April 8, 1969 R. E. REEM ET AL 3,436,820

METHOD OF MAKING ELECTRICAL CONNECTIONS

Filed Nov. 23, 1965 Sheet 1 of 2

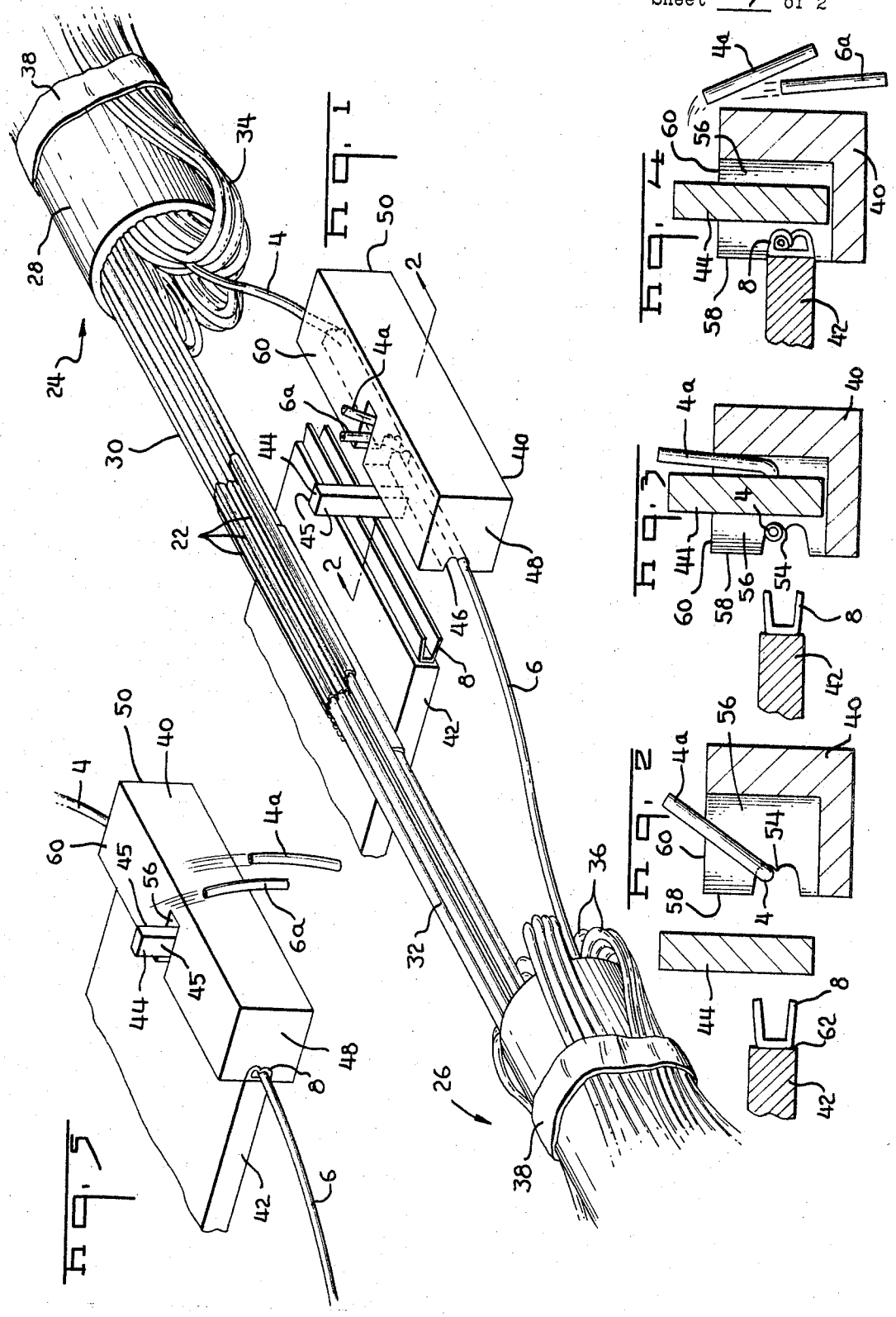


Fig. 1

Fig. 4

Fig. 3

Fig. 2

Fig. 5

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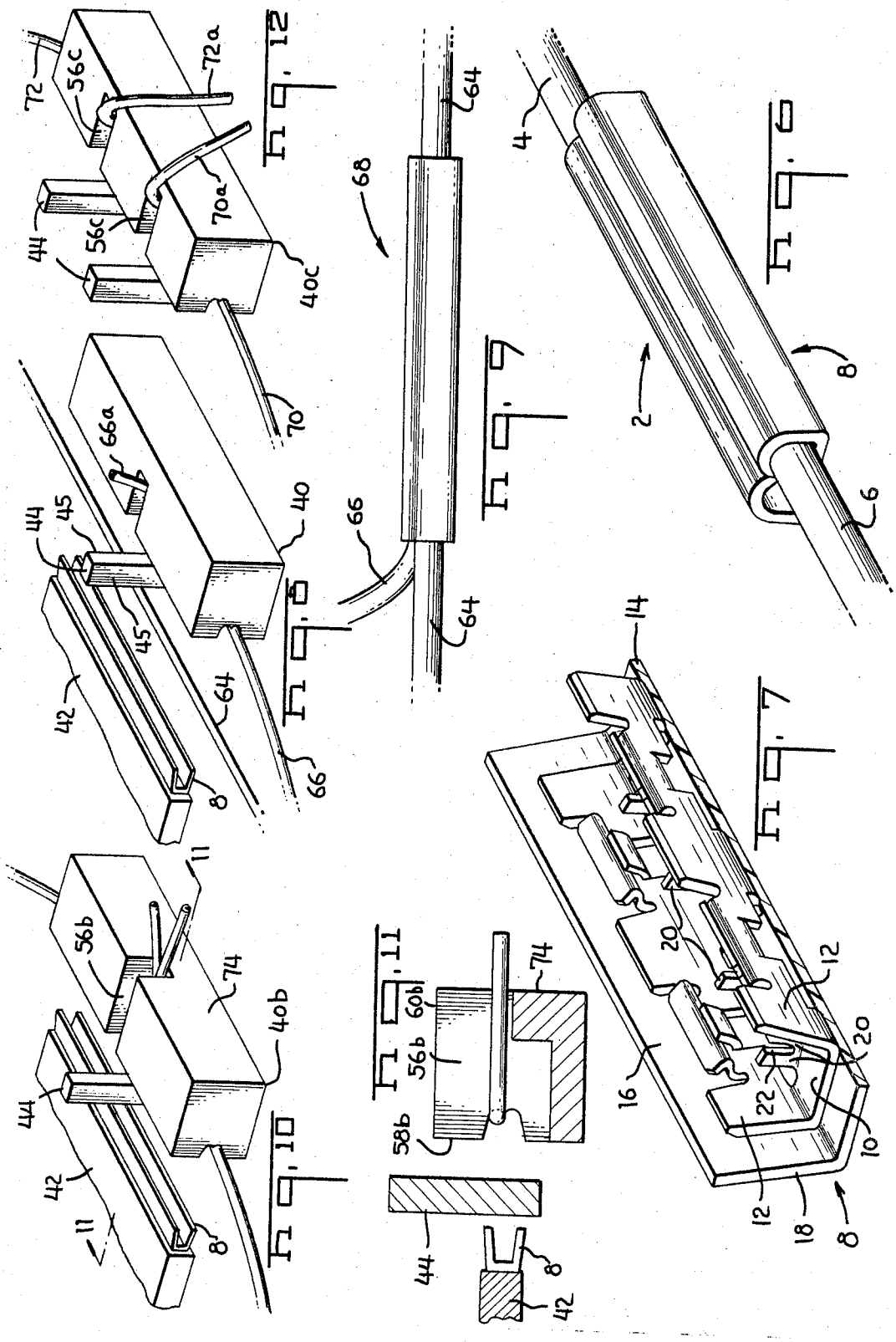


FIG. 12

FIG. 9

FIG. 6

FIG. 8

FIG. 7

FIG. 10

FIG. 11

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METHOD OF MAKING ELECTRICAL CONNECTIONS

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Int. Cl. H01r 43/00

U.S. Cl. 29—628

5 Claims

ABSTRACT OF THE DISCLOSURE

Ends of wires are trimmed and an open U-type connector is crimped onto the trimmed wire ends by means of a die and anvil. Crimping die has slot extending inwardly on one side and on side adjacent to one side. Wires are positioned along the one side of the die and ends of wires are passed through the slot. Severing member thereafter moves into slot to trim wires in planes defined by sides of the slot so that trimmed wire ends are located between one side of die and the anvil. Thereafter, anvil, on which open U-type connector is supported, is moved towards die and connector is crimped onto trimmed wire ends.

This application is a continuation-in-part of application Ser. No. 351,024, filed Mar. 11, 1964 and now U.S. Patent No. 3,328,872.

This invention relates to an improved method of trimming the end of a wire, or trimming the ends of wires, and substantially simultaneously crimping an electrical connecting device onto the trimmed end. The method in accordance with the invention can be used to splice two wires extending towards each other or to connect a tap wire (i.e., a branch conductor) to a through conductor.

An object of the invention is to provide an improved method for trimming the end of a conductor and crimping an electrical contacting device onto the trimmed end. A further object is to provide a method of crimping a connector onto a wire in which the positioning of the wire in the connector can be carried out rapidly and accurately. A further object is to provide a method which can be practiced by an unskilled technician and which will result in the achievement of a high-quality reliable electrical connection. A further object is to provide a method which is particularly, but not exclusively, adapted to the connecting of the numerous conductors in a communications cable such as a telephone cable.

These and other objects of the invention are achieved in one embodiment thereof in which a pair of wires extending towards each other are spliced by means of an open-sided connecting member. The connecting member is crimped onto the wires by means of a crimping die, a crimping anvil, and a severing member, the die having a forming surface in the form of a trough-like cavity extending along one side thereof for bending the sidewalls of the connector into crimped engagement with the wires. The die also has a slot intermediate its ends extending transversely of, and intersecting, the forming surface. This slot extends into the die on the one side thereof on which the forming surface is provided and inwardly on a side adjacent to said one side. The severing member is movable into this slot and the anvil is movable relatively towards the die. In accordance with the method of the present invention, the wires are positioned in the die cavity with their axes extending parallel to the cavity. The end portions of the wires are positioned in the slot

so that these end portions extend laterally with respect to the axes of the wires. The severing member is then moved into the slot and severs the wires in planes defined by the sidewalls of the slot and the sides of the severing member; in other words, this severing member in combination with the sides of the slot functions as a shearing device. After the severing member has been moved ino the slot, the trimmed wires remain in the die cavity and the anvil is thereafter moved towards the die. An open-sided connector supported on the anvil is thereby moved against the forming surfaces of the die cavity and the wires are located between the sidewalls of the connector. The connector sidewalls are then crimped onto the wires by the cooperative action of the forming surfaces of the die and the anvil.

In the drawing:

FIGURE 1 is a perspective view illustrating an initial step in the method of the invention and a basic form of apparatus for carrying out the method;

FIGURE 2 is a view taken along the lines **2—2** of FIGURE 1;

FIGURES 3 and 4 are views similar to FIGURE 2 but illustrating the successive stages of the method;

FIGURE 5 is a perspective view similar to FIGURE 1 but illustrating the concluding steps of the method;

FIGURE 6 is a perspective view of a splice connection;

FIGURE 7 is a perspective view of a typical open-sided connecting member used for making splice or tap connections in accordance with the method;

FIGURE 8 is a perspective view similar to FIGURE 1 but illustrating the manner in which the end of a tap conductor can be electrically connected to a through conductor by the method of the present invention;

FIGURE 9 is a plan view of a tap-type electrical connection;

FIGURE 10 is a perspective view similar to FIGURE 1 of an alternative form of apparatus which can be used to practice the method of the instant invention;

FIGURE 11 is a view taken along the lines **11—11** of FIGURE 10; and

FIGURE 12 is a perspective view of a further type of apparatus which can be used to practice the instant method.

While the method of the present invention can be used wherever wires are to be spliced to each other or wherever a tap wire is to be connected to a through conductor, the method is described below with reference to the problem of splicing the individual conductors of a telephone cable and connecting a tap wire to an individual conductor of a telephone cable. The method in accordance with the invention is particularly useful in forming such connections in telephone cables for the reason that connections can be made in a very short time and the manipulative steps of the method can be carried out conveniently in the typical circumstances under which a telephone splicer or repairman must frequently make splice connections. Furthermore, when the individual conductors of a broken telephone cable (which may have been broken as a result of a storm or hurricane) are being repaired, time is usually of the essence since the restoration of telephone service requires that all breaks in the cable be repaired. The magnitude of the job of restoring telephone service after, say a hurricane, can be appreciated if it is recalled that individual cables may have as many as about 5400 individual telephone wires therein so that each break requires the same number of individual splice connections.

The present method can be used to make splice connections **2** of the type shown in FIGURE 6 in which a pair of wires **4, 6** are spliced by means of a connector **8**. Connectors of this type (FIGURE 7) comprise a metallic ferrule having a web **10** and sidewalls **12** which extend

upwardly on opposite sides of the web. Advantageously, an insulating film **14** of Mylar (polyethylene terephthalate) or the like is bonded to the external surface of the ferrule and extends axially beyond the ends of the ferrule as shown at **18** and beyond the edges of the sidewalls as shown at **16**. A plurality of tongues **20** are struck up from the web **10** and these tongues are each provided with notches **22** into which the wires are forced during crimping. The sides of the notches thus penetrate the insulation of the wire and establish electrical contact therewith. During crimping, the sidewalls are bent inwardly and downwardly to force the wires into the notches and produce the completed splice connection **2** of FIGURE 6. A preferred form of splice connection of this type is described in detail in the copending application of James Earl Marley et al., Ser. No. 432,621, filed Feb. 15, 1965, now U.S. Patent No. 3,320,354, although the method of the invention can be practiced with open-sided connecting devices of alternative designs.

FIGURE 1 illustrates the manner in which the method of the invention can be practiced to splice the individual conductors at the ends **24, 26** of a communications cable. The cable may be in an underground manhole or may be suspended from utility poles aboveground. The cable might be in the process of being installed to provide new telephone circuits in a telephone system. Alternatively, a pre-existing cable might have been broken as a result of a storm and require splicing.

Conventional communications cables comprise a cylindrical sheath **28** which surrounds the individual conductors. In FIGURE 1, it is assumed that some of the conductors **30** have previously been spliced by splice connectors **2**. The remaining conductors **34, 36** are usually tied by tapes **38** to the sheath **28** and the individual conductors **4, 6** which are being spliced by the technician are extracted from the bundles of taped conductors **34, 36**.

The instant method can be carried out with a variety of types of apparatus, FIGURE 1 showing a basic and simplified type of apparatus in order to clearly illustrate the method steps of the invention. The apparatus comprises a die block **40**, an anvil **42** for supporting an uncrimped connector, and a severing member **44** which is normally located between the die block and the anvil.

The die block **40** has a trough-like forming cavity extending between its ends **48, 50** on the side **58** which faces the anvil. This forming cavity has generally convergent sidewalls **52** which are reversely curled towards each other to form a cusp **54**. The convergent forming surfaces **52** function to bend the sidewalls of the connector towards each other and towards the web of the connector when the anvil moves relatively towards the die as will be apparent from FIGURES 2–4. The die further includes a slot **56** intermediate the ends **48, 50** which extends inwardly from the side **58** and inwardly from an adjacent side **60**. This slot intersects and extends beyond the trough-like die cavity as shown in FIGURES 2–4.

The anvil **42** in the disclosed basic form of apparatus comprises a plate having a supporting surface **62** for the uncrimped connector. The shearing member **44** is shown as a simple rectangular bar which is movable into the slot **56** with a relatively close fit so that the sides **45** of this shearing member, in cooperation with the edges formed at the intersection of the slot **56** and the die cavity **52**, can function as a shearing means as described below.

The method of the invention comprises the steps of locating the wires **4, 6** in the trough-like die cavity on each side of the slot **56** and leading the end portions of these wires **4*a*, 6*a*** laterally through the slot **56** so that they emerge from the side **60** of the die block. This operation can be carried out rapidly by the technician since he need only extract the individual wires from the bundles **34, 36**, locate these wires in the die cavity, and pull the ends **4*a*, 6*a*** towards himself. After this operation has been completed, the shearing member **44** is moved into the slot **56** and the scrap ends **4*a*, 6*a*** of the wires are severed in the planes defined by the sides of the slot **56**, see FIGURES 3 and 5. These scrap wire ends can then be removed from the slot or, depending on the orientation of the apparatus, will fall by gravity and are thus conveniently removed from the work area. The trimmed end portions of the wires **4, 6** remain in the die cavity so that when the anvil **42** is moved relatively towards the die as shown in FIGURE 4, the trimmed ends will be located between the sidewalls of the connector and these sidewalls will be bent inwardly and downwardly as the connector is crimped on the wire ends. FIGURE 5 shows the position of the parts after the method has been carried out.

As previously pointed out, the apparatus for carrying out the method is illustrated in a rudimentary form and it will be understood that a variety of forms of apparatus might be used. Some specific tools and applicators for making splice-type connections in accordance with the invention are disclosed in detail and claimed in U.S. Patent No. 3,328,872, application Ser. No. 454,105, filed May 7, 1965 by Coey William Fritz et al., now U.S. Patent No. 3,287,790, and in application Ser. No. 426,257, filed Jan. 18, 1965 by William Roderick Over, now U.S. Patent No. 3,328,871. The specific tools and applicators described in these pending applications have certain refinements that facilitate the method of the invention although the basic method steps are as described above. These refinements include, for example, devices for holding the trimmed wire ends in the die cavity and feeding devices for feeding an uncrimped connector to a location between the die and anvil.

There are several advantages to the method of the invention as described above. The primary advantage is the speed with which a completed connection can be made. An additional advantage is that the amount of slack in the wires **4, 6** can be easily controlled by the operator since the ends **4*a*, 6*a*** are drawn through the slot **56**. Thus, the amount of slack remaining after the splice is made will depend upon the amount of wire drawn through the slot by the operator. The scrap wire is, of course, easily and quickly removed while the method is being carried out and the splice is being made, a significant advantage where the technician is making a large number of connections and must finish his task in the shortest time possible. It should also be noted that the splice connections can be staggered along the cable by merely moving the apparatus axially towards either one of the ends **24, 26** of the cable. For example, when a repairman sets about the task of splicing or connecting all of the conductors of the cable shown in FIGURE 1, he can first position the tooling (the die and anvil) adjacent to the end **24** of the cable and proceed to splice a first group of the conductors **34** to a corresponding number of the conductors **36**. During this potrion of the cable splicing operation, a relatively long section of the conductors **34** will be trimmed and a relatively short section of each of the conductors **36** will be trimmed by the shearing device and the finished splice connections will be located close to the end **24** of the cable. The repairman can then move the apparatus to the position shown in FIGURE 1 and splice an additional number of the conductors **34** to a corresponding number of conductors **36**. During this portion of the splicing operation, the scrap ends of wire indicated at **4*a*** and **6*a*** in FIGURE 1 will be of substantially equal length. Finally, the repairman can move the apparatus to a location adjacent to the end **26** of the cable and connect the remaining ones of the conductors **34** to the remaining conductors **36**. During this final portion of the cable splicing operation, the scrap ends of wire produced by the conductors **36** would be longer than the scrap ends of the wires **34**. By the use of this staggering technique, the

repairman can minimize the increase in diameter which results when the individual conductors of the cable are spliced since the connectors always occupy a greater volume than the individual conductors.

FIGURE 9 shows the type of connection in which a tap conductor **66** is connected to a through conductor **64** by means of a connecting device of the type shown in FIGURE 7. The type of apparatus used in this embodiment of the method can be the same as the type shown in FIGURE 1. In this instance, the tap wire is positioned in the die cavity and led through the slot **56** of the die as shown in FIGURE 8. The through wire **64** is located between the severing member **44** and the anvil. When the steps described previously are carried out and the severing member is moved into the slot, the end portion **66***a* of the tap wire is severed in the plane of the side of the slot but the through wire is not severed. When the anvil is subsequently moved towards the die, the connector is crimped onto the through wire and onto the tap wire as shown in FIGURE 9.

FIGURES 10 and 11 show a modified form of apparatus which can be used in the practice of the invention. In FIGURE 10, the die block **40***b* is substantially similar to the die block of FIGURE 1 except that the slot **56***b* extends inwardly from the side **74** of the die as well as the side **60***b*. Under some circumstances a die of this type might be somewhat more convenient for the operator or repairman than the die of FIGURE 1 since he can pull the wire ends towards himself (assuming that he is standing to the right of the die block as viewed in FIGURE 10). The apparatus shown in application Ser. No. 454,105 is of the general type shown in FIGURE 10 rather than the general type shown in FIGURE 1 although the method is the same for both types.

FIGURE 12 shows a further type of apparatus which can be used to practice the method in which the die block **43** has a pair of spaced-apart parallel slots **56***c* In practicing the method, the wire **70** extending from the left is led through the die cavity and the left-hand one of the slots **56***c* while the wire **72** extending from the right is led through the right-hand one of the slots **56***c*. The ends of the wires **70***a*, **72***a* can be gathered by the operator and the shearing members **44** move into the slots **56***c* to sever the ends of the wires as previously described.

It will be apparent from the foregoing description that an important step in the method of this invention is the locating of the wires in the die cavities with their ends extendng laterally through the slot in the die regardless of the precise nature of this slot or slots. By virtue of this step, the scrap wire ends produced by the severing operation are eliminated and removed from the crimping zone and do not interfere with the final crimp. The severing operation is carried out as part of the crimping operation and the technician or repairman is freed of the burdensome job of trimming the wires to the desired length. Finally, the entire locating and positioning operation requires only a very short time.

Changes in construction will occur to those skilled in the art and various apparently different modifications and embodiments may be made without departing from the scope of the invention. The matter set forth in the foregoing description and accompanying drawings is offered by way of illustration only. The actual scope of the invention is intended to be defined in the following claims when viewed in their proper perspective against the prior art.

We claim:

1. A method of crimping an open U-type connector onto a wire by means of a crimping die, an anvil for supporting said connector during crimping, and a severing member, said die having a forming surface extending along one side thereof for crimping said connector and having a slot extending inwardly on said one side and on a side adjacent to said one side, said slot transversely intersecting said forming surface, said severing member being normally disposed between said die and anvil and being engageable with said slot, said method comprising the steps of: positioning said wire adjacent to, and with its longitudinal axis extending substantially parallel to, said forming surface and with its end portion extending through said slot, moving said die and said severing member relatively towards each other until said severing member engages said slot to trim said end portion from said wire in a plane defined by a side of said slot and a side of said severing member and to leave the trimmed end of said wire adjacent to, and extending parallel to, said forming surface, and thereafter moving said anvil and a connector supported on said anvil relatively towards said die to crimp said connector onto said trimmed end.

2. A method of crimping an open U-type connector onto a pair of wires extending towards each other by means of a crimping die, an anvil, and a severing member, said die having a forming surface extending along one side thereof for crimping said connector onto said wire and having a slot extending inwardly from said one side and from a side adjacent to said one side, said slot transversely intersecting said forming surface, said severing member being normally disposed between said die and anvil and being engageable with said slot, said method comprising the steps of: positioning said wires on opposite sides of said slot adjacent to, and extending alongside, said forming surface, leading the end portions of said wires through said slot, moving said die and said severing member relatively towards each other until said severing member engages said slot to trim said end portions in planes defined by the sides of said slot and the sides of said severing member, and to leave the trimmed ends of said wires adjacent to, and extending parallel to, said forming surface, and thereafter moving said die relatively towards said anvil and a connector supported on said anvil to crimp said connector onto said wire.

3. A method as set forth in claim **2** wherein said slot extends inwardly from the side of said die opposite to said one side as well as said one side and a side adjacent to said one side, and said end portions of said wires are led through said slot and emerge therefrom on said opposite side.

4. A method of electrically connecting two wires which extend axially towards each other comprising the steps of positioning said wires in a crimping die with the end portions of said wires extending laterally through a transversely extending slot in said die, moving a severing member which is engageable with said slot, relatively towards said die until said severing member engages said slot to sever said wires in the planes defined by the sides of said slot leaving the trimmed ends of said wires in said die, and moving said die relatively towards an anvil and crimping an electrical connector, supported on said anvil, onto said wires.

5. A method of electrically connecting a tap wire to a through wire by means of a crimping die, an anvil for supporting an open U-type connector, and a severing member, said die having a forming surface extending along one side thereof for crimping said connector and said die having a transversely extending slot on said one side and on a side adjacent to said one side, said slot transversely intersecting said forming surface, said severing member being normally disposed between said die and anvil and being engageable with said slot, said method comprising the steps of: positioning said through wire between said die and said anvil and between said severing member and said anvil, locating said tap wire between said die and anvil with its end portion extending transversely through said slot, moving said severing member relatively towards said die until said severing member engages said slot to trim said end portion from said tap wire in a plane defined by a side of said slot

and a side of said severing member and to leave the trimmed end of said tap wire adjacent to, and extending parallel to, said forming surface, and thereafter moving said anvil relatively towards said die to crimp said connector onto said through wire and said tap wire.

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7—14.1; 29—33, 203; 72—410; 174—84; 227—21