Oct. 12, 1965 G. H. KALEN 3,210,832

INSERTION-REMOVAL TOOL

Filed April 24, 1964

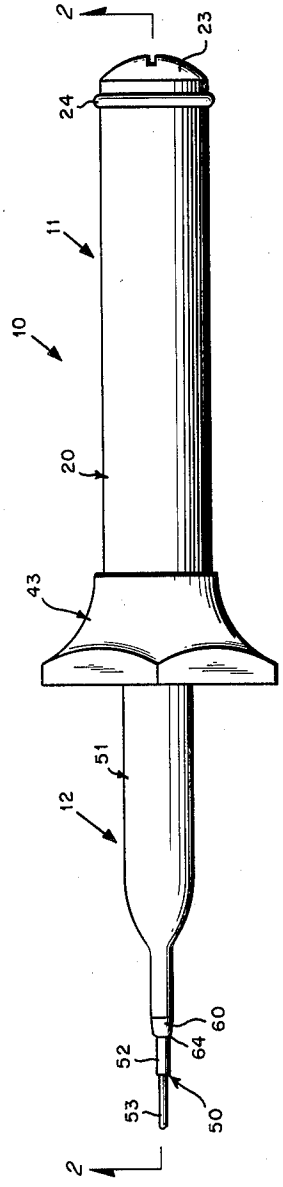

Fig. 1

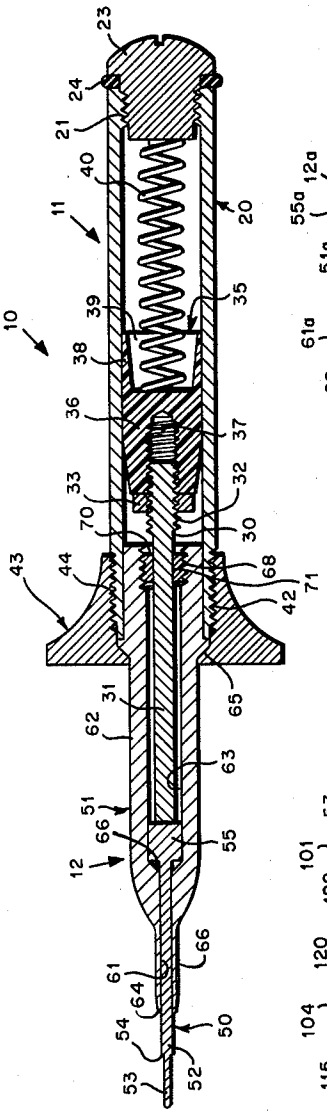

Fig. 2

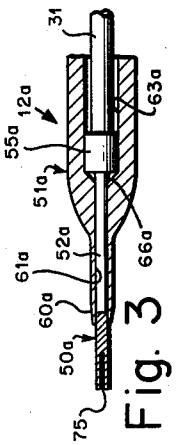

Fig. 3

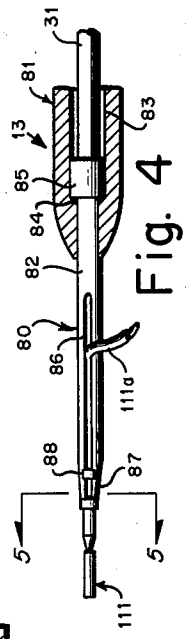

Fig. 4

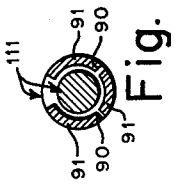

Fig. 5

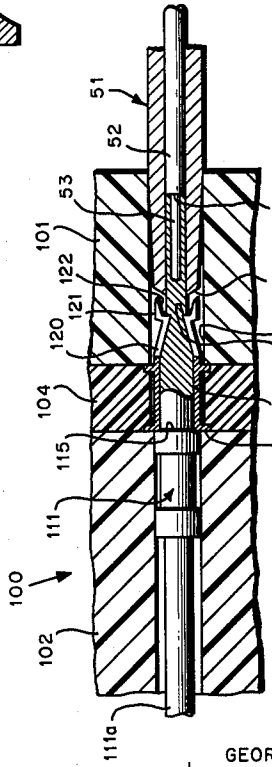

Fig. 6

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INSERTION-REMOVAL TOOL

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The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to hand tools and more particularly to hand tools for inserting and extracting removable contacts or pins from electrical connectors.

Electrical connectors utilizing removeable, crimp-type pin or socket contacts have been widely accepted in the electrical arts and are used in vast numbers, particularly in the construction of complex circuits in computers or the like where large numbers of connections are required and relatively small diameter wires are involved. Electrical connections are made with pin-type or socket-type contacts by merely inserting the contact into the connector or receptacle until the contact has the proper mechanical interlock within the connector. This mechanical interlock may be obtained by the use of a spring clip mechanism previously installed within the connector body. The connector may provide multiple openings for several contacts so that several conductors can be connected at a common junction. If the contacts are inserted properly into the connector, it will withstand substantial pull-out forces and the electrical integrity of the connection between the pin and the connector will be resistant to the deleterious effects of, for example, vibration and corrosion.

It is readily seen that the efficiency of the electrical connection is dependent upon the proper placement of the contact within the connector and the maintenance of the structural integrity of the receptacle during the insertion and removal operation. In order to effect the proper connection between the contact and the connector and to facilitate the subsequent removal thereof, hand tools of various configurations have been utilized. When these prior art hand tools are used for insertion, the contact member is held by the tip of the tool and inserted into the connector by a pushing action. In order to seat the contact into the proper cavity formed within the connector, a twisting or cocking action is applied by the operator of the tool. This action frequently has the effect of destroying the structural integrity of the material forming the connector insert body. Frequently during insertion of the contacts the tool encounters a resistance to insertion which may be due to either misalignment of the insertion tool or overhang of the material forming the body of the connector. This encountered resistance is frequently countered by the operator applying an increased force without providing sufficient time for the inserted contact to properly align and seat itself. In many instances this causes tearing of the material forming the walls of the contact apertures in the insert body of the connector, exiting of the contact through an adjacent opening, or damage to the contact retention member that was placed within the insert body of the connector. The aforementioned damages may also occur during the removal of the contacts from the electrical connectors.

It has been found that the soundness of an electrical connection between an inserted pin or socket and a connector can be established if a pull-out test force is applied to the contact. For example, one contact will, after proper insertion, withstand a pull-out force of up to 25 pounds but an improperly inserted one will be removed from the connector if a pull-out test force of a fraction

of that amount is applied. Thus, the soundness of the connection can be established at the time of insertion if a pull-out test force slightly less than 25 pounds is applied.

The general purpose of this invention is to provide an insertion and removal tool for electrical connectors which embraces all the advantages of similarly employed prior art devices and possesses none of the aforesaid described disadvantages. To attain this, the present invention contemplates a unique tool consisting of a pneumatic cylinder handle assembly and insertion probe and removable probe assemblies interchangeable therewith. By reason of the pneumatic action of the tool, twisting or pushing of a secondary part is not necessary to effect the insertion or removal of a contact from an electrical connector and insertion and removal is accomplished without damage to the contact retention mechanism, the material of the connector or to the contact.

An object of the present invention is to provide an implement or tool for connecting or disconnecting mating electrical components in a manner to insure optimum mechanical and electrical engagement between said units without injury to or impairment of either.

Another object of the present invention is the provision of a general purpose, universal type insertion and removal tool assembly for inserting electrical contacts into electrical connectors and for extracting electrical contacts from electrical connectors.

Still another object is to provide a general purpose, universal type insertion tool embodying a compulsory pull-out test feature so that each contact inserted with the tool must be pull tested by the operator.

A further object is to provide a tool by which a contact attached to a wire end, may while held by the tool, be telescoped and engaged within a connecting member quickly and securely in a simple operation even where the available working space is limited and the parts are not otherwise readily accessible.

A further object of the invention is to provide a contact-applying tool which may also be employed for disconnecting the contact from its contact retention member to which it is mechanically engaged.

Other objects and features of the invention will become apparent to those skilled in the art as the disclosure is made in the following description of an embodiment of the invention as illustrated in the accompanying sheet of drawing in which:

FIG. 1 is a full view of an embodiment of the present invention with a socket contact removal probe secured thereto;

FIG. 2 is a cross sectional view taken along the line 2—2 of FIG. 1;

FIG. 3 is a partial view in cross section of the pin contact removal probe;

FIG. 4 is a partial view in cross section of the insertion probe of the present invention with a socket contact engaged thereby;

FIG. 5 is a cross sectional view taken along the line 5—5 of FIG. 4; and

FIG. 6 is a cross sectional view of a connector with a socket contact secured thereto about to be extracted therefrom by the action of the removal probe of FIGS. 1 and 2.

In the illustrated embodiment of the invention, FIG. 1 shows a hand tool generally noted at **10** consisting of a handle assembly **11** and a probe assembly **12**. Although the probe assembly **12** of FIGS. 1 and 2 is of the socket-removal-type, it is understood that the handle assembly **11** is not limited in the use thereof with removal probe **12** and that the probe **12** may be substituted, as will be described below, by pin-type removal probe assembly **12***a* of FIG. 3 and insertion probe assembly **13** of FIG. 4.

The hand tool of the present invention is particularly adapted for use in the environment illustrated in FIG. 6 which illustrates an enlarged longitudinal cross section view of a standard electrical connector insert **100** and which forms no part of the present invention. The connector insert **100** includes body portions **101** and **102** of resilient material separated by a fibrous element **104**. A plurality of apertures, only one of which is shown at **105**, extend longitudinally of the connector insert **100** and each houses a spring clip retaining element or contact retention member **110** of conventional type known and used in the art which is introduced into connector insert **100** prior to the insertion of the pin-type or socket-type contact. A socket-type contact is shown at **111** and is also of conventional design and of the type known and used in the art.

As noted in FIG. 6, contact **111** includes a pair of retention shoulders **115** and **116** which, when properly seated with respect to the spring clip **110**, are in locking engagement with surfaces **115***a* and **116***a*, respectively, of clip **110**. Surface **116***a* is formed as a portion of a flexible skirt **120** which in turn terminates in a lip **121** having angularly related surfaces **122** constructed for wedging engagement with the angular edge **64** of the tapered neck portion **60** to be described below.

Referring now to FIGS. 1 and 2 for a detailed description of the hand tool **10**, the handle assembly or pneumatic cylinder **11** is illustrated as comprising a cylindrical tube **20** of stainless steel or the like which is internally threaded at **21** for receiving an externally threaded body plug **23** for sealing one end of the tube **20**. An O-ring seal **24** is additionally provided between the plug **23** and tube **20** to insure an air-tight seal at the end of the tube. It should be understood that without departing from the scope of the present invention, the tube **20** may be constructed of reamed bar stock with the end portion thereof remaining to form the sealed end.

A piston assembly generally noted at **30** is longitudinally slidable within the cylinder **20** and includes a piston rod **31** having a threaded portion **32** for threadably receiving a piston **35**. A nut **33** on threaded portion **32** wedgingly locks piston **35** with respect to rod **31**. Piston **35** is constructed of a deformable, flexible, resilient material, such as Teflon or the like, and includes both a solid body portion **36** having an internally threaded section **37** for receiving the threaded piston rod **31** and a relatively thin, longitudinally tapering circumferential lip component **38** forming a cup **39** facing the sealed end of the tube **20**. By reason of the resiliency and flexibility of the lip **38** an increasingly effective seal is obtained as the piston rod **31** and associated piston **35** is urged toward the sealed end of the tube **20**. As the air contained between the piston and sealed end is compressed, compressive forces are produced which urge the circumferential lip **38** against the inner sidewalls of the tube **20**. By reason of the adjustable character of the piston **35** with respect to piston rod **31**, the compressive force developed per increment of piston rod travel may be varied.

The cup **39** of the piston **35** additionally serves as a housing for receiving a compression spring **40** which is interposed between the piston and the body plug **23**. The compression spring **40** continually acts to urge the piston rod **31** outwardly of the cylindrical tube **20** and serves an important part in the insertion and removal functions described below.

The other end of tube **20** has an externally threaded portion **42** which receives an internally threaded nut **43** which serves to lock the probe assembly **12** within the cylindrical handle assembly **11**. The probe assembly **12** illustrated in FIGS. 1 and 2 is of the type used in the removal of a socket-type contact similar to that illustrated at **111** in FIG. 6 and includes a probe tip generally noted at **50** and longitudinally slidable within a probe body **51** which houses and guides the tip **50**. Probe tip **50** is composed of a shaft **52** which terminates at one end in a reduced portion **53** of a diameter slightly smaller than the diameter of the socket of the contact member to be removed. By reason of the reduced portion **53**, a shoulder **54** is formed which in the removal operation, FIG. 6, abuts the end of the socket contact. A collar **55** is integrally connected to the shaft **53**, is of larger diameter and slides within the inner confines of probe body **12**.

The probe body **51** includes a tapered, reduced neck portion **60** having a bore **61** therethrough for receiving the shaft of the probe tip **50** and an enlarged portion **62** having a counter bore **63** therein for permitting longitudinal sliding movement of the collar **55**. The counter bore **63** in turn terminates in a shoulder **66** which limits the forward movement of shaft **52**. The reduced neck portion **60** is of tapered configuration for ease of insertion and further includes an angular edge **64** for engaging and separating the flexible skirt **120** of the clip **110**. See FIG. 6.

Probe body **51** has a portion thereof telescopically received within the cylindrical tube **20** and includes an annular flange **65**. An annular flange **65** which is formed about the probe body **51** for abutment against the end of tube **20** and is rigidly held in this position by the engagement of complementary surfaces formed on the annular flange **65** and the nut **43** when the latter is threaded upon the threaded end **44** of the tube **20**.

Probe body **51** terminates at the other end thereof in an internally threaded portion **68** which receives a threaded bushing **70** which in turn includes an aperture **71** formed therein of a diameter greater than the diameter of the piston rod **31**.

In the assembly of the probe assembly **12** within the pneumatic cylinder **11**, the probe lock nut **43** is removed from the tube **20** and the probe **12** inserted within the tube **20** with the piston rod **31** passing through the aperture **71** in the bushing **70**. The probe lock nut is then passed over the probe assembly **12** and threaded on the threaded portion **44** of the tube **20** which draws the angular flange **65** into engagement with the end of the tube **20**. In this secured position, the piston rod **31** urges the probe tip to the outermost extended position.

In like manner removal probe **12***a* and insertion probe **13** may be substituted and inserted for the removal probe **12** shown in FIGS. 1 and 2. Probe **12***a* of FIG. 3 differs from probe **12** of FIGS. 1 and 2 in the construction of the probe tip **50***a*; the probe body **51***a* being identical in construction to probe body **50** of FIGS. 1 and 2 with the counter bore **63** terminating in a shoulder **66***a* which limits the forward movement of shaft **52***a*. Removal probe **12***a* is of the type used in the extraction of a pin-type removable contact and includes a probe tip **50***a* having a shaft **52***a* secured at one end thereof to collar **55***a* and the other end formed with a bore **75** of a diameter sufficient to envelope the outwardly extending pin of the contact to be removed and not shown.

Insertion probe **13** of FIG. 4 is also adapted for use with the pneumatic cylinder **11** and includes a probe tip **80** and a probe body or housing **81**, body **81** being similar to body **51** of FIG. 2 except that the neck **60** has been eliminated. A barrel or shaft **82** forms part of the insertion probe tip **80** and has secured at one end thereof a collar **85** which is longitudinally slidable within the counter bore **83** formed in the probe body **81**. The counter bore **83** in turn terminates in a shoulder **84** which limits the forward movement of shaft **82**. Barrel **82** is recessed at **86** to house wire **111***a* and includes a tapered hollow end **87** provided with an opening **88** for receiving the contact **111** which is to be inserted in the electrical connector insert **100**. As illustrated in FIG. 5, the tapered end **87** is formed with a plurality of slots **90** at the outermost portion to provide a plurality of expandable and resilient spring fingers **91** to securely hold contact **111**. The material used in the construction of the

tapered portion and the width and length of the slots **90** will determine the amount of holding power that the insertion probe will exhibit against a pullout force applied to the contact.

For purposes of illustration and not limitation, the following description of the use of the insertion tool will be described as the same is used in the insertion of a socket type contact **111**. It is understood that a pin type or other types of connectors may be utilized with the insertion tool without departing from the spirit and scope of the present invention. In operation, the insertion probe assembly is secured to the handle assembly as described above and the socket-type contact **111** is inserted in the tapered hollow end **87** of the insertion probe tip **80** and is held by the resilient action of the spring fingers **91**. The contact and probe tip is inserted into the aperture **105** of the electrical connector insert **100**, entering the left side thereof as viewed in FIG. 6. Continual force is applied by the operator until the contact is properly seated in the spring clip **110** which occurs when the spring elements engage the retaining shoulders formed in the contact member **111**. Upon proper seating of the contact **111** in the clip **110**, the probe tip **80** may be removed since the retaining force of the clip will overcome the resilient retaining force of the spring fingers **91**. It is understood that should any misalignment occur during the insertion of the contact which would inhibit the forward movement of a probe tip and contact, a further application of force by the operator will cause the probe body to telescope over the static probe tip and thereby provide sufficient time for the contact to free itself from its impediment and to be subsequently properly seated by the combined forces of the spring **40** and the compressed air.

Referring now to FIG. 6 for a description of the method of extracting a contact from the seated position thereof in the electrical connector, the proper removal probe is selected depending upon the diameter of the socket portion of the contact member and the selected probe assembly is secured to the pneumatic cylinder. The reduced shaft **53** of the probe tip is inserted in the socket portion of the contact and an axial force is applied by the operator. Upon application of this force, forward movement of the probe tip **50** is inhibited by the engagement of the shoulder **54** and the socket end. Continued application of force causes the probe body **51** to telescope over the probe tip and the tapered neck **60** to proceed into the body of the connector. As this forward motion occurs, the pressure in the pneumatic cylinder is building up. When the angular edge **64** engages the surface **122** of the spring **110** and the flexible skirt **120** spreads to release the contact the pressure will urge the piston, the associated piston rod and the probe tip to quickly move forward and eject the contact.

In the manner similar to that described above the removal probe illustrated in FIG. 3 may be utilized in the extraction of a pin-type removable contact.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. A hand implement for inserting and extracting removable contacts from electrical connectors, comprising:

a tubular member pneumatically sealed at one end thereof and open at the other end thereof;

piston means interposed within and slidably engaging said tubular member, said piston means having a force-transmitting means secured thereto;

spring means interposed between said piston means and said sealed end of said tubular member;

housing means having a longitudinally extending bore therethrough;

a shaft slidably positioned within said bore, said shaft terminating at one end thereof in a removable-contact engaging portion which extends beyond the confines of said housing means;

means at each end of said bore for abutting said shaft and limiting the movement of said shaft within said housing means;

said force exerting means extending within said housing means and engaging said shaft; and

locking means operatively securing said housing means to said tubular member.

2. A hand implement for inserting and extracting removable contacts from electrical connectors which employ spring clips for grasping a portion of the body of the contact, comprising:

a hollow tube pneumatically sealed at one end thereof and open at the other end thereof;

pneumatic piston means interposed within and fitted to said hollow tube for movement therein, said piston means having a longitudinally extending piston rod secured at one end thereof to outer face of said piston means;

mechanical spring means interposed between the inwardly facing surface of said pneumatic piston means and said pneumatically sealed end of said tube;

housing means having a longitudinally extending bore therethrough;

a shaft slidably positioned within said bore, said shaft terminating at one end thereof in a contact engaging portion which extends beyond the confines of said housing means and terminating at the other end in an enlarged collar portion;

first abutment means at the forward end of said bore for engaging said collar portion and limiting the forward movement of said collar portion;

second abutment means at the other end of said bore for limiting the rearward movement of said collar portion;

said piston rod extending within said housing, engaging said collar and urging said collar against said first abutment means; and

locking means operatively securing said housing means to said hollow tube.

3. The hand implement as defined in claim **2** wherein said pneumatic piston means includes a rearwardly facing dished portion for housing a portion of said spring means and for entrapping the air between said piston and said pneumatically sealed end of said tube.

4. The hand implement as defined in claim **3** wherein said dished portion is formed by a rearwardly extending, flexible, circumferential lip which engages the inside periphery of said tube whereby a seal is formed precluding the escape of the entrapped air.

5. The hand implement as defined in claim **4** wherein said piston rod is adjustable with respect to said pneumatic piston whereby the compressive force, resulting from the compression of the entrapped air and the compression of said spring means, acting on said piston per increment of relative movement between said piston rod and said tube may be regulated.

6. The hand implement as defined in claim **2** wherein:

said second abutment means is a closure threadably secured to said other end of said bore having an aperture therethrough through which the piston rod extends.

7. The hand implement as defined in claim **2** wherein:

said shaft includes a recess extending longitudinally along a portion of the length of said shaft; and wherein

said contact engaging portion of said shaft comprises a plurality of expandible resilient fingers for gripping the contact.

8. The hand implement as defined in claim **2** wherein:

said shaft includes a recess extending longitudinally along a substantial portion of the length of said shaft; and wherein

said contact engaging portion of said shaft is tapered to facilitate entry thereof into the connector and comprises a plurality of expandible resilient fingers for gripping the contact.

9. A hand implement as defined in claim **2** wherein: said contact engaging portion at said one end of said shaft includes a reduced diameter pin member for insertion within a portion of the contact.

10. A hand implement as defined in claim **9** wherein: said housing surrounding said shaft and collar includes a tapered longitudinally extending reduced neck portion for engaging the spring clip and for releasing the grasp thereof on the contact.

11. A hand implement as defined in claim **2** wherein: said contact engaging portion at said one end of said shaft includes a bore for receiving a portion of the contact.

12. A hand implement as defined in claim **11** wherein: said housing surrounding said shaft and collar includes a tapered longitudinally extending reduced neck portion for engaging the spring clip and for releasing the grasp thereon on the contact.

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