Oct. 25, 1955 H. J. MODREY 2,721,981

SLIDELESS SELF-LOCKING ELECTRICAL CONNECTOR

Filed July 7, 1950 5 Sheets-Sheet 1

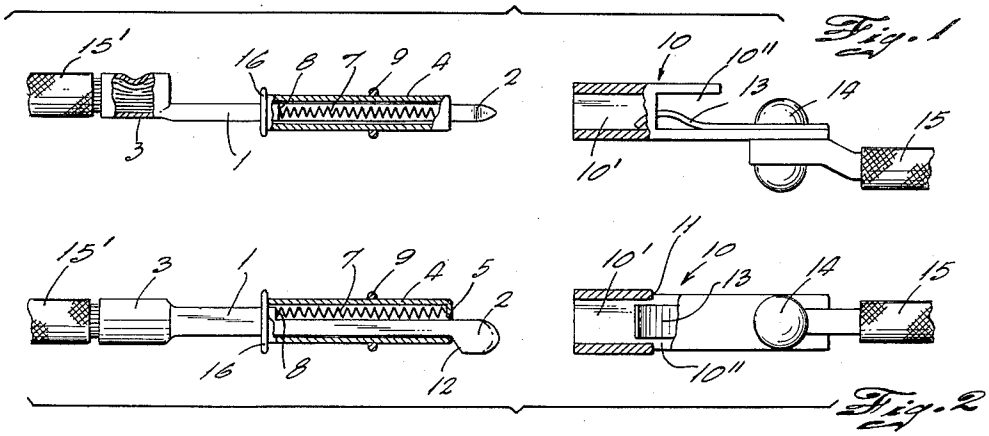


Fig. 1

Fig. 2

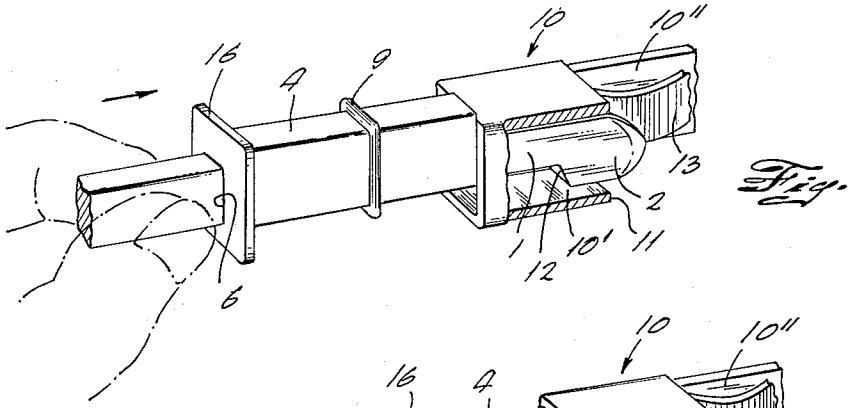


Fig. 3

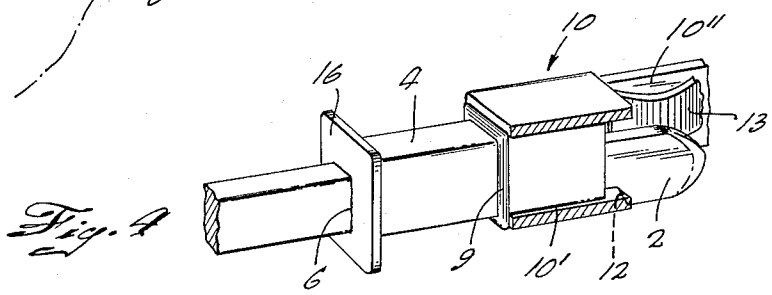


Fig. 4

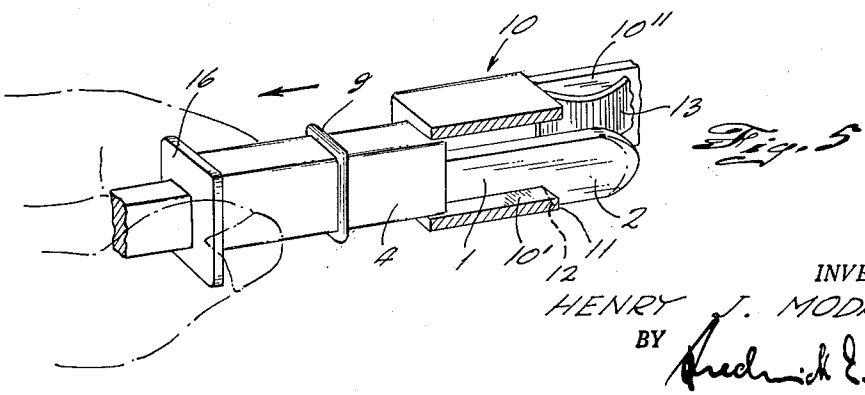


Fig. 5

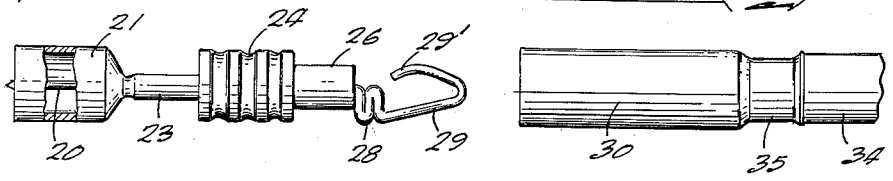
INVENTOR.
HENRY J. MODREY
BY Frederick E. Haas
ATTORNEY.

Oct. 25, 1955 H. J. MODREY 2,721,981

SLIDELESS SELF-LOCKING ELECTRICAL CONNECTOR

Filed July 7, 1950 5 Sheets-Sheet 2

Fig. 8



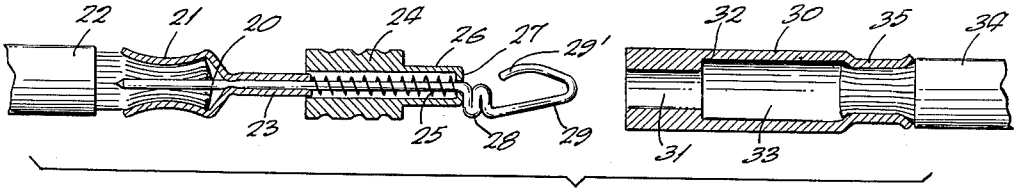


Fig. 9

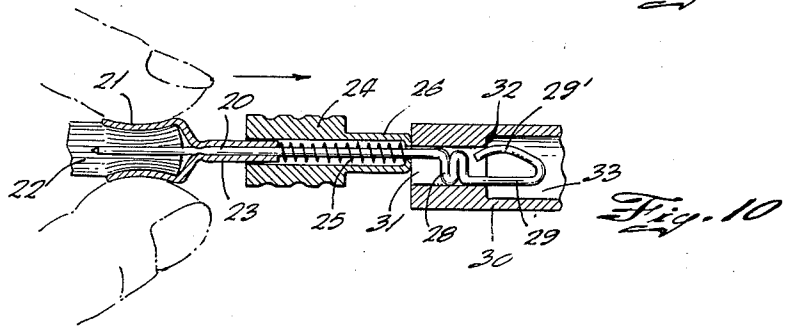
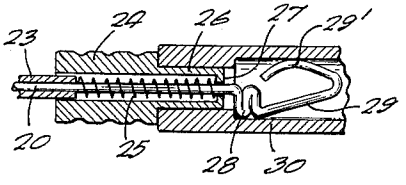


Fig. 10

Fig. 11



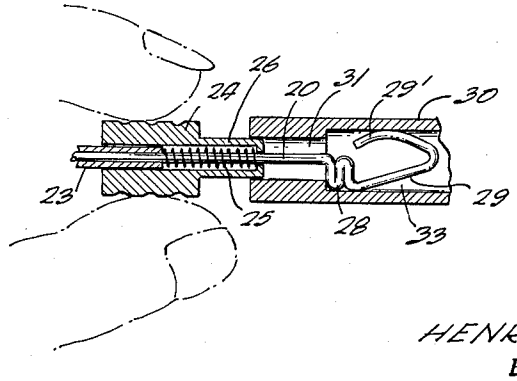


Fig. 12

INVENTOR.
HENRY J. MODREY
BY Frederick L. Hahn
ATTORNEY.

Oct. 25, 1955 H. J. MODREY 2,721,981

SLIDELESS SELF-LOCKING ELECTRICAL CONNECTOR

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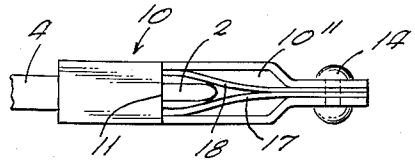


Fig. 6

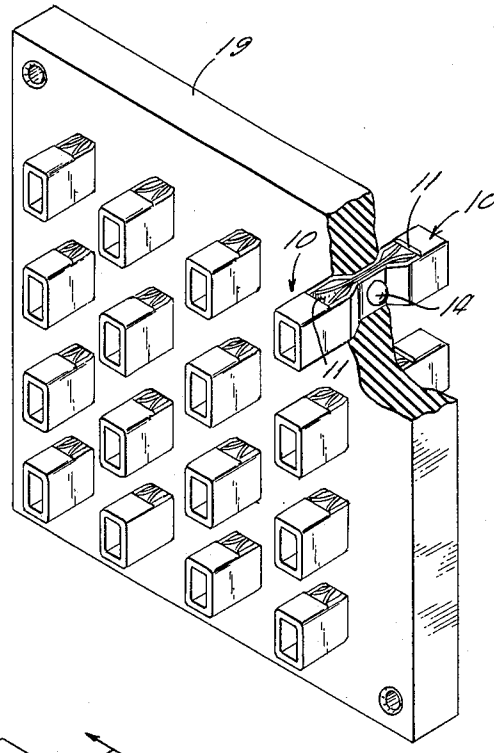


Fig. 7

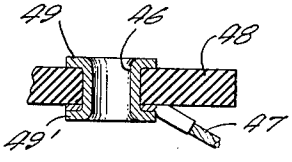


Fig. 14

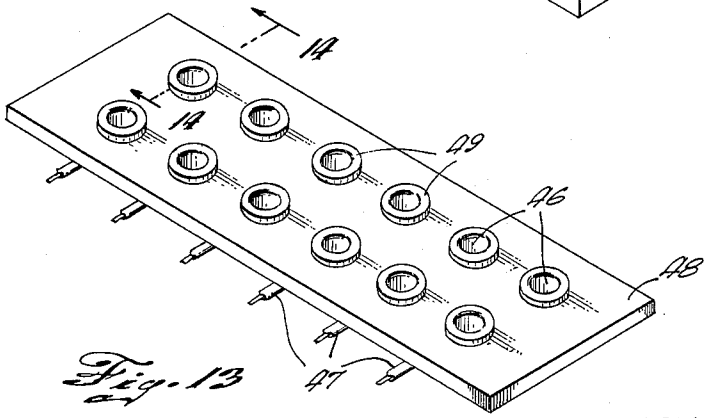


Fig. 13

INVENTOR.
HENRY J. MODREY
BY
Frederick E. Haas
ATTORNEY.

Oct. 25, 1955 H. J. MODREY 2,721,981

SLIDELESS SELF-LOCKING ELECTRICAL CONNECTOR

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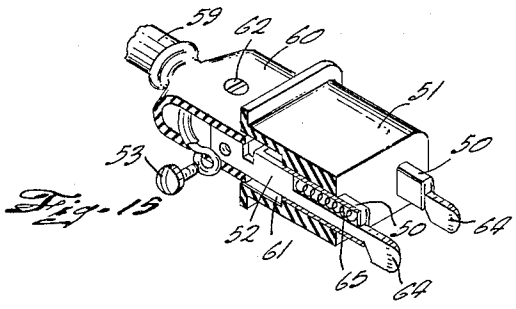


Fig. 15

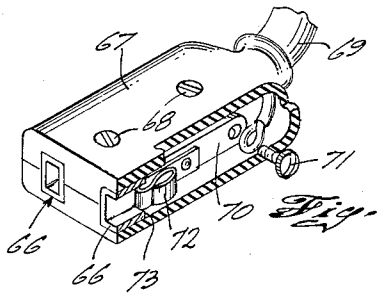


Fig. 17

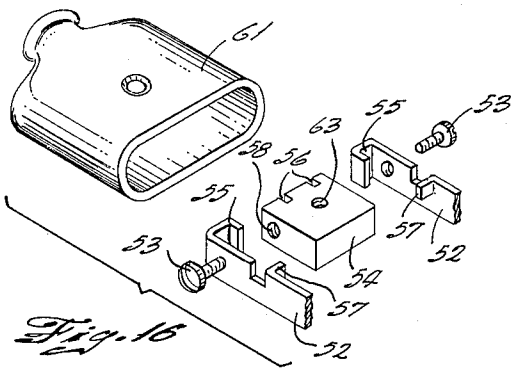


Fig. 16

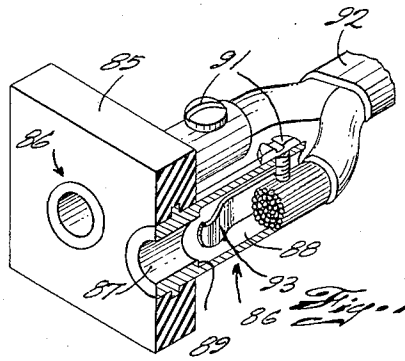


Fig. 19

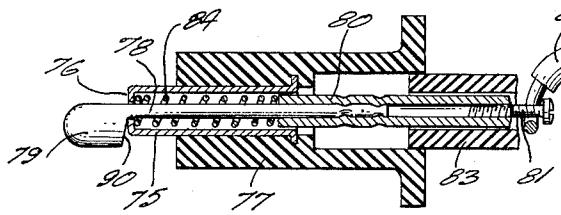


Fig. 18

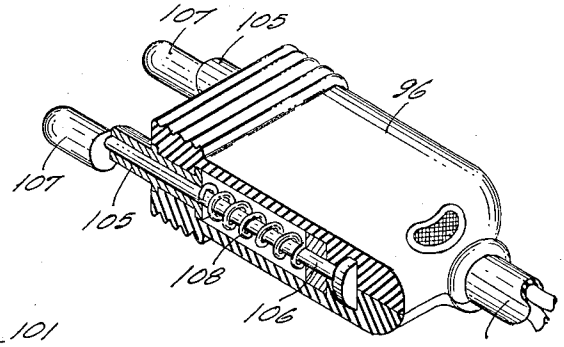


Fig. 21

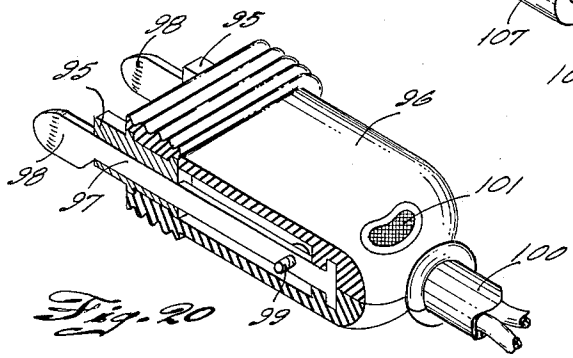


Fig. 20

INVENTOR.
HENRY J. MODREY
BY
Frederick E. Haas
ATTORNEY.

Oct. 25, 1955 H. J. MODREY 2,721,981

SLIDELESS SELF-LOCKING ELECTRICAL CONNECTOR

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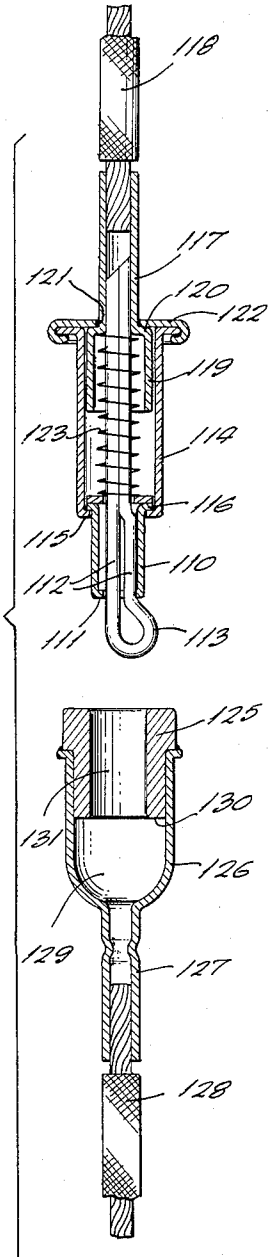


Fig. 22

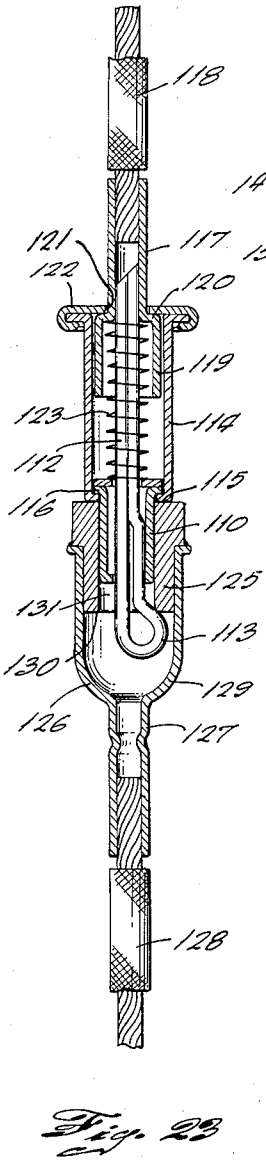


Fig. 23

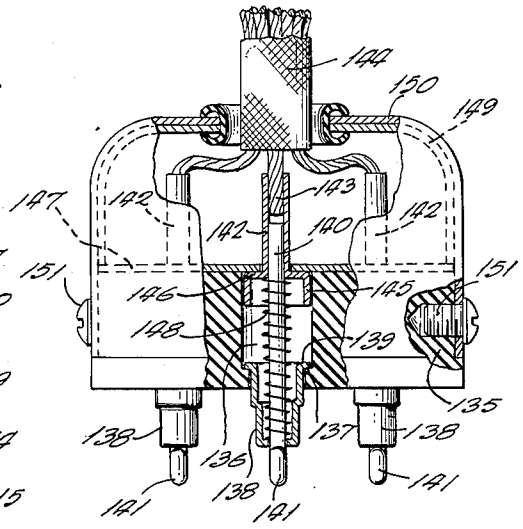


Fig. 24

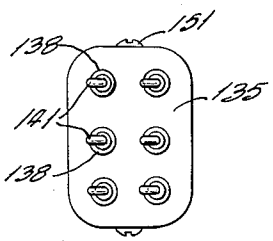


Fig. 25

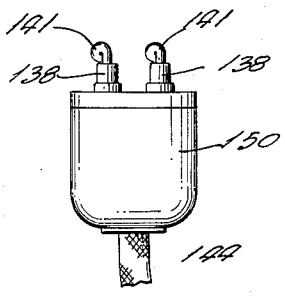


Fig 26

INVENTOR.
HENRY J. MODREY
BY Frederick L. Hamp
ATTORNEY.

United States Patent Office

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Patented Oct. 25, 1955

2,721,981

SLIDELESS SELF-LOCKING ELECTRICAL CONNECTOR

Henry J. Modrey, Mount Vernon, N. Y.

Application July 7, 1950, Serial No. 173,733

17 Claims. (Cl. 339—75)

This invention relates generally to self-locking connectors for detachably connecting two coupling members, and particularly to self-locking electrical connectors in which a locked conducting engagement between a plug and a socket is effected by insertion of the plug in the socket.

One object of the invention is to provide a plug, either of the flat-pin or the round-pin type and either of the single pole or multiple pole type, that may readily be locked in its socket so as to prevent an unintentional separation of the connector elements when pull is exerted upon the plug or the socket or upon the cord or cable connections to the plug and the socket respectively.

Another more specific object of the invention is to provide a novel and improved electrical connector of the general type, above referred to, in which the number of parts required for the locking mechanism is reduced by the elimination of a wedging slide generally used in self-locking connector designs, as hitherto known, thereby permitting a less expensive and simpler manufacture of the connector.

Another object of the invention is to provide electrical plugs and sockets with lower and more constant contact resistance at the current carrying elements and generally improved electrical contact properties by combining the contact making parts of the plug and the socket with a spring actuated self-locking mechanism effecting a highly desirable pressure contact, in addition to which the conventional frictional contact between the plug and socket contacts may be employed.

Another object of the invention is to provide a plug that locks itself automatically to its socket but only when fully inserted.

Another object of the invention is to provide an electrical connector which, when the plug and socket are locked by insertion, is vibration and shock proof and hence lends itself for use on aircraft, missiles, railway cars, automobiles, tanks, tractors, and other appliances that are subject to vibration and mechanical shock.

Other and further objects, features and advantages of the invention will be pointed out hereinafter and set forth in the appended claims forming part of the application.

In the accompanying drawings several now preferred embodiments of the invention are shown by way of illustration and not by way of limitation.

In the drawings:

Fig. 1 is a sectional view of a single pole plug and socket according to the invention.

Fig. 2 is a sectional view of the same plug and socket as shown in Fig. 1, turned about its axis through an angle of 90°.

Fig. 3 is a perspective, partly sectional view of the relative position of the plug and socket parts during insertion of the plug of Figs. 1 and 2 into the corresponding socket.

Fig. 4 is a perspective, partly sectional view similar to Fig. 3 showing the plug fully inserted and locked.

Fig. 5 is a perspective, partly sectional view showing

an intermediate relative position of the plug and socket parts during withdrawal of the plug from the socket.

Fig. 6 is a plan view of a modification of a socket according to the invention having spring means for securing tight contact and locking connection between plug and socket, an inserted plug being partly shown.

Fig. 7 is a perspective, partly sectional view of a multiple socket arrangement intended for instance for use as bulk-head connector for aircraft.

Fig. 8 is a side view of a modification of a plug and socket according to the invention in disengaged position.

Fig. 9 is a sectional view of the plug and socket according to Fig. 8.

Fig. 10 shows a plug according to Figs. 8 and 9, partly inserted in the corresponding socket.

Fig. 11 shows the plug fully inserted in the socket.

Fig. 12 shows the plug partly withdrawn from the socket.

Fig. 13 is a perspective view of a modification of a multiple socket arrangement according to the invention.

Fig. 14 is a sectional side view of an individual socket taken on line **14—14** of Fig. 13.

Fig. 15 is a perspective, partly sectional view of a twin pole, flat-pin plug according to the invention.

Fig. 16 is a perspective exploded view of the plug according to Fig. 15.

Fig. 17 is a perspective, partly sectional view of a socket according to the invention suitable for a plug as shown in Figs. 15 and 16.

Fig. 18 is a sectional view of a plug according to the invention having round-pin contacts.

Fig. 19 is a perspective, partly sectional view of a socket according to the invention suitable for a plug such as shown in Fig. 18.

Fig. 20 is a perspective, partly sectional view of a twin pole plug according to the invention having a flexible housing.

Fig. 21 is a perspective, partly sectional view of a modification of a plug of the type shown in Fig. 20.

Fig. 22 is a longitudinal sectional view of a single pole connector according to the invention with double action sleeve, the plug and socket being shown in disengaged position.

Fig. 23 shows the connector of Fig. 22 with the plug and the socket applied one to the other.

Fig. 24 is a partly sectional view of the plug member of a multiple pole connector according to the invention.

Fig. 25 is a bottom view of the plug member according to Fig. 24 on a reduced scale, and

Fig. 26 is an upside down side view of Fig. 24 on a reduced scale.

Referring first to Figs. 1 to 5 in detail, the plug of the connector according to these figures comprises a clamping rod **1** provided at its ends with a clamping head **2** and a terminal **3** respectively. Rod **1** is eccentrically and slidably disposed within a sleeve or housing **4**, the clamping head protruding from a slot **5** in the respective closed end of sleeve **4**. The rod is guided in its sliding action by the slot **5** and an opening **6** in the closed opposite end of sleeve **4**. A spring **7** which abuts against an inner end wall of sleeve **4** and a shoulder **8** of the clamping rod **1** respectively, is so biased that it urges clamping head **2** against the exterior of housing **4**. As can best be seen in Fig. 2, the clamping head **2** overhangs one-sidedly the peripheral contour of sleeve **4** and the total width of head **2** is preferably substantially equal to that of sleeve **4**.

The receiving socket or outlet, as shown in Figs. 1 and 2, comprises a metal sleeve generally designated by **10**. This sleeve has an outer portion **10'** positively guid-

ing sleeve 4 and an inner portion 10''. Sleeve portion 10' constitutes part of the locking mechanism of the connector and serves releasably to retain the clamping head 2, as will be more fully explained hereinafter, while portion 10'' serves as a terminal member shown in form of an attachment lug or tag for a conductor to be connected to the socket but does not participate in the locking operation. As can be seen in Figs. 1 to 5, sleeve portion 10'' may be laterally open or it may be laterally closed in which latter case its inner cross-section must be sufficiently enlarged to accommodate the overhanging portion of clamping head 2. A contact spring 13 within portion 10'' is connected by suitable means such as soldering or a rivet 14 to a cable 15 which rivet also serves to fasten spring 13 to portion 10''. However, spring 13 may also be omitted, cable 15 being connected directly to portion 10''. Similarly, terminal 3 of the plug is connected to a cable 15'.

Fig. 3 shows the clamping head 2 in a position in which it has partly penetrated through portion 10'' of sleeve 10. The clamping head 2 is pushed into the sleeve by exerting axial pressure upon clamping rod 1. As the clamping head overhangs sleeve 4 one-sidedly, the forward end of sleeve 4 cannot enter sleeve portion 10' as yet but abuts against and is arrested by the front edge of sleeve portion 10'. At this stage of insertion, the position of the plug is asymmetrical with regards to the longitudinal axis of sleeve 10. Sleeve 4 remains in its abutting position while and when the clamping rod 1 with its enlarged clamping head 2 is pushed deeper into sleeve 10. During the aforesaid forward movement of rod 1, spring 7 is being compressed to a considerable degree. When the clamping head 2 has traversed the full length of outer portion 10' of sleeve 10, it slides over the edge 11 forming the boundary between outer portion 10' and the attachment portion 10'' and thus transposes the plug into a position in which sleeve 4 can enter the outer portion 10' of sleeve 10, as is shown in Fig. 4. Spring 7 which is now released snaps the clamping head into the position shown in Fig. 4 in which the clamping lip 12 of the head abuts against edge 11. A collar 9 on sleeve 4 serves to limit the depth of insertion of sleeve 4 into the receiving opening of the socket. As can best be seen on Fig. 4, the depth of an insertion of sleeve 4 is so selected that the clamping head is held by edge 11 in a position in which the head is slightly projected relative to sleeve 4. As a result, spring 7 remains loaded and presses the clamping head or more specifically lip 12 thereof against edge 11. This has the advantage that the contact between the clamping head and sleeve portion 10' is a pressure contact.

It will be apparent from the previous description that it is not necessary to make the entire sleeve 10 out of metal but that it is sufficient when the wall portion of the sleeve forming edge 12 is made electrically conducting and connected to cable 15.

The plug is now perfectly locked and secured against accidental removal by reason of vibration or pull on either cable. The outer portion 10' of sleeve 10 is substantially completely filled by sleeve 4. This sleeve, in turn, constitutes a firm longitudinal guide which secures clamping rod 1 in its position relative to the longitudinal axes of sleeves 4 and 10 so that the overhanging portion of the clamping head 2 locks the plug in current-carrying position. As will be noted, the plug is deeply lodged in its socket, thereby preventing any wobbling of the plug.

The electrical contact thus established between the plug and the socket is primarily through the spring-loaded knife-edge contact between clamping lip 12 of the clamping head 2 and edge 11 of sleeve portion 10'. The quality of this contact as to constancy and resistance value is directly dependent upon the action of the plug operating spring 7 and is not subject to fatigue which is often a cause for contact failure with conventional leaf springs. If a spring 13 is provided, contact is also established between this spring and the clamping head. There is, of course, also contact between sleeve 4 and sleeve portion 10' but this may be of doubtful quality as sleeve 4 is or may be only in slight sliding engagement with the component parts of both plug and socket. Contact of this type may be disregarded in precision connectors according to the invention as the outstanding electrical characteristic of such connectors is establishment of a knife-edge contact of a very high electrical order.

Removal of the plug is effected by axial pull in the direction of the arrow on sleeve 4 which may have a collar or rim 16 for this purpose. While sleeve 4 is withdrawn and until it clears the outer edge of sleeve portion 10', the clamping head 2 is retained by edge 11 so that the operating spring 7 inside the housing is again compressed. As soon as sleeve 4 clears the socket sleeve portion 10', the clamping head 2 is guided by means of its clamping lip 12 into a symmetrical position in which it is snapped back from the socket into the position of Fig. 2 by the now released operating spring 7. Hence, the actual process of breaking contact at edge 11 and spring 13, if any, takes place under spring tension and with considerable celerity thus avoiding the development of a breaking arc. Such action is equivalent to that customarily applied to switches in which a spring is loaded until it rapidly disrupts the contact connection.

The previously described actions of insertion and removal of the plug from its socket are fully automatic and the required variation in operation is achieved by gripping, for insertion, the terminal end 3 of the plug or rod 1 directly and, for removal, sleeve 4 or collar 16 of the plug. It may be mentioned that the plug can be inserted or removed also by holding it at sleeve 4 and depressing the terminal 3 in a piston or syringe-like manner until the clamping head 2 protrudes so far that the plug can be "wriggled" into and out of socket sleeve portion 10'.

Fig. 6 shows a socket with a plug inserted therein. The plug may be visualized as being of the design described in connection with Figs. 1 to 5 inclusive though without collar 9. As was pointed out, this collar serves to limit the depth of insertion of sleeve 4 to a position in which the clamping head is retained in a projected position and spring 7 is loaded for the purpose of attaining a pressure contact at edge 11. This function of the collar is performed with a socekt according to Fig. 6 by a pair of contact springs 17 and 18. The two contact springs are joined together at one end by rivet 14 to form the two prongs of a fork. If now clamping head 2 is passed through the outer portion of sleeve 10 and penetrates between the two prongs of the fork forcing the same apart, the action of the contact springs which tend to return into their original relative position will bias the clamping head outwardly. Hence, the lip 12 of the head will be pressed against edge 11 of the socket thereby attaining the desired pressure contact.

Fig. 7 shows a socket arrangement that is particularly useful as a bulk-head connector for aircraft. A plurality of sockets of the type shown in Fig. 6 are duplicated to form twin structures. These twin sockets are embedded in an insulation plate 19. As is clearly shown on the figure, one half of each individual socket protrudes from each side of the plate so that the corresponding plugs can be inserted from either side. The entire structure is pressure proof from one side to the other and affords convenient multiple electrical connections between the two sides of a bulkhead.

It will be apparent that the same principle can be applied also to other socket designs hereinbefore or hereinafter described.

Figs. 8 to 12 show another modification of the invention based on the principle of eccentric locking as hereinbefore described. The design of Figs. 8 to 12 is especially suitable for plug and socket connectors of small size and current-carrying capacity and is further useful

where round section socket outlets of a very simple type are desirable.

A clamping rod **20** is formed from wire and disposed in a flattened terminal cup **21** which permits the exposed part of a cable **22** to be trimmed or soldered in contact with the terminal end of clamping rod **20**. Terminal cup **21** is extended to form a cylindrical sleeve **23** adapted to slide inside a corresponding opening of a plug housing or sleeve **24**. Sleeve **23** also serves as an abutment for one end of an operating spring **25**. The outside of the plug sleeve **24** is preferably provided with convenient gripping ridges. Plug sleeve **24** has a smooth cylindrical front portion **26** of smaller diameter closed at the end by a wall member **27** having a hole therethrough permitting passage of clamping rod **20**. The operating spring **25** surrounding clamping rod **20** abuts at its opposite end against the inside of wall member **27**.

Clamping rod **20**, at its end protruding from sleeve **24**, ends in a clamping head shown as an eccentric hook-shaped enlargement **28** which overhangs one-sidedly the circumference of sleeve portion **26** and is preferably substantially equal in width to said portion. The clamping head **28** at its extreme outer end may be extended and bent to form an open loop **29** curved inwardly at its tip **29'**. The width of the loop exceeds the outer diameter of sleeve portion **26**. As will be apparent, the enlarged clamping head conjointly formed by parts **29** and **29'** corresponds to clamping head **2** of Figs. 1–5.

The corresponding socket is generally designated by **30**. It comprises a metal sleeve **31** the diameter of which permits passage of the front portion **26** of plug sleeve **24** and which positively guides the said sleeve portion. Sleeve **31** is extended via a sharp inner ridge **32** by a sleeve **33** the inner diameter of which is slightly wider than the diameter of front sleeve **31**. A cable **34** is connected to socket **30** by crimping the recessed portion **35** of sleeve **33** over the exposed end portion of the cable. As will appear more fully in the subsequent description, the front sleeve portion **31** constitutes part of the locking mechanism of the connector and serves releasably to retain the clamping head of the plug, it corresponds to sleeve portion **10'** of Fig. 1. The inner sleeve portion **33** with its recessed part **35** corresponds to sleeve portion **10''** of Fig. 1 and constitutes a terminal member shown in form of an attachment lug or tag for connecting a conductor to the socket but does not participate in the locking operation. Accordingly, sleeve portion **33**, **35** may take any shape suitable to fulfill its purpose as a terminal member for a conductor (see for instance the tag shown in Figs. 1 and 2).

Figs. 10 to 12 show insertion and withdrawal of the plug, in positions similar to Figs. 3–5. The plug is inserted by pushing the same in the direction indicated by an arrow while holding the plug at its terminal end **21**. While the clamping head **28** with loop **29** is sliding through and fills more or less the front sleeve **31** of socket **30**, sleeve portion **26** is forced into an asymmetrical position and its front wall **27** consequently abuts against the face of sleeve **31**, thereby causing compression of spring **25** (Fig. 10). When the clamping head has passed the narrow front sleeve **31**, sleeve portion **26** is free to enter the front sleeve **31** and is rapidly forced into it by the expansion of the now released spring **25**.

During passage through the narrow front sleeve **31**, the front loop **29** is also compressed somewhat in the manner of a safety pin. The front loop **29** is opening up again in the wider sleeve **33** thereby touching the inner walls of the said sleeve thus establishing a supplemental frictional contact between the clamping rod **20** and the socket **30**, in addition to the primary contact between the eccentric clamping head **28**, **29** and the inside ridge **32** between front sleeve **31** and sleeve **33**. This primary and main contact is an edge contact and under pressure by the operating spring **25** which urges the eccentric head **28**, **29** backwards and thus into firm engagement with the ridge **32** which forms in effect the inner end of the locking sleeve **31**. Again, the frictional contact between the sleeve portion **26** and the front sleeve **31** may be considered as less important for a high grade electrical connector.

In the position shown in Fig. 11 the plug is locked in conducting engagement with the socket outlet and is secured against pull at cables **22** and **34** and vibration. As will be noted, the ridge or shoulder between sleeve portions **24** and **26** is in effect similar to collar **9** and limits the depth of insertion of the plug so that hook **28** abuts under spring-loaded tension against shoulder or ridge **32**. At the same time, the plug is so deeply inserted in the socket that it is fully steadied.

The plug can be removed by pull at the plug sleeve **24** against the action of spring **25**. Such pull lifts the front portion **26** of sleeve **24** out of the front sleeve **31** thus recompressing spring **25** until sleeve portion **26** clears front sleeve **31** so that now the eccentric hook **29** may re-enter the front sleeve **31**. Guided by the bent-off portion **29'** of loop **29**, the loop upon removal of the plug will enter the narrower front sleeve **31** and, by the wedging action of the wall of bore **31** against loop portion **29'**, compress the front loop **29** during passage through front sleeve **31**.

It will be noted that in this simplified design the front loop **29** takes over some of the functions which in Figs. 1–5 are assigned to the separate socket spring. Hence, principle and operation of the connector designs are essentially identical.

Figs. 13 and 14 show an exemplification of a multiple terminal strip with a plurality of sockets according to the invention. Each socket comprises a round eyelet **46** made of electrically conducting material and connected to a wire **47**. These eyelets may be said to represent the most basic exemplification of a locking sleeve according to the invention. The eyelets are inserted in a strip **48** made of insulation material. Plugs with round poles such as shown in Figs. 8 to 12 or in Fig. 22 hereinafter described may be inserted in the eyelets from either side. It will be apparent from the previous description that either of the flanges **49** and **49'** of each eyelet corresponds in function to the edge **32** of Figs. 8 to 12, depending upon from which side a plug is inserted. Let it be assumed that the plug is inserted from the top side of Fig. 14, then the overhanging portion of the clamping head **28** will abut against flange **49'**. It will further be apparent that the cross-sectional area of the eyelet hole should be so selected that it is capable of positively guiding the front portion of sleeve **26** and that the axial depth of the eyelet should be so that when the ridge of sleeve portion **24** abuts against flange **49**, the clamping head is held by flange **49'** in a projected position relative to sleeve portion **26** in which spring **25** is loaded for the purpose of attaining the desired pressure contact.

The twin-pole plug according to Figs. 15 and 16 embodies essentially two plugs of the type shown in Figs. 1–5. The plug comprises two sleeves **50** rigidly fitted in an outer insulation housing **51**. Each of said sleeves slidably guides a clamping rod **52** having on one end a one-sidedly overhanging clamping head **64** biased by a spring **65** toward and against the face of the respective sleeve **50**. Each rod is connected to a screw terminal **53**. The rods are joined together by an insulation center block **54** to which they are secured by a flange **55** engaging corresponding grooves **56** in one end of block **54** while noses **57** abut against the opposite end of insulation block **54**. The terminal ends of the clamping rods **52** are further secured against displacement by the terminal screws **53** threaded into corresponding holes **58** in block **54**. After the wires of a cable **59** are connected to terminal screws **53**, an insulation cap **60** is pushed over the terminal assembly and telescoped into the oval bore **61** of outer housing **51**. Cap **60** is secured to insu-

lation center block 54 by a screw 62 threaded into a hole 63 in center block 54.

The assembly, as described, shows both plug sleeves 50 protruding from the face of insulation housing 51 and cap 60, though slidable within housing 51, firmly connected to the wiring terminals of both the clamping rods. Hence, a push against cap 60 is equivalent to a push against the terminal end of the clamping rods as explained with reference to Figs. 1–5 and a pull on housing 51 is equivalent to a pull on the plug sleeves 50 as housing 51 and cap 60 do not only form an insulating cover but also the necessary mechanical connection between the operating parts of the plug.

Fig. 17 shows a socket designed to cooperate with a plug as shown in Figs. 15 and 16. Two socket sleeves 66 similar to sleeves 10 are inserted in an insulation housing 67 composed of two identical halves secured one to the other by screws 68. The wires of a cable 69 are connected to contact strips 70 extending from sleeves 66 by terminal screws 71. There may also be provided contact springs or tongues 72. The contact springs are shown as S-shaped with the lower loop open towards the receiving end of the socket. These open S-loops are somewhat shorter than the axial length of clamping heads 64 so that when the clamping heads are pushed into the opening of the S, the spring contacts are slightly uncurled. The S-contacts, therefore, result in frictional contact on both sides of the clamping heads 64 and through their tendency to return into the original S-shape exert pressure upon the tapered tips of the clamping heads 64. The axial length of the protruding portion of sleeves 50 is so selected that when the plug of Fig. 15 is applied to the socket of Fig. 17 and the face of housing 51 abuts against the face of housing 67, the clamping heads 64 are held by ridges or shoulders 73 of sleeves 66 in a position in which the clamping heads are projected relative to sleeves 50 and springs 65 are loaded thereby effecting a pressure contact as is described in connection with Figs. 1 to 5.

Fig. 18 shows a twin pole plug with round pins. However, it should be understood that the design according to this figure can also be applied to flat pin plugs. According to Fig. 18, an inner sleeve 75 closed at one end by a wall member 76 having an opening therethrough is fixedly inserted in an outer insulation sleeve or housing 77, the portion of the sleeve 75 protruding from the housing or sleeve 77 determining the depth of insertion of the sleeve in the receiving opening of a corresponding socket. An electrically conducting clamping rod 78 is slidably guided in the sleeve 75. The end of the clamping rod extending through said opening forms a clamping head 79 one-sidedly overhanging the circumference of sleeve 75. The other end of the clamping rod supports a metal sleeve 80 crimped to the clamping rod and telescoped into sleeve 75. A terminal screw 81 is threaded in the outer end of sleeve 80 and serves to connect a wire 82 to the clamping rod. Sleeve 80 and with it the clamping rod are insulated by a grip in form of an insulation cap 83 seated on sleeve 80 and telescoped into an axial bore of sleeve or housing 77. A spring 84 abutting at one end against wall 76 and at the other end against sleeve 80 fixed to the clamping rod serves to bias the clamping head toward and against the exterior wall 76.

The plug according to Fig. 18 can be applied to a socket of the type shown on Fig. 19.

This socket is shown as comprising an insulation plate 85 in which two metal sleeves 86 are fixedly inserted. Each of these sleeves has an outer bore 87 and a somewhat wider inner bore 88. A sharp edge or ridge 89 between the two bores of each sleeve 86 again serves as an abutment for a clamping lip 90 of clamping head 79. Terminal screws 91 connect the exposed portions of the wires of a cable 92 to the respective sleeve 86.

As will be apparent from the previous description, the plug of Fig. 18 is applied to the socket of Fig. 19 by gripping cap 83 and inserting first clamping head 79 and subsequently the protruding portion of sleeve 75 in bore 87. When the plug is fully inserted, each lip 90 abuts against the respective edge 89 and each wall 76 against the face of the respective sleeve 86. The clamping head is now slightly projected so that spring 84 remains loaded thereby attaining the desired pressure contact and the protruding portion of sleeve 75 is positively guided in bore 87. For the purpose of detaching the plug, housing 77 is pulled back until sleeve 75 clears bore 87 so that the clamping head can slip into bore 87 and be withdrawn.

In addition to the edge contact provided by the clamping head and edge 89, contact may be provided by a contact spring 93 secured within bore 88.

Fig. 20 shows a twin pull plug with flat pins comprising two metal inner sleeves 95 fixedly inserted in an outer flexible insulation sleeve or housing 96. A clamping rod 97 is slidably guided in each of sleeves 95 and one end of each clamping rod again supports a clamping head 98 one-sidedly overhanging the periphery of the respective sleeve 95. The other end of each clamping rod is secured to outer sleeve or housing 96 and connected by means of a terminal screw 99 to the respective wire of a cable 100.

As will be apparent from the previous description, an axial compression of outer sleeve or housing 96 which may be facilitated by providing a grip 101 is equivalent to an axial pressure exerted upon cap 83 of Fig. 18 or cap 3 of Fig. 1. As will be noted, with the design according to Fig. 20 the flexibility of sleeve or housing 96 permits to eliminate the spring of the previous designs.

Fig. 21 shows a plug very similar to the plug of Fig. 20 though designed as a twin pole plug with round pins. The plug again comprises two inner sleeves 105 fixedly inserted in an outer flexible insulation sleeve or housing 96. A clamping rod 106 is slidably guided in each sleeve 105. Each clamping rod supports on one end a clamping head 107 one-sidedly overhanging the circumference of the respective sleeve 105 and is secured at the other end to sleeve or housing 96. The biasing action of sleeve or housing 96 upon the clamping rods is supplemented by a spring 108.

Plugs of the type shown on Figs. 20 and 21 may be applied to sockets such as shown on Figs. 17 and 19. The operation of the plugs will be obvious from the previous description. It will further be obvious that the plug according to Fig. 20 may be provided with a spring and that the spring of the plug according to Fig. 21 may be omitted.

Figs. 22 and 23 show a connector with similar locking mechanism as previously described though the operation of the plug is somewhat different.

The plug of the connector according to Figs. 22 and 23 comprises a cup-shaped guide member 110 having an opening 111 in its closed end. Cup 110 slidably guides a clamping rod 112 having on one end a protruding clamping head 113 one-sidedly overhanging the circumference of cup 110. The clamping rod and the clamping head are shown as being formed by bent-off wire. However, it should be noted that a solid clamping head as previously described may be employed and that the clamping head in this design as also in the previous designs may have any desired cross-section. It is only essential that it overhangs the respective guide member. Cup 110 is slidably guided in a control member shown as sleeve 114. For this purpose, sleeve 114 has an inwardly extending flange 115 engageable with an outwardly extending flange 116 of cup 110. As a result, a one-way coupling is formed between sleeve 114 and cup 110 permitting relative movement of the cup and the sleeve upon movement of the sleeve in one direction (downwardly in the drawing) and coupling sleeve 114 with cup 110 upon movement of the sleeve in opposite

direction (upwardly in the drawing). The upper end of rod 112 supports a metal sleeve 117 fixed to the clamping rod by any suitable means such as crimping. Sleeve 117 and hence the clamping rod are electrically connected with a wire 118. As will be noted, sleeve 117 has an enlarged portion 119 slidably guided in sleeve 114 and forming a shoulder 120. The narrower portion of sleeve 117 is slidably extended through an opening 121 in a plate 122 secured to the open end of sleeve 114 or integral therewith.

As will be noted, shoulder 120 and plate 122 form a second one-way coupling permitting relative movement of sleeve 114 and the clamping rod upon movement of the sleeve in one direction (upwardly in the drawing) and coupling the sleeve with the clamping rod upon movement of sleeve 114 in opposite direction (downwardly in the drawing). In other words, the two one-way couplings are operative in opposite directions. A spring 123 biases clamping head 113 toward and against cup 110.

The socket of the connector comprises a metal sleeve 125 fixedly inserted in a metal cap 126 which is extended by a sleeve 127 within which is fixed a wire 128.

As will be noted, cap 126 provides a space 129 sufficient to accommodate clamping head 113 and the lower edge 130 of sleeve 125 serves as an abutment for the overhanging portion of the clamping head as will be more fully explained hereinafter.

The operation of a plug according to Figs. 22 and 23 is as follows:

When it is desired to apply the plug to the socket, the operator grips sleeve 114 and inserts clamping head 113 in axial bore 131 of sleeve 125. After clamping head has penetrated bore 131 to a certain extent the face of cup 110 engages the face of sleeve 125. However, the cup cannot enter bore 131 as yet since the clamping head forces cup 110 into an eccentric position relative to the bore. As the clamping head is pressed deeper into the bore, the one-way coupling formed by flanges 115 and 116 causes cup 110 to be telescoped into sleeve 114 while the second one-way coupling formed by shoulder 120 and plate 122 prevents a relative movement of sleeve 114 and clamping rod 112. Consequently, the clamping head is projected relative to cup 110 and can further penetrate into bore 131 until finally the overhanging portion of the clamping head reaches the position shown on Fig. 23. As a result, cup 110 moves into a centric position relative to bore 131 and is snapped by the action of spring 123, which has been compressed by and during the projection of the clamping head, into bore 131 of sleeve 114 and into the position shown on Fig. 23. As will be noted on this figure, the axial length of cup 110 and the axial depth of bore 131 are so selected relative to each other that the clamping head is held by abutment 130 in a position projected relative to cup 110. As a result, spring 123 remains loaded thereby attaining the desired pressure contact between the clamping head and abutment 130.

When it is desired to detach the plug from the socket, the operator pulls sleeve 114 upwardly (as seen in the drawing). As a result, cup 110 is pulled out of bore 131, flanges 115 and 116 being now in coupling engagement and shoulder 120 and plate 122 permitting a relative movement of sleeve 114 and the clamping rod. As soon as cup 110 clears bore 131, the clamping head can move back into bore 131 and be withdrawn from the bore.

As will appear from the previous description, sleeve 114 serves to effect both the connecting and the disconnecting operation, whereas with the previously described exemplifications of the invention the clamping rod or a part secured thereto is gripped for purpose of connection and the sleeve of the plug for purpose of disconnection.

Figs. 24 to 26 show a multiple plug arrangement similar in principle to the design of Figs. 22 and 23. The plug arrangement according to Figs. 24 to 26 comprises an insulation block 135 having therethrough as many bores 136 as plug poles are desired, six plug poles being shown. Each bore 136 forms a shoulder 137 which corresponds in function to shoulder 115. A cup 138 is slidably inserted in each bore. Each cup has an outwardly extending shoulder 139 corresponding in function to shoulder 116. A clamping rod 140 having a one-sidedly overhanging clamping head 141 is slidably guided in each cup 138. The clamping heads protrude through an opening in the closed end of the cups 138. The upper end of each clamping rod protrudes from insulation block 135 and supports a sleeve 142 secured to the respective clamping rod. Sleeves 142 serve to connect respective wires 143 of a cable 144. Each sleeve 142 has an enlarged portion 145 forming a shoulder 146 corresponding in function to shoulder 120 and coacting with a plate 147. This plate is common to all sleeves 142 and has six openings for sleeves 142 and corresponds in function to plate 122. A spring 148 in each bore biases the respective cup 138 against the overhanging portion of the respective clamping head. Plate 147 is held in position by a bail 149 which in turn is held by a hood 150 covering the entire assembly and secured to insulation block 135 by screws 151.

The plug arrangement according to Figs. 24 to 26 inclusive is designed to be applied to a multiple socket arrangement based upon the same principle as the previously described single pole or twin pole sockets.

It will be evident from the previous description that insulation block 135 with its hood 150 correspond in function to double-action sleeve 114 and that the plug arrangement is applied to the socket unit by pressing the hood against the socket arrangement and that it is detached from the socket arrangement by gripping the hood and pulling the same away from the socket arrangement.

Finally, it should be mentioned that the plug arrangement according to Figs. 24 to 26 can be designed for round pins, flat pins or any other cross-sectional design of the pins.

While the invention has been described in detail with respect to certain preferred examples and embodiments it will be understood by those skilled in the art after understanding the invention that various changes and modifications may be made without departing from the spirit and scope of the invention, and it is intended therefore, in the appended claims, to cover all such changes and modifications.

What is claimed as new and desired to be secured by Letters Patent is:

1. In a self-locking electrical connector for detachably connecting two conductors, in combination a plug member comprising an elongated guide member having an opening therein, an electrically conductive clamping rod guided axially slidable within said guide member and adapted to be electrically connected to one of said conductors, said rod having on one end an axially elongated clamping head protruding from the opening of said guide member and one-sidedly overhanging the peripheral cross-section thereof, and yieldable means coacting with the rod so as to bias the head thereof toward the guide member and to permit projection of the clamping head relative to the guide member against the action of the yieldable means; and a socket member comprising an electrically conductive sleeve member adapted to be electrically connected with the other conductor, the peripheral outline of said elongated clamping head and of said guide member respectively, each substantially conforming to the inner configuration of said sleeve member so as to provide for an axially guided passage of the clamping head through said sleeve member and an axial guidance of the guide member within the sleeve member upon application of the plug member to one end of the sleeve member, the opposite end of said sleeve member forming an abutment for the overhanging portion of the clamping head upon complete passage of the latter through said sleeve member and subsequent insertion of the guide member in the said sleeve member thereby latching the plug member to the socket member in axial alignment therewith when

pressure applied to the yieldable means for projection of the clamping head is released and the latter is abutting against said abutment.

2. An electrical connector according to claim 1, comprising a terminal member on said sleeve member for connecting the same with the other one of the two conductors to be detachably connected.

3. In a self-locking electrical connector for detachably connecting two conductors, in combination a plug member comprising an elongated electrically conductive guide member having an opening therein, an electrically conducting clamping rod guided axially slidable within said guide member and adapted to be electrically connected to one of said conductors, said rod having on one end an axially elongated clamping head protruding from the opening of said guide member and one-sidedly overhanging the peripheral cross-section thereof, and yieldable means coacting with the rod so as to bias the head thereof toward the guide member and to permit projection of the clamping head relative to the guide member against the action of the yieldable means; and a socket member comprising an electrically conductive sleeve member, the peripheral outline of said elongated clamping head and of said guide member respectively each substantially conforming to the inner configuration of said sleeve member so as to provide for an axially guided passage of the clamping head through said sleeve member and an axial guidance of the guide member within the sleeve member upon application of the plug member to one end of the sleeve member, the said sleeve member being adapted to be electrically connected with the other conductor, the opposite end of the sleeve member forming an abutment for the overhanging portion of the clamping head upon complete passage thereof through said sleeve member and subsequent insertion of the guide member in the said sleeve member, thereby latching the plug member to the socket member in axial alignment therewith when pressure applied to the yieldable means for projection of the clamping head is released and the latter is abutting against said abutment; and limit means included in one of said connector members and coacting with the other connector member so as to cause the clamping rod to be biased into a position in which the clamping head thereof is pressed against said abutment when the two connector members are applied one to the other thereby effecting a pressure contact between said clamping head and said sleeve member of the socket member.

4. A self-locking electrical connector according to claim 3, where in the said limit means are disposed on the guide member and are engageable with the sleeve member so as to limit the depth of insertion of said guide member in the sleeve member to a position in which the clamping head is retained by said abutment in a projected position relative to the guide member and in which position said yieldable means are loaded thereby effecting a pressure contact between said clamping head and said abutment and between the guide member and the sleeve member.

5. An electrical connector as defined in claim 3 wherein said limit means comprise a shoulder on the guide member engageable with the receiving end of the sleeve member of the socket member, thereby limiting the depth of insertion of the guide member in the said sleeve member, the axial length of the guide member portion between said shoulder and the end of the guide member from which the clamping head protrudes being shorter than the axial depth of the socket sleeve member, thereby retaining an inserted clamping head in the said pressure contact effecting position.

6. An electrical connector as described in claim 3, wherein said limit means comprise a pair of flexible contacts mounted on the socket member spaced apart to receive the clamping head thereinbetween and positioned to bias said clamping head, when inserted in said receiving opening, against said abutment.

7. An electrical connector as described in claim 6, wherein said flexible contacts are joined at their ends distal to the receiving end of the sleeve member of the socket member and biased to form a fork having prongs arranged and positioned to receive the clamping head thereinbetween.

8. In a self-locking electrical connector for detachably connecting two conductors, in combination a plug comprising an electrically conductive guide sleeve, an electrically conducting clamping rod disposed slidably within said sleeve and having an axially elongated clamping head on one end protruding from the sleeve and one-sidedly overhanging the peripheral outline of the sleeve, said rod being adapted to be electrically connected with one of said conductors, yieldable means coacting with the rod so as to bias the clamping head thereof toward said sleeve; and a socket comprising an electrically conductive sleeve including a narrow portion and a wide portion, said narrow sleeve portion forming the receiving member of the socket and having an inner configuration corresponding to the outer configuration of the clamping head and the guide sleeve respectively so as to provide for an axially guided passage of the clamping head through said narrow sleeve portion and for axial guidance of the guide sleeve when inserted in said narrow sleeve portion, said wide sleeve portion being shaped to accommodate the overhanging portion of the clamping head, the wall portion of the socket sleeve forming the boundary between said narrow and said wide sleeve portion providing an abutment for the overhanging portion of the clamping head upon complete passage thereof through said narrow sleeve portion and subsequent insertion of the guide sleeve in the said sleeve portion, the said wide sleeve portion forming a terminal member adapted to be electrically connected with the other conductor, whereby, upon projection of the clamping head relative to the guide sleeve by application of pressure to the yieldable means and passage of the clamping head thus projected through the narrow sleeve portion and subsequent insertion of the guide sleeve in the narrow sleeve portion, the plug is locking to the socket in axial alignment therewith upon release of the yieldable means, said guide sleeve having limit means thereon engageable with the narrow sleeve portion for limiting the depth of insertion of said guide sleeve in said narrow portion of the socket sleeve to a position in which the clamping head is retained by the abutment in a projected position relative to said guide sleeve in which position said yieldable means are loaded for effecting a pressure contact between the clamping head and said abutment, and between the guide sleeve and the adjacent end of the narrow portion of the socket sleeve.

9. An electrical connector as described in claim 8, wherein said limit means comprise a shoulder on the outside wall of the guide sleeve engageable with the receiving end of the narrow portion of the socket sleeve thereby limiting the depth of insertion of the guide sleeve, and wherein the axial length of the guide sleeve between said shoulder and the end of the said sleeve from which the clamping head protrudes is shorter than the axial depth of said narrow portion of the socket sleeve thereby retaining an inserted clamping head in said projected relative position in which the yieldable means are loaded for effecting the said pressure contact between the clamping head and said abutment and between the guide sleeve and the receiving end of the narrow portion of the socket sleeve.

10. An electrical connector as described in claim 8, wherein yieldable contact means are disposed within said wide portion of the socket sleeve and positioned to be engaged by the clamping head when inserted in the said opening and abutting against said abutment, said contact means being adapted to be electrically connected with the respective conductor.

11. In a self-locking electrical connector in combina-

tion a plug and a socket for detachably connecting two conductors, said plug comprising an elongated guide member having an opening therein, an electrically conducting clamping rod slidably guided in said guide member and adapted to be electrically connected with one of said conductors, said rod having on one end an axially elongated clamping head protruding from said opening and one-sidedly overhanging the peripheral outline of the guide member, yieldable means coacting with the clamping rod so as to bias the clamping head toward said guide member and to permit projection of the clamping head relative to the guide member against the action of the yieldable means, and control means for effecting connection and disconnection of the plug and the socket, said control means comprising a control member in which said guide member is slidably disposed with the clamping rod extending into the control member, first coupling means for coupling the control member with the guide member, and second coupling means for coupling the control member with the clamping rod, said coupling means being arranged to be effective for coupling action in opposite directions so as to provide for displacement of the guide member relative to the control member and the clamping head in response to a control member movement in one direction and for displacement of the guide member conjointly with the control member relative to the clamping head in response to a control member movement in opposite direction; and said socket comprising an electrically conductive sleeve member adapted to be connected with the other conductor, the peripheral outline of said elongated clamping head and of said guide member respectively each substantially conforming to the inner configuration of said sleeve member so as to provide for an axially guided passage of the clamping head through said sleeve member and an axial guidance of the guide member within the sleeve member upon application of the plug member to one end of the sleeve member, the opposite end of the sleeve member forming an abutment for the overhanging portion of the clamping head upon complete passage thereof through the sleeve member and subsequent insertion of the guide member in the sleeve member thereby latching the plug to the socket in axial alignment therewith when pressure applied to the yieldable means for projection of the clamping head is released and the latter is abutting against said abutment.

12. An electrical connector as defined in claim 11, in combination with limit means for limiting the depth of insertion of said guide member in the sleeve member of the socket to a position in which the clamping head is retained by said abutment in a projected position relative to the guide member and in which said yieldable means are loaded for effecting a pressure contact between said clamping head and said abutment at the respective end of the sleeve member of the socket.

13. In a self-locking electrical connector for detachably connecting two conductors, in combination a plug member comprising an inner sleeve, an electrically conducting clamping rod adapted to be electrically connected to one of said conductors and slidably guided within said sleeve, said rod having on one end an axially elongated clamping head protruding from one end of said sleeve and one-sidedly overhanging the peripheral outline of the sleeve, an outer sleeve encompassing said inner sleeve and fastened thereto in a position in which the inner sleeve end from which the clamping head extends protrudes from the outer sleeve, the respective end of the outer sleeve forming an abutment, the opposite end of the sleeve protruding beyond the other end of the inner sleeve, the end of the rod opposite to the clamping head being slidably guided in the said protruding end of the outer sleeve, and yieldable means biasing the clamping head toward the respective end of the inner sleeve; and a socket member comprising an electrically conductive sleeve member, the peripheral outline of said elongated clamping head and of said inner sleeve of the plug member respectively each substantially conforming to the inner configuration of said sleeve member of the socket member so as to provide for an axially guided passage of the clamping head through said sleeve member of the socket member and an axial guidance of the inner sleeve of the plug member within the sleeve member of the socket member upon application of the plug member to one end of the sleeve member of the socket member, the sleeve member of the socket member being adapted to be electrically connected with the other conductor, the end of the socket sleeve member opposite to the receiving end thereof forming an abutment for the overhanging portion of the clamping head upon complete passage thereof through said socket sleeve member and subsequent insertion of the inner sleeve member of the plug member in the socket sleeve member, the abutment formed by the respective end of the outer sleeve limiting the depth of insertion of the inner sleeve in the socket sleeve member thereby locking the plug member to the socket member in axial alignment therewith when pressure applied to the yieldable means for projection of the clamping head relative to the respective end of the inner sleeve is released and the clamping head is abutting against the abutment formed by the respective end of the socket sleeve member.

14. A plug for a self-locking electrical connector of the type defined in claim 3, comprising a hollow guide member having an opening therein, an electrically conducting clamping rod slidably guided within said guide member and extending from the opening thereof, the protruding rod portion forming an axially elongated clamping head one-sidedly overhanging the peripheral outline of the guide member, terminal means on the opposite end of said rod adapted to be electrically connected with a conductor, and yieldable means within the guide member coacting with the rod so as to bias the clamping head toward the guide member.

15. A plug for insertion in the socket member of a self-locking electrical connector of the type defined in claim 3, said plug comprising an electrically conducting sleeve having on its outer side wall an enlarged portion laterally protruding from the peripheral outline of the sleeve for limiting the depth of insertion of the sleeve in the socket member of a connector, an electrically conducting clamping rod slidably guided in said sleeve and extending with one end from one end of said sleeve, the said protruding rod end being bent off to form an axially elongated clamping head one-sidedly overhanging the peripheral outline of the sleeve, a coil spring disposed within the sleeve coacting with the clamping rod and a wall portion of the sleeve for biasing the clamping head toward the respective end of the sleeve, and terminal means on the rod end opposite the clamping head adapted to be electrically connected with a conductor.

16. A plug for insertion in the socket member of a self-locking electrical connector of the type defined in claim 13, said plug comprising an inner sleeve, an electrically conducting clamping rod adapted to be electrically connected to a conductor and slidably guided within said sleeve, said rod having on one end an axially elongated clamping head protruding from one end of said sleeve and one-sidedly overhanging the peripheral outline of the sleeve, an outer sleeve encompassing said inner sleeve and fastened thereto in a position in which the inner sleeve end from which the clamping head extends protrudes from the outer sleeve, the respective end of the outer sleeve forming an abutment limiting the depth of insertion of the inner sleeve in the socket member of a connector, the opposite end of the outer sleeve protruding beyond the other end of the inner sleeve, a grip member seated on the other end of the rod and slidably guided in the said protruding end of the outer sleeve, and yieldable means coacting with said clamping rod and said inner sleeve for biasing the clamping head toward the respective end of the inner sleeve.

17. A plug for insertion into the socket member of a

self-locking electrical connector of the type defined in claim 13, said plug comprising a rigid inner sleeve, an electrically conducting clamping rod adapted to be electrically connected to a conductor and slidably guided within said sleeve, said rod having on one end an axially elongated clamping head protruding from one end of said sleeve and one-sidedly overhanging the peripheral outline of said sleeve, a flexible outer sleeve encompassing said inner sleeve and fastened thereto in a position in which the inner sleeve end from which the clamping head extends protrudes from the outer sleeve, the respective end of the outer sleeve forming an abutment limiting the depth of insertion of the inner sleeve into the socket member of a connector, the opposite end of the outer sleeve protruding beyond the other end of the inner sleeve, the said protruding end of the outer sleeve being secured to the rod end opposite to said clamping head for projecting said clamping head relative to the inner sleeve by compressing said flexible outer sleeve in axial direction.

References Cited in the file of this patent

UNITED STATES PATENTS

1,387,252	Fredericks	Aug. 9, 1921
2,159,655	De Mooy	May 23, 1939
2,365,648	Rossmann	Dec. 19, 1944
2,396,725	Thomas	Mar. 19, 1946
2,398,644	Johnson	Apr. 16, 1946
2,423,250	Modrey	July 1, 1947
2,427,297	Modrey	Sept. 9, 1947
2,444,843	Modrey	July 6, 1948
2,508,767	Modrey	May 23, 1950
2,586,854	Myers	Feb. 26, 1952