United States Patent

[11] 3,590,481

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Continuation-in-part of application Ser. No. 721,997, Apr., 1968.

[54] **METHOD AND MEANS FOR FACILITATING RAPID TERMINATION OF COAXIAL CONNECTORS**
8 Claims, 18 Drawing Figs.

[52] U.S. Cl. 29/624, 29/628, 29/203
[51] Int. Cl. H01b 13/00, H05k 3/00
[50] Field of Search ..... 29/628, 624, 600, 601, 203 D, 203 S; 339/177; 206/56 A

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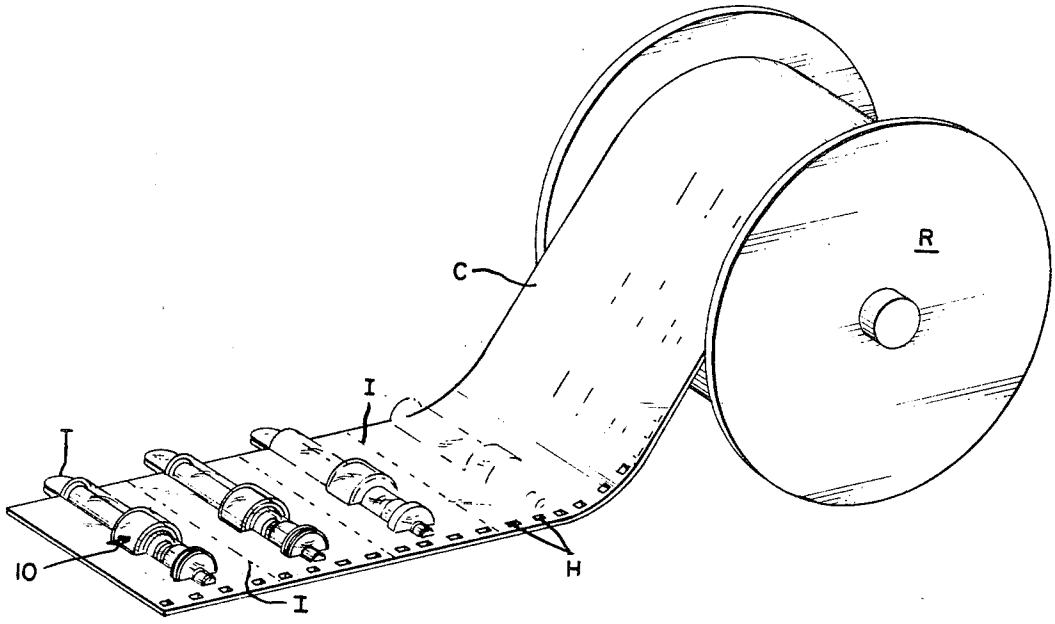
ABSTRACT: A method and means for facilitating rapid termination of coaxial connectors to coaxial cable is disclosed which features a thin, flexible carrier containing a series of coaxial connectors, each comprised of a number of distinct elements properly arranged on the carrier for insertion of coaxial cable therein. The carrier is comprised of plastic sheets formed to extend over the connectors in a manner to guide cable parts into the connector elements. The carrier has characteristics to permit reeling and is indented to facilitate removal of one or a number of connectors therefrom. The sheets may be sealed to protect each connector with each portion containing a set of connector elements including means facilitating removal of a portion of the sheets to permit insertion of a cable within the elements. The arrangement of elements on the carrier is made to facilitate terminating connector elements to cable parts without having to physically handle any of the elements of the connector.



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SHEET 1 OF 6

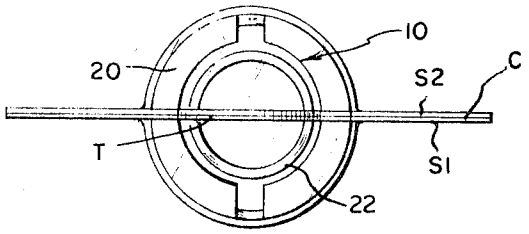

FIG 3

FIG 1

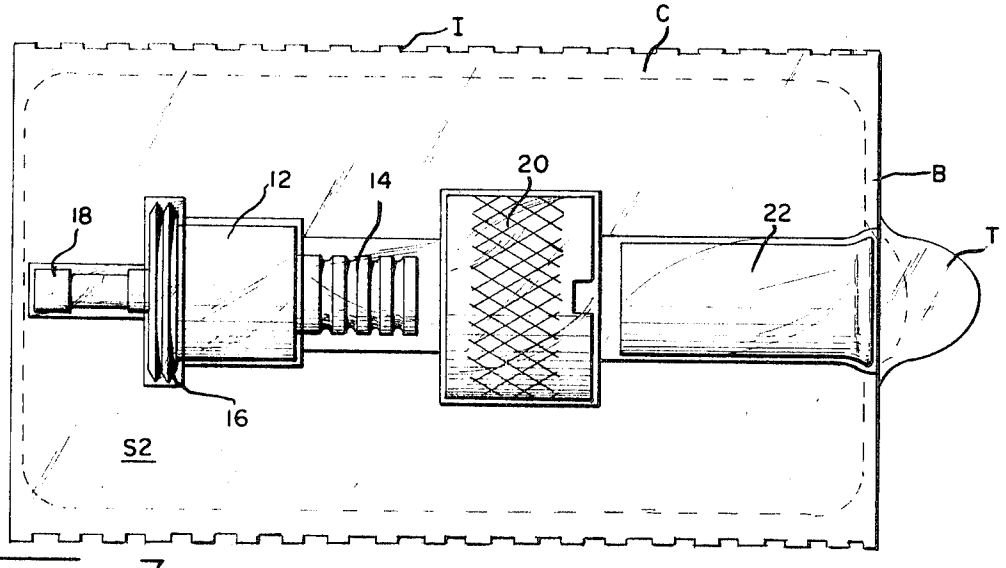

FIG 2

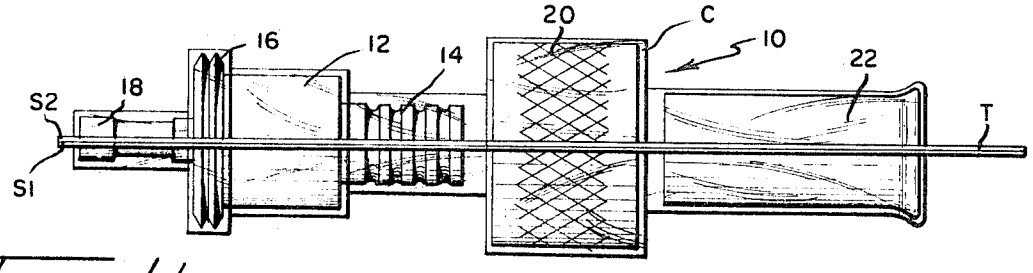

FIG 4

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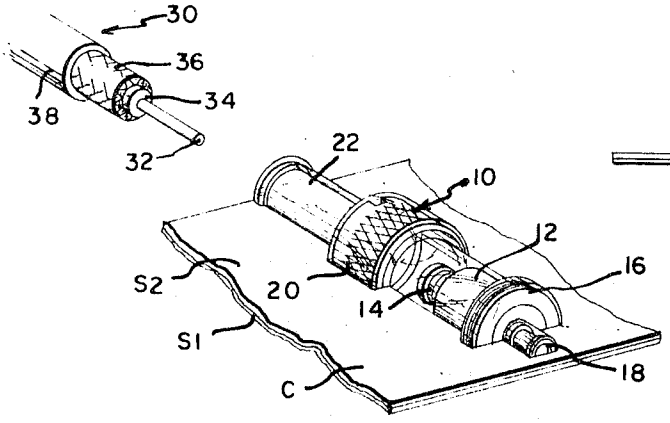

FIG 6

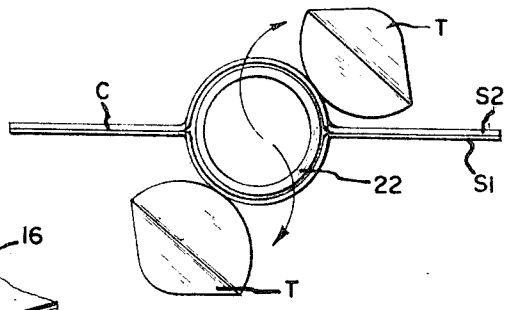

FIG 5

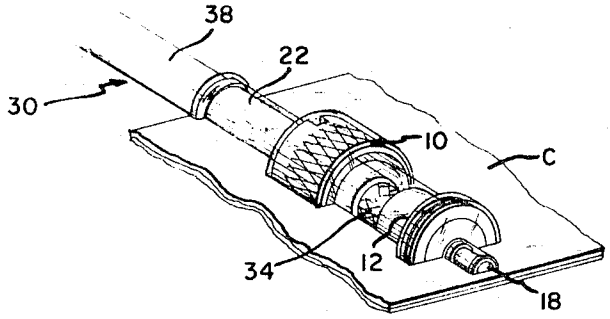

FIG 7

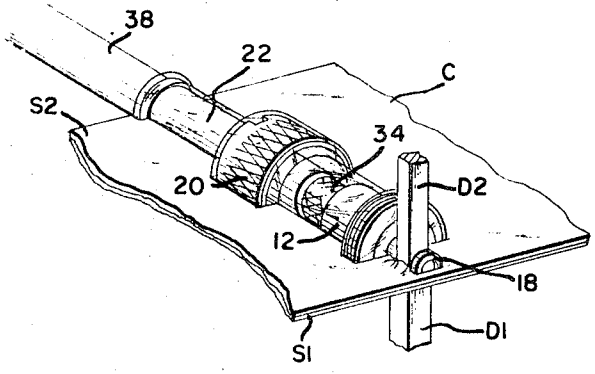

FIG 8

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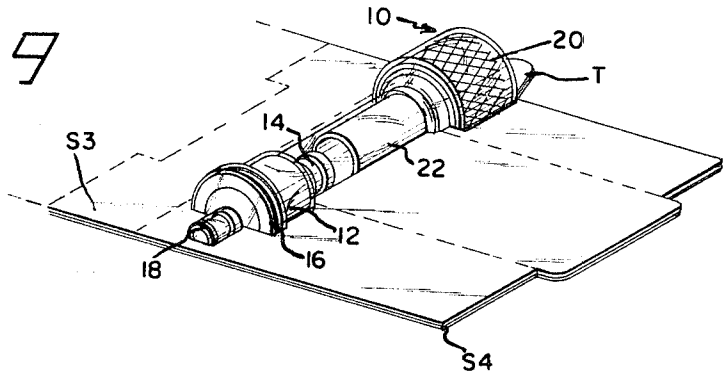
FIG 9



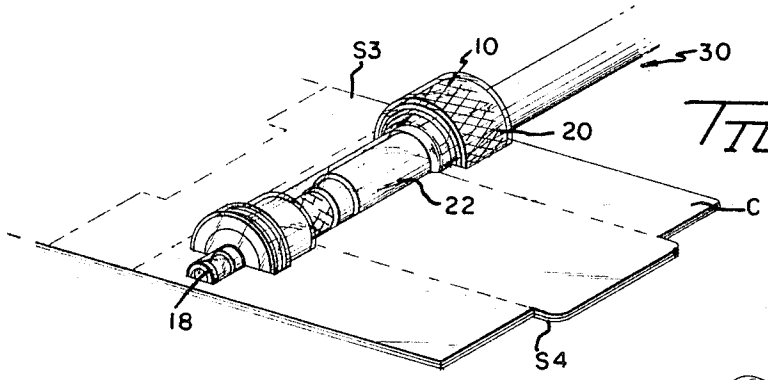
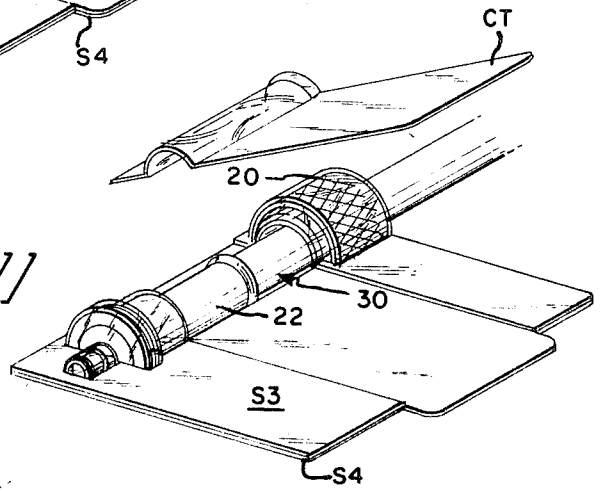


FIG 10

FIG 11



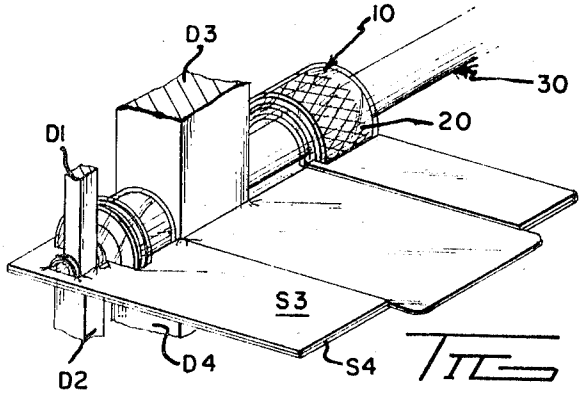


FIG 12

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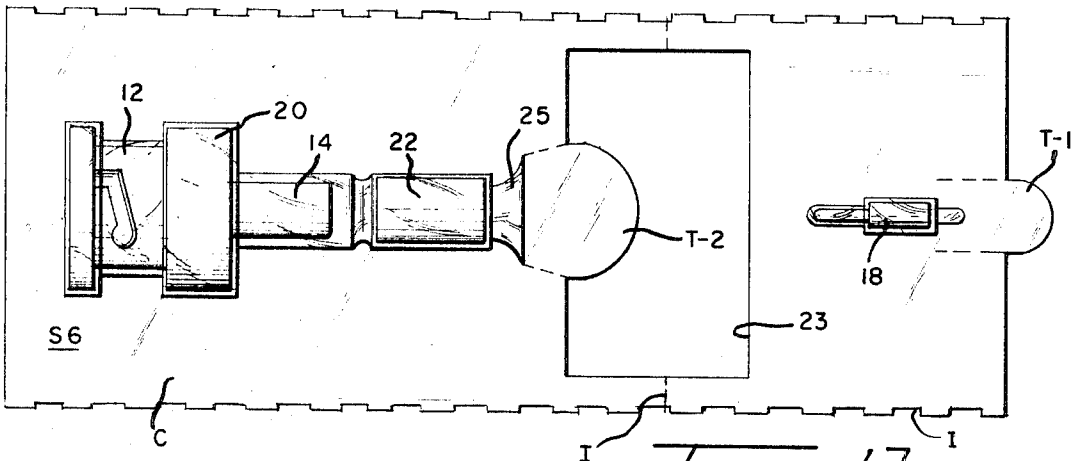

FIG 13

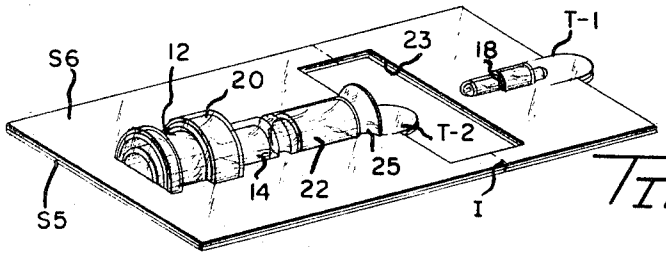

FIG 14

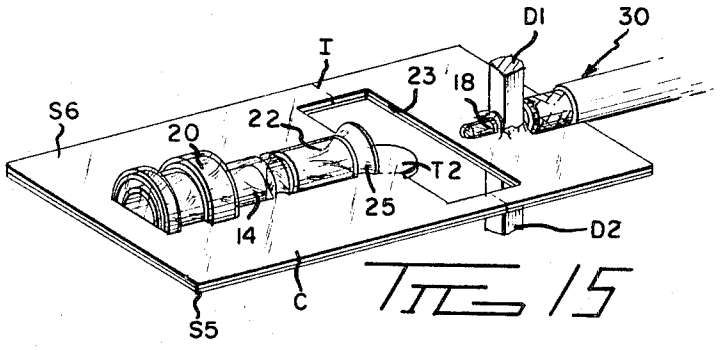

FIG 15

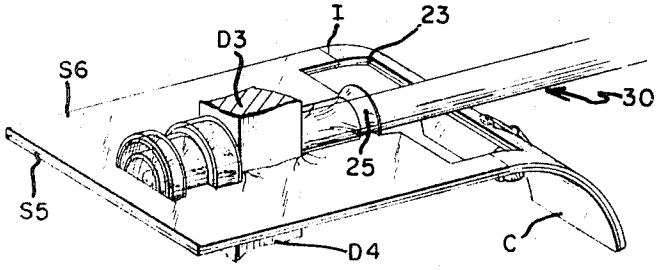

FIG 16

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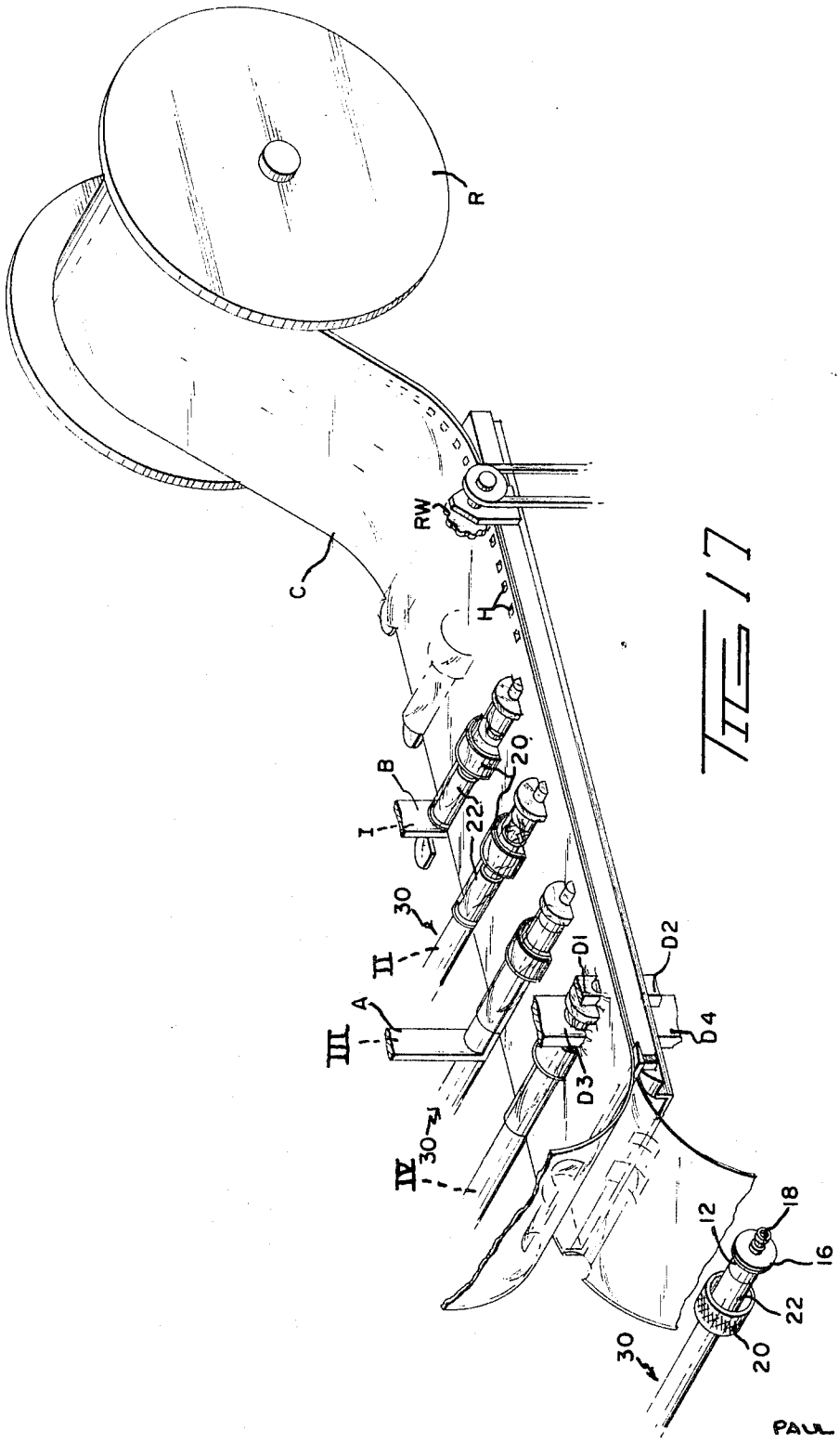

FIG 17

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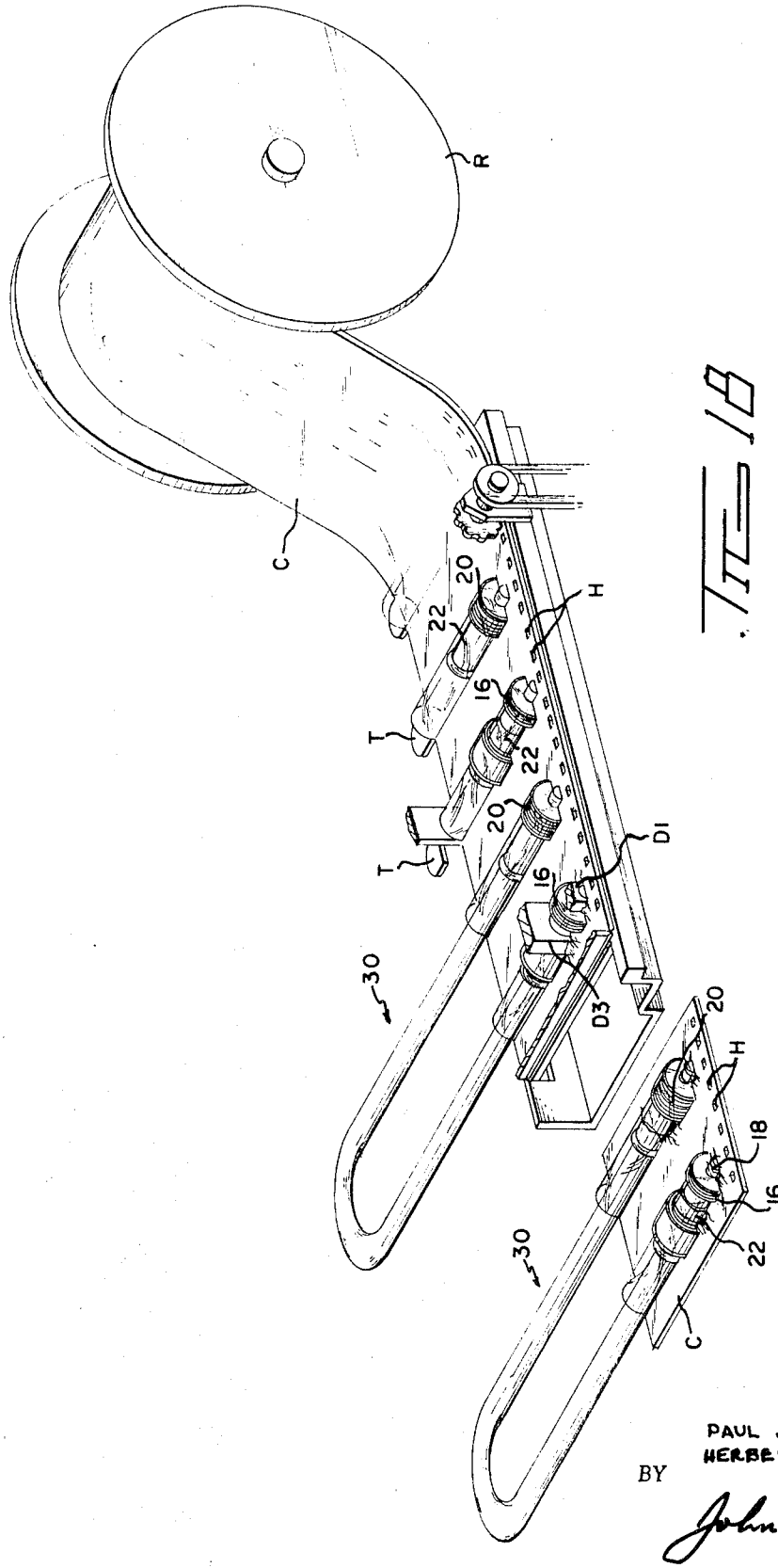

FIG 18

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METHOD AND MEANS FOR FACILITATING RAPID TERMINATION OF COAXIAL CONNECTORS

RELATED CASES

This application is a continuation-in-part of application Ser. No. 721,997 filed Apr. 17, 1968, and entitled PACKAGE FACILITATING ASSEMBLY OF CONNECTOR ELEMENTS ONTO CABLE.

BACKGROUND OF INVENTION accurately

A typical high performance coaxial connector is comprised of precision formed metal and dielectric elements which must be accureately and carefully assembled onto a coaxial cable in a precise relationship to obtain proper mechanical and electrical performance. At least certain of the metal elements usually are plated to a rather close tolerance with precious metal to enhance electrical performance by inhibiting surface oxides and for general appearance. Each of the plug and jack halves of a precision connector may include five or six individual elements. Each half may, for example, include a center contact member, a connector body and outer conductive shell, one or more dielectric members which mount the center pin in the shell, a nut or outer mechanical fitting andsome means for mechanically and electrically terminating the cable outer conductor to the body, such as a wedge ring assembly or crimping ferrule. Eachconnector half may further include one or more sealing gaskets. With precision connectors, all of these elements must be exactly positioned and the elements forming the coaxial signal path must be maintained to a particularly close tolerance in a radial and axial sense relative to each other to avoid impedance mismatch and discontinuities resulting in a signal reflection. In accordance with present practice connectors are frequently handled with the various elements for each half in loose-piece form placed in a separate envelope. Many such envelopes are not airtight and it is not unusual to find costly assemblies heavily oxidized even before sale or use.

In use, the typical prior art connector package is first opened with the various loose-piece elements sorted out and then manually pushed up, placed and held in proper position on a stripped coaxial cable. With a typical crimp type connector half assembly, the outer crimping ferrule is usually placed on first with the connector body then positioned with the sleeve extension thereof worked under the braid and the dielectric material sheath of the cable worked within the shell so that the center conductor is extended into the center contact member. The center contact member may either be loose-piece or affixed within a dielectric insert of the connector half and it usually includes an aperture to permit viewing of the center conductor inserted therein. In many available connectors the mechanical fitting, such as a nut or bayonet fitting is carried on the connector shell. In other devices these elements are separately fitted on prior to insertion of the cable into the connector. With these various elements properly positioned on the cable the outer ferrule is then worked up over the outer conductor of the cable and crimped inwardly to permanently terminate the cable to the connector. Either before or after this step a crimp may be applied to the center contact member to crimp the material thereof permanently to the center conductor of the cable. With noncrimp assemblies the center contact is usually soldered to the center conductor of the cable with a wedge ring or clamp structure then being applied to the rear end of the connector to terminate the outer conductor to the shell of the connector. With both solder type or crimp type connectors failure to place certain of the elements on before a given element is soldered or crimped or otherwise affixed to the cable may mean that certain of the additional elements cannot be passed over the attached element and properly positioned on the assembly. For example, if the outer crimping ferrule is not placed on the cable before the center contact member is crimped, there is with most designs, no practical way to remedy this error and the connector must be severed from the cable and discarded with a fresh assembly used with a newly prepared end of the cable. However, if the elements are properly assembled on the cable in the order of assembly into a connector, it is obvious to an artisan that, once again they will not pass over the attached element. However, this time, they are already on the cable, and thus the attached element prevents removal of the remaining elements from the cable, as heretofore experienced during the long history of assembly of such connectors.

As a most important consideration, the foregoing type of packaging of connector elements contributes considerably to the cost of termination and such is attributable solely to the requirement for physically handling numerous small elements and the time taken to accurately arrange and position such parts relative to the elements of the cable.

SUMMARY OF THE INVENTION

This invention relates to a method and means for providing a more rapid and reliable termination of electrical connectors to electrical leads.

It is an object of the invention to provide a method and means which minimizes the need to physically handle the several elements of electrical connectors. It is another object to provide a method and means to provide a more rapid and reliable termination of coaxial cable to coaxial connectors of the type comprised of a number of distinct elements. It is still another object to provide a method and means for multielement connectors and the like which prepositions the various elements of such connectors in a proper manner for use and installation onto electrical conductors.

The foregoing objects are attained by the present invention in one embodiment through the use of a carrier comprised of thin plastic material formed to receive the elements of one or both halves of a connector assembly and hold such elements in a position which facilitates the insertion of a prestripped lead into the elements as contained on the carrier. The carrier may be in the form of a package which includes tear strips facilitating a sealing of the elements one side or edge of the carrier to provide such time as the tear strips are removed to provide access and insertion of a conductive lead into the elements. The sheet material of the carrier is made sufficiently flexible and is indented to permit a series of packaged connector assemblies to be reeled for handling, storage, machine feeding and individual or multiple separation. In one embodiment the plastic material is sufficiently thin and of proper characteristics to permit termination of the inner and/or outer conductors of a cable as fitted within the elements of a connector as by crimping through at least a portion of the carrier material. In such embodiment the connector elements are positioned toward one side or edge of the carrier to provide access to crimping dies without interference by the body of the carrier. In another embodiment the carrier is comprised of a sheet of paper or the like precut to receive and position the connector elements with their transparent sheets of plastic vacuum formed thereover. The several embodiments include holes disposed along the package sides to facilitate machine processing.

In the drawings:

FIG. 1 is a perspective of a series of coaxial connector carriers mounted in accordance with the invention with part of the carrier being shown as disposed on a reel;

FIG. 2 is a plan view somewhat enlarged of a portion of a segment of the carrier containing connector elements properly aligned for assembly as shown in FIG. 1;

FIG. 3 is an end-on view of the carrier shown in FIG. 2;

FIG. 4 is a side view of the carrier shown in FIGS. 2 and 3;

FIG. 5 is an end-on view of the carrier shown in FIGS. 2, 3 and 4, with tabs to remove to provide access to connector elements in the carrier for insertion of a stripped coaxial lead therein;

FIG. 6 is a perspective view showing a connector assembly with the tabs of the carrier removed and with a stripped coaxial lead positioned for insertion into the connector elements;

FIG. 7 is a view of the structure shown in FIG. 6 with the lead inserted in the connector elements;

FIG. 8 is a view of the structure shown in FIGS. 6 and 7 with dies being applied through portions of the carrier to terminate the center contact element to the center conductor of the cable;

FIG. 9 is a perspective view of a carrier containing an assembly of coaxial connector elements in an alternative embodiment;

FIG. 10 is a view of the assembly of elements and carrier shown in FIG. 9 with a coaxial lead inserted therein;

FIG. 11 is a view of the assembly of FIG. 10 with a portion of the carrier removed to provide access for crimping of the connector center contact member and outer ferrule to terminate the lead to the connector assembly;

FIG. 12 is a view showing the structure of FIG. 11 with dies being applied to the center pin and outer ferrule of the connector elements to terminate the connector to the cable;

FIGS. 13 and 14 are plan and perspective views, respectively, of an alternative carrier embodiment;

FIGS. 15 and 16 are perspective views showing a use of the carrier of FIGS. 13 and 14; and

FIGS. 17 and 18 show schematically uses of the invention in a machine application of leads to connectors.

DESCRIPTION OF PREFERRED EMBODIMENT

Before turning to a detailed description of the invention, reference is made to U.S. Pat. No. 3,297,979 to M. F. O'Keefe et al., granted Jan. 10, 1967, for a teaching of the construction of a connector like that to be described and of its termination to coaxial cable. In brief summary the connector shown in the O'Keefe et al. patent is comprised of an assembly including an outer conductive shell having a pair of dielectric inserts fitted therein to captivate a center contact pin member and hold such pin member within the shell. The assembly further includes an interiorly threaded nut member which, in use, fits over the threading of a receptacle to hold the connector in engagement therewith. A crimpable ferrule is provided which fits over the rear of the shell and is crimped inwardly to terminate the outer conductor of the cable to the connector. The center conductor of the cable is extended within the pin and the forward end of the pin is crimped inwardly to terminate the center conductor of the cable thereto. The general arrangement of elements depicted in the O'Keefe patent is found in other types of connectors including connectors which are not crimped onto a cable, but rather are soldered thereto or attached in some other fashion. Connectors of the general type are utilized to terminate coaxial cable wherein there is a need to accommodate signals having an appreciable frequency or frequency component. When signals have an appreciable frequency or contain components of an appreciable frequency, as in the case under certain high speed pulse applications, impedance matching of the connector to the cable is of considerable importance to the electrical performance of the device. In large part, mismatch and signal reflection is due to physical discontinuities affecting the spacing and position of inner and outer conductor surfaces of the device. For this reason it is important to maintain the various elements in a precisely controlled physical position.

Turning now to FIG. 1, the symbol R represents a reel of multielement connector assemblies mounted on a carrier C. As can be discerned, the connector assemblies, the connector assemblies are connector halves. The connector assemblies shown as 10 in FIG. 1 are held on C in a side-by-side relationship, spaced apart and positioned to facilitate reeling and to provide an adjacent area of carrier for individual handling. The carrier C includes a series of holes H along each side to facilitate machine handling. FIG. 2 shows each assembly 10 to be comprised of a connector shell 12 having a rear extension 14 and a forward threaded portion 16. A center pin contact member 18 is provided for each assembly and may be considered as positioned within a dielectric insert within shell 12. Each assembly includes a nut member shown as 20 which is interiorly threaded to mate with 16 and to mate with the threading of either a receptacle or the threading on a mating connector half. A malleable ferrule 22 is provided which in application to a cable is fitted over the outer conductor of a cable and over the sleeve 14 to be crimped inwardly thereagainst. The arrangement of elements is as shown in FIG. 2, with the ferrule positioned to the right proximate the edge of the carrier C and with the pin 18 positioned to the left proximate to the left edge of the carrier. From FIGS. 2 and 3 it may be discerned that the carrier C as shown in FIG. 1 is divided into segments defined by indentations I along the joined edges of the carrier. These indentations permit one or more of the segments to be readily removed from the carrier reel and also facilitate handling of a single assembly at a time. The series of index holes H are provided along the sides of C to accommodate sprocket teeth of a feed mechanism which may be employed either in original production or in use with application tooling.

Each segment is comprised of two sheets of transparent plastic material shown as S1 and S2 in FIG. 3. The two sheets include tab portions T, as shown in FIG. 2, which extend out from the right side to provide access to the interior of the package formed by the carrier C. The lower sheet S1 is preferably more rigid than the upper sheet S2 and is vacuum formed to provide recesses for each of the elements of the assembly 10. The various elements of the assembly 10 are then placed in the recesses or pockets defined by the configuration of the recesses of S1 with the sheet S2 then being vacuum formed thereover. The body of the elements is made to include an access volume extending between the left end of 22 and the right end of the nut 20 and between the left end of the nut 20 and the larger diameter of 12 to provide a clearance for the insertion of the cable within the package in the manner to be described. Connector assembly 10 may be sealed within the carrier by a bond between S1 and S2 extending in the manner indicated in FIG. 2 along the dotted line B This bond may be made in any suitable fashion as by the selective application of heat to the package or by adhesive deposited on one of the sheets S1 and S2 prior to the lamination.

As an alternative it is also contemplated that each of the sheets S1 and S2 may be vacuum formed into an appropriate configuration in strip form with the assembly of elements being properly positioned in one of said sheets and the other sheet then being brought down and sealed against the sheet containing the assembly of elements. The arrangement of elements and the position therebetween in conjunction with the configuration of elements and the need to establish interior volumes between the sheets will somewhat determine which of the foregoing procedures is preferable. In either event at least one of the sheets is preferably transparent so that the assembly of elements may be readily observed through the sheets. As mentioned, the composite formed by the sheets containing an assembly of elements should have characteristics permitting reeling of the strip of subpackages in the manner depicted in FIG. 1. In one actual embodiment sheets S1 and S2 were vacuum formed to the configuration shown of a material identified as 0.005 of an inch polyvinyl chloride in rigid sheet form bonded together by adhesive.

The tabs T as shown in FIG. 2 are separated at the outside end as indicated by the dotted line to facilitate an opening of the carrier package by peeling the tabs therefrom in the manner shown in FIG. 5. If the sheet material is of a thin stiff plastic such as polyvinyl chloride the configuration and edge of ferrule 22 may be sufficient to assure tearing of the material without indentation in the region of the tab. If the material is more elastic indentations extending about the right end of the package around the end of the ferrule 22 may be provided to facilitate removal of the tabs.

FIG. 6 shows an assembly 10 with the corner package tabs removed and with a coaxial cable, prepared by axially stripping segments thereof, positioned for entry into the assembly of elements. The cable shown as 30 includes a center conductor 32 surrounded by a dielectric sheath 34, an outer

conductor 36 and an outer protective sheath 38. In a typical cable construction the outer conductor 36 is a braid of fine wires. In accordance with the invention concept a segment is held with the cable then being inserted therein to a proper position. FIG. 7 depicts this insertion. As can be discerned from FIG. 7, the pin 18 of the connector assembly includes a hole in the end thereof and the transparent material of the carrier package facilitates viewing the end of the center conductor to assure that it is properly inserted within the pin. The transparent material of the segment also permits a viewing of the end of the outer conductor 36 to assure that it is properly positioned over sleeve 14. In performing the insertion step of FIG. 7 it has been found advisable, if the end of the braid is not even or contains strands which tend to catch on the package, to rotate the cable slightly as it is inserted. This has been found to enhance feeding of the cable into the carrier package and into a proper position.

In accordance with one aspect of the invention, and the particular arrangement of elements thus far depicted, a segment may then be positioned in a tool with dies brought down to crimp the center contact pin 18 to the center conductor in the manner shown in FIG. 8. Any suitable crimping means may be utilized to provide such crimp. The dies shown as D1 and D2 need only be driven together in relative closure to deform the material of the contact pin 18. During this crimping operation the segment provides a means of handling the connector assembly without actually touching the elements or without having the operator's fingers close to the dies. It is to be noted that at this time the various connector assembly elements are all properly serially positioned relative to cable parts and that with the concept of the invention the possibility of inadvertently leaving off ferrule 22 or perhaps nut 20, is precluded.

With the concept as thus far detailed it is contemplated that the connector may be then removed by removing the strips S1 and S2 and effecting the crimp of the ferrule 22 in a suitable tool.

As an alternative embodiment of the invention the carrier heretofore described may be given a configuration as depicted in FIGS. 9—12 which is somewhat similar in construction to that heretofore detailed with a different arrangement of connector assembly elements therein and a different positioning of such elements thereon. As can be discerned, a carrier segment is comprised of two sheets S3 and S4, encapsulating an assembly of elements shown as 10 with the elements positioned relatively toward one edge of the segment. As shown in FIG. 9, nut 20 is positioned outboard of the ferrule 22 and entry into the segment is made, after removal of tab T, through the nut 20. FIG. 10 shows a cable inserted within the segment package. As shown in FIG. 11, the upper sheet S3 includes a center tab section shown as CT which is removable to expose the center contact and outer crimping ferrule of the connector assembly. Sheet CT is preferably bonded to the left-hand edge of S3 so that when CT is removed the lower left-hand portion of S4 is also removed in the manner shown in FIG. 11 to provide access to the portions of the assembly to be crimped. FIG. 12 shows the assembly with dies D1 and D2 being brought down against the center contact pin and dies D3 and D4 being brought down against the ferrule 22. After crimping of the connector assembly elements to the cable the remaining portions of the segment package may be peeled off of the elements.

FIGS. 13 and 14 show an alternative carrier construction including a pair of sheets S5 and S6 with a connector half mounted therein of a type having the center contact member separated from the connector body to facilitate crimping prior to insertion within the connector body. The connector elements are otherwise similar to those previously described with respect to FIGS. 1—12 and are similarly identified. In the embodiment of FIGS. 13 and 14 the connector body 12 is positioned forwardly with the nut 20 thereon. The outer crimping ferrule 22 is positioned slightly away from the end of the sleeve extension 14 and the center contact 18 is positioned in alignment with but separated from the ferrule. The segment package includes a slot 23 between the portion housing 18 and the rest of the elements. The segment includes a tab portion T1 providing access to 18 and a separate indentation I extending across the webs defined by 23. In use the segment package is employed as indicated in FIG. 15 with the center contact then terminated to the stripped center conductor of a cable 30. Separation of the subpackage leaves the ferrule 22 exposed for insertion of the crimped center conductor. After crimping of 18 and removal of portions 14 of tab T2 the contact may be removed from the sheets and inserted in the manner shown in FIG. 16, the sheets being folded down to provide clearance, or removal, if desired. Ferrule 22 is then pushed forwardly to surround the cable outer conductor. FIG. 16 also shows ferrule 22 being crimped by dies D3 and D4 through the sheet material. As can be seen from FIG. 13, the carrier package includes an inner configuration to guide the cable braid during insertion into a proper surrounding position over the extension 14 of the connector body. The bell mouth portion 25 operates to guide the braid into the ferrule and as can be seen from FIG. 13, such portion extends inwardly beyond the edge of the ferrule.

While the invention package has been detailed for use with readily available crimping tools applied from a free edge of a carrier package, it is contemplated that termination of cables may be made through crimping dies applied to a segment package prior to removal from the carrier strip; the strips of the carrier being left joined to serve as a carrier for machine feed of terminated connectors to at least an adjacent removal station. FIGS. 17 and 18 show schematically a series of stations with various steps of assembly from a reeled supply to severing of mating halves of connectors left in a carrier package for later use. The carrier shown in FIG. 17 is like that shown in FIGS. 1—5. The carrier shown in FIG. 18 is similar to that of FIGS. 1—5 but with the ferrule 22 displaced forwardly, as it may be with many types of cables.

In FIG. 17 a carrier C is fed from a reel R under drive of a ratchet wheel RW to a station I where tabs are removed by a blade B and then to a station II where cables are inserted. At a station III the ferrule 22 is pushed forward as by a member A and then moved to a station IV where the assembly is crimped by dies D1, D2 and D3, D4. The carrier is then fed through a station serving to pull the reel through preceding stations with terminated assemblies then being removed. FIG. 18 depicts a similar arrangement for a carrier C containing mating connector halves which are left, after severing, tied together for handling prior to use. The concept of the invention lends itself particularly to lead assembly operations by machine or by semiautomatic procedures.

While the technique of termination chosen to illustrate the invention is one of forging or crimping, it should be apparent that the invention is a major aspect contemplates terminating connector elements to conductors of a cable. Those skilled in the art of termination of electrical connectors should appreciate that welding and soldering processes would be used for such termination as an alternative, the essence of the invention approach in method and means serving an identical function.

Having now disclosed the invention in terms intended to enable a preferred practice thereof, claims are appended which define what is asserted as inventive.

We claim:

1. In a method of preliminarily locating connectors each comprised of a set of elements including two distinct coaxially disposed center and outer conductive contact elements which are assembled onto the end of a cable having at least two separate conductors, the steps comprising: providing sets of connectors with each set having at least two of said distinct contact elements in at least partially disassembled form, providing a flexible tape means, securing said sets to said tape means on separate side-by-side locations thereof with the longitudinal center axis of each element of each set extending essentially transversely to the length axis of said tape means and with the said contact elements being substantially aligned rela-

tive to the serial engagement of a cable with the elements of a set and also relative to one another in positions allowing assembly thereof into a single connector, positioning the contact elements with the longitudinal center axis of each contact element extending coaxially along a common axis to facilitate cable insertion, crimping at least one of said elements to said cable such that said crimped element retains the remaining elements over said cable, and removing all of said elements and said cable from said tape means to permit assembly of said elements into a single connector.

2. In a method of preliminarily locating coaxial connectors of a type having first and second contact elements and a crimping ferrule element on a coaxial cable, the steps comprising: providing a carrier means including a series of segments, securing to each segment a set of aligned elements serially arranged in their order of assembly resulting in a coaxial connector including the first contact element, displacing said carrier means to position a segment at a time at a cable insertion station, inserting a cable serially internally of said serially aligned elements, terminating said cable to at least one of said elements, thereby preventing removal of said elements from said carrier means, and removing said elements and said cable from said carrier means in order to permit assembly of said elements into a coaxial connector.

3. A method of preliminarily locating coaxial connector component elements on a coaxial cable in readiness for subsequent assembly of said elements into a coaxial cable connector, comprising the steps of: maintaining at least one set of said plurality of said component elements in axial aligned and fixed positions on a carrier means with said set of component elements in relative positions allowing assembly thereof into a coaxial cable connector, inserting a coaxial cable serially internally of said component elements, crimping at least one of said elements permanently in position on said cable to prevent separation of said serially located elements from said cable, and removing said cable and said serially located components from said carrier means, thereby releasing said elements from their fixed positions on said carrier means and allowing subsequent assembly of said set of elements and said crimped element into a coaxial connector.

4. The method as recited in claim 3, wherein said carrier means comprises a package, and further including the steps of: inserting said component elements in fixed axial alignment within said package, and inserting said cable internally of said package together with the step of inserting said cable serially within said component elements prior to said crimping step.

5. The method as recited in claim 4, and further including the steps of: initially covering said package with a removable covering means, removing said covering means providing access means to said elements, and inserting said cable through said access means and internally of said package and serially within said exposed elements prior to said crimping step.

6. The method as recited in claim 3, wherein said carrier means comprises a removable center portion, and further including the steps of: removing said removable central portion to expose at least one of said elements, and crimping said exposed element permanently in location on said inserted cable prior to removal of said elements and said cable from said carrier means.

7. The method as recited in claim 3, wherein said carrier means includes a pair of spaced packages, with at least one of said aligned component elements in one package and the remaining aligned component elements in the other of said packages, and further including the steps of: initially inserting said cable internally of said component in said one package, crimping said component permanently on said cable, inserting said cable internally of said axially aligned components within said other package, and crimping at least one of said components in said other package to said cable in order to prevent removal of said component elements from said cable when and after said component elements are removed from said carrier means.

8. The method as recited in claim 3, wherein said carrier means maintains a plurality of sets of elements, with each set in side-by-side location along said carrier means, and further including the steps of: inserting a separate cable serially of the elements of each set, and crimping at least one element of each set to a respective cable, and removing separately each set of elements together with an associated inserted cable from said carrier means.