Aug. 30, 1938. J. J. HARLEY 2,128,412

CABLE PLUG

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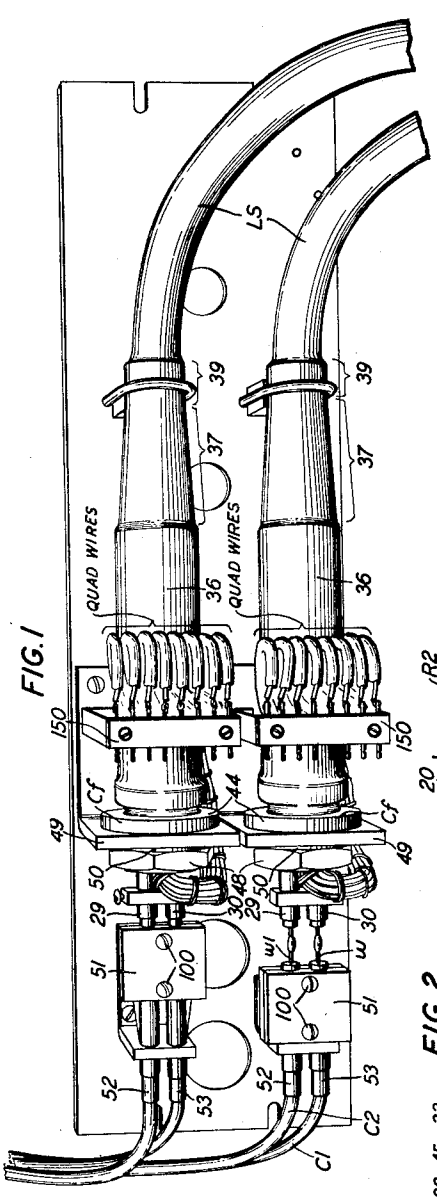

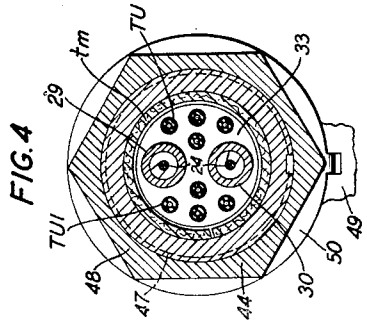

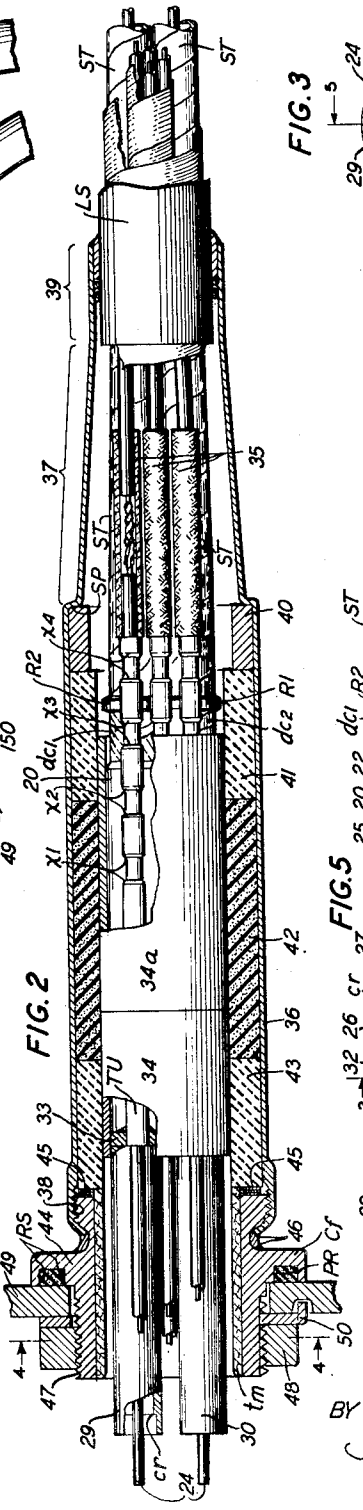

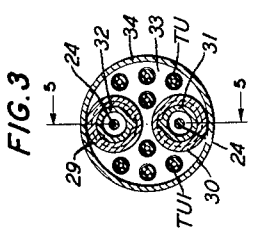

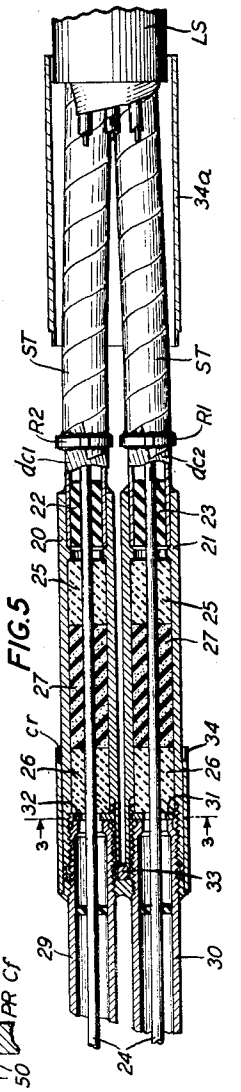

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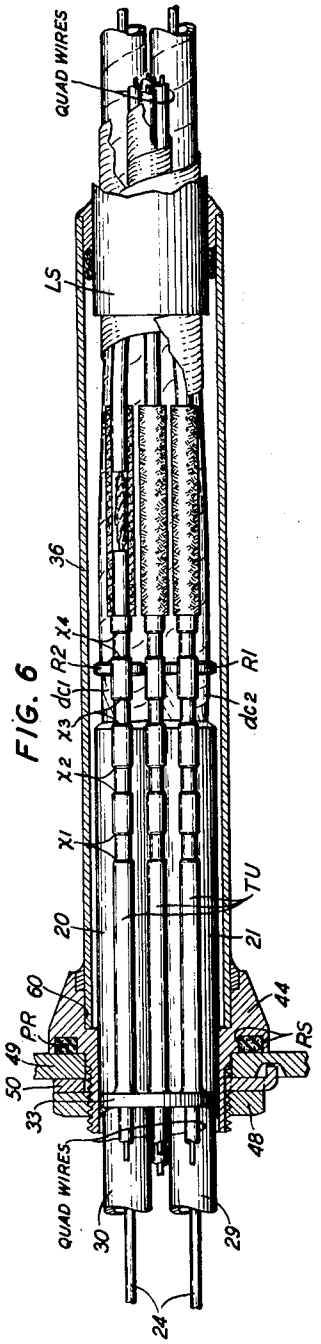

FIG. 6

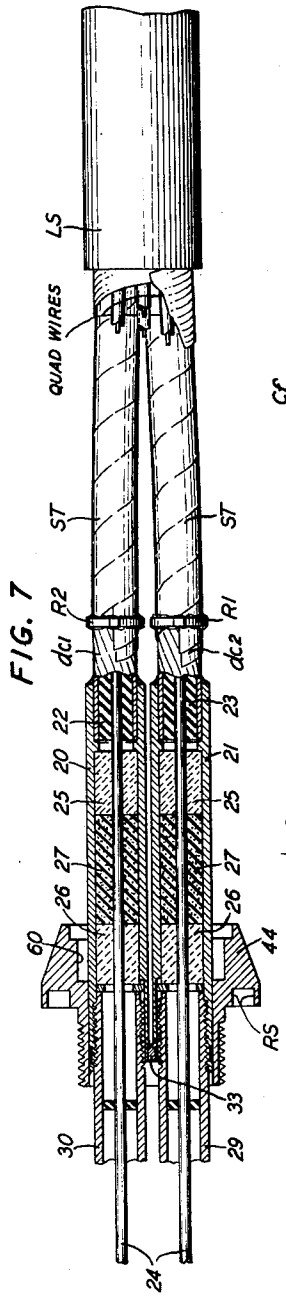

FIG. 7

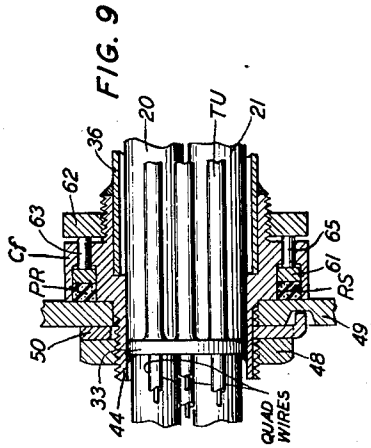

FIG. 9

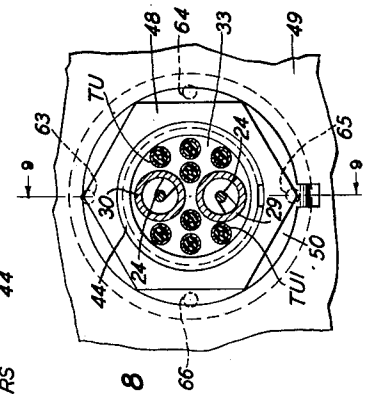

FIG. 8

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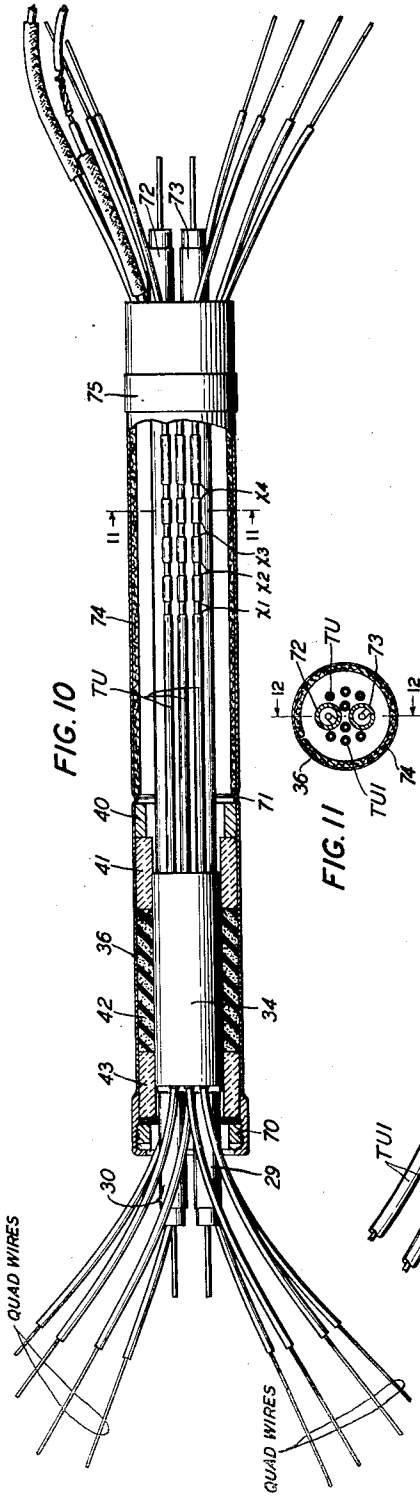

FIG. 10

FIG. 11

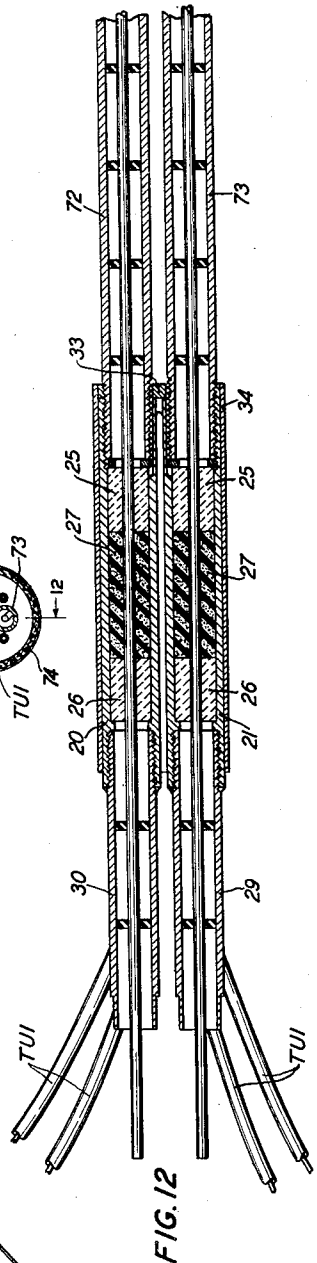

FIG. 12

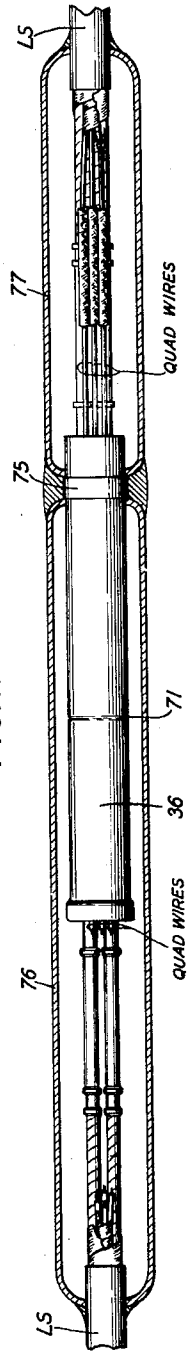

FIG. 13

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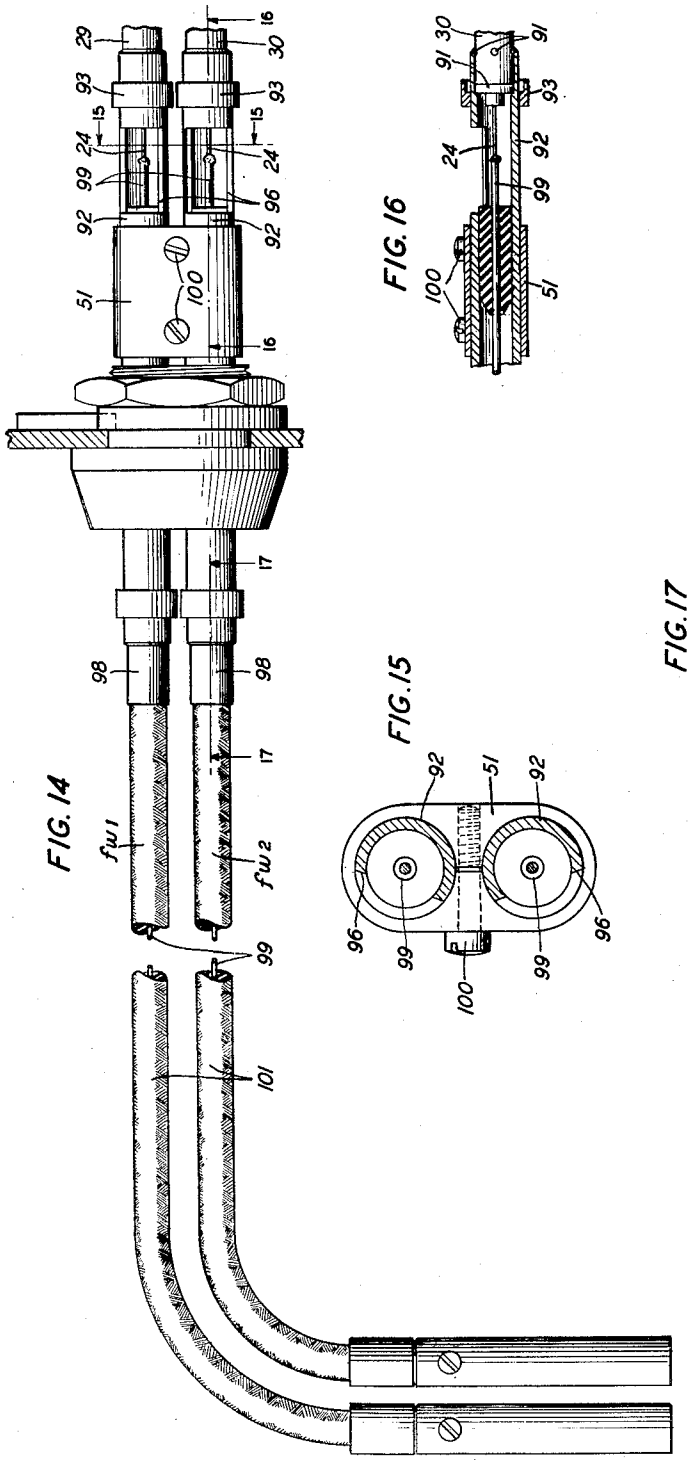

FIG. 14

FIG. 16

FIG. 15

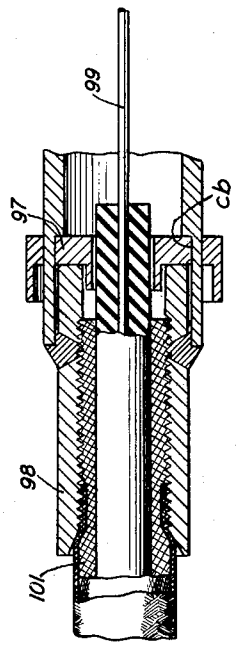

FIG. 17

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UNITED STATES PATENT OFFICE

2,128,412

CABLE PLUG

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Application November 28, 1936, Serial No. 113,133

4 Claims. (Cl. 173—353)

This invention relates to so-called coaxial cables, and more particularly to plugs for use in such cables.

These cables consist of one or a plurality of concentrically disposed conductors and series of wires arranged in quad groups enclosed in a common lead sheath filled with an inert gas above atmospheric pressure which must be maintained at all times within small plus or minus difference limits.

According to the invention, the cable sheath is provided at its ends and along its length with plug arrangements which divide the lead sheath and the conductors of the cable into a plurality of gas-tight sections, the plugs at the terminating ends of the cable providing means whereby the conductors may be extended beyond the lead sheath while effectively preventing the escape of gas at these points so as to maintain a constant gas pressure condition in the section of the cable.

More specifically, in the plug arrangements of the invention metallic sleeves are slipped over the centrally disposed conductors of the coaxial cable and secured to the ends of the tubular conductors. Into these sleeves are inserted beads of soft rubber which are compressed to force them against the walls of the sleeves and onto the centrally disposed conductors to form gas-tight closures at these points. The compressing operation of the beads is effected by the engagement of other sleeve members slipped over the centrally disposed conductors and engaging the screw-threaded ends of the metallic sleeves. The compressing sleeve members, together with tubings which are crimped on the rubber insulation of the quad wires, are secured as by soldering to a disc member which serves as a closure for a tubular core extending over the individual wires and the sleeves soldered at the ends of the tubular conductors of the cable. On this tubular core is mounted a bushing of rubber, for example, which is compressed between the wall of a shell and the periphery of this core to form a gas-tight closure therebetween and a screw-threaded head-piece member engaging one end of the shell is provided for compressing the rubber bushing in the shell and provides means for securing the plug assembly thus formed to a support, the other end portion of the shell being secured to the lead sheath of the cable as by soldering, while the ends of the concentric conductors and of the individual wires extend beyond the head-piece of the plug for connection on banks of wire terminals carried by the shell support and other electrical apparatus.

Other novel features and advantages of the invention will appear from the following description and by the claims appended thereto, reference being had to the accompanying drawings in which,

Fig. 1 is a perspective assembly view of a pair of terminal plug arrangements mounted on a common supporting member;

Fig. 2 is an enlarged longitudinal sectional view of one of the plugs showing a number of parts with portions cut away;

Fig. 3 is a cross-sectional view taken on line 3—3 of Fig. 5;

Fig. 4 is a cross-sectional view taken on line 4—4 of Fig. 2;

Fig. 5 is a central longitudinal sectional view taken on line 5—5 of Fig. 3;

Fig. 6 is a longitudinal sectional view of a modified terminal plug arrangement;

Fig. 7 is a longitudinal sectional view shown with its outer shell removed;

Fig. 8 is a left end view of the plug shown in Fig. 6 modified;

Fig. 9 is a sectional view taken on line 9—9 of Fig. 8;

Fig. 10 is an assembly view of a modified plug arrangement;

Fig. 11 is a cross-sectional view taken on line 11—11 of Fig. 10;

Fig. 12 is an enlarged longitudinal sectional view taken on line 12—12 of Fig. 11;

Fig. 13 is an assembly view of the modified plug arrangement shown in Fig. 10, the lead sheath housing being shown in section;

Fig. 14 is an assembly view of a wire terminal used in connection with the terminal plug shown in Figs. 1 and 6;

Fig. 15 is an enlarged cross-sectional view taken on line 15—15 of Fig. 14;

Fig. 16 is a sectional view taken on line 16—16 of Fig. 14; and

Fig. 17 is an enlarged sectional view taken on line 17—17 of Fig. 14;

In the cable terminal arrangement of the invention the ends of the steel tapes ST of a pair of coaxial conductors are first secured on the tubular conductors *dc*1 and *dc*2 by clamping rings R1 and R2 shown in Figs. 2 and 3. The ends of conductors *dc*1 and *dc*2 are fitted and soldered into the ends of conducting sleeves 20 and 21, insulating beads as 22 and 23 being provided for holding the centrally disposed wires 24 of each coaxial conductor concentric relative to the tubular conductors *dc*1 and *dc*2 at these ends of the sleeves.

The wires 24 are further held in concentric relation to the sleeves 20 and 21 by similar beads 25 and 26 of insulating material, such as porcelain, and the beads 27 of rubber. The opposite ends of conducting sleeves 20 and 21 are interiorly screw-threaded for engaging with peripherally screw-threaded sleeves 29 and 30, and friction washers as 31 and 32 are interposed between the ends of sleeves 29 and 30 and the adjacent ends of insulating beads 26 for preventing the damaging of these beads upon the turning movement of sleeves 29 and 30 for compressing the rubber beads 27 and thereby forcing them tightly around the wires 24 and against the walls of sleeves 20 and 21, thus effectively preventing the flow of gas between these sleeves and the centrally disposed wires 24 at these points.

As shown in Figs. 2, 3, 4 and 5 the sleeves 29 and 30 threadedly engage similarly threaded holes in a disc member 33 to which the conducting sleeves 29 and 30 are secured as by soldering. The disc member 33 in turn is secured in a metallic sleeve 34, in order to form a gas-tight closure between the sleeves 29 and 30 and the sleeve 34, the latter having a circular recess or for receiving a complemental sleeve portion 34*a*.

The disc 33 is provided with two series of four holes each as shown in Fig. 4 in which similar ends of two sets of tubings TU and TU1 are secured as by soldering. The quad wires of each series having ordinary rubber covering are passed through these tubings which are afterward crimped at substantially equal spaced relation over the insulation of these wires as at points as *x1*, *x2*, *x3* and *x4*, shown in Fig. 2, thus providing effective gastight closures at these points.

The complemental sleeve portion 34*a* is then engaged with its cooperating sleeve portion 34 and soldered thereon to form a single sleeve unit. The groups of quad wires in the sets of tubings TU and TU1 are then spliced to the corresponding quad wires of the coaxial cables by twisting and soldering them together in the ordinary manner preparatory to the insertion of insulating sleeves 35 over such splices as shown in Figs. 2 and 6.

The conductor assembly thus formed is placed in a shell or housing 36 having at one end an interiorly screw-threaded portion 38 and terminating at its other end with a conical portion 37 and a comparatively short cylindrical portion 39 of a diameter slightly greater than the outer diameter of lead sheath LS of the coaxial cables in order to provide an annular clearance adapted to be filled with solder for uniting the shell to the lead sheath at this point.

A spacer ring 40 is inserted in the shell or housing 36 against the shoulder portion SP of this shell to serve as abutment for a porcelain bead 41 which serves together with a rubber bead or sleeve 42 and another porcelain bead 43 to hold the sleeve or core unit 34—34*a* in position concentric with respect to the shell 36. A head-piece 44 shown in Figs. 1, 2 and 4 is provided with a screw-threaded portion for engaging the screw-threaded portion of shell 36 for compressing the rubber sleeve 42 so as to force it against the wall of the shell 36 and against the periphery of sleeve unit 34—34*a*, thus effectively preventing the escape of gas at this point, a number of friction washers as 45 shown in Fig. 2 being provided for preventing damaging the porcelain bead 43 during the turning movement of the head-piece 44 in the shell and a tubing member *tm* of insulating material is forced into the bore of head-piece 44 for insulating it from the sleeves 29 and 30.

The head-piece 44 is provided with an exteriorly disposed groove 46 adjacent a circular flange *cf* to from a shoulder portion against which the circular edge of the shell 36 is formed and soldered for preventing relative movement between the head-piece 44 and the shell and to effectively prevent the escape of gas at this point, the flange being formed with an annular recess RS for receiving a packing ring PR provided to form a seal between the flange portion of head-piece 44 and the wall 49 of a gas-tight casing not shown into which the coaxial cable terminates.

The head member 44 is provided at its other end with a screw-threaded portion 47 for receiving a similarly screw-threaded nut 48 for securing the terminal plug thus formed to the wall 49 of the gas-tight casing, while a locking washer 50 is interposed between the nut 48 and the wall 49 for preventing the turning movement of the terminal plug during the tightening operation of the nut.

The quad wires in the two series of tubings TU and TU1 are led and soldered to the terminals in a bank 150 shown in Fig. 1, while the centrally disposed conductors of the coaxial cable are connected to respective wires as W, W1 of cords C1 and C2 and the sleeves 29 and 30 of tubular conductors *dc1* and *dc2* are jointly connected by a metallic block 51 which may be moved in position for bridging the gap between the sleeves 29 and 30 and the sleeves 52 and 53 at the terminating ends of other conductors of cords C1 and C2 leading to electrical apparatus, not shown.

In the modification shown in Figs. 6 and 7 unlike the plug shown in Fig. 1 the disc 33 through which the sleeves 29 and 30 and the sets of tubings TU and TU1 extend is soldered directly into the bore of head-piece 44 and the shell or housing which is in the form of a cylindrical tubing 36 at one end is secured to the lead sheath LS, as by soldering, and its other end engages a bore 60 in the head-piece 44 where it is secured as by soldering, thus effecting a gas-tight seal between the lead sheath LS and the head-piece 44.

Figs. 8 and 9 show a modification of the head-piece 44 of Fig. 1 and according to this modification the annular recess RS as shown in Fig. 9 is made sufficiently deep for receiving a metallic ring 61 in addition to the rubber packing ring PR. The compression of this packing ring is effected by the turning movement of a nut 62 abutting against the ends of pins 63, 64, 65 and 66 slidably mounted in holes in the flange of the head-piece and engaging the metallic ring 61 for forcing it against the packing ring PR, which is in turn forced against the casing wall 49 to form a gas-tight joint at this point, the advantage of this construction being that it provides a greater compressing range for the packing ring PR.

In Figs. 10, 11, 12 and 13 of the drawings which show a modification of the invention adapted to a line plug, the shell or housing 36 is interiorly screw-threaded at one end for engaging with a similarly screw-threaded ring 70 used for compressing the rubber bead or sleeve 42 onto the core 34 in the manner described in connection with the terminal plug shown in Fig. 1. The shell or housing 36, however, as used in this modification is formed with an annular recess 71 which serves as an abutment for the ring 40 and extends a considerable distance over the metallic sleeves

72 and 73 connecting with the concentric conductors from which the shell 36 is electrically protected by a sleeve 74 of insulating material. The shell 36 is formed at its opposite end with a peripherally disposed collar 75, the sides of which form abutment for the lead sleeves 76 and 77 shown in Fig. 13, these lead sleeves being united to the shell or housing 36 at these points as by soldering while the other ends of sleeves 76 and 77 are secured to the adjacent ends of lead cable sheaths LS in the ordinary manner, thus dividing the length of the coaxial cable into gas-tight sections.

Fig. 14 discloses an arrangement used in connection with the terminal plugs shown in Figs. 1 and 6 for connecting the free ends of sleeves 29 and 30 to the ends of flexible wires *fw1* and *fw2*. In this arrangement plugs such as 90 shown in Fig. 16 which are made of aluminum are inserted in the ends of sleeves 29 and 30. These plugs extend beyond a series of radially disposed holes 91 at the ends of sleeves 29 and 30 in order to prevent solder from bridging the concentrically disposed conductors when soldering the connecting sleeves as 92 at the ends of the sleeves 29 and 30. A collar 93 made of aluminum is placed over one end of each sleeve 92 for preventing running of the solder onto the centrally disposed conductors 24 when soldering the sleeves 29 and 30 to sleeves 92, the collars 93 also serving as stops for the slidable block 51 shown in Figs. 1, 15, 16 and 17 adapted to be moved over the openings 96 in sleeves 92 for preventing crosstalk and the entrance of dust and other foreign particles in these sleeves, screws such as 100 being provided for securing the block 51 in adjusted position on the sleeves 92.

The sleeves 92 are provided at their opposite end portions with counter-bores *cb* shown in Fig. 17 for receiving bushings 97 made of aluminum and serving as abutment for metallic sleeves 98 which are interiorly screw-threaded for receiving the insulating covering 101 of the conductors 99 connecting with the centrally disposed conductors in the opening 96 of sleeves 92, the conductors 99 being provided for connecting the coaxial cables to their associated electrical apparatus at the sending and receiving stations.

It is understood that minor changes may be made to the invention without departing from the scope of the appended claims.

What is claimed is:

1. The method of forming a terminal plug for a plurality of coaxial conductors disposed adjacent and in parallel relation to each other in a lead cable sheath which consists in passing the conductors in individual conducting tubes, inserting beads of soft material in the tubes, compressing the beads against the walls of the tubes and the centrally disposed conductors by screwing other conducting tubes in perforations in a disc member and into the first-mentioned tubes, securing the disc member to a sleeve extending over the first-mentioned tubes, placing such a sleeve in a shell, compressing another ring of soft material against the wall of the shell and the periphery of the sleeve through the tightening action of a screw-threaded member engaging the shell, the shell being secured at its other end to the lead sheath by soldering.

2. A terminal plug for a plurality of concentrically disposed conductor members encased in a lead sheath, said plug comprising a conducting sleeve soldered onto the end of each tubular conductor, a bead of rubber placed over each of the centrally disposed conductors in said sleeves, a plurality of means threadedly engaging the other ends of said conducting sleeves for compressing said beads to force them to expand to form a gas-tight closure between said conducting sleeves and the centrally disposed conductors, a disc member secured to all of said means, a metallic sleeve extending over said conducting sleeves and having one of its ends secured to the periphery of said disc member, another bead of rubber placed over said metallic sleeve, a metallic shell placed over the last-mentioned bead, and means threadedly engaging one end of said shell for compressing said bead to force it to expand to form a gas-tight closure between said shell and said metallic sleeve, said shell having its other end soldered to the lead sheath.

3. A terminal plug for a pair of concentric cables disposed in parallel relation to each other in a lead sheath, said plug comprising a pair of conducting sleeves secured on adjacent ends of the tubular conductors, other conducting sleeves, a disc member having means for threadedly receiving similar ends of the second-mentioned sleeves and these sleeves engaging the ends of the first-mentioned sleeves, a tubular member secured to the periphery of said disc and extending over the first-mentioned sleeves, means in the first-mentioned sleeves compressed by the tightening movement of the second-mentioned sleeve into the first-mentioned sleeves to form gas-tight closures between the walls of the first-mentioned sleeves and the centrally disposed conductors, a tubular housing, a plurality of rings of different material for holding said tubular member in position concentric to said housing, a head-piece member having a screw-threaded portion engaging one end of said housing for compressing said rings to force one of them against the wall of said housing and the periphery of said tubular member to form a gas-tight closure therebetween, said housing being subsequently soldered at one end to the lead sheath and its other end to said head-piece member for preventing relative turning movement between said housing and said head-piece.

4. A plug for a coaxial cable having a plurality of conductor members encased in a lead sheath, said plug comprising a plurality of tubings each having a rubber member compressed therein, a disc having means for receiving the ends of said tubings and soldered thereto, a metallic sleeve extending over said tubings and having one end soldered on the periphery of said disc, a tubular housing for enclosing said tubings and said metallic sleeve, a plurality of beads of different material for holding said tubular housing in position concentric to said sleeve and a head-piece threadedly engaging said housing for compressing said beads to force one of them to expand radially to form a closure between the tubular housing and said metallic sleeve, said head-piece having means for securing the plug to a support.

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