

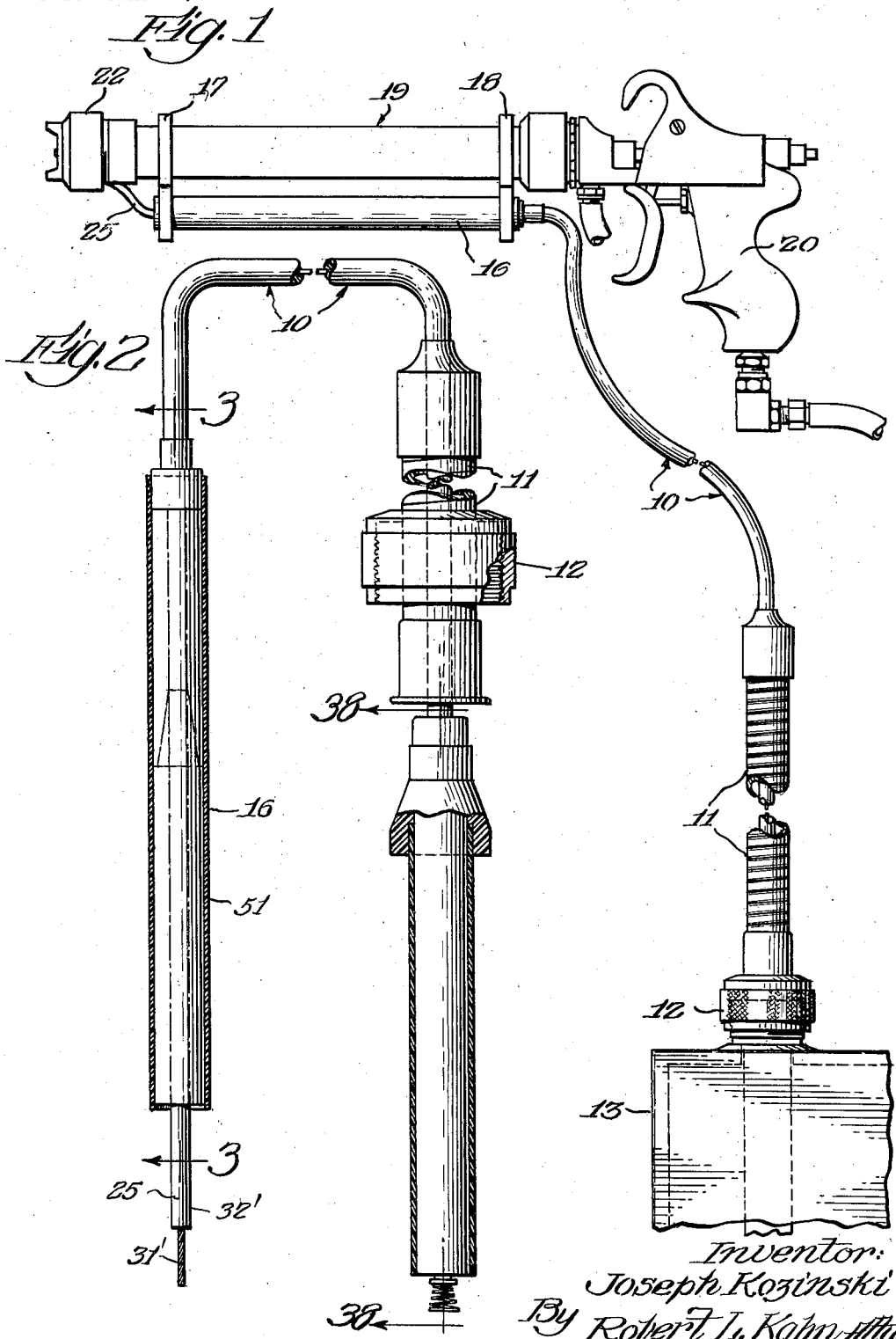
**Sept. 24, 1963**

**J. KOZINSKI**  
**ELECTRIC RESISTOR**

**3,105,218**

Filed June 30, 1961

7 Sheets-Sheet 1



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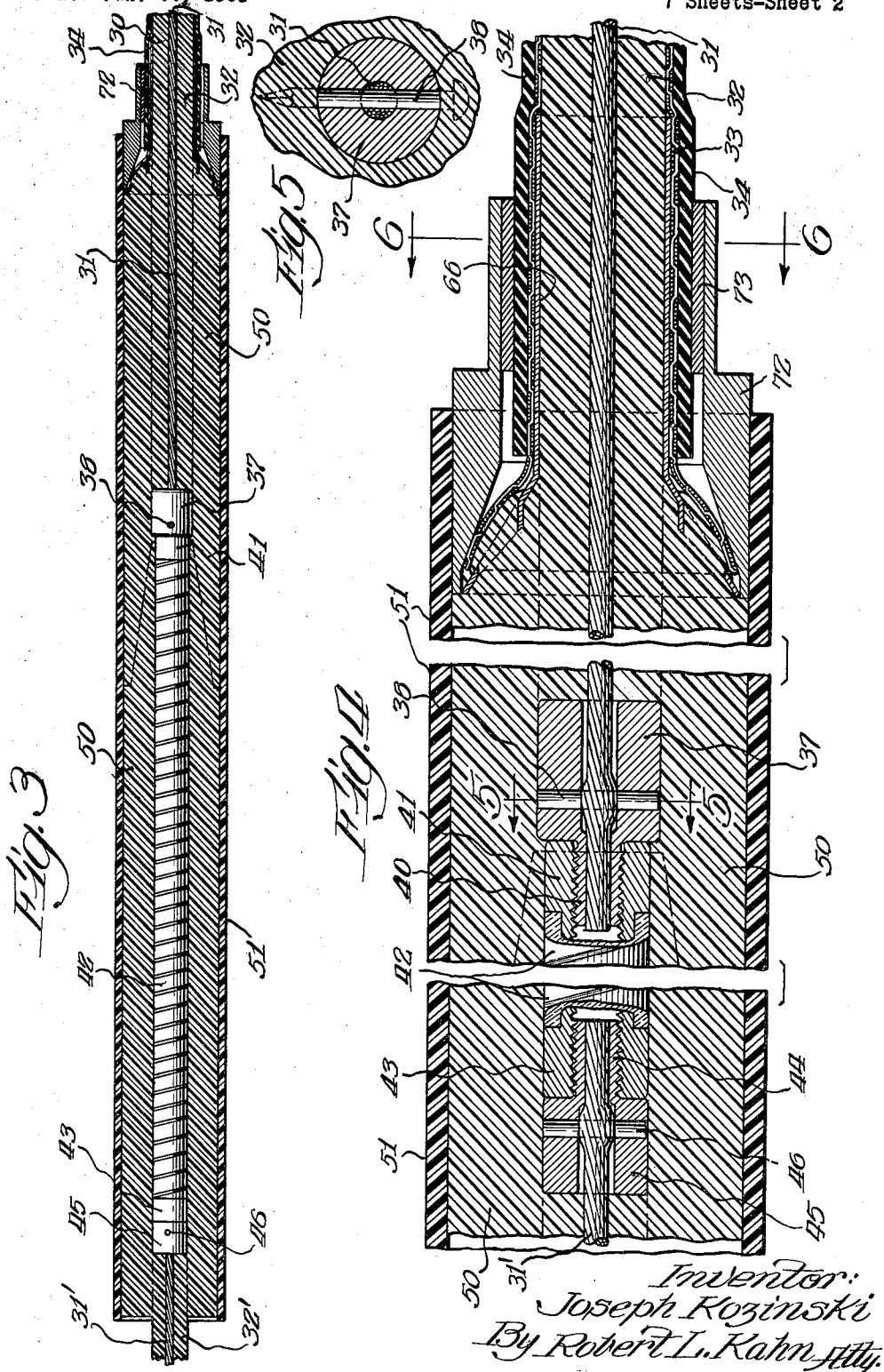
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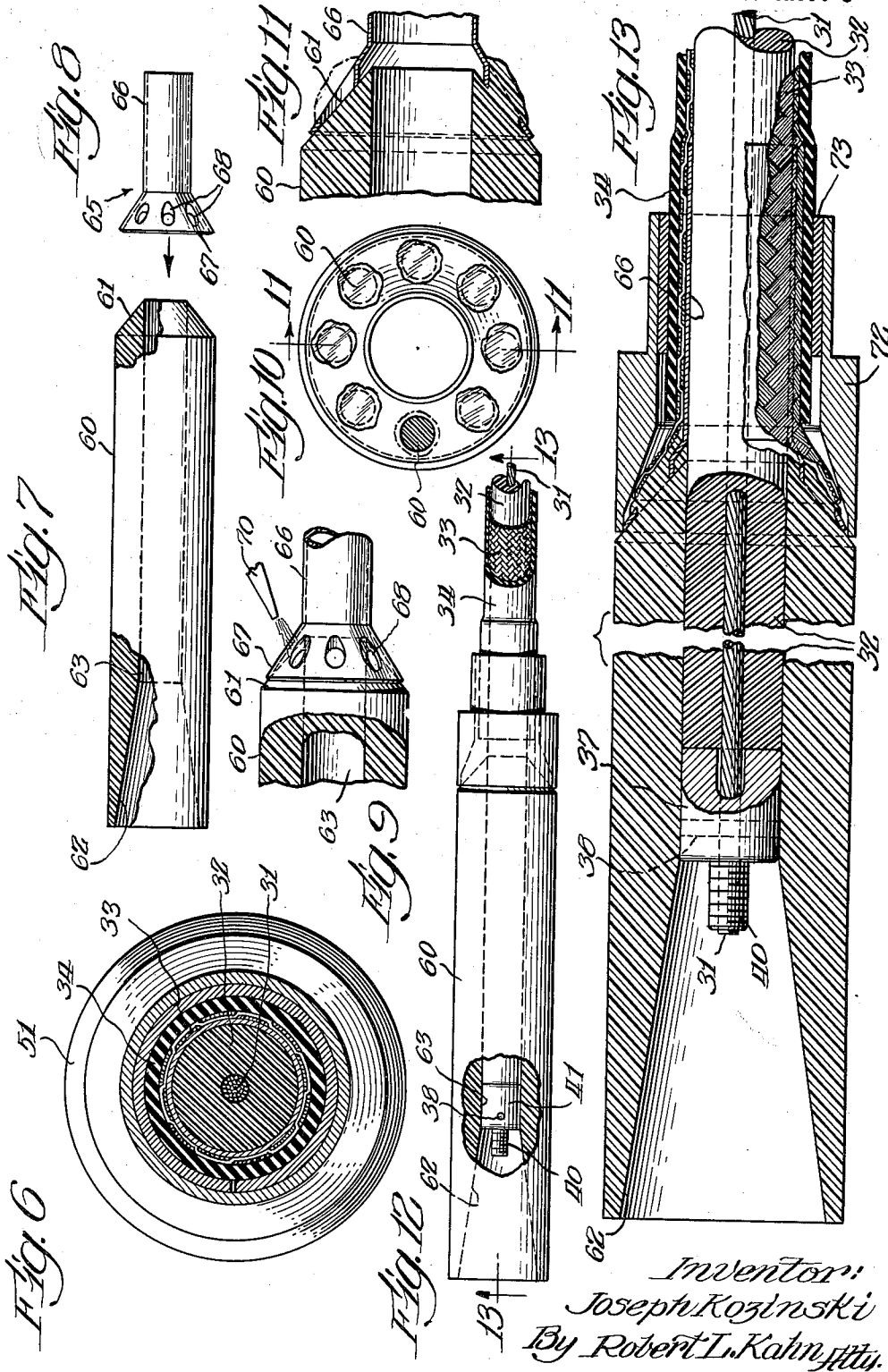
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7 Sheets-Sheet 3



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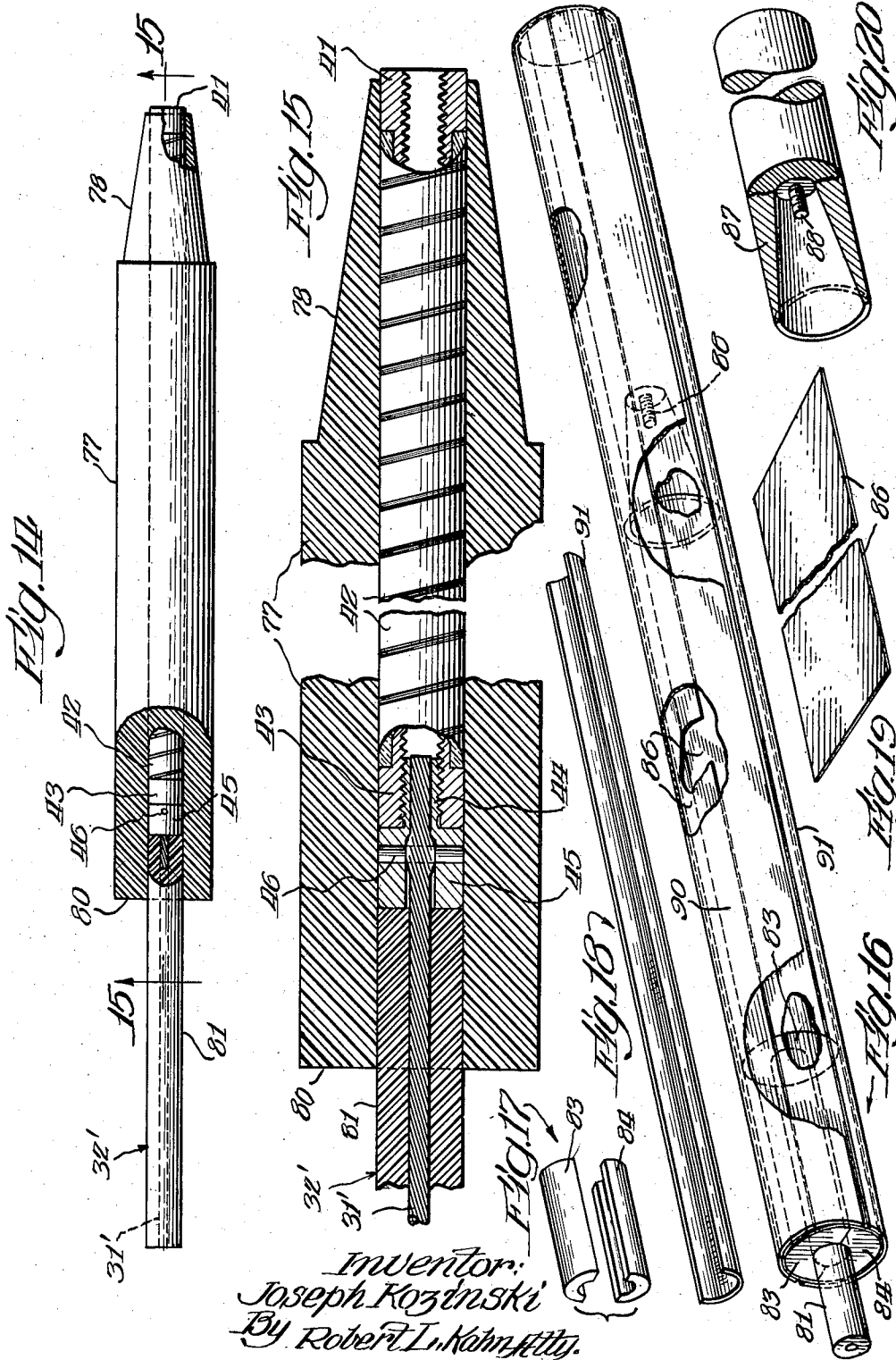
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7 Sheets-Sheet 4



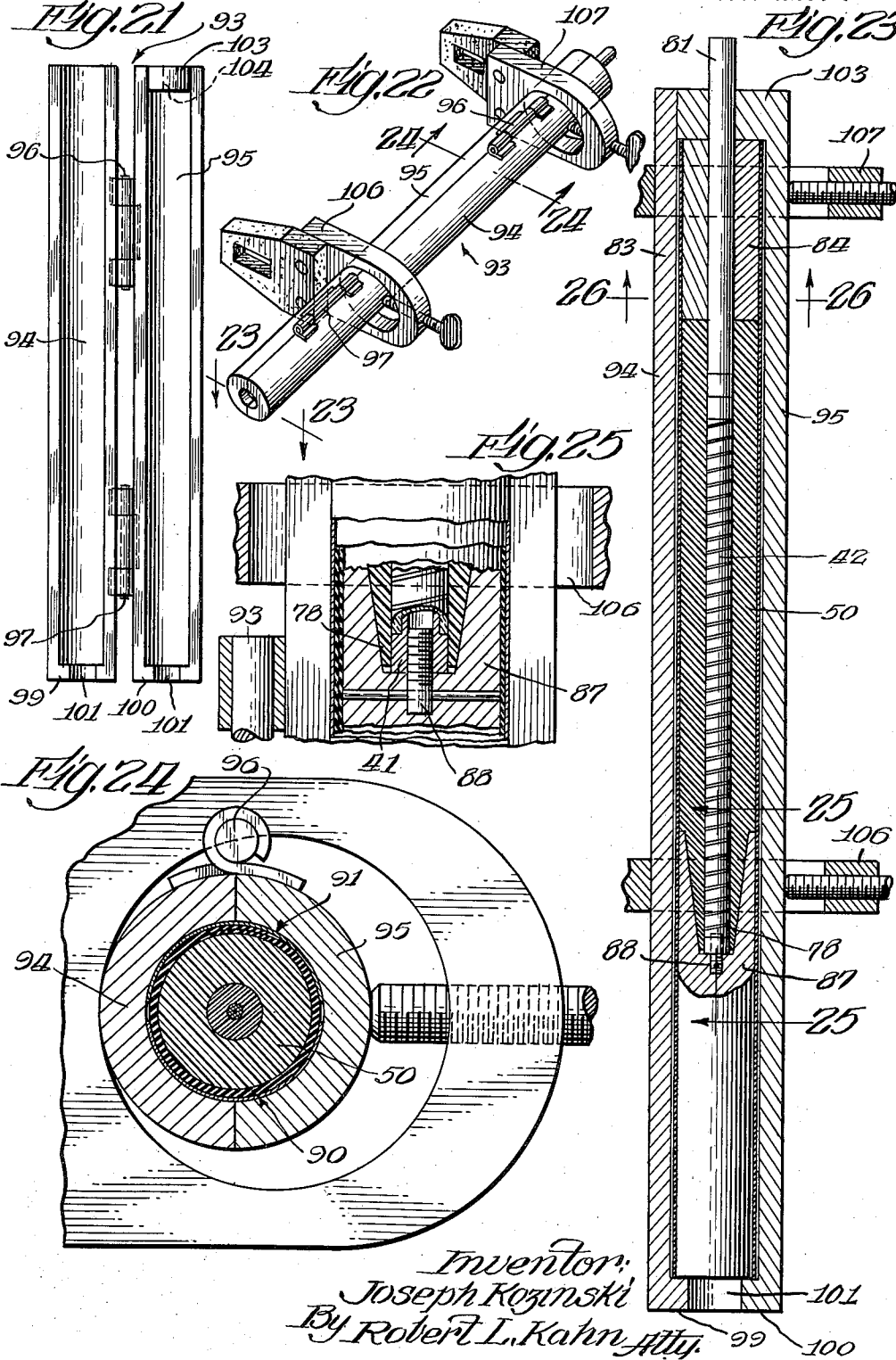
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*Fig. 26*

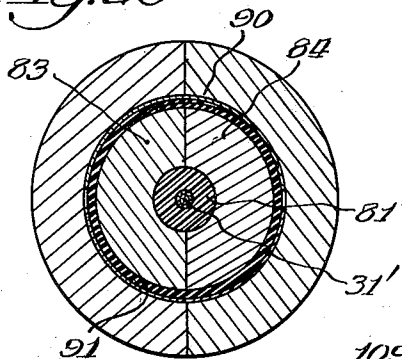


*Fig. 27*

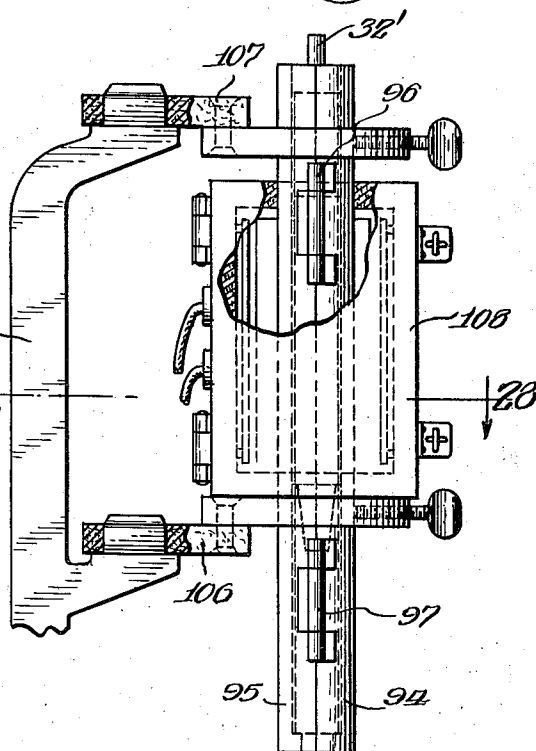


*Fig. 36*

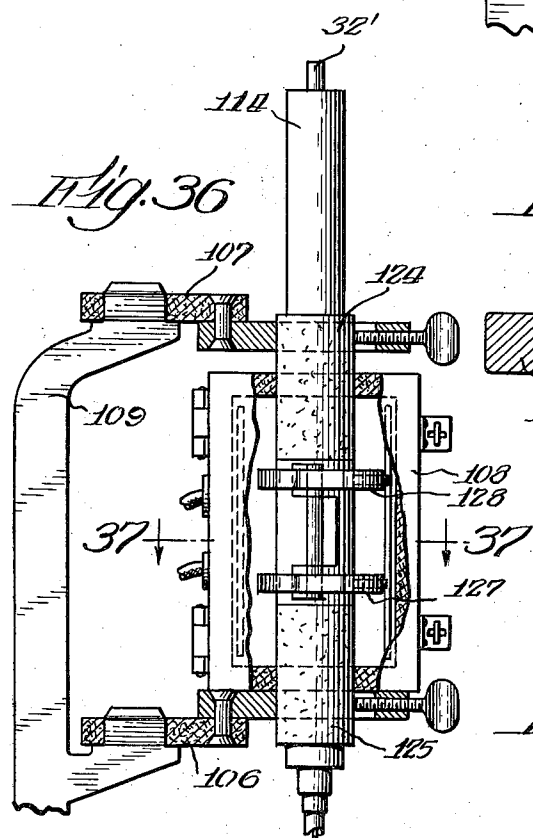


*Fig. 28*

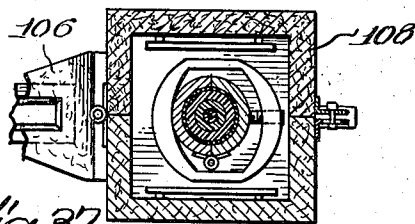
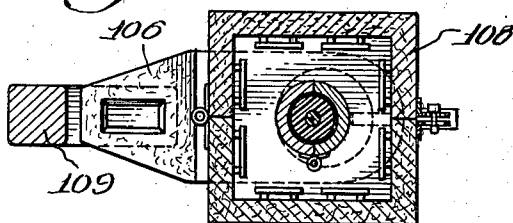


*Fig. 37*

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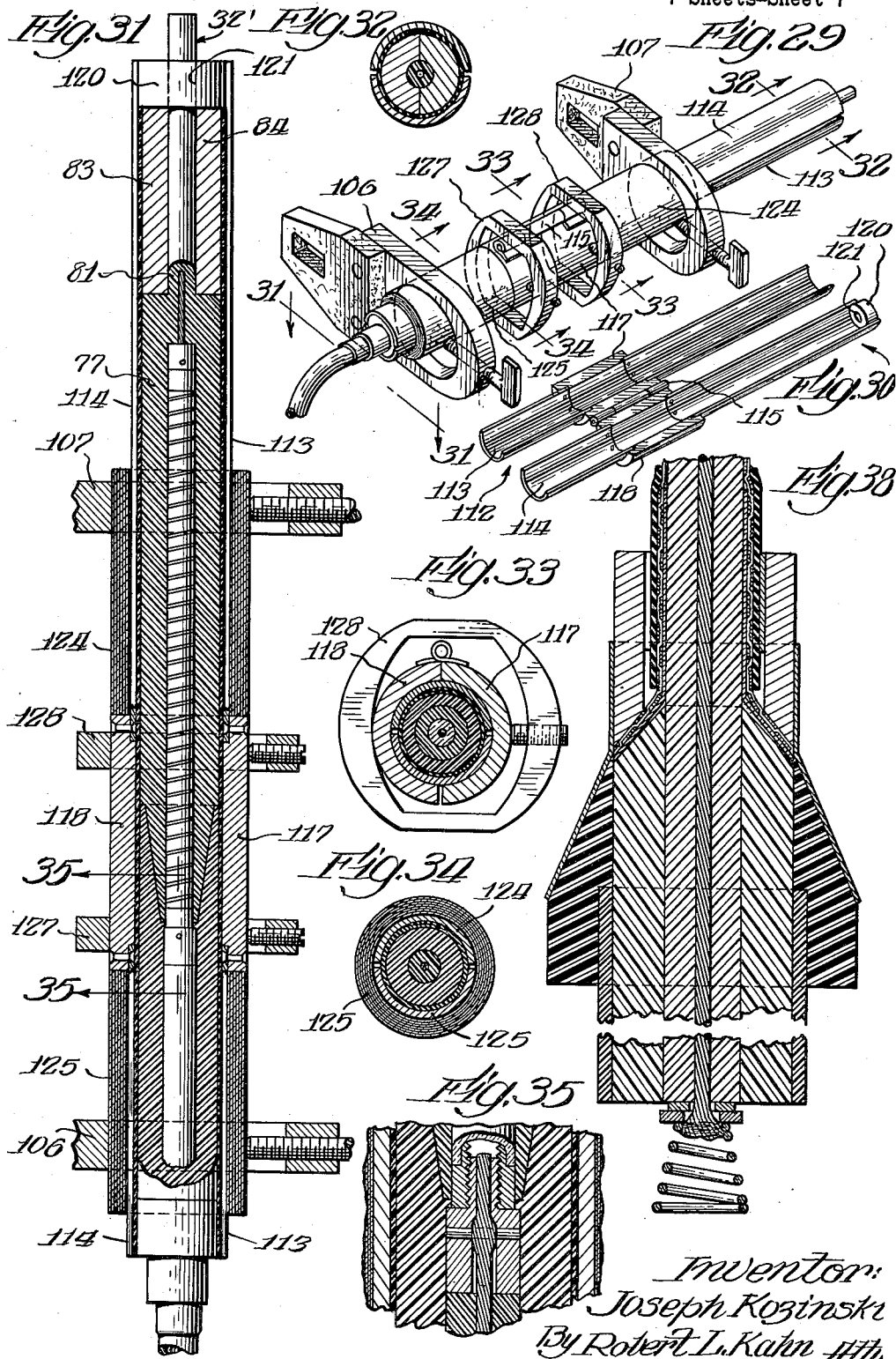
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7 Sheets-Sheet 7



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3,105,218

## ELECTRIC RESISTOR

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Filed June 30, 1961, Ser. No. 120,987  
4 Claims. (Cl. 338-214)

This invention relates to a high potential cable and method of making same and more particularly to a high potential cable which may be readily connected and disconnected.

The high potential cable forming the subject matter of this invention and the method of making the same are particularly useful for electrostatic coating systems. In such systems, potentials of the order of 100,000 volts are customary. The normal current in such systems is of the order of a few milliamperes. Generally the power supply for such a system has a dropping voltage regulation. Consequently, any significant current leakage may result in a sharp drop in output potential. It is therefore clear that excellent insulation between the power supply and atomizing means for the coating material is essential.

Apart from the above, in spite of poor voltage regulation, any defects of insulation in the cable system may be dangerous to an operator. The cable embodying the present invention has its insulation problem aggravated by the presence of a resistor in the cable. This resistor is generally in the megohm range and under some circumstances may have substantially the entire potential difference developed by the power supply impressed across its terminals.

The resistor may be at a portion of the cable which is handled by an operator. In the preferred embodiment, the cable portion containing the resistor is close to the atomizing means of a coating system. Thus when a conventional spray gun is the atomizing means, the portion of the cable containing the resistor can be attached to the gun and may be readily accessible to an operator.

The insulation for high potential cables used for coating systems, X-ray tube systems and the like generally consists of a suitable plastic such as polyethylene. In order to mold the polyethylene or other plastic, it has been considered necessary to provide expensive molding forms and accessories. Unfortunately, cables of this character are not made in large quantities, and furthermore the cables do not all require the same value of resistors. In many instances, the exact value of a resistor is not known until a particular installation has been designed or used.

While a material like polyethylene melts at a relatively low temperature, considerable difficulty is encountered in molding a cable portion containing special fixtures. Of utmost importance is the necessity for avoiding air bubbles in the plastic insulation. An air bubble or void in a medium such as polyethylene, which has a dielectric constant higher than air, is likely to induce arcing across the air bubble or void when a high potential field is present. Such arcing disintegrates the solid insulation and renders the same conductive. Thus the insulation is ultimately destroyed.

The present invention makes it possible to have a cable with special accessories, such as resistors, and provided with a thermoplastic insulation, such as polyethylene, homogeneous without danger of voids. This construction is obtainable in a simple manner with simple equipment and avoids any substantial expense in molds, casting forms and the like. The equipment necessary for molding is so simple that any desired cable configuration may be provided to suit the occasion.

The invention will be disclosed in connection with drawings, and accordingly, reference will now be made to such drawings.

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FIGURE 1 is an illustration of a cable embodying the present invention disposed between the casing of a power supply and a spray gun for use in an electrostatic coating system.

FIGURE 2 shows the high potential cable with the terminations illustrated in section and certain welded joints between insulation shown in dotted lines.

FIGURE 3 is an enlarged section of a portion of the cable on line 3-3 of FIGURE 2.

FIGURE 4 is an enlargement on a still larger scale of a portion of the cable illustrated in FIGURE 3.

FIGURE 5 is a sectional detail on line 5-5 of FIGURE 4.

FIGURE 6 is an enlarged sectional detail on line 6-6 of FIGURE 4.

FIGURE 7 is a view with parts broken away of an insulating sleeve forming part of the cable structure prior to fabrication.

FIGURE 8 is a detail of a metal stress sleeve to be used with the insulating sleeve of FIGURE 7.

FIGURE 9 is a view illustrating the metal sleeve and insulating sleeve being joined.

FIGURE 10 is an end view of the joined sleeves.

FIGURE 11 is a sectional detail on line 11-11 of FIGURE 10.

FIGURE 12 is a view with certain parts broken away illustrating the supported end of the cable after one preliminary operation.

FIGURE 13 is an enlarged sectional view on line 13-13 of FIGURE 12.

FIGURE 14 is a view illustrating a short length of cable containing a resistor disposed in an insulating sleeve for fabrication.

FIGURE 15 is a sectional view on an enlarged scale on line 15-15 of FIGURE 14.

FIGURE 16 is a perspective view with certain parts broken away showing cable portions and molding accessories assembled preliminary to a first molding operation.

FIGURE 17 shows a portion of the mold.

FIGURE 18 shows a still different portion of the mold.

FIGURE 19 shows a strip of steel forming part of the mold.

FIGURE 20 illustrates the strip of Teflon in which the work is encased during the molding.

FIGURE 21 shows the first mold with the halves open prior to insertion of the work.

FIGURE 22 shows the first mold disposed in clamps for locking, at which operation the resistor is molded into the polyethylene sleeve.

FIGURE 23 is an enlarged sectional detail on line 23-23 of FIGURE 22 illustrating the cable portions in the first mold.

FIGURE 24 is a sectional detail on line 24-24 of FIGURE 22.

FIGURE 25 is an enlarged sectional detail on line 25-25 of FIGURE 23.

FIGURE 26 is a section on line 26-26 of FIGURE 23.

FIGURE 27 shows the first mold in position in a heater for molding the first time.

FIGURE 28 is a section on line 28-28 of FIGURE 27.

FIGURE 29 is a perspective view illustrating the disposition of the various parts for the second molding operation in a second mold.

FIGURE 30 shows the two metal members making up the second mold.

FIGURE 31 is an enlarged sectional view on line 31-31 in FIGURE 29 showing the parts in preparation for the second molding.

FIGURE 32 is a sectional detail on line 32-32 of FIGURE 29.

FIGURE 33 is a sectional detail on line 33—33 of FIGURE 29.

FIGURE 34 is a sectional detail on line 34—34 of FIGURE 29.

FIGURE 35 is an enlarged sectional detail on line 35—35 of FIGURE 31.

FIGURE 36 is a view generally similar to FIGURE 27 but illustrating the second molding procedure.

FIGURE 37 is a section on line 37—37 of FIGURE 36.

FIGURE 38 is an enlarged sectional detail on line 38—38 of FIGURE 2.

Referring first to FIGURES 1, 2 and 38, a high potential cable, generally indicated by 10, has terminating assembly 11 coupled by screw sleeve 12 to transformer or power supply casing 13. Assembly 11 has a helical spring wound around the same to prevent this end of the cable from being bent or kinked too sharply. The helical spring around assembly 11 and casing 13 are preferably of metal and are normally grounded. The conductor may have a spiral helical spring at the transformer end for easy connection.

Cable 10 may have any desired length and has assembly 16 supported by clamps or brackets 17 and 18 from spray gun barrel, generally indicated by 19. The spray gun illustrated here may have the usual gun handle 20 with connections to air and coating material such as paint. Barrel 19 of the spray gun may be of insulating material, although this is not essential to the present invention. In any event, the spray gun has insulating nozzle structure 22 provided with electrodes inside therein, not shown. The electrode within nozzle 22 is normally maintained at high potential by insulated cable 25 going into the interior of the nozzle structure.

Cable 10 may be provided in various lengths and must be able to be easily disconnected from casing 13 at the power supply and the gun. As has been previously pointed out, it is of the utmost importance that terminating structures 11 and 16 of the cable be constructed in such manner that the full insulating value of the cable is maintained at all times.

There is no problem involved with regard to assembly 11, since this is standard on all units or can be standardized. The problem is present in connection with assembly 16 containing a high value resistor. The value of this resistor will depend upon the particular system installed and such a resistor may vary from a comparatively low value such as 100,000 ohms to as much as 1,000 megohms. A resistor having a high value will have a high potential difference across the terminals thereof. Accordingly, the insulation of the resistor both along the length thereof and laterally is of great importance.

The invention generally concerns itself with the molding of assembly 16. This molding is accomplished in two stages and will now be described.

Referring first to FIGURES 3 to 5 inclusive, the finished assembly will be described. The polyethylene cable has portion 30, which may be considered as the portion going from the cable proper into assembly 16. Cable 30 consists of stranded copper wire 31 surrounded by a body of polyethylene 32. Disposed around polyethylene body 32 is metal braid or shield 33 over which is layer 34 of rubber or some hard glossy plastic or fabric material to protect the cable against abrasion.

While ordinarily the current carried by the conductor is quite small, in the order of milliamperes, copper wire 31 generally consists of a number of stranded conductors and may be the equivalent of No. 10 or No. 12 wire. The polyethylene body 32 will normally have a radial thickness of the order of about a quarter of an inch and may even be somewhat larger. Copper braid or shield 33 will be the conventional shielding wire common in shielded cables. The outer sheath 34 may be of heavy rubber or plastic having suitable abrasion resistance. Copper conductor 31 extends into terminal fitting 37 of brass or copper. In order to anchor the wire to the fit-

ting, metal pin 38 is provided transversely of fitting 37 and passes through stranded conductor 31. Fitting 37 is provided with threaded coupling sleeve 40 which can be screwed into threaded terminal sleeve 41 forming part of resistor 42. Resistor 42 is a long, tubular member whose length and the value of whose resistance will vary depending upon specifications. As a rule, the diameter of the resistor may be of the same general order as that of polyethylene body 32.

Resistor 42 has threaded terminal sleeve 43 into which may be screwed threaded terminal sleeve 44 of fitting 45. Fitting 45 is similar to fitting 37 and is provided with transverse pin 46 passing through stranded conductor 31'.

Beyond the end of assembly 16 where cable 31' emerges, conductor 31' can have the same polyethylene insulation 32' and be similar generally in all respects to the incoming cable to the assembly.

The objective of the present invention is to surround the resistor and the conductors at the two ends of the resistor with an adequate body of polyethylene and properly center the resistor in the polyethylene. As illustrated in FIGURES 3 and 4, polyethylene, generally indicated by 50, is disposed around the entire resistor and leads thereto to form a unitary body. Disposed around the outside of polyethylene body 50 is rigid insulating tube 51 of Bakelite or other suitable material to protect the polyethylene against bending or damage. Tube 51 may be of any rigid material and need not even be of insulating material. The dotted lines shown in FIGURES 3 and 4 show the weld lines between what was previously separate bodies of polyethylene but which have become consolidated and merged into one unitary construction. Because of the high potential involved, it is desirable to provide a stress relief metal cone construction where shield braid 33 goes into enlarged polyethylene body 50. This will be described in connection with the method of fabricating this assembly.

In order to fabricate this assembly, it is necessary to begin with polyethylene sleeve 60 illustrated in FIGURE 7. Sleeve 60 has externally tapered end 61 and internally tapered end 62. Sleeve 60 has bore 63 which is just large enough to accommodate polyethylene insulation 31 around cable 30. Fitting over tapered end 61 is stress relief cone 65 of brass or any other suitable metal. Stress relief cone 65 consists of tubular portion 66 and cone portion 67, the latter having a plurality of slots 68 disposed around the cone. Tubular portion 66 has its inside diameter substantially equal to the inside diameter of bore 63 and can thus accommodate layer 31 of the cable insulation. Cone portion 67 is shaped to snugly fit against tapered end 61 of sleeve 60.

As illustrated in FIGURE 9, stress relief cone 65 is positioned against tapered end 61 of the polyethylene sleeve and the polyethylene is melted by torch 70 so that a good interlock between the two is secured. Tubular portion 66 of the stress relief cone is slipped below or inside of shielding braid 32, as illustrated in FIGURE 13. The end portion of braid 32 is fanned out to slip over the stress relief cone portion 67. Due to the high voltage and the low current at which the cable is operated, it is generally not necessary to solder the braid to the stress relief cone. However, this may be done if desired.

In order to finish the braid and stress relief cone, it is preferred to slip sleeve 72 over the outside of the cable and tapered end of sleeve 60. Sleeve 72 may be of metal or insulation and can be provided with inner ring portion 73 for snugly engaging outside layer 33 of the high potential cable. In practice, sleeve 72 has enough clearance to slide smoothly along the outside of the cable but will tend to lock where the cable is somewhat enlarged, as illustrated in FIGURE 13. This is where tubular portion 66 is underneath the braid and enlarges the outside diameter of that end of the cable. The above step of join-

ing the stress relief cone to the polyethylene sleeve may be deferred to the second molding operation.

As has been previously pointed out, cable 31 is anchored to fitting 37 by means of pin 38 passing through the same. Fitting 37 has external sleeve portion 40. As illustrated in FIGURE 13, fitting 37 is disposed so that the end thereof is within bore 63 of sleeve 60 near the small end of internally tapered portion 62.

Resistor 42 is straight and has a cylindrical outer surface which is substantially equal in diameter to the outside diameter of polyethylene portion 32 of the cable. Resistor 42 is to be disposed within polyethylene sleeve 77, illustrated in FIGURE 14. Polyethylene sleeve 77 has the outside diameter substantially equal to the outside diameter of polyethylene sleeve 60. For convenience, sleeve 60 will be referred to as the cable sleeve, while sleeve 77 will be referred to as the resistor sleeve. Resistor sleeve 77 has externally tapered portion 78 which is shaped to complement internally tapered portion 62 of the cable sleeve. Resistor sleeve 77 is somewhat longer than the resistor body so that fittings 43 and 45 at the end of the resistor are within the sleeve. In addition, a small part of cable 32' can also be within resistor sleeve 77.

Resistor sleeve 77 is first molded to resistor 43. The means for accomplishing this is illustrated in FIGURES 16 to 28 inclusive. Prior to inserting resistor 43 into resistor sleeve 77, cable portion 32' is threadedly coupled to the resistor by turning one with respect to the other. When the cable portion and the resistor are thus joined, the resistor is slid into resistor sleeve 77, this being illustrated in FIGURE 14. Cable 32' has portion 81 of the cable which is adjacent end 80 of the resistor sleeve. Disposed around portion 81 of the cable are two semi-cylindrical sleeve portions 83 and 84 of metal such as aluminum, brass or of material like ceramic which will not be damaged by heat or the molten polyethylene and to which the polyethylene will not stick. Sleeve portions 83 and 84 are adapted to fit snugly around portion 81 of the cable. The outside diameter of sleeve portions 83 and 84 when fitted together is equal to the outside diameter of resistor sleeve 77. A metallic mold is disposed around the resistor sleeve and the aluminum semi-circular sleeves. In order to prevent the metallic mold from sticking to the polyethylene, sheet 86 of a suitable non-stick material is wrapped around the entire assembly. This is illustrated in FIGURE 23. Sheet 86 is preferably of a material like Teflon, which is a fluoro carbon resin, or if desired, a sheet of Kel-F may be used, this being generally similar. This material has the property of not adhering to practically all plastics. Sheet 86 is large enough to be wrapped completely around resistor sleeve 77 and metal sleeve parts 83 and 84. Preferably, sheet 86 is large enough so that more than one turn can be taken, with the overlap preventing any direct contact between polyethylene and the region outside of sheet 86.

Prior to wrapping the sheet into position, dummy head 87 of aluminum or other metal is positioned over tapered end portion 78 of the resistor sleeve. Dummy head 87 is shaped to provide a snug fit over the tapered end of the resistor sleeve and is so dimensioned that the outside surface of head 87 is flush with the outside surface of resistor sleeve 77. Dummy head 87 is preferably provided with bolt portion 88 for engaging the fitting at the end of the resistor body at tapered portion 78. The Teflon sheet overlays dummy head 87, as well as semi-cylindrical portions 83 and 84.

The assembly of resistor sleeve and other parts wrapped in Teflon is now disposed between two semi-cylindrical metal sleeves 90 and 91. The metal may be of steel, aluminum or any other material which can be heated. As illustrated in FIGURE 16, sleeve portions 90 and 91 are long enough to cover dummy head 87 and sleeve blocks 83 and 84. This assembly, as illustrated in FIGURE 16, is now disposed in fixture 93 of metal such as

aluminum, steel or the like. Fixture 93 consists of two semi-cylindrical portions 94 and 95 hingedly secured at 96 and 97 so that the two can close to form a cylindrical chamber. The bottom end of portions 94 and 95 of the fixture is provided with end walls 99 and 100 shaped to provide a generally circular passageway 101. The top end of fixture 93, as illustrated in FIGURE 21, is preferably provided with circular end wall 103 carried by part 95 of the fixture and provided with opening 104 there-through. Through this opening 104, it will be necessary to thread cable portion 32' of the assembly, as the assembly is disposed in the fixture. The fixture is made of sufficiently heavy metal so that it may be heated conveniently.

The assembly disposed in the fixture is now put into clamps 106 and 107 of any suitable construction having jaws and clamping bolts as illustrated for maintaining the fixture tightly closed around the assembly to be molded. Preferably the fixture and clamping means are of sturdy construction, since polyethylene expands when it melts.

The entire assembly as seen in FIGURES 23 and 24 is now disposed vertically in an oven 108 supported on stand 109 as seen in FIGURE 27 and is heated by any suitable means, such as for example, an electric heating element. It is essential that the temperature of the assembly be raised to a point at which the polyethylene liquifies. The vertical positioning of the mold and contents is important for the reason that air bubbles can escape along the copper wire strands or near the outside of the polyethylene. The use of the dummy cap illustrated in FIGURE 18 prevents polyethylene from going to the bottom terminal of the resistor body. The construction of the fixture and the end walls thereof provide a confining force for the polyethylene as it expands and melts, with the result that a substantial pressure is built up and the resistor body is firmly molded into the polyethylene. In addition, the part of cable 32' which is disposed within resistor sleeve 77 is also welded to the sleeve to form a unitary construction.

When the mold cools, the polyethylene at portion 81 of the cable within metal sleeve portions 83 and 84 will contract and pull away from sleeve portions 83 and 84. It will therefore be unnecessary to provide any anti-stick means between sleeve portions 83 and 84 on the one hand and portion 81 of the cable. It is understood that portion 81 of the cable only has polyethylene around the wire and that otherwise this portion of the cable is free of braid or an outer covering. However, there is no reason why the part of cable portion 81 outside of end 80 of the polyethylene sleeve cannot incorporate the same braid and outer covering as is true of the main body of the cable described earlier.

When the mold has cooled, the fixture is taken out of the clamps and the entire mold assembly is dismantled to leave the resistor sleeve firmly molded to the polyethylene cable.

The next step is to mold the cable sleeve to the resistor sleeve. This is illustrated in FIGURES 29 to 37 inclusive. Referring back to FIGURE 3, the dotted lines show the line of separation between the cable sleeve and the resistor sleeve prior to molding. Prior to the second molding operation, cable portion 30 with its terminal fixture is slipped into position over tapered portion 78 of resistor sleeve 77. The cable is still loose in the cable sleeve and may easily be turned so that the terminals of the cable and resistor body may be coupled together. With the two terminal portions tight, the stress relief cone is heated to cause the polyethylene to flow in position and join the stress relief cone and cable sleeve. Thereafter, sleeves 72 and 73 may be positioned properly. It is also possible to leave this for the final molding. This complete assembly is now prepared for the molding operation. Due to the fact that the resistor sleeve has already been

molded to the cable, it is necessary to use a somewhat different arrangement for the second molding operation.

Referring now to FIGURES 30 and 37 inclusive, the entire assembly of the two polyethylene sleeves is wrapped in a layer of Teflon or the like for non-stick protection. Disposed around cable portion 81 are aluminum sleeve portions 83 and 84 as in the first molding operation. The entire assembly consisting of sleeve portions 83 and 84, resistor sleeve 77 and cable sleeve 60, together with the cable and resistor body as illustrated in FIGURE 31, is now wrapped in a sheet of Teflon or other material to prevent sticking. Disposed around the outside of the Teflon is a hinged metal sleeve, generally indicated by 112, and consisting of semi-cylindrical portions 113 and 114 hinged at 115. It will be noted that hinged metal sleeve 112 has the outer surface provided with abnormally heavy sleeve portions 117 and 118. Preferably, portions 117 and 118 are so constructed that these portions are of aluminum, whereas the remainder of portions 113 and 114 are of steel.

As FIGURE 30 illustrates, the various portions are riveted together so that the aluminum and steel is flush on the inside of the sleeve member with aluminum portions 117 and 118 being extra heavy and projecting as illustrated. Centering member 120 suitably apertured at 121 is provided at one end of one of the semi-cylindrical members, here shown as 114. The entire sleeve member is adapted to enclose the polyethylene sleeves, as illustrated in FIGURE 31. The location of aluminum portions 117 and 118 is such as to be around the portion of the assembly where tapered portion 62 of the cable sleeve fits over tapered portion 78 of resistor sleeve 77. The reason for the two different metals is that the aluminum will conduct heat rapidly, while the steel will conduct the heat so sluggishly as to confine the heat practically to the aluminum sleeve part. The direction of heat transferred is along the length of the steel so that the thin steel has relatively low conductivity in that direction. On the other hand, the heat applied for molding in the second step will go mainly inwardly perpendicular to the walls of the aluminum part of the sleeve.

As will be readily understood, the assembly of polyethylene sleeve is disposed in hinged sleeve member 112 with cable portion 31' being threaded through aperture 121 in end wall 120. The hinged sleeve is now closed, as illustrated in FIGURE 31. In order to confine the heat to aluminum portions 117 and 118, sleeves 124 and 125 of heat insulating material are disposed around the outside of hinged sleeve 112 on opposite sides of aluminum portions 117 and 118. These insulating sleeves may be of any suitable material, such as for example, mica, micalex or ceramic. For convenience, the outside diameter of heat insulating sleeves 124 and 125 are generally flush with the outside surfaces of aluminum surfaces 117 and 118. This entire assembly is now put into clamps 106 and 107 as in the first molding operation. These clamps are disposed around the sleeve insulating sleeve portions. Additional clamps 127 and 128 are disposed around the aluminum portions 117 and 118 to keep them tightly in position. As in the first molding operation, it is necessary that the entire mold be kept vertical as illustrated in FIGURE 31. In this position, aluminum portions 117 and 118 are heated in an electric oven as shown in FIGURE 26. The heat is sufficient to melt the polyethylene at the tapered junction between the two polyethylene sleeves. It is important that the position of the tapered joint be as illustrated in FIGURE 31 with the joint going outwardly and upwardly. Thus as the polyethylene is melted, air bubbles can escape to the outer edge of the polyethylene sleeves and escape along the outer surface of the polyethylene. Since the polyethylene within insulating sleeve 124 will not reach melting point, there will be enough clearance between the polyethylene sleeve and the Teflon material so that air bubbles can escape. Due to the expansion of the

polyethylene when heated to melting, there will be considerable pressure at the joint where welding takes place. Thus a homogeneous polyethylene construction for the cable is provided. The entire polyethylene will be welded into one unitary mass together with the polyethylene of the cable and this mass will be free of air bubbles.

If the stress relief cone had not previously been interlocked by melting the polyethylene at end 61 of the cable sleeve, it will be interlocked during this final molding step.

After heating, the mold is allowed to cool and the assembly removed from the mold. The finished product will be as illustrated in FIGURE 3 with the exception that there will be no line of cleavage between what was formerly separate masses of polyethylene.

What is claimed is:

1. A high potential cable structure comprising a length of conductor within a layer of moulded polyethylene, a metallic grounding sheath around said layer of polyethylene, said layer of polyethylene having a diameter of the order of about  $\frac{1}{4}$ " for most of the cable length, a resistor having a generally cylindrical body with terminals at the ends thereof, said resistor having one end terminal connected to one end of said cable conductor, a second length of high potential cable having a layer of polyethylene and having its conductor connected to the other terminal of said resistor, a polyethylene moulded sleeve disposed about the resistor body and extending beyond the resistor ends and moulded to parts of the polyethylene layers surrounding the conductors connected to the resistor terminals, said moulded sleeve having a substantially greater diameter than the polyethylene layers, said moulded sleeve merging with the polyethylene layers to provide homogeneous polyethylene insulation free of voids or discontinuities, one end of said moulded sleeve adjacent the one end of said cable conductor tapering down to the diameter of the polyethylene layer, a metallic stress relief cone at said one sleeve end, a metal sleeve attached to said cone, said metal sleeve extending beneath the grounding sheath, the end of said grounding sheath flaring out over the metal cone, and a covering sleeve of insulating material about the moulded sleeve for protecting the cable assembly.

2. The construction according to claim 1 wherein said resistor body has substantially the same diameter as the first named layer of polyethylene.

3. The construction according to claim 1 wherein said stress cone is disposed adjacent an end of the resistor body and has apertures therethrough with moulded polyethylene passing through said apertures for maintaining the stress cone firmly in position.

4. A high potential cable structure comprising a length of stranded conductor within a layer of polyethylene, a metallic grounding sheath around said layer of polyethylene, said layer of polyethylene having a diameter of the order of about  $\frac{1}{4}$ " for most of the cable length, a resistor having a generally cylindrical body with terminals at the ends thereof, means including a pin extending transversely through the stranded conductor for connecting said stranded conductor to one terminal of said resistor, a second length of high potential cable having a layer of polyethylene and having a stranded conductor similarly connected to the other terminal of said resistor, a polyethylene sleeve disposed about the resistor body and moulded thereto and extending beyond the ends of the resistor and moulded to portions of the polyethylene layers surrounding the stranded conductors going to the two resistor terminals, said sleeve having a substantially greater diameter than the polyethylene layers around the stranded conductors, said sleeve merging with the polyethylene layers to provide homogeneous polyethylene insulation free of voids or discontinuities, one end of said moulded sleeve adjacent the one end of said cable conductor tapering down to the diameter of the polyethylene layer, a metallic stress relief cone at said one

sleeve end, a metal sleeve member forming part of said stress cone and being disposed beneath the grounded sheath flaring out around the stress relief cone, a second sleeve disposed around the outside of the cable, said second sleeve having a conical portion adapted to overlie the stress cone, said ground sheath flaring out to extend between the two conical surfaces, and a rigid insulating tube disposed about the polyethylene sleeve and covering the conical portion of the second sleeve.

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