereafter removing the mold members from cooperative position with the nipples.

3. The method of positioning a unitary body of insulating compound in a shielding tube, housing an insulated wire comprising, positioning threaded nipples on each end of the length of tubing, attaching mold members by a threaded relation with the nipples to each end of the tubing, placing an insulated wire from a continuous strand in the tube and attaching the free end thereof to one of the mold members, holding the continuous strand of wire adjacent the other mold, extruding an insulating compound into the tube through the last mentioned mold to completely fill the spaces between the insulated wire, the molds and tubing with a continuous piece of insulating compound, severing the wire contained in the assembly from the continuous strand of wire adjacent the holding means, curing the insulating compound in position, removing the mold members from cooperative position with the nipples and

thereafter attaching terminals to the ends of the wire.

4. The method of securing a high tension electrical conductor covered with suitable insulation in a metallic shielding tube comprising, positioning the insulated conductor into the shielding tube by inserting from one end thereof and holding the ends of the conductor in centered relation with the tube, attaching a closed mold member to one end of the tube cooperating in concentric relation with one end of the conductor, at-

5 attaching an open mold to the other end of the tube cooperating in concentric relation with the conductor, extruding an insulating compound through the open mold into the tube to completely fill the space between the conductor and the tube and the conductor and the molds, severing the body of insulating compound adjacent the end of the open mold and curing the insulating compound to form a unitary body of insulating material.

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