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[56]

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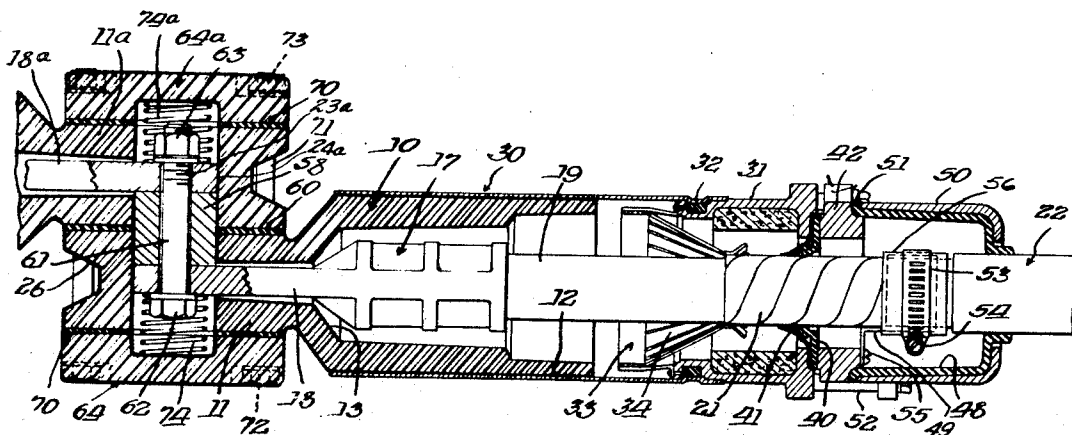
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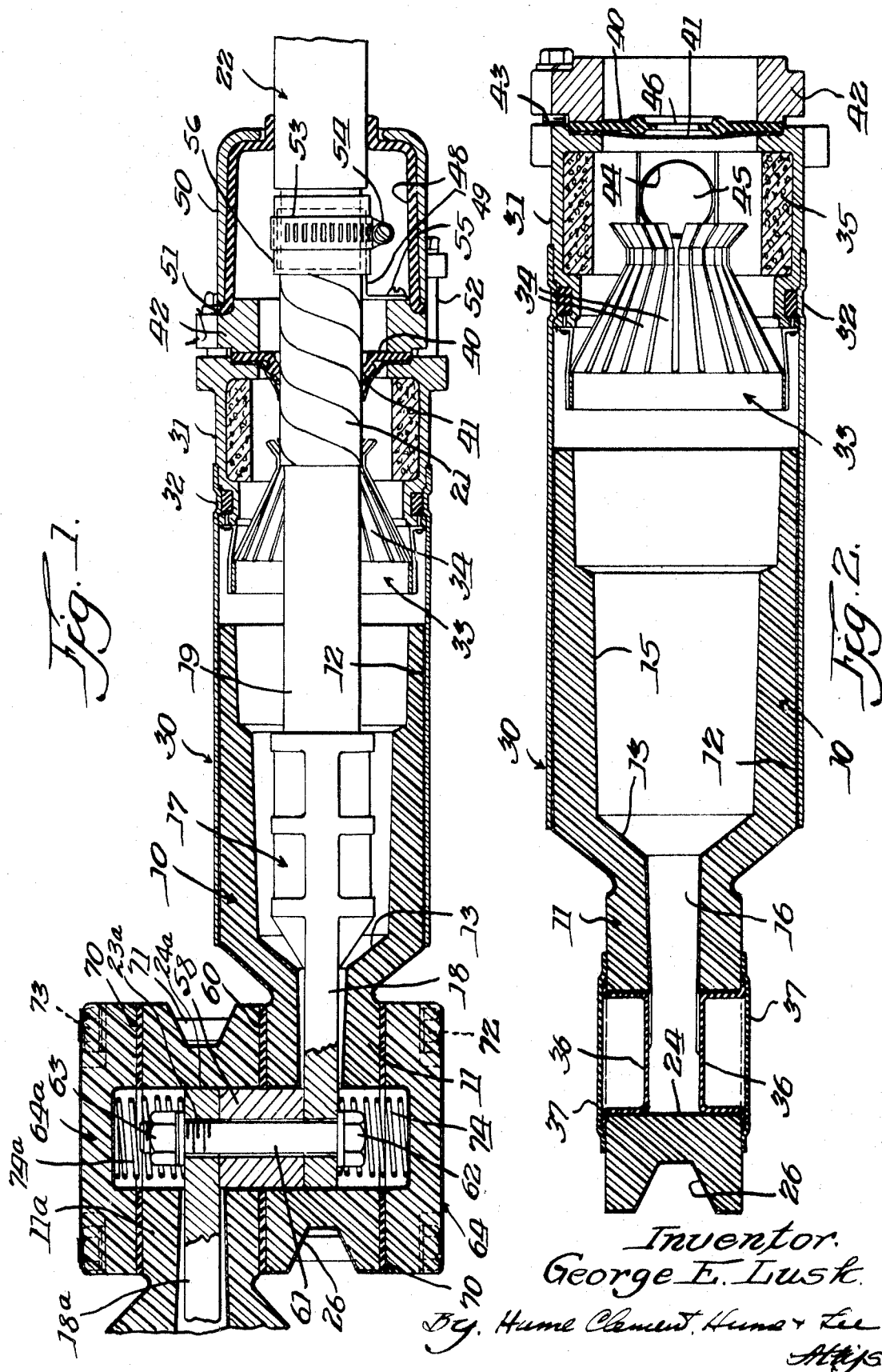
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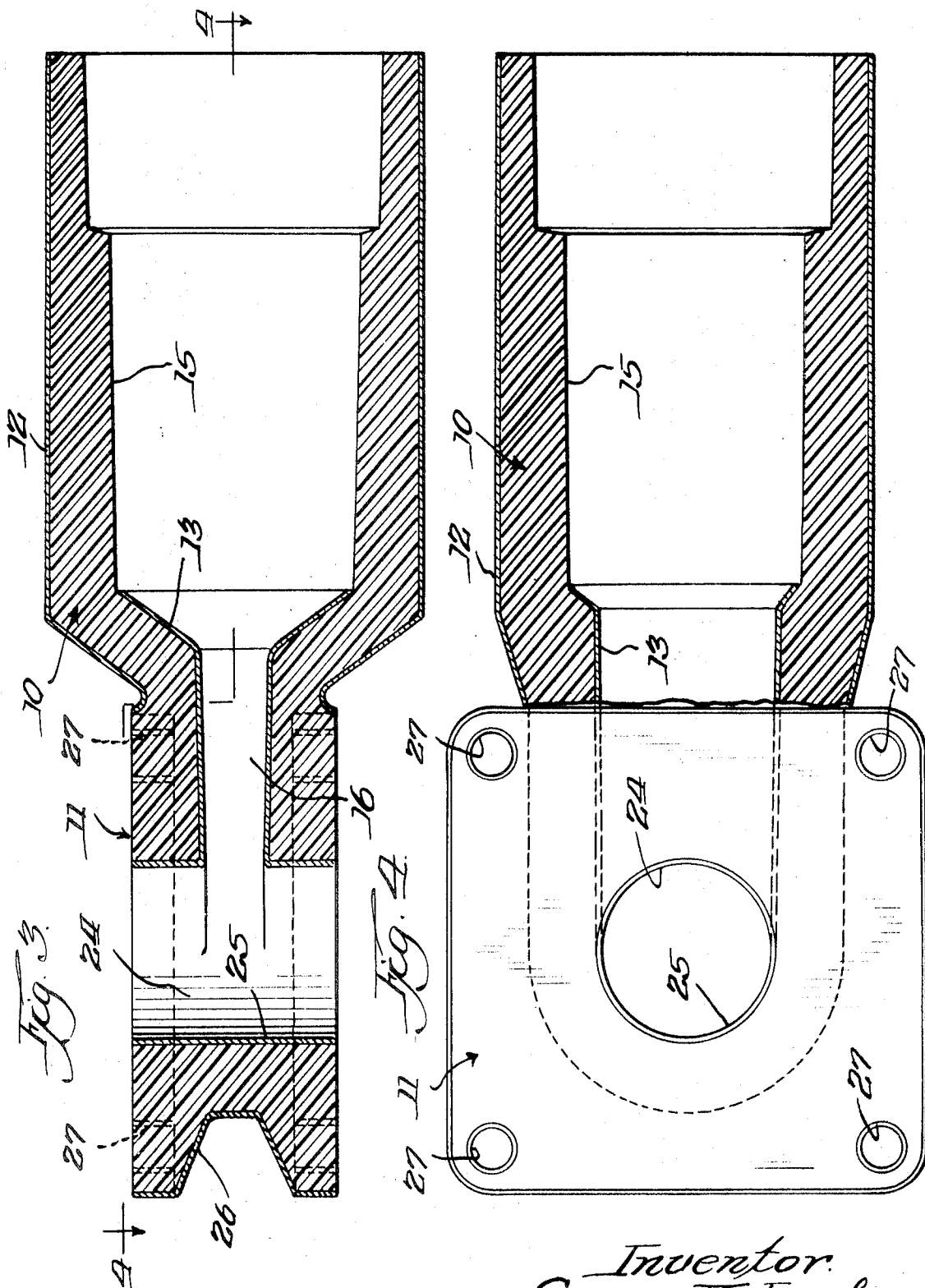
[54] UNIVERSAL POWER CABLE JOINT 11 Claims, 15 Drawing Figs.

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 [51] Int. Cl..... **H02g 15/02**,
 H02g 15/08, H01b 17/26
 [50] Field of Search..... 174/18, 19,
 21, 71, 73, 75, 75 D, 77, 78, 79, 84, 84.3, 87, 88,
 88.3, 142, 152, 153; 339/136, 143, 148, 149, 211,
 213

ABSTRACT: The cable joint of the invention is modular in concept since any joint configuration can be constructed from identical components. The basic module includes a tubular housing of plastic material having a passage extending through the same and which terminates at its forward end in a junction pad. The prepared end of the power cable is provided with a metal connector having a forwardly projecting tang and which extends through the passage of reduced size and into a transverse opening formed in the junction pad.

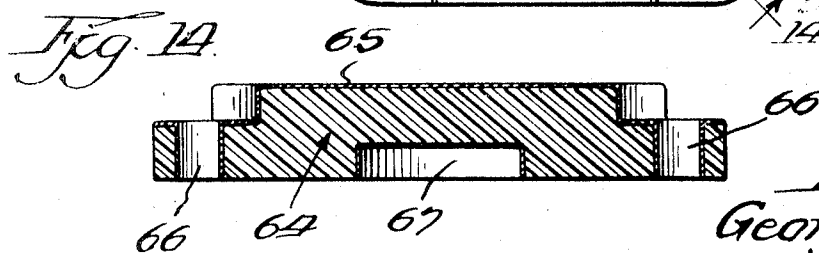
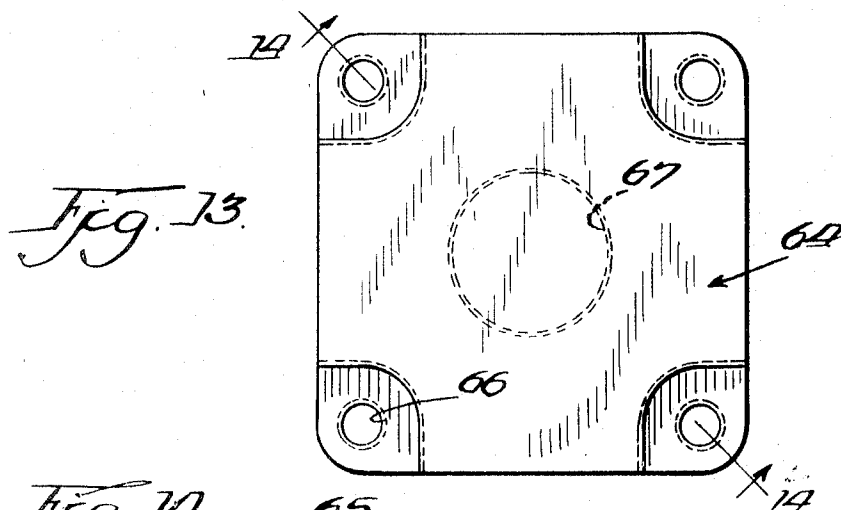
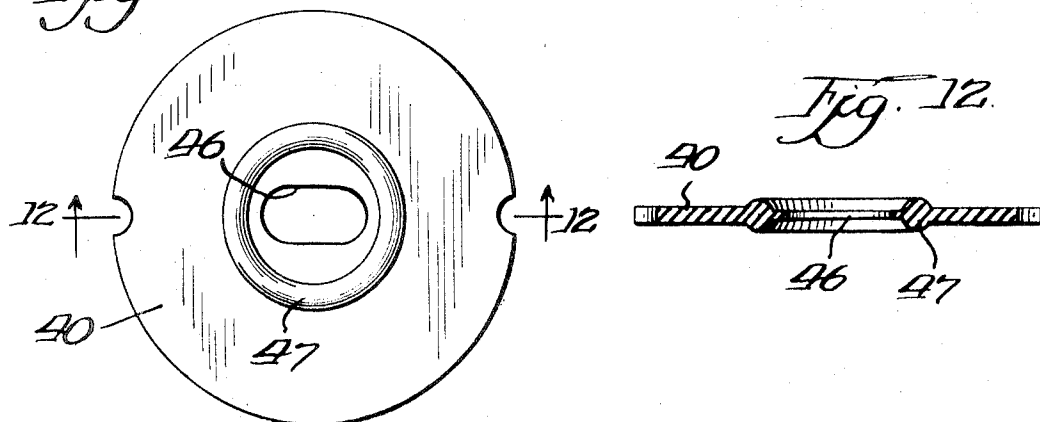
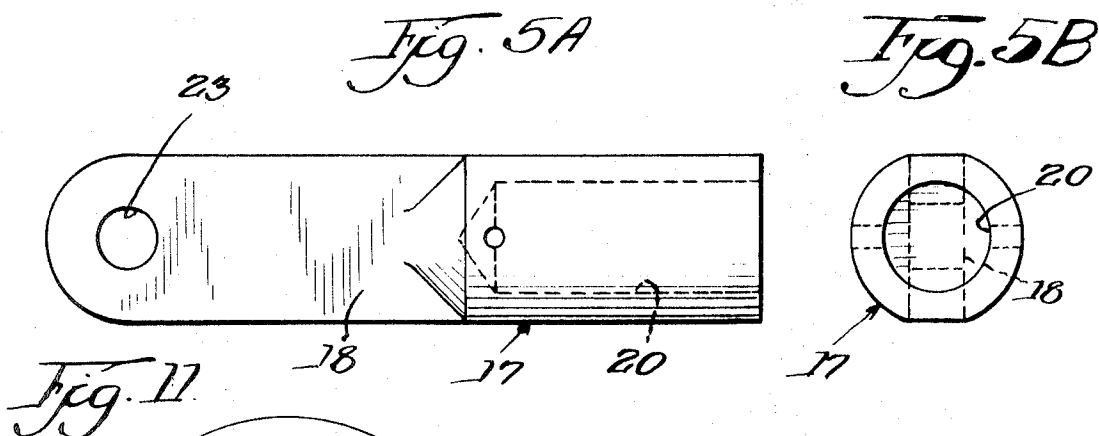






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Fig. 6

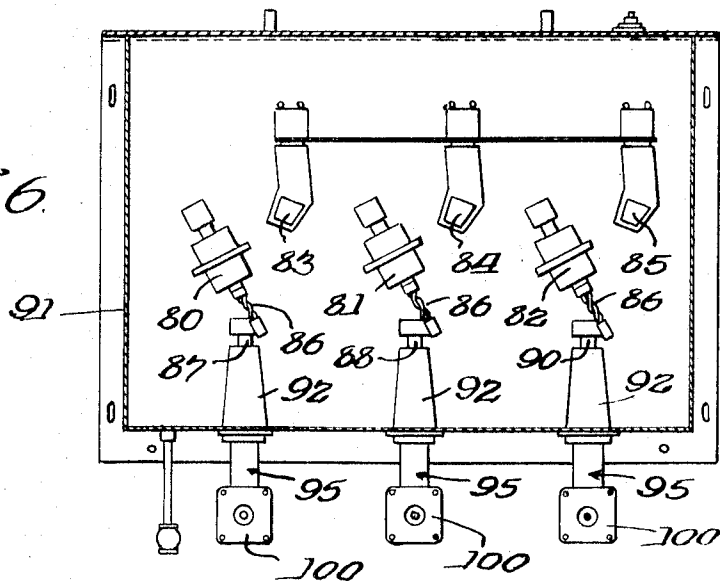


Fig. 7

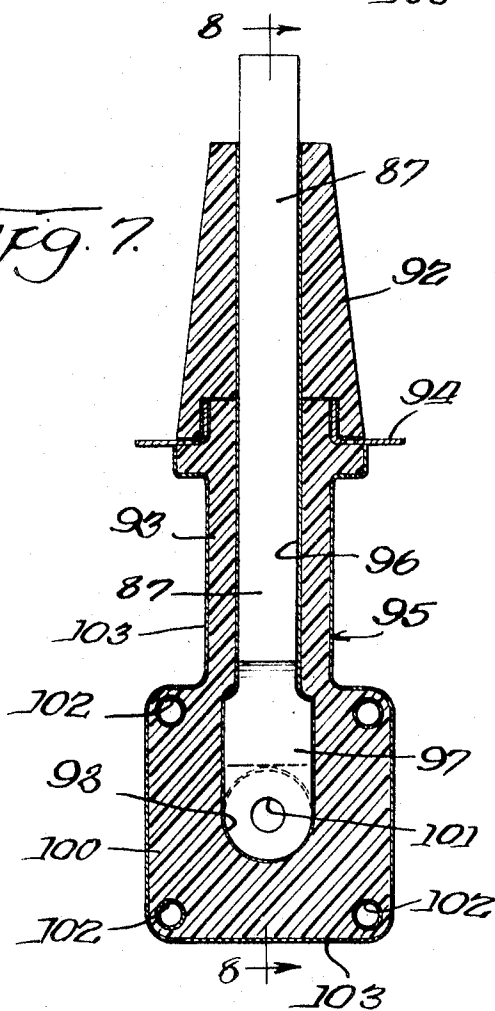
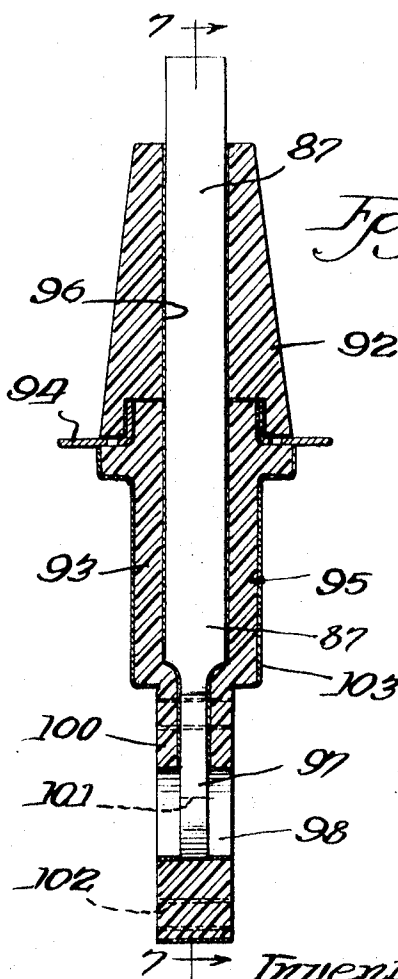


Fig. 8



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UNIVERSAL POWER CABLE JOINT

The invention relates to power cables and has reference in particular to improvements in a power cable joint which will be substantially universal in its utility having application to practically all types of nonpressurized or solid dielectric insulated power cables.

High-voltage cables having a rating of 15,000 v. and higher, very often must be joined together due to the circuit lengths involved which are in excess of the maximum length of the cable that can be manufactured and pulled into place in one piece. The maximum lengths of cable that can be installed in one length usually vary from 1,000 to 2,500 feet. Cable circuits can and do exceed 15 miles in length. Thus several lengths of cable must be joined together to complete a circuit.

The device used to accomplish the joining operation is called a connector. Very often the user of the cable may elect to connect more than one cable to another cable and may wish to connect the cable at a joint point to a piece of electrical equipment such as a switch, circuit breaker, fuse box or transformer. When only two cables are joined together the joint is a normal one. When three cables are jointed at one point, the structure is generally referred to as a Wye or Tee joint depending upon the angular orientation of the joined cables. Four cables joined together would necessitate the use of a cross or H joint.

The connection of equipment to a cable run has in the past required that the joining operation be accomplished within the piece of equipment itself. The cable joint designs in current use utilize cable conductor connectors shaped to provide the desired type shape and size of cable configuration desired. The exposed cable conductors and connector are reinsulated by hand wrapping electrical insulating tapes over the exposed current carrying parts until a sufficient thickness of insulating wall has been built up to withstand the voltage. The thicknesses required are considerably in excess of the thickness of the original cable insulation to compensate for the poorer quality of the hand applied insulation. The craftsmanship required to perform this operation can be extremely high when the more complicated joints are constructed such as those involving the joining of more than two cable ends.

Since the system heretofore used in the construction of cable joints effects the joining of the cable conductors and insulation together in one mass, it is obvious that any alteration desired in the joining points such as the addition of an extra cable or the connection of new equipment requires that the existing joint be totally disassembled and that a new joint be constructed in its entirety. None of the work expended to construct the original joint can be salvaged, nor is any of the material used in the original joint in a condition for reuse.

The new cable joint of the invention is totally modular in concept since any joint configuration can be constructed from identical components. A further object of the invention resides in the provision of a cable joint having the capability of being modified after installation without the loss of either labor or material and which will eliminate the massive hand applied taping operations heretofore associated with the joined installations.

With these and various other objects in view the invention may consist of certain novel features of construction and operation, as will be more fully described and particularly pointed out in the specification, drawings and claims appended thereto.

In the drawings which illustrate and embodiment of the device and wherein like reference characters are used to designate like parts

FIG. 1 is a sectional view taken longitudinally through a cable joint embodying the novel features of the invention;

FIG. 2 is a sectional view taken longitudinally through the housing member of the joint and illustrating the internal construction of the same prior to the insertion of the prepared end of a power cable;

FIG. 3 is a longitudinal sectional view on an enlarged scale of the cable housing member of insulating material and showing the same with a conductive coating over certain inside and outside surfaces;

FIG. 4 is a longitudinal sectional view taken on the same scale substantially along line 4-4 of FIG. 3;

FIG. 5A is an elevational view of the metal connector which is fitted to the prepared end of the power cable;

FIG. 5B is an end view of the metal connector shown in FIG. 5A;

FIG. 6 is a sectional view, with parts being shown in elevation of a switching device wherein the bushing module joint of the invention is employed;

FIG. 7 is a longitudinal sectional view on an enlarged scale showing the form of a bushing module joint employed in the switching device of FIG. 6;

FIG. 8 is a longitudinal sectional view on the same scale taken substantially along line 8-8 of FIG. 7;

FIG. 9 is an elevational view with parts being shown in section and illustrating the combination of certain standard parts which embody the feature of the invention in the production of a Tee joint;

FIG. 10 is an elevational view showing the Tee joint structure of FIG. 9;

FIG. 11 is a top plan elevational view of the elastomeric diaphragm employed in the present power cable joint;

FIG. 12 is a sectional view taken substantially along line 12-12 of FIG. 11;

FIG. 13 is a plan elevational view showing the exterior of one of the end plates; and

FIG. 14 is a sectional view taken substantially along line 14-14 of FIG. 13.

The modular power cable joint of the invention is formed of several unitary parts one of which consists of a housing 10 having the junction pad 11 integral therewith as shown in FIGS. 3 and 4. The integral combination of housing and pad is formed of any suitable dielectric grade plastic material and the same is electrically conductively coated on its exterior as at 12 and on certain of its interior surfaces as at 13. The conductive coating is necessary to provide the desired electrostatic shielding surface. It will be observed that the surfaces of the pad are not so coated. The plastic housing is cored centrally for substantially its entire length, the same providing the recess 15 and passageway 16 for receiving the metal connector 17 having the tank 18 integral therewith, all as shown in detail in FIG. 5. It will be understood that the connector is preferably formed of high conductivity, suitably plated aluminum or copper alloy and that the said connector is cored at its rear end as at 20 for receiving the bare end of the power cable metal conductor for the cable 22 to be connected by the device. For purposes to be presently described the tang 18 of the metal connector 17 is provided with an opening 23.

Whereas the recess 15 in the plastic housing 10 accommodates the body portion of the connector 17, the aligned passageway 16 accommodates the tang 18 of the connector. When the metal connector is fully inserted in the plastic housing, the opening 23 in the tang is positioned centrally of the vertical opening 24 formed in the integral pad 11. The conductive finish or coating which is applied at 13 is extended within the passageway 16. Also the vertical opening 24 in the junction pad 11 is conductively coated as at 25 and on the exterior of the pad at 26. The four corners of the pad are each apertured at 27 to provide openings for receiving securing bolts for retaining the pad and its housing in fixed connected relation with another similar junction pad and housing combination.

The plastic housing 10 with the integral junction pad 11 is only a part of the main module which receives the prepared end of the power cable to be joined. As shown in FIGS. 1 and 2 the metal casing 30 of tubular formation has encircling relation with the plastic housing 10 and said metal casing is fixedly connected to the metal end member 31 by means of the indicated part 32. The end member 31 supports the stress control metal shield 33 having a plurality of spring fingers 34. An

elastomeric closed cell sponge element 35 is also positioned within the end member 31 in close contact with the inside circular walls of the same. The structure of this end of the module is similar in most respects to cable termination systems of the character as shown and claimed in the Lusk patents, U.S. Pat. No. 3,322,883 granted May 30, 1967 and U.S. Pat. No. 3,336,435 granted Aug. 15, 1967. Since the main module is adapted to contain an insulating compound, both ends of the module are sealed at the factory and the interior of the module is completely filled with the insulating compound. At the forward end of the pad 11 the vertical opening 24 is sealed by the plastic caps inserts 36 FIG. 2, and by the filament reinforced tape 37. At the opposite end of the module the same is sealed by the elastomeric diaphragm 40 and by the thin plastic film 41. These two elements overlie each other. They are retained and sealed to the bottom surface of the end member 31 by the clamping ring 42. The diaphragm and plastic film are interposed between the end member 31 and the clamping ring 42 and the same are clamped by the ring and held in place since the ring is secured to the end member by the securing bolts 43, FIG. 2.

The end member 31 is provided with an opening 44 normally closed by the threaded plug 45. At the factory this plug is removed and the module as shown in FIG. 2 is filled with an insulating compound and then the plug is replaced. The compound may comprise a blended mixture of high-molecular weight polybutenes and low-molecular weight polyolefins with an inhibitor. The compound is preferably characterized by having a high-tack value to the solid dielectric cable insulation of the power cable and to the metal of the stress control shield down to temperatures as low as minus 20° Fahrenheit. The sealing by means of plastic caps 36 and the tapes 37 at the forward end, and the seal which is effected by the clamping ring 42 around the periphery of the clamped plastic film 41 and the diaphragm 40 retains the filling compound within the module until the insertion of the power cable 22 which operation will now be described.

The power cable to be inserted within the module is first of all stripped to expose the bare metal conductor to which is fitted the metal connector 17. The stripping of the cable also exposes the solid dielectric insulation 19 of the cable and the cable shielding system 21. For the insertion of the prepared cable end, the threaded plug 45 is removed so as to allow the excess compound to escape. The tang 18 of the metal connector is now pushed through the opening 46 in the diaphragm 40 and into the module causing the thin plastic film to be perforated. Continued insertion of the prepared end of the cable will push the cable through the stress control shield 33 and eventually cause the tang to project into the vertical opening 24 formed in the junction pad 11. As best shown in FIG. 1 as well as FIG. 11 and FIG. 12 the elastomeric diaphragm 40 is preferably provided with the circular bead 47 around the opening 46. This structural feature gives added sealing force around the cable periphery and also prevents the opening 46 from splitting or tearing due to the insertion of the cable.

The module for housing the prepared cable end is completed by securing ground strap 49 in circumferential orientation over the cable overshield 21. The elastomeric cushion 56 over the ground strap is secured with hose clamp 53, which is held in tight relation with the cable within the elastomeric boot 48, by the fastening screw 54, and said ground strap and hose clamp are grounded to the clamping ring 55.

The flexible elastomeric boot 48 and the compression cylinder 50 are then brought up to clamping ring 42. The securing bolts 52 are provided for securing the compression cylinder 50 to the clamping ring 42. The flexible elastomeric boot has surrounding relation with the cable and the same is formed with the lip 51 which is held by the compression cylinder 50 in contact with the end clamping ring 42.

The prepared end of one cable is mechanically and electrically connected to the prepared end of a second cable in a manner as shown in FIG. 1. The pad 11a of the second cable

module is placed in overlying superimposed relation with the pad 11 of the first cable module. In accordance with the invention a metal spacer 58 is interposed between the tangs 18 and 18a and an elastomeric gasket 60 is located between the adjacent surfaces of the junction pads 11 and 11a. The disposition of the pads in superimposed relation brings into vertical alignment the openings 24 and 24a so that the spacer 58 occupies part of each opening so aligned. It will also be observed that the metal spacer 58 is in full contact with the tangs 18 and 18a so that a good electrical conductive path is provided from one power cable to the other power cable.

The mechanical connection of the tangs 18 and 18a is effected by a connecting bolt 61 which passes through the opening 23 in tang 18, through the spacer 58 and then through the opening 23a in the tang 18a. The head 62 of the bolt is in contact with the tang 18 and the nut 63 is in contact with the tang 18a. Belleville washers may be placed between tang 18 and head 62 and tang 18a and nut 63 to insure maintenance of adequate contact pressure. The universal joint is completed by the end plates 64 and 64a of insulating plastic material similar to the housing 10. Each end plate as shown in FIGS. 13 and 14 has a stepped outer surface which is conductively coated as at 65 and which continues to within the bolt openings 66. The inside surface of the end plate is recessed at 67 and the same is conductively coated in the same manner as the exterior surface. The shape of the end plates 64 and 64a and the conductive surface finish is desirable for a proper electrical performance. The end plates are placed on the pads 11 and 11a with the elastomeric gaskets 70 being interposed between, and the combined structure is bolted together by the securing bolts 71 having the heads 72 and the nuts 73. The bolts 71 pass through the openings 66 in the end plates provided for the purpose. See FIG. 13. As previously stated the bolt 61 maintains the tangs 18 and 18a in contact with the spacer 58. The cavity 67 formed in the inside surface of each end plate 64 is conductively coated. The coil springs 74 and 74a which surround the head 62 and the nut 63 of the bolt 61 maintain the same voltage potential between the tangs and the conductively coated cavity 67 and 67a of the end plates.

The cable joining structure as herein described is totally modular in concept in that any joint configuration desired can be constructed from identical components. Also the present joint provides the capability of being modified after installation without the loss of either labor or material. One modification of the cable joint structure is shown in FIGS. 9 and 10 which illustrate a Tee joint. For such a joint, three modules such as shown in FIG. 2 are employed, with the prepared end of the tree power cables having an inserted relation with the same respectively. Thus as shown in said Figures the tang 18 is electrically connected by the metal spacer 58 with the tang 18a. The elastomeric gasket 60 is interposed between the junction pads 11 and 11a. In a similar manner the tang 18a is electrically connected to the tang 18b by the spacer 58a and likewise the junction pads 11a and 11b have the gasket 60a located between the three tangs and the two spacers are secured in superimposed relation by the bolt 75 which is similar to bolt 61 as shown in FIG. 1 only somewhat longer in order to accommodate the third joint structure. The Tee joint is completed by the usual coil springs 74 and 74a and by the top and bottom end plates 64 and 64a. The long bolts 76 similar to 71 are employed for joining the top and bottom end plates.

A further modification of the present device for joining power cables is shown in FIGS. 6, 7 and 8. The switch structure of FIG. 6 shows three service entrances into one tank or switch structure. The plastic bushing entrances 95 represent a three phase service. Movable contacts 80, 81 and 82 inside switch structure are provided. The movable contacts are adapted to coact with the stationary contacts 83, 84 and 85, respectively, for closing and opening the circuits. The movable contacts are connected by the flexible braid conductors 86 with the terminal conductors 87, 88 and 90 which extend through the metal housing 91 of the switch structure for electrical connection with power cables, respectively.

The invention contemplates the provision of molded plastic bushings for housing and protecting the terminal conductors 87, 88 and 90, respectively. The plastic bushing and terminal conductor are molded as a unitary, one piece structure as is clearly evident from FIGS. 6 and 7 and which may be described as a bushing module 95. The plastic bushing portion of the bushing module having surrounding relation with that portion of the terminal conductor within the switch housing is indicated by the numeral 92 and the plastic universal joint pad portion of the bushing module outside the switch housing is indicated by the numeral 93. In the molding of each unit, a metal flange 94 is incorporated in the same between the plastic bushings 92 and 93 and said flanges are employed in the installation of the bushing modules in the switch structure such as shown. The wall of the switch structure is formed with spaced openings for receiving the bushing modules 95 and following insertion of the same the flange 94 is suitably secured as by welding to the wall of the switch structure.

The interior surfaces of the bushing modules are conductively coated at 96 and this coating is in contact with the terminal conductor of the unit. Also it will be observed that each terminal conductor is formed with a tang 97 having location within the opening 98 formed in the junction pad 100 of the bushing module. The tang is apertured at 101 and the junction pad is provided with four corner openings 102 for accommodating securing bolts such as 71 of FIG. 1 or the bolts 76 of FIG. 9. The exterior surfaces of the module 95 including portions of the pad 100 are also conductively coated as indicated by numeral 103. The combination of tang and junction pad as shown in FIGS. 7 and 8 is thus a substantial duplicate of the tang and pad of the standard module of FIG. 1 and the procedure for mechanically and electrically connecting power cables employing the bushing module entrance joints 95 is the same as described for the standard modules.

The present module concept for a power cable joint makes possible a Wye joint in addition to a Tee joint such as shown and described in FIGS. 9 and 10. This variable utility for the basic module joint is made possible by the 90° symmetry of the junction pad. It is also within the utility of the invention to produce a dead end joint. A single joint module can be capped off with two end plates 64 and 64a and with the proper size spacers 58 thus making a dead end joint. Such a joint electrically prepares and seals a cable end which can be disassembled and a joint module added to it at any future time to complete any type of joint or connection to the existing equipment.

I claim:

1. A cable joining device comprising, a tubular housing member formed of a plastic material for housing the prepared end of a power cable adapted to be inserted in the housing, said tubular housing member having an open rear end and terminating at its opposite end in a forwardly projecting junction pad, said housing member and pad having certain areas exteriorly and interiorly of the same coated with an electrically conductive material for providing electrostatic shielding surfaces, said junction pad having a central opening therein transversely of the pad, and the longitudinal passage through the tubular housing member being reduced in diameter in advance of the junction pad, and said passage of reduced diameter extending to and communicating with the transverse opening.

2. A cable joining device as defined by claim 1, wherein the forwardly projecting junction pad is approximately square in plan elevation, and wherein said junction pad is provided with a bolt receiving opening at each corner.

3. A cable joining device as defined by claim 1, wherein the forwardly projecting junction pad has flat top and bottom surfaces and is approximately square in plan elevation, wherein said junction pad is provided with a bolt receiving opening at each corner, and wherein the passage of reduced diameter is approximately circular in shape transversely of the passage.

4. A cable joining device comprising, as a first combination, a tubular housing member formed of a plastic material for receiving and housing the prepared end of a power cable adapted to be inserted in the housing, said plastic housing hav-

ing an open rear end and terminating at its opposite end in a forwardly projecting junction pad, said junction pad having a central opening therein transversely of the pad, the longitudinal passage through the tubular housing member being reduced in size in advance of the junction pad, said passage of reduced size extending to and communicating with the transverse opening, a second combination including a housing member having a forwardly projecting junction pad, the said first and second mentioned junction pads being associated in superimposed contacting relation, a tang provided by the prepared end of a power cable having inserted relation in the respective tubular housing members, each tang extending into the central transverse opening of its particular junction pad, a metal spacer member in the aligned transverse openings and located between and in contact with the said tangs, and means in associated relation with the said tangs and interposed metal spacer mechanically and electrically connecting the said tangs.

5. A cable joining device as defined by claim 4, wherein the means mechanically and electrically connecting the said tangs includes a bolt extending through a central transverse opening in each tang and through a center opening provided therefor in the metal spacer.

6. A cable joining device as defined by claim 4, wherein the means mechanically and electrically connecting the said tangs includes a bolt extending through a central transverse opening in each tang and through a center opening provided therefor in the metal spacer, plastic end caps located over the exterior surface of each junction pad, securing means releasably securing the plastic end caps in place with the junction pads interposed between, and additionally including resilient means between each end cap and its respective tang.

7. A cable joining device comprising, a tubular housing member formed of a plastic material for housing the prepared end of a power cable having an inserted relation within the tubular housing member, said plastic housing member having an open rear end and terminating at its opposite end in a forwardly projecting junction pad, said junction pad having a central opening therein transversely of the pad, the longitudinal passage through the tubular housing member extending to and communicating with the central transverse opening in the junction pad, a tang provided by the prepared end of a power cable and which extends into the central transverse opening, and plastic end plates in releasable connected relation with the junction pad, said end plates being located and secured to respective sides of the junction pad, whereby to form a dead end cable joint.

8. A cable joining device as defined by claim 7, wherein the rear open end of the tubular housing is closed by an elastomeric diaphragm, means securing and sealing the elastomeric diaphragm to the housing member at the rear end thereof, and said diaphragm having sealing relation with the prepared end of the said power cable.

9. A cable joining device comprising, a tubular housing member formed of a plastic material for housing the prepared end of a power cable adapted to be inserted in the housing wherein the plastic housing member has an open rear end and terminates at its opposite end in a forwardly projecting junction pad, said junction pad having a central opening therein transversely of the pad, the longitudinal passage through the tubular housing member being reduced in diameter in advance of the junction pad, said passage of reduced section extending to and communicating with the transverse opening, a metal casing in surrounding fixed relation with the tubular housing and extending rearwardly thereof, an end plate member fixed to the rearwardly extending portion of the metal casing, said end plate member having a central opening therein, a clamping ring releasably secured to the end plate member, a thin plastic film and a centrally apertured elastomeric diaphragm being clamped in superimposed relation between the end plate member and the clamping ring, whereby the thin plastic film closes and temporarily seals the opening in the end plate member, and whereby the elastomer-

ic diaphragm provides for the insertion of the prepared end of the power cable and has the capability of forming a seal with the cable during and following insertion.

10. A cable joining device as defined by claim 9, wherein certain areas of the housing and pad exteriorly and interiorly thereof have a coating of an electrically conductive material for providing electrostatic shielding surfaces.

11. A cable joining device comprising a tubular housing member formed of a plastic material wherein the plastic housing member has an open rear end and terminates at its opposite end in a forwardly projecting junction pad, said junction pad having a central opening therein transversely of the pad, the longitudinal passage through the tubular housing member being reduced in size in advance of the junction pad, said passage of reduced size extending to and communicating with the transverse opening, a power cable including a prepared end adapted to be inserted in the housing wherein the prepared end of the power cable includes a metal connector which is fitted to the bare metal conductor of the cable, the

said metal connector providing a forwardly projecting tang having a central opening therein, and wherein the forwardly projecting tang extends through the passage of reduced size and into the transverse opening formed in the junction pad, a metal casing in surrounding fixed relation with the tubular housing and extending rearwardly thereof, an end plate member fixed to the rearwardly extending portion of the metal casing, said end plate member having a central opening therein, a clamping ring releasably secured to the end plate member, a thin plastic film and a centrally apertured elastomeric diaphragm being clamped in superimposed relation between the end plate member and the clamping ring, whereby the thin plastic film closes and temporarily seals the opening in the end plate member, and whereby the elastomeric diaphragm provides for the insertion of the prepared end of the power cable and has the capability of forming a seal with the cable during and following insertion.

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