Jan. 12, 1971 H. W. DEMLER, SR., ET AL 3,553,835

METHOD OF PROVIDING COAXIAL CONNECTIONS

Original Filed Oct. 14, 1963 5 Sheets-Sheet 1

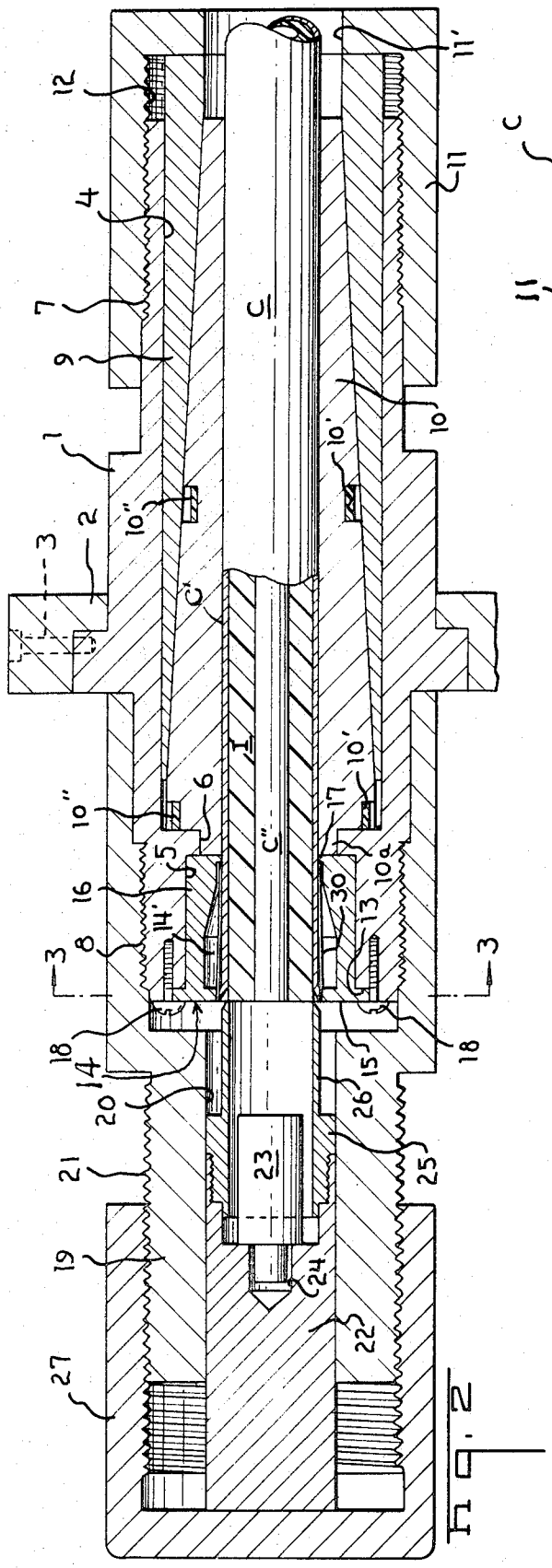


FIG. 2

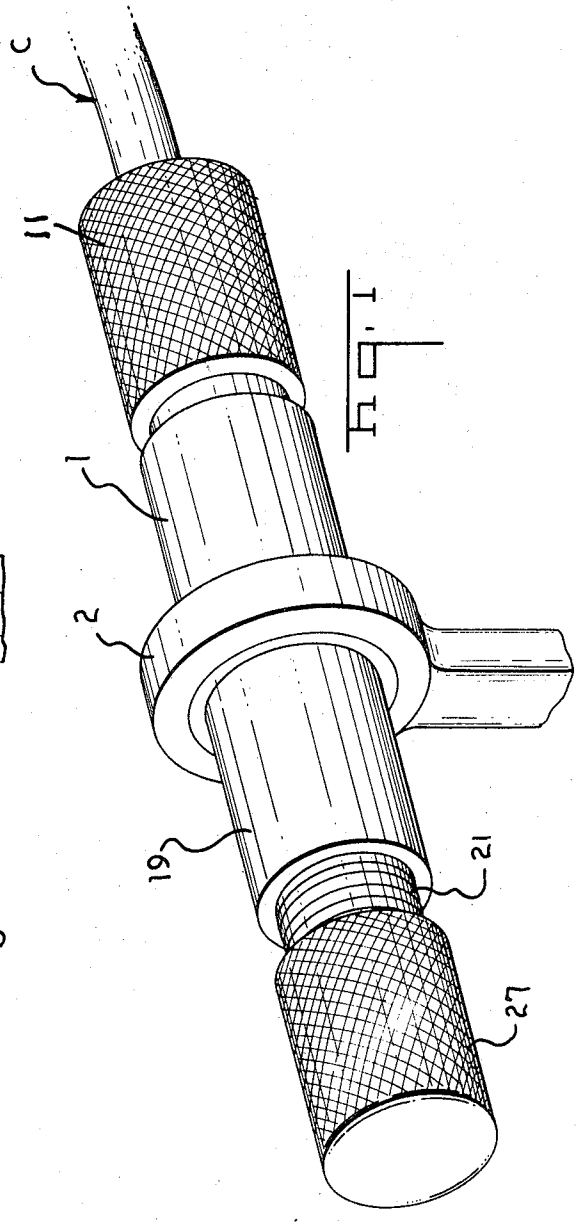


FIG. 1

INVENTOR.
HENRY W. DEMLER, SR.
GEORGE W. ZIEGLER JR.

METHOD OF PROVIDING COAXIAL CONNECTIONS

Original Filed Oct. 14, 1963 5 Sheets-Sheet 2

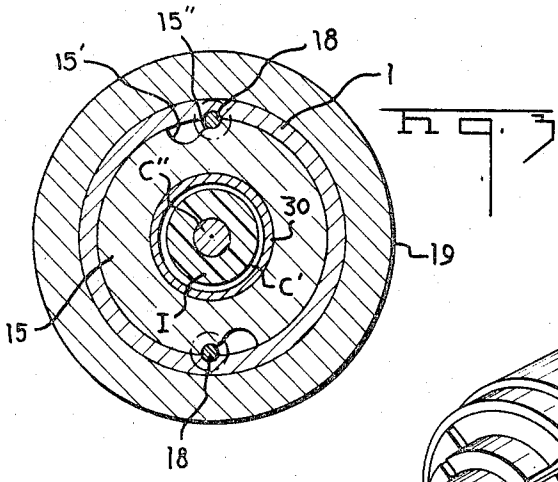


Fig. 3

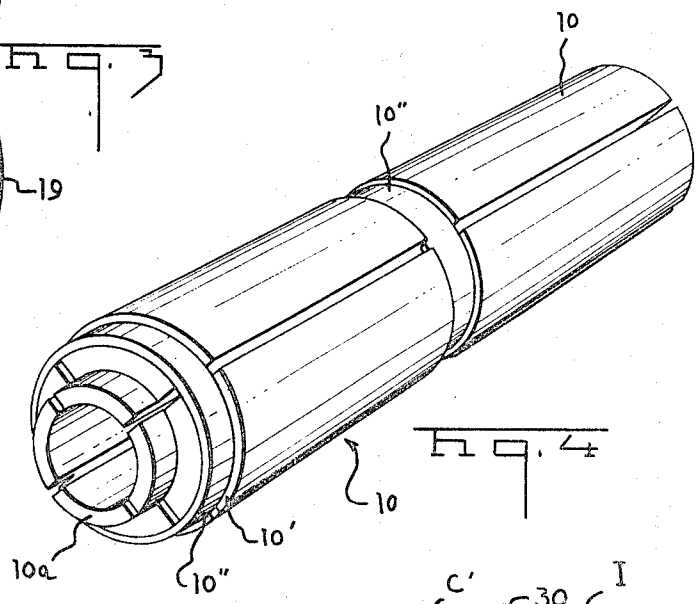


Fig. 4

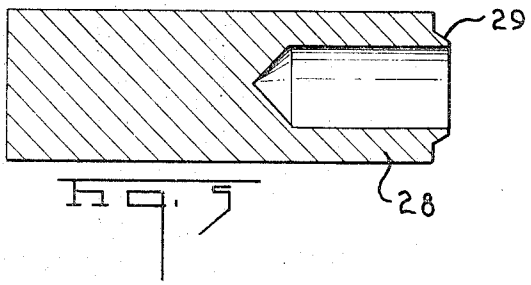


Fig. 5

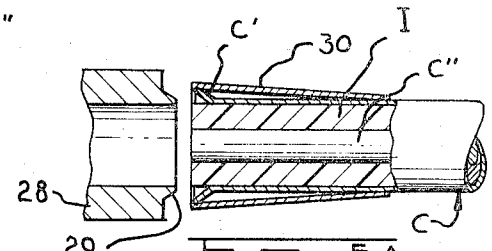


Fig. 5A

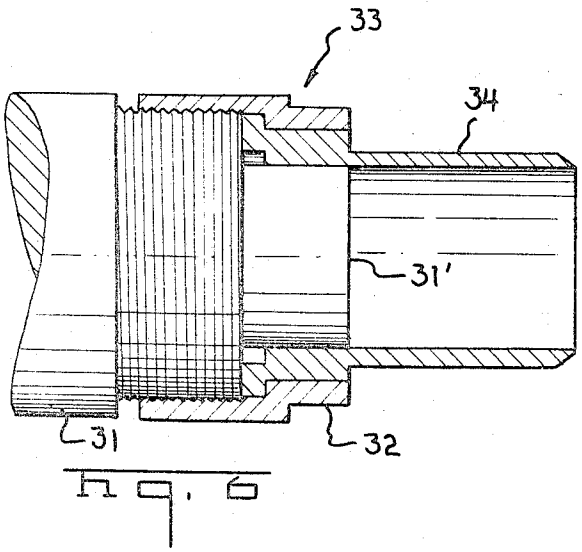


Fig. 6

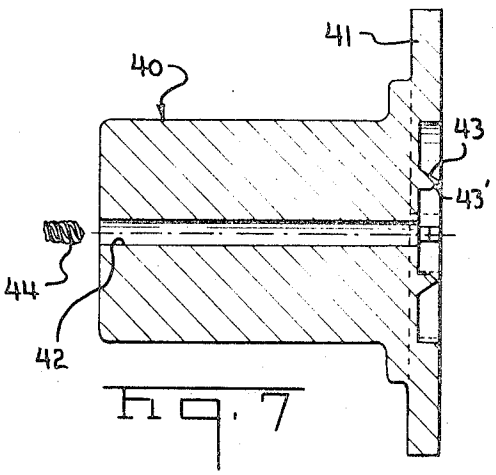


Fig. 7

INVENTOR.
HENRY W. DEMLER, SR.
GEORGE W. ZIEGLER JR.

METHOD OF PROVIDING COAXIAL CONNECTIONS

Original Filed Oct. 14, 1963 5 Sheets-Sheet 3

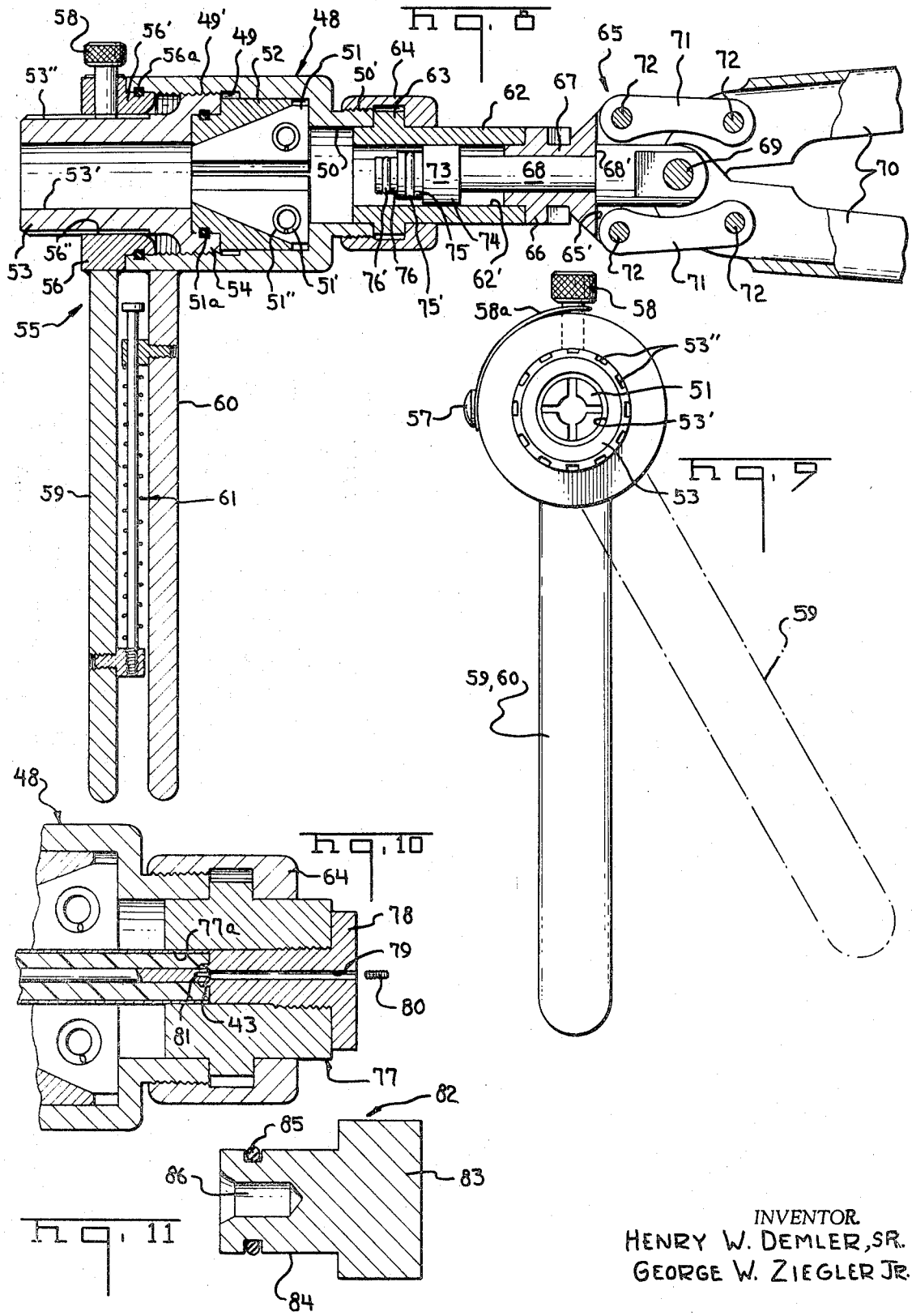


FIG. 8

FIG. 9

FIG. 10

FIG. 11

INVENTOR.
HENRY W. DEMLER, SR.
GEORGE W. ZIEGLER JR.

METHOD OF PROVIDING COAXIAL CONNECTIONS

Original Filed Oct. 14, 1963 5 Sheets-Sheet 4

Fig. 12

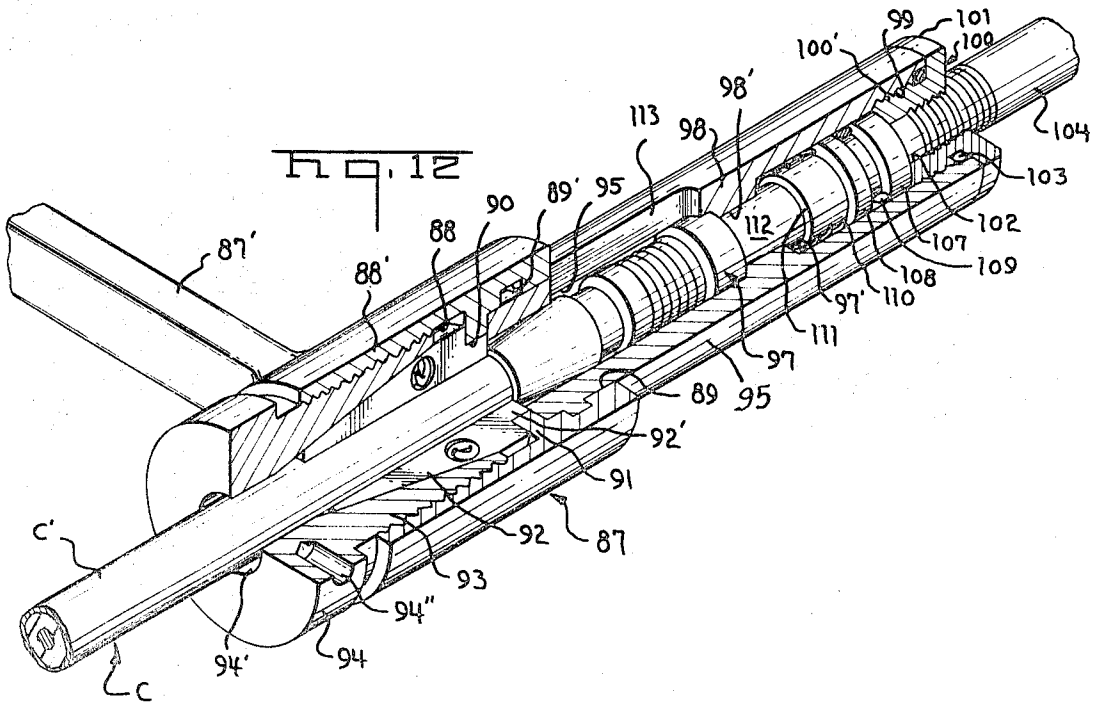


Fig. 13

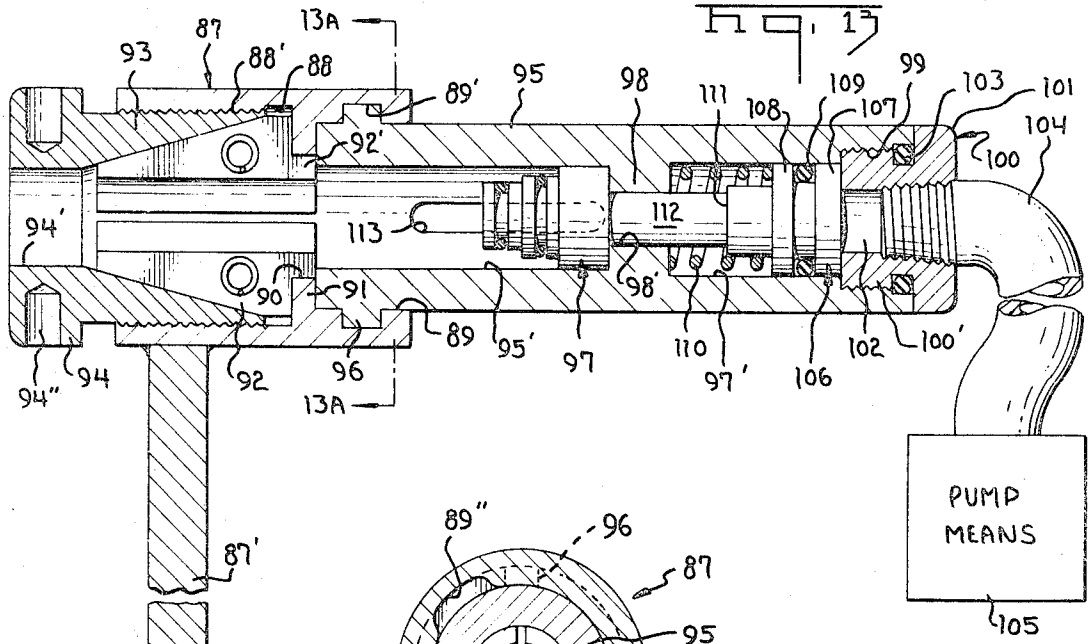
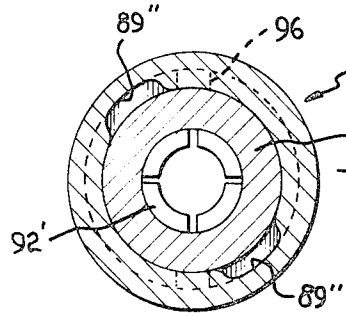


Fig. 13A



INVENTOR.
HENRY W. DEMLER, SR.
GEORGE W. ZIEGLER JR.

METHOD OF PROVIDING COAXIAL CONNECTIONS

Original Filed Oct. 14, 1963 5 Sheets-Sheet 5

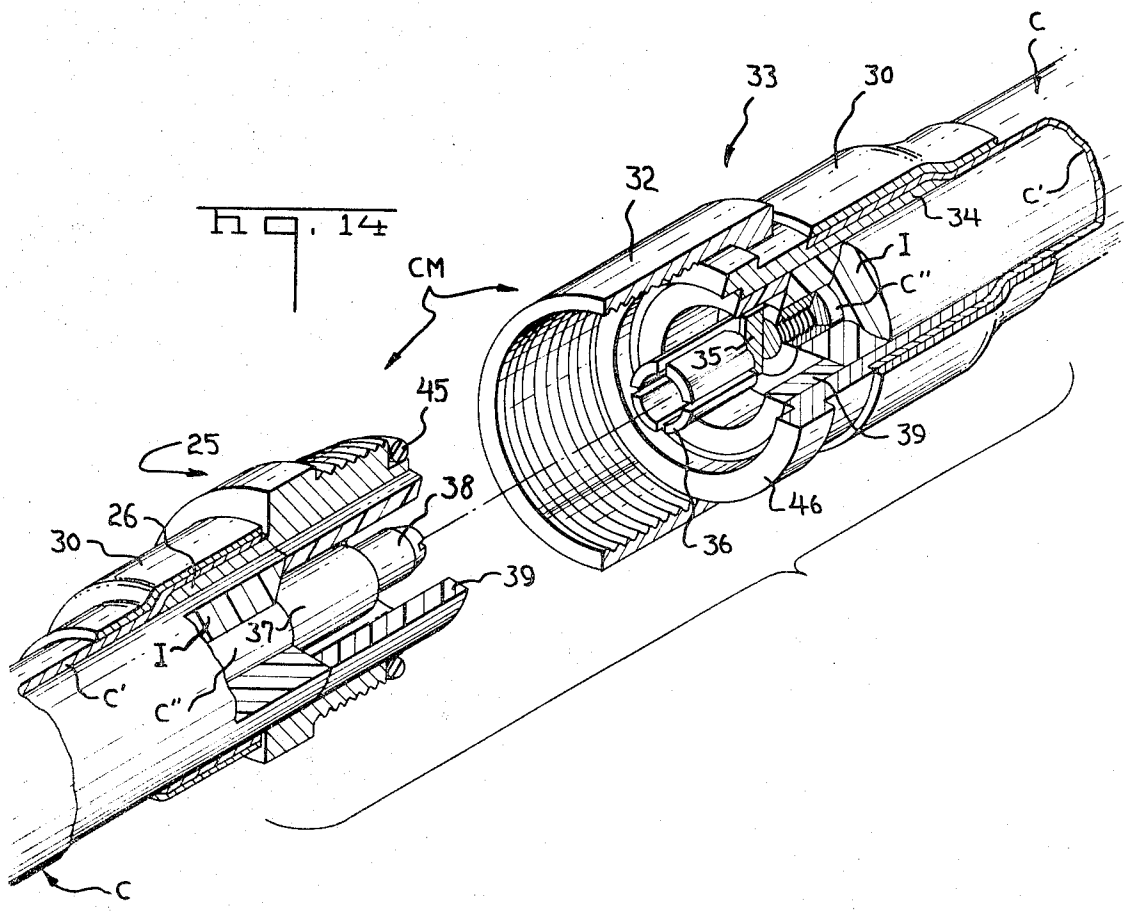


Fig. 14

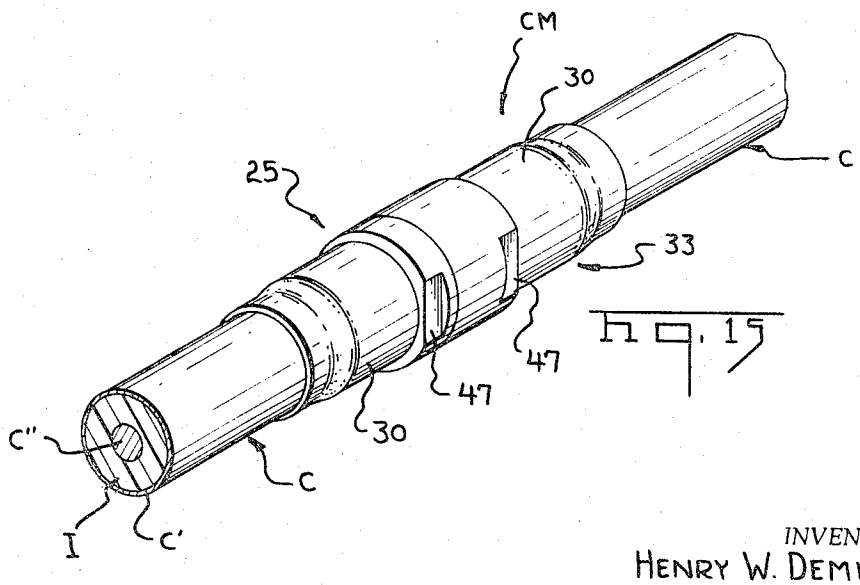


Fig. 15

INVENTOR.
HENRY W. DEMLER, SR
GEORGE W. ZIEGLER JR.

United States Patent Office 3,553,835
Patented Jan. 12, 1971

3,553,835

METHOD OF PROVIDING COAXIAL CONNECTIONS

Henry William Demler, Sr., Lebanon, and George William Ziegler, Jr., Carlisle, Pa., assignors to AMP Incorporated, Harrisburg, Pa.

Original application Oct. 14, 1963, Ser. No. 315,787, now Patent. No. 3,270,392. Divided and this application May 23, 1966, Ser. No. 552,062
Int. Cl. H01r 43/00
U.S. Cl. 29—628 4 Claims

ABSTRACT OF THE DISCLOSURE

A method of connecting a coaxial connector member onto a rigid conductor of a coaxial cable which comprises holding one end of the cable while placing a loading ring on the conductor adjacent one end thereof. The conductor is flared along at least a portion thereof into engagement with the loading ring and the connector member is then pushed onto the conductor in a coaxial direction thereby forcing the conductor against the loading ring to provide mechanical and electrical engagement therebetween.

This application is a division of application, Ser. No. 315,787, filed Oct. 14, 1963 and now U.S. Pat. 3,270,392.

This invention relates to a tool, especially a tool for applying connector members onto conductor means such as a coaxial cable, and the method therefor.

In the coaxial cable field, it is necessary to interconnect and terminate coaxial cables by connector members. It is essential that the connector members provide excellent mechanical and electrical characteristics when on the coaxial cables, as well as being readily mounted thereon. Various types of connector members have been used as well as the application thereof which have not proven satisfactory.

It is, therefore, a primary object of the present invention to provide a method for readily applying connector members onto a cable means.

A further object of the present invention is to provide a method for securely holding the cable means and fixedly applying a connector member thereon.

An additional object of the present invention is the provision of a method and a tool which fixedly mounts a connector member to the outer conductor of a coaxial cable.

A still further object of the present invention is to provide a tool which is useful in carrying out the above method and which has interchangeable parts to perform different functions.

A still additional object of the present invention is the provision of a tool that does not disturb the insulation of the coaxial cable means.

Still another object of the present invention is to provide a tool that centers the center conductor of the coaxial cable means in order to drill and tap same.

Other objects and attainments of the present invention will become apparent to those skilled in the art upon a reading of the following detailed description when taken in conjunction with the drawings in which there is shown and described illustrative embodiments of the invention; it is to be understood, however, that this embodiment is not intended to be exhaustive nor limiting of the invention but is given for purposes of illustration in the invention and principles thereof and the manner of applying it in practical use so that they may modify it in various forms, each as may be best suited to the conditions of a particular use.

In the drawings:

FIG. 1 is a perspective view of one embodiment of the present invention;

FIG. 2 is a longitudinal cross-sectional view of FIG. 1 with cable means and a connector member therein;

FIG. 3 is a cross-sectional view of FIG. 2 along lines 3—3 of FIG. 2;

FIG. 4 is a perspective view of the chuck device;

FIGS. 5, 6, and 7 are, respectively, cross-sectional views of the flaring member, female pusher member and drill jig for use in the embodiment of FIG. 1;

FIG. 5*a* is a cross-sectional view showing the flaring member and cable means after flaring thereof;

FIG. 8 is a cross-sectional view of another embodiment of the present invention;

FIG. 9 is an end view looking from the left of FIG. 8;

FIG. 10 is a part cross-sectional view showing a drill and tap jig engaging the center conductor of the cable means;

FIG. 11 is a cross-sectional view of the male fitting holding member;

FIG. 12 is a view similar to FIG. 1 but of a further embodiment of the present invention, and with parts broken away;

FIG. 13 is a longitudinal cross-sectional view of FIG. 12;

FIG. 13*a* is a cross-sectional view taken along lines 13*a*—13*a* of FIG. 13;

FIGS. 14 and 15 are, respectively, an exploded perspective partially sectioned and broken away view and a perspective view of a cable assembly having connector members applied therein by the present invention.

Turning now to the drawings and more particularly FIGS. 1–3, there is shown a hollow tool body **1** removably mounted in a mounting means **2** by a set screw **3** or in any other conventional manner. Tool body **1** has a first bore **4**, a second bore **5** of smaller diameter than bore **4** and an intermediate bore **6** connecting bores **4** and **5** but of smaller diameter than either one. Each end of body **1** has threads **7**, **8** on the external surface thereof.

Removably disposed in bore **4** is a sleeve **9** whose outer surface corresponds to that of bore **4** and an inner conical surface whose diameter progressively increases from the outer part of bore **4** toward the inner part thereof. Removably disposed on the interior of sleeve **9** is a chuck device **10** comprising preferably four jaw members. Chuck device **10** has an outer surface corresponding to the inner surface of sleeve **9** and an inner surface which engages outer conductor C′ of cable means C and holds same within body **1**. Thus, chuck device **10** and sleeve **9** move relative to each other in order to grip and hold a cable means in accordance with the size thereof. The inner end of chuck device **10** engages the inner end of bore **4** to limit the inner movement therein, and each of the jaws of the chuck device includes an extension **10***a* which is disposed in bore **6** and has the same length thereof. If desired, chuck device **10** can have less than or more than four jaws.

In order to keep the jaws of the chuck device in engagement against the inner surface of sleeve **9**, notches **10′** are disposed in each jaw contiguous the inner end and about midway thereof. In each notch there is secured a strip of plastic material **10″**, such as nylon, Teflon, or other suitable material. With the use of the strip of plastic material secured to each of the jaws, they do not become separated from each other. Of course, if desired, spring means can be interposed between adjacent jaws to accomplish the same purpose.

A chuck nut **11** having threads **12** on the internal surface and an opening **11'** in the bottom thereof corresponding to the minimum diameter of the inner surface of sleeve **9** is threadably engaged on threads **7**. The outer end of sleeve **9** extends beyond the outer end of body **1** and engages the inner surface of the bottom of nut **11**. Thus, upon nut **11** being threadably moved along body **1**, sleeve **9** is moved inwardly to compress the jaws of chuck device **10** onto cable means C disposed therein by camming action until the cable means is securely held thereby. The outer surface of nut **11** is preferably knurled to aid in rotating same.

It is to be understood that various chuck devices having different inner diameters can be used in order to accommodate different sized cable means.

Arecess **13** having a larger diameter than bore **5** is disposed in the end of body **1** having threads **8** thereon. A ring-locating member **14** has an outer flange **15** which fits in recess **13**, a body portion **16** which fits within bore **5** and an inner flange **17** which has a portion abutting against the wall connecting bores **5** and **6** and another portion abutting against extensions **10***a* of chuck device **10**.

Ring-locating screws **18** are disposed in body **1** in the outer part of recess **13** in diametrical relationship. In the periphery of outer flange **15** (see FIG. 3) there are adjacent notches **15'** and **15''** with one larger than the other which permit insertion of the ring-locating member **14** into body **1** via the larger notches passing over the heads of screws **18** and with a slight turn, they are secured therein via the smaller notches which engage the shanks of screws **18** underneath the heads thereof. Of course, other conventional securing means can be utilized to secure member **14** in body **1**.

Ring-locating member **14** is preferably made in two parts which will be discussed hereafter. As can be discerned, body portion **16** of ring-locating member **14** has a cavity **14'** of substantially conical configuration between flanges **15** and **17** which also will be discussed hereafter.

A guide member **19** has internal threads which mate with threads **8** and has a guide bore **20** which is coaxial with bores **4**, **5** and **6**. The rear part of guide member **19** has threads **21** on the outer surface thereof. A male pusher member **22** is disposed in guide bore **20** and has a stop member **23** threadably disposed in a threaded hole **24**. The inner part of pusher member **22** has internal threads which mate with the external threads of a male fitting **25** of a coaxial connector member CM. Male fitting **25** has an insertion part **26** which is to be inserted between the inner surface of the outer conductor of cable means C and the outer surface of insulation I thereof.

A drive nut **27** having internal threads which mate with threads **21** of guide member **19** is threadably mounted thereon. The inner surface of the bottom of drive nut **27** engages the outer end of male pusher member **22** in order to drive same upon drive nut **27** being screwed upon guide member **19** thereby driving the insertion part **26** into position as stated above. The outer surface of drive nut **27** can be knurled, if desired.

FIG. 5 shows flaring member **28** which has an outer diameter slightly less than guide bore **20** so as to be movable therein. The front end of flaring member **28** has a projection **29** whose outer surface is inclined toward the axis of flaring member **28** to form a flaring section. Thus, a loading ring **30** is fitted into cavity **14'** of ring-locating member **14** over the outer conductor of the cable means. Loading ring **30** has a slight inclination extending from the inner end to the outer end. As can be seen from FIGS. 2 and 5*a*, ring **30** abuts against inner flange **17** to limit the inner movement thereof so that the outer edge is located flush with the end of the cable means. The inner surface of outer flange **15** is spaced from outer conductor C' by an amount which is equal to the thickness of ring **30** plus the distance that conductor C' is to be moved by the flaring member and the insertion of insertion part **26** of the male part of the connector member. Flaring member **28**, therefore, flares a small portion of the outer conductor against loading ring **30** (see FIG. 5*a*) to hold ring **30** temporarily in place and to provide an easy entrance for insertion part **26**. Flaring member **28** does not damage the insulation and can be provided, if desired, with cutting members (not shown), such as, sharpened serrations, in order to cut away some of the inner surface of outer conductor C'.

FIG. 6 shows a female pusher member **31** threadably engaging a coupling nut **32** of a female fitting **33** of the connector member CM. Female fitting **33** includes an insertion part **34** similar to insertion part **26** of male fitting **25** and is applied to another cable means (not shown) in the same manner as the male fitting and the other end of loading ring **30** maintains coupling nut **32** freely rotatably on insertion part **34** so that the coupling nut can threadably engage the male fitting **25** (see FIGS. 14 and 15.)

The inner ends of the insertion parts are preferably tapered in order to render an easy insertion thereof within the cable means.

Prior to the application of each fitting to its respective part of the cable means, the center conductor C'' can be drilled and tapped along the axis thereof in order to mount thereon a metallic contact member **35** in female fitting **33** which has resilient members **36** extending outwardly therefrom and a metallic contact member **37** in male fitting **25** which has a plug portion **38** adapted to be engaged by resilient members **36** (see FIG. 14). Between the contact members **35**, **37** and the fittings **25**, **33**, there is disposed tubular dielectric inserts **39**.

In order to drill and tap center conductor C'' along the axis thereof, it is essential that the center conductor be centered; because it is possible that the center conductor has deviated from the center axis of the conductor means. In FIG. 7 there is shown a drill jig **40** including a flange **41**, a center hole **42** and projections **43** extending outwardly therefrom. Flange **41** has a thickness corresponding to the depth of recess **13** in which it is to be mounted by means of notches similar to those in outer flange **15** of ring-locating member **14**. Projections **43** are preferably four in number and are disposed 90° with respect to each other as well as the same distance from the axis of drill jig **40**. Each of projections **43** is provided with an inclined surface **43'** directed toward the axis of drill jig **40** so that if center conductor C'' is off center, the inclined surfaces of the projections will center the center conductor.

Once drill jig **40** is mounted in position in recess **13** of body **1** with guide member **19** removed therefrom, a drill **44** is passed through opening **42** and the center conductor then has a hole drilled therein by the drill **44**. It should be pointed out that hole **42** is slightly larger than drill **44** to aid in the support thereof since the drill is rather small. After the hole is drilled, drill jig **40** is removed from recess **13** and a tap jig (not shown) similar to drill jig **40** but having a larger opening therein than opening **42** is mounted in recess **13** in like manner and a tapping member is inserted through the large opening to thereby tap the drilled hole. The outer surface of the jigs are preferably knurled to aid in handling them. While the above drill and tap jigs are the preferable means to drill and tap the center conductor, these jigs could have about the same outside diameter as that of guide bore **20** minus flange **41**, and the bottom of drive nut **27** could have a hole therein in order to be used in conjunction with guide member **19**; but since the drill and tapping members are rather small in diameter, this would place a tremendous stress thereon.

Ring-locating member **14** is preferably made in two pieces, so that upon application of a male or female fitting onto the conductor means, the conductor means with a fitting thereon can be removed through body **1**.

The operation of the foregoing device is as follows: chuck nut **11** is slipped over an end of a cable means C

through opening 11'; the cable means is placed within chuck device 10, which is generally open to its fullest extent against the inclined surface of sleeve 9, until the end thereof is in the same plane as the opening containing recess 13; then chuck nut 11 is tightened to thereby move sleeve 9 relative to chuck device 10 so as to secure the cable means in body 1.

Drill jig 40 is then locked in recess 13 to center the center conductor by means of the inclined surfaces of projections 43, if necessary, and a suitable drill 44 is used to drill a hole in the center conductor. The drill jig is removed from recess 13, and the tap jig is locked therein to tap the hole just drillled by a suitable tapping member. Tap jig is then removed from recess 13, and ring-locating member 14 is locked therein.

Loading ring 30 is disposed within equity 14' and over the outer conductor of the cable means and then guide member 19 is threadably mounted on body 1 via threads 8. Flaring member 28 is inserted in guide bore 20, and drive nut 27 is threadably mounted on threads 21 to drive the flaring member 28 into engagement with the cable means to thereby flare a small length of the outer conductor into engagement with loading ring 30 (see FIG. 5*a*).

Flaring member 28 is replaced by either male pusher member 22 with male fitting 25 therein or female pusher member 31 with female fitting 33 thereon within guide bore 20; drive nut 27 then pushes the pusher member with its fitting thereon so that the insertion part is pushed between the inner surface of the outer conductor and the outer surface of insulation I to thereby push the outer surface of the outer conductor into tight engagement with loading ring 30. The insertion part of the fitting is, therefore, securely disposed between the inner surface of the outer conductor and the outer surface of the insulation to provide an excellent mechanical and electrical engagement therebetween without any damage to either the outer conductor or the insulation. The connection between the outer conductor and the insertions of each fitting has been found to be so tight that upon a torque, being applied to the cable means, the cable means will mechanically fail before relative slippage of the cable means with respect to the connector means.

When inserting the male fitting, stop means 23 is used which engages the end of the conductor means to thereby limit the inner movement of the insertion part. In order that coupling nut 32 is not placed in tight engagement with the loading ring 30, female pusher member 31 is provided with a surface 31' which engages the end of the cable means.

After each fitting is applied to one end of a cable means, chuck nut 11 is loosened to disengage chuck device 10 from the cable means, the cable means is moved outwardly from recess 13, ring-locating member 14 is removed therefrom and the cable means and fitting thereon is removed from body 1. Contact members 35 and 37 are threaded into the tapped holes of the inner conductors and the dielectric inserts 39 are wedged against the inside surfaces of the fittings as shown in FIG. 14; coupling nut 32 threadedly engages male fitting 25 to provide the completed cable assembly as shown in FIG. 14.

The outer end of the male fitting is stepped and an O-ring of suitable material 45 is disposed thereon which engages a surface 46 of the female fitting in order to provide an effective seal against an environment such as moisture, corrosive gases or other similar undesirable factors. Flat surfaces 47 are provided on each fitting which permit the use of tools to tighten the connector means.

As an alternative arrangement, outer conductors C' and insulation I can be removed allowing a suitable length of inner conductors C'' of the cable means to extend outwardly therefrom, and these can be provided with external threads while contact members 35 and 37 can be internally tapped with corresponding threads, thereby eliminating use of any drill and tap jigs. If this arrangement is used, male and female pusher members 22, 31 and flaring member 28 are provided with a central opening in order to accommodate the outwardly extending inner conductors.

Turning now to FIGS. 8 and 9, there is shown a second embodiment of the present invention which uses handles to apply connector fittings on cable means. This embodiment comprises a hollow body 48 which has a first bore 49 and a second bore 50 having a smaller diameter than bore 49. Threads 49' are provided on the inner surface of bore 49, and threads 50' are provided on the external surface of bore 50.

A chuck device 51 having preferably four jaws and similar to chuck device 10 in FIGS. 2 and 4 is disposed in bore 49 and engages the inner surface thereof. Chuck device 51 is shorter than chuck device 10 and has an outer surface which is provided with a larger inclination than that of chuck device 10. Sleeve 52 has a mating interior inclined surface engaging the inclined surface of chuck device 51 and an outer surface slightly smaller than bore 49 so as to be movable therein. The jaws of chuck device 51 are preferably maintained in engagement with the inclined surface of sleeve 52 by spring means 51' such as coil springs disposed in openings 51'' of the jaws.

A driving member 53 having an opening 53' corresponding to the minimum diameter of the inclined surface of sleeve 52 threadably engages threads 49' of bore 49. Driving member 53 and sleeve 52 have engaging mating step portions 54 which are maintained in engagement by spring means 51*a*. The outer surface of driving member 53 has equally spaced slots 53'' therein.

A ratchet device 55 is used to drive driving member 53 axially in two directions to move sleeve 52 toward the inner end of bore 49 and in the opposite direction thereby causing chuck device 51 to engage and disengage a cable means disposed therein. Ratchet device 55 comprises an engaging member 56 having a boss 56' which is disposed within the outer surface of bore 49 adjacent threads 49' and rotates relative thereto. Engaging member 56 has an opening 56'' in which the portion of driving member 53 containing slots 53'' is disposed.

A spring biased ratchet pin 58 is disposed in engaging member 56 and engages slots 53'' thereby enabling the ratchet device to be operated in two directions. A leaf spring 58*a* engages pin 58 and is mounted on member 56 by screw 57. Member 56 is maintained within the outer part of bore 49 by a key means 56*a* which is disposed in opposed grooves therein.

A handle 59 extends from engaging member 56 and is disposed parallel to another handle 60 extending from body 48 in the same direction. An over center spring mechanism 61 is connected between handles 59 and 60 which facilitates driving the ratchet device in either direction.

A guide sleeve 62 has a guide bore 62' and a flange 63 extending outwardly from the outer surface and near the inner end thereof. The outer surface of sleeve 62 has a diameter slightly less than the diameter of bore 50. A sleeve nut 64 has an opening therein to accommodate sleeve 62 and a surface which engages one side of flange 63. Sleeve nut 64 has internal threads mating with threads 50' in order to maintain guide sleeve 62 on body 48. As can be seen, the other surface of flange 63 engages the outer end of bore 50, and an inner portion of guide sleeve 62 is disposed within bore 50. Instead of a sleeve nut, guide sleeve 62 could be connected to body 48 by a conventional bayonet connection.

A mounting member 65 mounts guide sleeve 62 thereon via a conventional bayonet connection 66. The lugs of the bayonet connection extend outwardly from a piston sleeve 67 which is disposed within guide bore 62' and has a piston 68 movably disposed therein. The outer end of piston 68 is pivotally connected by pivot pin 69 to the inner ends of handles 70 which in turn are pivotally connected to mounting member 65 by link members 71 and pivot pins 72. Thus, when handles 70 are moved

away from each other, piston **68** is moved in a direction toward handles **70**, while upon moving handles **70** toward each other, piston **68** moves in a direction away from handles **70**.

It should be pointed out that mounting member **65** and guide sleeve **62** can be an integral piece thereby eliminating bayonet connection **66**.

A female fitting holding member **73** comprises three stepped sections **74**, **75** and **76**. Step section **74** has a diameter slightly less than guide bore **62'** so as to be movable therein. The inner end of step section **74** rests on the inner end of member **67** when handles **70** are disposed in their outermost inoperative position, and upon movement of handles **70** toward each other, piston **68** engages this inner end to move member **73** toward body **48**. The other stepped sections **75** and **76** have O-rings **75'** and **76'** of suitable plastic material disposed in grooves therein. Member **73** is preferably a separate piece and is, therefore, readily removed from guide bore **62'**.

A female fitting as shown in FIG. 6, is adapted to be mounted on member **73** with the inner threaded surface of coupling nut **32** disposed on stepped section **75** and the internal surface of insertion part **34** disposed on stepped section **76**. O-rings **75'** and **76'** hold nut **32** and part **34** of the female fitting on member **73**, which is then placed in guide bore **62'** as shown in FIG. 8. The inner end of stepped portion **76** engages the end of the cable means to limit the inner movement of the insertion part within the cable means. Piston **68** also has a shoulder **68'** which engages a surface **65'** to also limit the inner movement of piston **68**.

FIG. 10 shows a drill and tap jig **77** similar to that shown and described in FIG. 7 which is held on body **48** in the same manner as guide sleeve **62** by nut **64**. An insert **78** is threadably mounted in jig **77** and has an opening **79** passing therethrough through which a tap member **80** passes in order to tap a hole **81** that has been drilled in center conductor C'' by a drill. As shown in FIG. 10, a flared projection **43'** extends outwardly from the inner end of insert **78** and centers the center conductor in the same manner described above. As can be seen, the inner end of insert **78** is spaced from the inner end of jig **77** so that the cable means is disposed within bore **77***a* in order to support and center same. Insert **78** is to be used in conjunction with tap member **80** because opening **79** is large enough to accommodate same; however, a drill insert (not shown) is to replace insert **78** when center conductor C'' is to be drilled, and the drill insert has a smaller opening than opening **79** since the drill will be smaller than the tap member.

It is also possible to allow center conductor C'' to extend out from the cable means about a quarter of an inch, and instead of drilling and tapping the center conductor, it can be threaded to receive a contact member in mating relationship thereon, as described above, in conjunction with FIGS. 14 and 15. Also, instead of threading the center conductor, the contact member can be frictionally mounted on the outwardly extending center conductor. If the center conductor is to extend outwardly, then female fitting holding member **73** will have to be provided with a central opening in order to accommodate the outwardly extending center conductor upon application of this fitting to the cable means.

FIG. 11 shows a male fitting member **82** including a portion **83** similar to portion **74** of female fitting holding member **73** and another portion **84** of less diameter than portion **83**. An O-ring **85** is disposed in a groove of portion **84**. Member **82** is adapted to hold a male fitting such as shown in FIGS. 2 and 14 by portion **84** being disposed on the inner surface thereof and O-ring **85** maintains it thereon. An opening **86** is disposed in the center of portion **84** in order to accommodate the outwardly extending center conductor, if this be the case. To facilitate entry of the center conductor within opening **86**, it is tapered at the entrance thereof.

A flaring member similar to that shown and described in connection with FIGS. 5 and 5*a* is also used in FIGS. 8 and 9; and since it has the same configuration and operation as that of FIGS. 5 and 5*a*, it is not necessary to provide any further description thereof except to mention that the diameter thereof has to be slightly less than bore **62'**. Of course, the flaring member will have to be provided with a central opening similar to opening **86** of member **82** for the same reason.

The operation of FIGS. 8 and 9 is as follows: Ratchet device **55** is operated to open chuck device **51** and a cable means is placed therein until the end thereof is flush with the end of bore **50**. Ratchet device **55** is then operated in the opposite direction to secure the cable means in the chuck device. If the center cable is to be drilled and tapped, then the jig shown and described in conjunction with FIG. 10 is used to accomplish same. If, on the other hand, the center conductor is to extend outwardly from the cable means, as described above, then a loading ring **30** is placed on the outer conductor C' with the inner end thereof engaging the inner ends of the jaws of chuck device **51**. Sleeve **62** is mounted on body **48** by nut **64**, the flaring tool is disposed in bore **62'**, mounting member **65** is mounted on sleeve **62** and handles **70** are moved toward each other thereby flaring the end of the outer conductor against loading ring **30**.

As can be seen, no ring-loading member **14** is used in the embodiment of FIGS. 8 and 9, since the cable means extends far enough into bore **62'**, which has a sufficient diameter thereby providing support, and the inner part of chuck device **51** limits the inner movement of ring **30**.

After the flaring operation has been completed, then either a male or female fitting mounted on its respective holding member is placed in bore **62'** to thereby be applied to the cable means upon inner movement of handles **70**. After the fitting has been applied to the cable means, then ratchet device **55** is operated to loosen chuck device **51**, and the cable means, fitting and holding member are removed from the tool through opening **53'**.

Turning now to FIGS. 12–13*a* there is shown a third embodiment of the present invention. In this embodiment, there is provided a hollow body **87** having a chuck bore **88** containing threads **88'** and a sleeve receiving bore **89** of smaller diameter than bore **88**. Bore **89** has an annular groove **89'** disposed therein. Bores **88** and **89** are in communication with each other through another bore **90** having a diameter less than these bores. Bore **90** is disposed in wall **91** separating them. A handle **87'** extends outwardly from body **87**.

A chuck device **92** similar to chuck device **51** of FIG. 8 is disposed in bore **88**. Since chuck device **92** is the same as chuck **51**, no further explanation thereof is necessary except to point out that chuck device **92** has has extensions **92'** that are disposed in bore **90** and the height thereof is equal to the length of bore **90**.

A chuck sleeve **93** has an inclined inner surface mating with the inclined surface of chuck device **92** and an external threaded surface mating with threads **88'** so that upon rotation thereof, chuck device **92** is moved toward and away from the longitudinal axis of body **87**. Sleeve **93** also includes a flange **94** having an opening **94'** therein which has a diameter slightly larger than the maximum diameter of the inner surface of chuck device **92** through which the cable means passes. Flange **94** also has disposed in the periphery thereof inwardly directed and spaced openings **94''** which are engaged by a spanner wrench (not shown) in order to rotate sleeve **93** to tighten and loosen same to operate chuck device **92**. Other means can, of course, be utilized to operate sleeve **93**.

A guide sleeve **95** having substantially the same diameter as bore **89** has a portion disposed therein, and this portion has lugs **96** extending outwardly therefrom which engage groove **89'** to form a bayonet connection.

Lugs 96 enter groove 89' through slots 89'' disposed in the front end of bore 89 (see FIG. 13*a*). Guide sleeve 95 has a guide bore 95' in which a female fitting holding member 97 is guided. Female fitting holding member 97 is similar to member 73 used in conjunction with FIG. 8 and, therefore, need not be further described. The same is true with regard to the male fitting holding member, flaring member and drilling and tapping jig.

A piston bore 97' is disposed in sleeve 95 rearwardly of bore 95' and is separated therefrom by a wall 98 having a bore 98' therein but of smaller diameter than bores 95' and 97'. Rearwardly of bore 97' is a larger threaded bore. 99.

A plug 100 has a portion 100' threadably engaged in bore 99, a flange 101 engaging the end of sleeve 95 and a central threaded opening 102. A sealing member 103 is provided in a groove in portion 100' adjacent flange 101 in order to provide an effective seal between plug 100 and sleeve 95. A conduit 104 is threadably engaged in opening 102 and is connected to a conventional pressure source 105, such as pneumatic, hydraulic, etc.

Disposed in bore 97' is a piston member 106 having spaced flange portions 107 and 108 between which is disposed an O-ring 109 to provide a seal between the piston member and bore 97'. A spring means 110 extends between flange portion 108 and the side of wall 98 to normally maintain flange portion 107 in engagement with plug 100. Forward of flange portion 108 is a surface 111 of larger diameter than bore 98' which engages the side of wall 98 to limit to inner movement of piston member 106 in bore 97'. A driving member 112 extends outwardly from surface 111 and is disposed in bore 98' to be moved relative therewith to thereby engage member 97 upon actuation of the piston member. Sleeve 95 has slots 113 disposed therein through which the movement of the fitting holding member and fitting thereon can be observed.

The operation of FIGS. 12–13*a* is as follows: Sleeve 93 is rotated to open chuck device 92, a cable means C is disposed therein until the end of the cable means is flush with the outer end of bore 89 and sleeve 93 is rotated to tighten chuck device 92 on the cable means. If the center conductor is to be drilled and tapped, then a drill and tapping jig similar to that disclosed in connection with FIG. 10 is used to accomplish this operation. A loading ring 30 is then placed over the outer conductor C', a flaring tool similar to that described in FIG. 5 is inserted in bore 95' and sleeve 95 is mounted in place on body 87. Pressure means 105 is actuated and drives piston member 106 inward against spring means 110 so that driving member 112 drives the flaring member into engagement with the cable means so that a part of the outer conductor is flared against ringe 30 in the same manner as shown in FIG. 5*a*.

Pressure means 105 is relieved so that spring means 110 returns the piston member to its normal position, sleeve 95 is removed from body 87, the flaring tool is removed from bore 95', and a fitting holding member 97 with a fitting thereon, such as a male fitting and male fitting holding member shown in FIG. 12, is placed in bore 95' and sleeve 95 again mounted on body 87. Pressure means 105 is again actuated to drive piston member 106 and driving member 112 inwardly so that the insertion part of the fitting is inserted between the outer conductor and the insulation. Pressure means 105 is relieved, sleeve 94 is rotated to disengage chuck device 92 and the cable means and applied fitting is removed from the tool. To apply a female fitting onto another cable means, the same procedure, as above, is followed.

In the insertion of the fittings into the respective ends of cable means by the tools described hereinabove, it is though that actual cold welding occurs due to the contact of surfaces wherein oxide products therebetween have been substantially reduced.

As can be discerned, there has been described a tool means to effectively apply connector fittings to the ends of cable means by an axial motion with the connector fittings and cable means positively disposed in coaxial position in a manner not heretofore contemplated. For further information with regard to the connector means, reference is made to U.S. patent application, Ser. No. 308,265 filed Sept. 11, 1963 and now U.S. Pat. 3,245,027.

It will, therefore, be appreciated that the aforementioned and other desirable objects have been achieved; however, it should be emphasized that the particular embodiments of the invention, which are shown and described herein, are intended as merely illustrative and not as restrictive of the invention.

We claim:

1. In a method of providing a connection of a rigid metallic tubular member to a metallic tubular connector means, the steps comprising positioning a tapered ferrule of resilient metallic material over said tubular member at the end thereof to be connected, holding said ferrule over said tubular member and against axial displacement but free for radial expansion of the ferrule, axially driving said connector means into said tubular member to a point of insertion underlying the said ferrule for an appreciable portion of the length of the ferrule, and expanding outwardly by insertion of said connector means the portion of said tubular member between said connector means and said ferrule to resiliently expand said ferrule and produce a substantial residual circumferential loading of the metallic material thereof which compressibly holds said connector means and said tubular member in intimate compressed engagement.

2. A method of securing an electrical connector member upon a rigid tubular outer conductor of a coaxial cable comprising the steps of clamping one end of said coaxial cable in a fixed position, positioning a tapered loading ring of resiliently hard maetallic material around said outer conductor at said one end, holding said loading ring in position against axial displacement but free for radial movement of the leading ring wall, flaring at least the end portion of said rigid outer conductor into engagement with said loading ring, and forcibly driving said connector member into said rigid outer conductor in an axial direction to a point of insertion underlying said loading ring for a substantial portion of the length thereof, expanding outwardly by insertion of said connector member the portion of said outer conductor into compressive engagement with said loading ring, and also resiliently expanding by insertion of said connection member the loading ring to develop substantial residual circumferential stresses in the loading ring which compresses together said connector member and said cable outer conductor into mechanical engagement.

3. In a method of providing a connection of a rigid metallic tubular member to a metallic tubular connector means, the steps comprising positioning a tapered ferrule of resiliently hard metallic material over said tubular member at the end thereof to be connected, holding said ferrule against axial displacement but free for radial movement of the ferrule wall, axially driving said connector means into said tubular member to a point of insertion underlying the said ferrule for an appreciable portion of the length of the ferrule, and expanding outwardly the portion of said tubular member between said connector means and said ferrule to expand said ferrule and produce a substantial residual circumferential loading of the material thereof which holds intermating surfaces between said connector means and said tubular member and between the said ferrule and said tubular member in intimate engagement.

4. A method of securing an electrical connector member upon a rigid tubular outer conductor of a coaxial cable comprising the steps of clamping one end of said coaxial cable in a fixed position, positioning a tapered loading ring of resiliently hard metallic material around

said outer conductor at said one end, holding said loading ring in position against axial displacement but free for radial movement of the loading ring wall, flaring at least the end portion of said rigid outer coductor into engagement with said loading ring, anrd forcibly driving said connector member into said rigid outer conductor in an axial direction to a point of insertion underlying said loading ring for a substantial portion of the length thereof, and thus expanding outwardly the portion of said outer conductor between said connector member and said loading ring and also expanding the loading ring to develop substantial residual circumferential stresses in the loading ring which provide mechanical and electrical engagement between said connector member and said cable outer conductor.

References Cited

UNITED STATES PATENTS

2,449,983	9/1948	Devol	174—88.2
2,219,218	10/1940	Bergen et al.	
2,986,720	5/1961	Chess	339—177X
3,196,382	7/1965	Morello	339—177
3,199,061	8/1965	Johnson et al.	339—177X
3,206,540	9/1965	Cohen	339—177X
3,245,027	4/1966	Ziegler	339—177X

JOHN F. CAMPBELL, Primary Examiner

C. E. HALL, Assistant Examiner

U.S. Cl. X.R.

29—629, 507, 523; 174—75, 89; 339—89, 177

PO-1050
(5/69)

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,553,835 Dated January 12, 1971

Inventor(s) HENRY WILLIAM DEMLER SR., GEORGE WILLIAM ZIEGLER

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 10, line 37, delete "maetallic" and insert - - - metallic - - -;

Column 10, line 53, after "mechanical" insert - - - and electrical - - -;

Column 11, line 5, delete "anrd" and insert - - - and - - -.

Signed and sealed this 11th day of May 1971.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR
Commissioner of Patents