June 29, 1971 G. W. ZIEGLER, JR 3,588,982

STAKING TOOL

Filed May 15, 1970 2 Sheets-Sheet 1

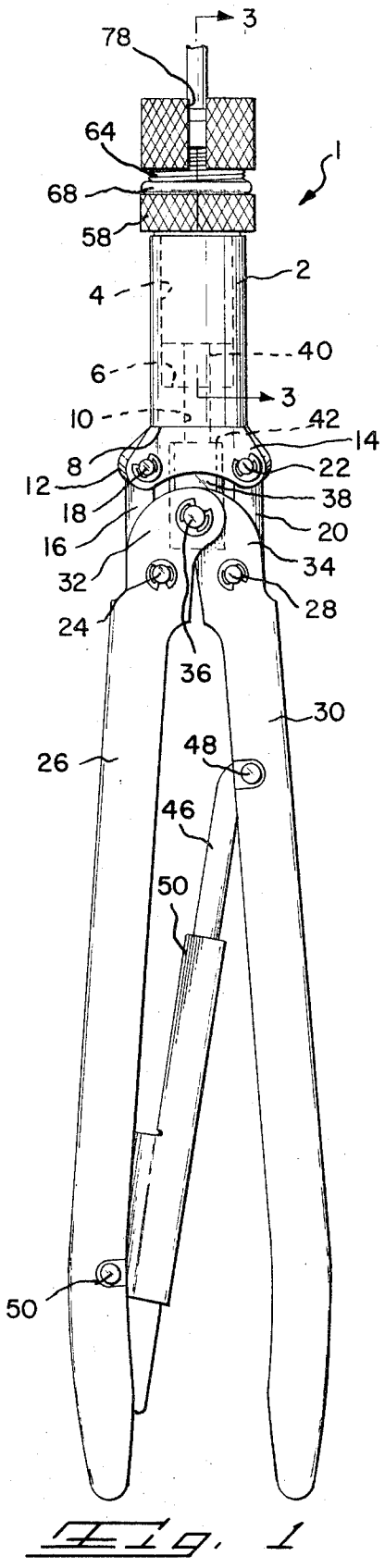

Fig. 1

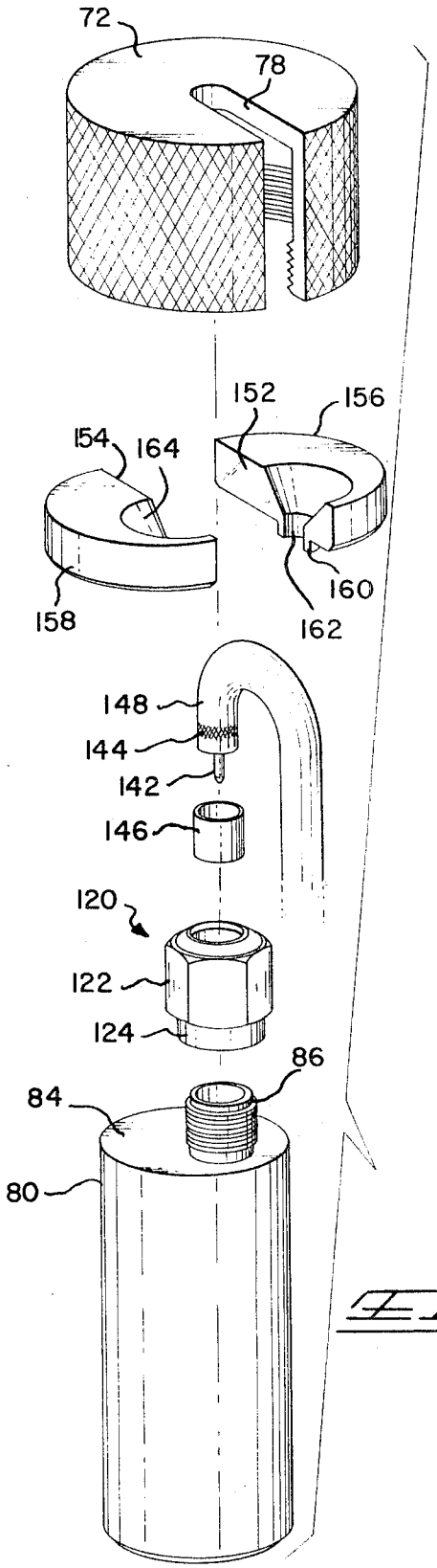

Fig. 2

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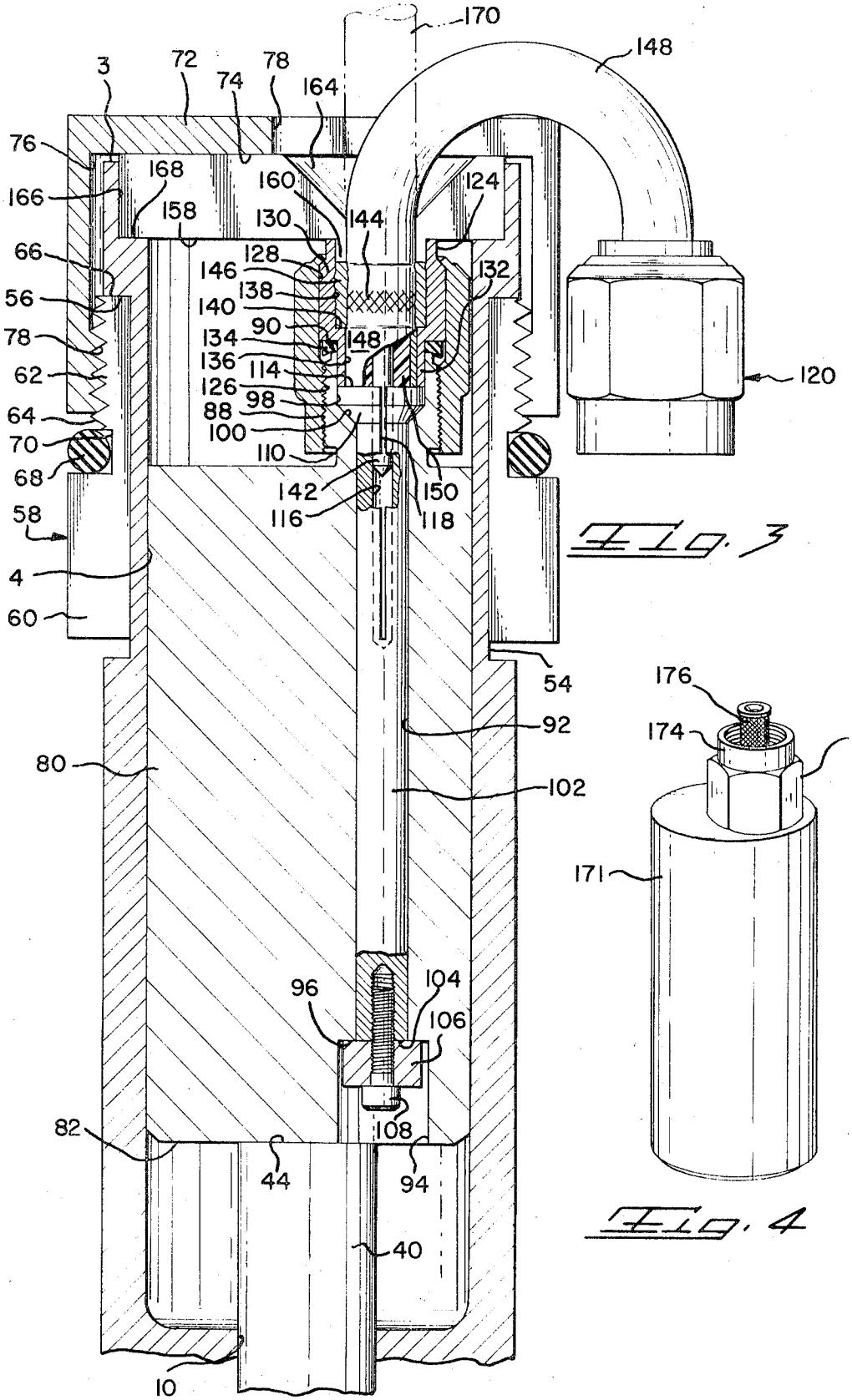

Fig. 3

Fig. 4

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3,588,982

STAKING TOOL

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Continuation-in-part of application Ser. No. 689,649, Dec. 11, 1967, now Patent No. 3,533,051, dated Oct. 6, 1970. This application May 15, 1970, Ser. No. 37,796
Int. Cl. H01r 43/04
U.S. Cl. 29—203D 8 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for terminating coaxial cable including a hollow body for supporting a coaxial cable, a ferrule and an electrical connector in concentric relationship, with a staking means having a protruding wall engaging the ferrule, and a pair of levers on the apparatus for supporting the protruding wall into engagement with one end of the ferrule to inelastically deform it in engagement against the coaxial cable and connector.

CROSS REFERENCE TO RELATED APPLICATION

The present invention relates to apparatus for terminating coaxial cable and is a continuation-in-part of application Ser. No. 689,649, filed Dec. 11, 1967 and now Pat. No. 3,533,051, issued Oct. 6, 1970. More particularly, the invention relates to a hand tool for electrically terminating coaxial cable with a plug or jack.

BACKGROUND OF THE PRIOR ART

Heretofore, termination of coaxial cable was accomplished by application of crimp or collet devices which were deformed for mechanical gripping relationship on the outer conductor of a coaxial cable sought to be terminated. Such practice necessitated the use of a backup ferrule to alleviate excessive cable deformation. Additionally, a metal tube outer conductor seal for the gripped portion of the termination was required, especially in the application of a radially deformable collet of split configuration.

Solder type terminations required considerable skill in application and involved expenditures of time and care to prevent damage of the cable from excessive heat. Furthermore, discontinuities in solder terminations were difficult to detect by inspection.

SUMMARY OF THE INVENTION

The present invention is provided to quickly terminate a coaxial cable without damage thereto and with a minimum deformation thereof. According to the invention, a plug or jack type terminal is initially provided internally thereof with a ferrule. The end portion of a coaxial cable is freely received within the ferrule. Accordingly, the ferrule is received between the cable and the surrounding terminal. A precisely controlled amount of compression is applied to the ferrule, in a manner to be hereinafter explained in detail, causing it to deform into intimate gripping contact with both the cable outer conductor and the surrounding terminal, thereby mechanically and electrically securing the terminal to the cable outer conductor. Termination is thus accomplished with a minimum cable deformation, without a need for soldering and with a precisely controlled degree of ferrule compression and resultant deformation, securing the terminal to the coaxial cable with precisely controlled gripping forces therebetween. A further feature of the invention permits termination of a coaxial cable end portion immediately adjacent to a purposely curved or U-shaped bent cable. The invention in the form of a hand tool eliminates a need for an auxiliary wrench, or for tool translation upon deforming

the ferrule and effecting the desired termination. Accordingly, the tool may accomplish coaxial cable termination in a minimum space requirement.

It is thus an object of the invention to provide apparatus and a method for terminating coaxial cable with a minimum of cable distortion. Another object of the present invention is to provide a hand tool for securing a terminal to a coaxial cable with precisely controlled gripping forces therebetween.

A further object of the invention is to provide a hand tool for terminating a coaxial cable end portion which is immediately adjacent to a curved or U-shaped cable length. A further object of the invention is to provide a hand tool which is operated without translation thereof in order to terminate a coaxial cable end portion in a relatively inaccessible location. Still another object of the invention is to provide a coaxial cable with either a plug or jack terminal without a need for solder.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevation of the preferred embodiment, particularly illustrating a hand tool in a position completing termination of a coaxial cable;

FIG. 2 is an exploded perspective of selected components of the embodiment illustrated in FIG. 1;

FIG. 3 is an enlarged cross section taken along line 3—3 of FIG. 1, of a portion of the preferred embodiment illustrated in FIG. 1, with parts shown partially broken away and with additional parts shown in phantom to illustrate particular details thereof; and

FIG. 4 is a perspective of an alternative component of the preferred embodiment of FIG. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

With more particular reference to FIGS. 1 and 3 of the drawings, there is shown generally at **1**, a hand tool according to the present invention. The tool is provided with a cylindrical elongated portion **2** having a terminal end **3** provided interiorly thereof with an elongated longitudinally extending enlarged diameter recess **4** terminating in a bottom wall **6** in parallel spaced relationship with a terminal planar end **8** of the cylindrical portion **2**. A reduced diameter aperture **10** extends between the end **8** and the bottom wall **6** and is axially aligned with and in communication with the enlarged diameter bore **4**. The end **8** of the cylindrical portion **2** is provided with a pair of projecting flanges **12** and **14** in mutual laterally spaced relationship. An end portion of a first toggle arm **16** is received between the flanges **12** and **14** and is pinned at **18** for pivotal motion. An end portion of a second toggle arm **20** is received between the flanges **12** and **14** and is pinned at **22** for pivotal motion. Accordingly, the toggle arms **16** and **20** are mutually laterally spaced and attached between the spaced flanges **12** and **14** for pivotal motion. The other end of the toggle arm **16** is pinned at **24** to an elongated, manually grippable handle portion. **26**. The other end of the toggle arm **20** is pinned at **28** for pivotal motion to an elongated manually grippable portion **30** in opposed spaced relationship with respect to the handle portion **26**. An extended end portion **32** of the handle **26** extends beyond the pin **24** and overlaps a corresponding extended end portion **34** of the handle **30** extending beyond the pin **28**. The extended end portions **32** and **34** are joined together for pivotal motion by a common pin **36**. Additionally, the pin **36** pivotally secures the end portions **32** and **34** to an enlarged diameter rod **38** freely received between the spaced flanges **12** and **14**. The rod is provided thereon with an axially aligned reduced diameter elongated cylindrical ram **40** with a planar end portion **42** encircling the rod **38**. The reduced diameter ram **40** is freely reciprocably received in the aperture **10** and protrudes

into the bore 4 generally centrally through the bottom wall 6 thereof. The end portion 44 of the ram is substantially planar for a purpose hereinafter to be described.

Between the handle portions 26 and 30 is provided a diagonally extending ratchet bar 46 pinned for pivotal motion at 48 to the handle 30 and received slidably within a ratchet housing 50 pinned at 52 for pivotal motion to the handle portion 26. The ratchet bar 46 and housing 50 together comprise an over-the-center release device which prevents pivotal motion of the handle portions 26 and 30 away from one another until first pivoted sufficiently toward one another to permit retraction of the ratchet bar 46 from the housing 50. Such a device is manufactured under the name of Certi-Grip by AMP Incorporated, Harrisburg, Pa.

With reference now being made to FIGS. 1 and 3, the cylindrical portion 2 is provided with a reduced diameter portion 54 intermediate of the end portions 3 and 8, which reduced diameter portion provides a circumferentially surrounding recess defining an inverted annular shoulder 56 in adjacent spaced relationship from the terminal end 3. The recessed portion 54 receives, in freely slidable and rotatable relationship, a ring 58 the length of which is substantially less than the longitudinal dimension of the recessed portion 54 to permit slidable motion of said ring within the recessed portion. The ring 58 is further characterized by an enlarged diameter portion 60, which is externally knurled, and an adjacent reduced diameter portion 62, provided with external threads 64 and having an annular end portion 66 adapted to seat upon the inverted shoulder 56, for a purpose to be hereinafter explained. As shown in FIG. 1, the ring 58 may be fabricated in two semi-cylindrical halves which matingly abut to surround the recessed portion 54. In such case, the halves are resiliently maintained in mating engagement by the provision of an encircling elastomeric annulus 68 advantageously seated in a recess 70 provided in the reduced diameter ring portion 62 adjacent the enlarged diameter portion 60. To complete the external outward appearance of the hand tool, the threaded portion of the ring 58 threadably receives thereover a cylindrical cap 72 having a planar wall 74 and a cylindrical side wall 76 which is internally threaded at 78 for matingly engaging the threads 64 of the ring 58. As shown, more particularly in FIGS. 1, 2, and 3, the cap is provided with a laterally extending slot 78 in both the end wall 72 and the side wall 76 thereof.

With reference to FIGS. 2 and 3 of the drawing, the particular internal structure of the hand tool will be described. An elongated cylindrical work holder 80 is removably received for longitudinal sliding motion in the direction of its elongated dimension within the cylindrical recess 4 of the tool 1. The work holder 80 is sized so that sliding motion within the recess 4 is accomplished without skewing and is provided with a planar terminal end 82 for seating against the planar end 44 of the tool piston 40. The other terminal end 84 of the work holder 80 is provided with an integral projecting reduced diameter nipple 86 externally threaded at 88. The nipple 86 is purposely offset from the longitudinal axis of the work holder 80 for a purpose to be described. An end portion 90 of the nipple is provided centrally therethrough with a bore 92 extending entirely through the nipple and through the adjoining portion of the work holder 80. The bore 92 is provided with an enlarged counterbore 94 provided in the end portion 82 of the piston and defining an inverted annular shoulder 96 surrounding the bore 92. The portion of the bore 92 through the nipple 86 is provided with an enlarged diameter portion 98 connected to the remaining portion of the bore by a frusto-conical sidewall 100. The bore 92 receives therein a reduced diameter cylindrical rod 102 which is provided with a terminal end 104 abutting an enlarged diameter end block 106, which, in turn, is received in the counterbore 94 and capped to the end 104 by a suitable cap screw 108. The other end of the rod 102 is provided with an enlarged head portion 110 configured to be matingly received in the frusto-conical portion 100 and the enlarged cylindrical portion 98 of the bore 92. The head 110 is provided with a planar circular end 114 provided centrally thereof with an elongated reduced diameter recess 116 extending through the head 110 and into a portion of the rod 102. A laterally extending slot 118 is provided parallel to and communicating with the recess 116 permitting radial contraction of the head 110 to insure its seating against the frusto-conical portion 100 of the bore 92.

With reference to FIGS. 2 and 3, the nipple 86 is adapted to receive threadably thereover a coxial cable terminal in the form of a male connector 120 characterized by an external sleeve nut 122 rotatably received over a captive sleeve, a portion of which protrudes at 124. With particular reference to FIG. 3, the nut 122 is provided with an internal reduced diameter portion 126 which is internally threaded to be received over the threaded nipple 86. The nut is further provided with an adjacent internal enlarged diameter portion 128 which rotatably receives a corresponding enlarged outer diameter portion 130 of the sleeve 124. The sleeve is further provided with an adjacent reduced diameter portion 132 which seats on the top surface 114 of the rod 110. A seal 134 surrounds the reduced diameter portion 132. Together the seal 134 and the reduced diameter portion 130 of the metallic sleeve is fully captive within the enlarged diameter portion 128 of the nut 122. The reduced diameter portion of the sleeve is provided with a reduced diameter bore 136 which communicates with an enlarged diameter bore 138 in the corresponding enlarged diameter portion of the sleeve. An annular shoulder 140 is defined between the communicating bores 136 and 138.

With reference now to FIGS. 2 and 3, a coaxial cable end portion to be terminated is first trimmed to expose a length of its center conductor 142 and a portion of the trimmed outer conductor is provided thereover with a relatively narrow band of knurling 144. A length of cylindrical ferrule 146 of ductile material such as copper is assembled over the outer conductor, the internal diameter of the ferrule in contact with the outer conductor and overlying the knurled band. The assembly is then inserted within the protruding portion 124 of the connector sleeve. As shown in FIG. 3, the coaxial cable is inserted until its trimmed outer conductor 148 and dielectric 150 are seated against the top surface 114 of the rod 102, the protruding inner conductor portion 142 being freely received within the bore 115 of the rod 102. With the trimmed coaxial cable thus seated, the connector sleeve internal diameter 136 will be in surrounding mating engagement with the outer conductor 148 and the metal ferrule will be seated against the annular shoulder 140 and in engagement with the sleeve enlarged diameter 138. Additionally, the ferrule will be in circling relationship about the knurled portion 144 of the outer conductor.

To complete assembly of the hand tool, there is illustrated in FIGS. 2 and 3, a staking die comprising two half stakers for applying compression to the ferrule. More particularly, each half staker is generally of half-cylindrical configuration with a planar sidewall 152 contiguous with an outer semi-cylindrical sidewall 154. The sidewalls 152 and 154 are bounded by planar semi-circular end walls 156 and 158. Each half staker is provided with a depending semi-cylindrical male die portion 160 protruding from the end wall 158 and offset longitudinally from the mid portion of the side wall 152. The die portion 160 is provided centrally therethrough with a reduced diameter bore 162 opening into a wide angle frusto-conical recess 164 extending through the end wall 156. The half stakers are adapted to matingly engage along their planar sidewalls 152 with their respective die portions 160 in opposed relationship together defining a cylindrical male die. As shown in FIG. 3, the half stakers are shown assembled on the tool 1 with the die portions 160 encircling completely the coaxial cable outer conductor 148 and received slidably within the protruding portions

124 of the male connector. Additionally, the die portions 160 together comprise a cylindrical die which engages the end portion of the ferrule 146. With reference yet to FIG. 3, the half stakers are shown to be slidably received partially within a cylindrical recess 166 in the terminal end 3 of the tool cylindrical portion 2. The recess 166 provides an annular planar shoulder 168 upon which the half stakers are seated when assembled on the tool as shown in FIG. 3. To complete assembly of the tool, the cap 72 is received over the half stakers, the length of coaxial cable protruding through the cap slot 78. An operator of the tool manually retains the cap in fixed position over the threaded portion 64 of the sleeve 58 and manually rotates the knurled portion 60 of the sleeve thereby progressively receiving the cap over the threaded portion 554 of the sleeve and impinging the bottom wall 74 of the cap against the planar surfaces 156 of the half stakers, which half stakers partially protrude from the end portion 3. Such action firmly seats the half stakers on the annular shoulder 168 without requiring rotation of the cap 72. The operator then manually urges together the handles 26 and 30 of the tool 1 in scissor-like fashion. Such action forces the piston 40 progressively into the recess 4 of the tool. The piston end portion 44 abuts the end portion 82 of the work holder 80 urging it to slidably translate longitudinally of the recess 4. Such action is transmitted to reciprocal motion of the ferrule 146 against the depending die portions 160 of the half stakers. This action causes the die portions 160 to compress the ferrule against the shoulder 140 of the male connector sleeve, radially expanding the ferrule into intimate gripping engagement with the knurled portion 144 of the coaxial cable outer conductor 148, and in gripping intimate contact with the inner diameter 138 of the male connector sleeve. In this fashion, the ferrule provides metal-to-metal electrical contact of the outer conductor 148 with the male connector without destruction or excessive deformation thereof. To insure that sufficient compression of the ferrule has taken place, the Certi-Grip feature prevents separation of the handle 26 and 30 until the work holder 80 has traveled a predetermined distance, thereby insuring sufficient compression of the ferrule by the die members 160.

Upon removal of the cap and the half stakers and the male connector threadably from the nipple 86, the male connector and the cable outer conductor 148 will be mechanically and electrically connected.

The particular offset construction of the half stakers and nipple receiving the male connector, permits the connector to be immediately adjacent to the tool cylindrical sides, namely the cylinder 2, the ring 58, and the cap 78, which components are of purposely low cylindrical profile. The frusto-conical recess portion 164 of the half stakers provides lateral relief for a curved portion of cable length, permitting termination thereof immediately adjacent to such curved portion.

The cylindrical cap 72 clamps the half stakers to the tool and maintains them in mating relationship. The slot construction 78 of the cap lends side support to the cable length during termination of either a curved cable length or a straight cable length, as indicated in phantom line at 170.

The die portions 160 of the half stakers completely surround the ferrule end preventing unwanted extrusion of the ferrule as it is compressed into gripping engagement. As shown in FIG. 3, the ferrule grips not only the knurled portion 144, but extends on either side thereof to provide a metal-to-metal seal on each side of the gripping area afforded by the knurled portion.

Provision of the rod 102 in the work holder 80 allows positive seating of the trimmed outer conductor 148 and dielectric sheath 150 upon the planar surface 114. Since the planar surface 114 also provides a seat for the inner sleeve of the male connector, alignment of the outer conductor with the termination is assured.

A further feature is that rotation of the sleeve 58 completes assembly of the tool without requiring tool cranking motion or other tool translation, thereby accomplishing termination without excessive tool motion and within a minimum space requirement.

Other modifications are contemplated. For example, in FIG. 4, there is shown an alternate cylindrical work holder 170 provided with an integral offset nipple and threadably receiving a nut 172 thereon with an internally threaded protruding sleeve 174 having a jack or female connector 176 therein. It is noted that the work holder 170 is substituted for the ram 80 when termination of a coaxial cable with a male connector is desired upon operation of the tool as described.

The jack 176 is received in the nut 172 as shown and is externally threaded to be secured in the nipple of work holder 170. The jack is internally threaded to receive therein a protruding portion of center conductor of a coaxial cable trimmed to a configuration similar to that shown in FIG. 2. In operation, cable is terminated with the jack 176 and the nut 172 according to the tool operation as described. The jack and nut are threadably removed from the nipple of work holder 170, the threads of the jack and plug being of the same pitch so that damage of the threadably connected jack and center conductor is prevented.

What is claimed is:

1. A tool for securing a cylindrical member to a surrounding tubular member by deforming a ductile ferrule interposed between the two members comprising,
   a hollow body means open at one end,
   means for supporting the two members and ferrule within the body means in concentric relationship,
   staking means having a central aperture to receive the cylindrical member and provided with a protruding wall surrounding the marginal edge portion of the aperture, the thickness of the outer edge of the wall being substantially that of the ferrule,
   means for mounting the staking means in the body means with the wall extending inwardly toward the supporting means,
   a pair of levers pivotally mounted on the body means, and means operated by the levers in response to movement about their pivots to effect relative movement between the supporting means and the mounting means to force the edge of the protruding wall into engagement with one end of the ferrule to inelastically deform it to bear against the two adjacent surfaces of the members.

2. A tool in accordance with claim 1 in which the staking means comprises a plurality of separate identical staking die elements.

3. A tool in accordance with claim 1 in which the means operated by the levers comprises a pusher bar slidable through the opposite end of the body member for moving said supporting means toward said staking means.

4. A tool in accordance with claim 1 in which the means for mounting the staking means comprises a ledge on the body member for supporting the staking means, and means for maintaining the staking means against the ledge comprising a cap member for detachable connection to the body means for bearing against the staking means.

5. A tool according to claim 4 including mateable threaded means on the body member and cap member for securing the cap member thereto.

6. A tool according to claim 5 in which the threaded means on the body member comprises a threaded rotatable sleeve mounted on the outer surface of the body member.

7. A tool according to claim 4 wherein the cap member is substantially cup-shaped and includes a slot extending

longitudinally along its peripheral wall and radially along the bottom wall.

8. A tool according to claim 4 including a cap member securable to the body member for overlying the staking means, the inner wall of the cap member being shaped to be complementary to the shape of the adjacent surface of the staking means for mating therewith, the cap member having a continuous slot extending longitudinally along its peripheral wall and radiallly along the bottom wall.

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THOMAS H. EAGER, Primary Examiner

U.S. Cl. X.R.

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