June 20, 1967 R. F. KROLAK 3,327,282

ELECTRICAL CONNECTORS

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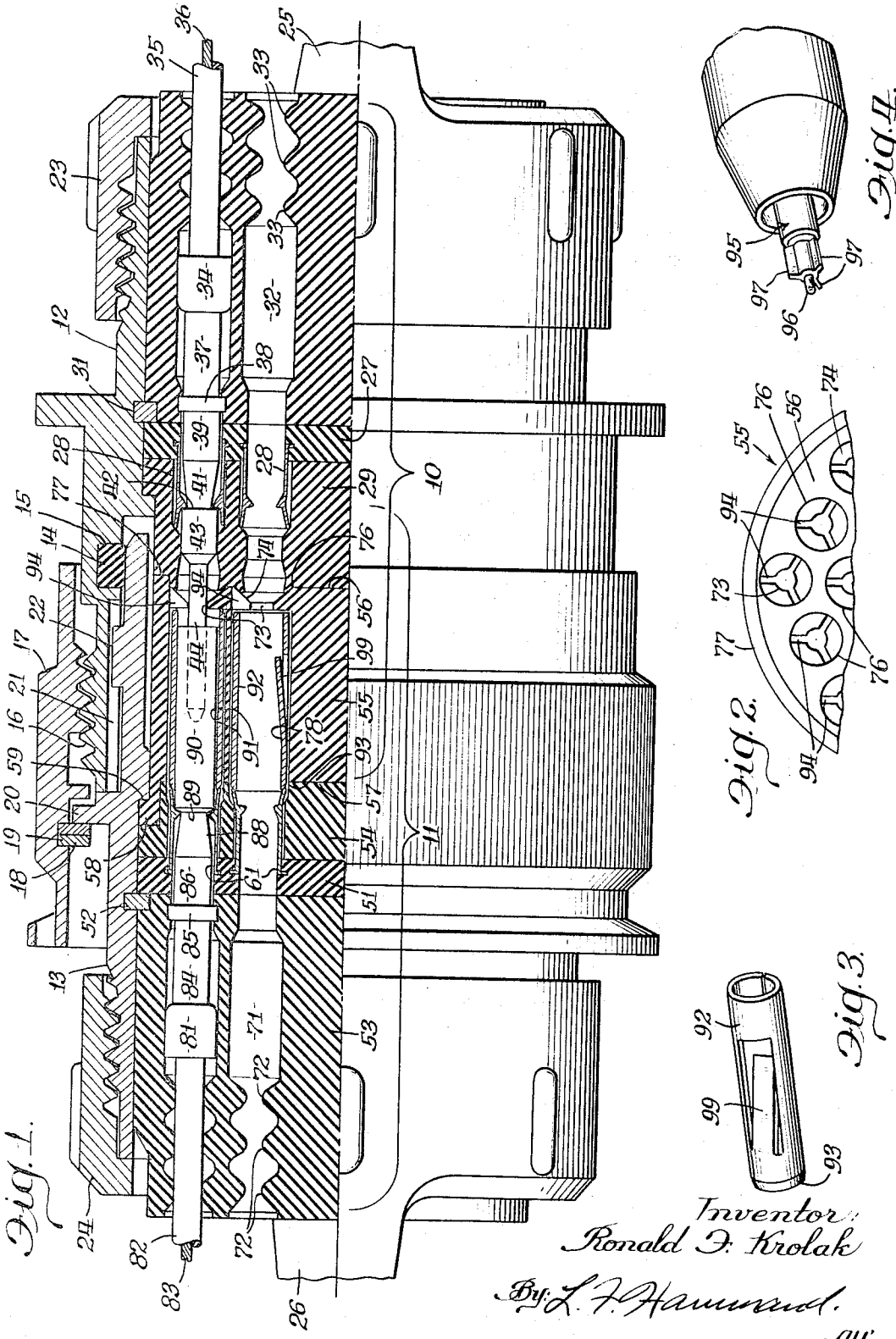


Fig. 1.

Fig. 4.

Fig. 2.

Fig. 3.

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Fig. 6.

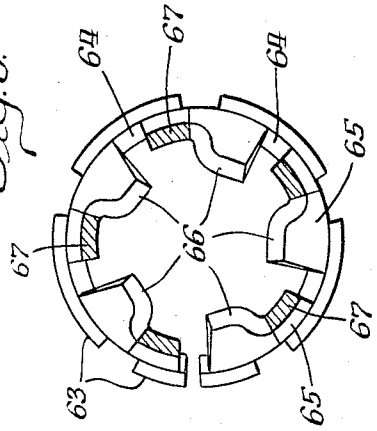


Fig. 5.

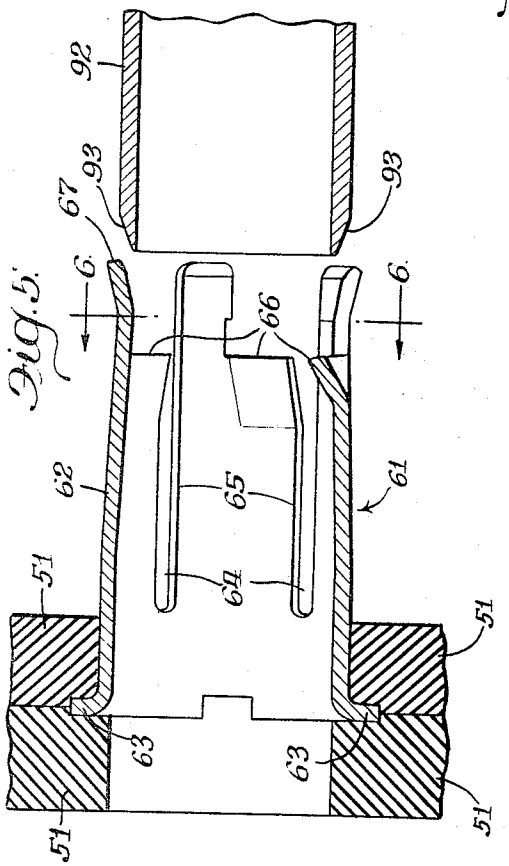


Fig. 7.

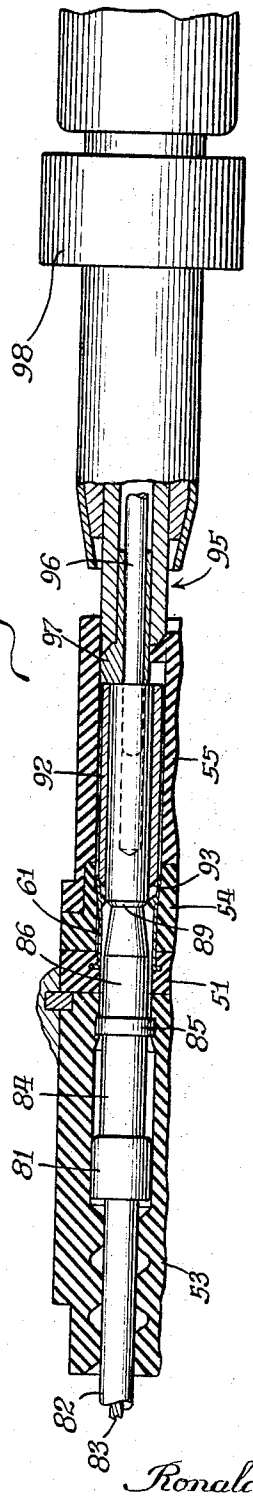
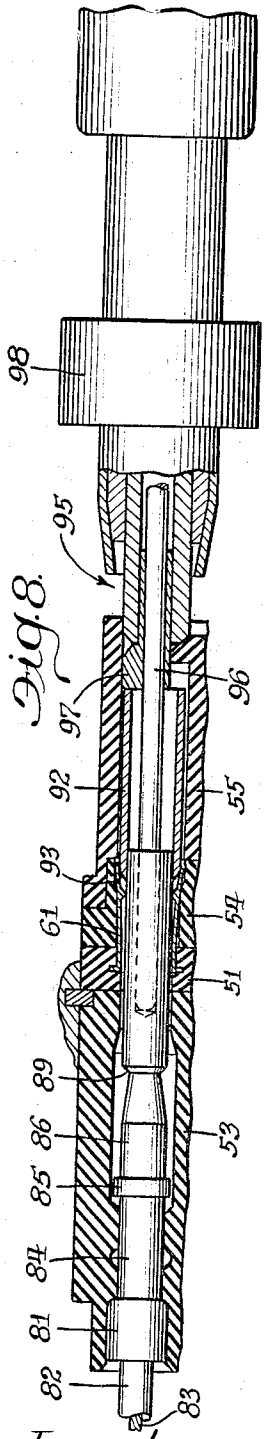


Fig. 8.



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ELECTRICAL CONNECTORS

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This invention relates to electrical connectors. It is the general aim of the invention to provide an improved electrical connector suitable for atomic missile usage and having all of the advantages of earlier types relating to resistance to adverse environmental conditions, ruggedness of construction, compactness, and ease of servicing, yet having greatly increased reliability.

It is a specific object of the invention to provide a connector of the general type wherein the individual contacts may be affixed to their conductors prior to assembly in the plug or receptacle of the connector and may thereafter be quickly, easily and conveniently mounted in operating position in the plug or receptacle of the connector and as easily removed therefrom for inspection or replacement, yet with a mechanical arrangement of parts such that any malfunctioning due to misalignment of the contacts is almost entirely eliminated, and by a design wherein so-called "false checkouts" are eliminated.

It may be explained that in some prior types of connectors, particularly when subjected to misuse or abuse, it is possible for the plug and receptacle of the connector to be improperly coupled to each other, yet in a condition that may function intermittently in a manner not always detected by circuit tests but with latent defects that can be catastrophic in actual operation.

Obviously, the accomplishment of the foregoing objects requires the development of a connector having a large number of features that are individually recognized as being desirable, but it further requires the reconciliation of electrical, mechanical and environmental factors that have heretofore been believed to be impossible of simultaneous accomplishment, or at least so antagonistic to each other as to preclude successful combination.

As a solution to this generally recognized dilemma, the present invention proposes utilization of a plug and receptacle wherein both sets of contacts are individually removable by application of properly designed removal tools inserted from the front face of the connector, yet with the plug body being of the so-called "hard front, closed entry" type wherein the plug contacts are housed in hard, rigid dielectric material with openings sized to exclude oversize or misaligned pins, so that the likelihood of misalignment of the connector contacts during engagement of the plug and receptacle is minimized. The present invention further proposes a relationship of parts such that, should any significant misalignment occur, it will infallibly prevent completion of the current path through the connector parts in a manner to be instantly and unquesionably apparent in the pre-flight testing of the missile circuitry.

The present preferred embodiment of the invention speicfically designed for the control circuitry of an atomic missile is illustrated in the drawings of this application, wherein:

FIGURE 1 is a greatly enlarged quarter-sectional view through a multiple contact connector of the pin-and-sleeve type;

FIGURE 2 is a fragmental front elevational view of the front face of the plug body of the connector shown in FIGURE 1;

FIGURE 3 is a detail perspective of a latch release member utilized in the illustrated connector;

FIGURE 4 is a perspective view of contact removal tool adapted to be utilized with the sleeve contacts used in the plug of the connector;

FIGURE 5 is a greatly enlarged central sectional view of a contact retention clip as used in both the plug and receptacle, showing its operating relationship with a latch release tube of the plug;

FIGURE 6 is a similarly enlarged detail sectional view of a contact retention clip, taken substantially on the plane of the line **6—6** of FIGURE 5;

FIGURE 7 is a fragmental sectional view taken through a contact cavity of the plug and showing the mode of operation of the contact latch releasing means therefor; and

FIGURE 8 is a fragmental sectional view similar to FIGURE 7 but showing the manner of removal of the sleeve contact from the plug body.

With reference now to FIGURE 1 particularly, the connector receptacle **10** and plug **11** each have an exterior tubular metal shell **12, 13**, having the forward ends arranged to telescope within each other and to provide a peripheral seal for the interior of the connector by an O ring **14**, carried in the internal groove **15** of the receptacle shell **12**. The forward end of the receptacle shell **12** is threaded at **16** to receive a threaded coupling collar **17** having an internal spring ring **18** seated in an internal groove **19** adapted to bear against the flange **20** of the plug shell **13** to removably draw the plug and shell into coupled relation. As shown, the receptacle shell is provided with one or more internal keyways **21** and the forward end of the plug shell has a corresponding key or keys **22** to maintain the desired angular relationship betwen the plug and its receptacle and to thus properly polarize the various individual contacts therein. As illustrated, the receptacle and plug each have a cable support nut **23, 24** threaded to the rearmost end of the shells **12** and **13**, with rearwardly extending arms **25** and **26** to support cable clamps (not shown) in the conventional manner.

The plug and receptacle each have a multi-part dielectric insert in which the individual contacts are supported. In the receptacle **10**, this insert includes a thin, flat, rigid disc **27**, generally referred to as an anti-deflection disc, transversely disposed in the shell **12** and carrying one or more contact retention clips **28** to support the individual pin contacts of the receptacle. The disc **27** is also preferably provided with a resilient sealing member **29** bonded to its forward face and, as shown, has a resilient grommet **30** similarly bonded on its rearward face. The parts **27, 29** and **30** are all locked in the shell **12** by a spring ring **31** each of these parts have aligned apertures in registry with each of the contact retention clips **28**, to provide an elongated longitudinal contact cavity **32** running entirely through the insert at the location of each contact. The rearward ends of each of these cavities, in the area of the resilient grommet **30**, have a plurality of sealing risers **33** formed integrally with the grommet.

In the connector illustrated, the receptacle portion **10** carries the male contacts which, as shown, include a cylindrical sleeve **34** adapted to receive the insulating layer

35 of a flexible conductor 36 which extends into a sleeve portion 37 of the contact wherein its is held by any conventional means, such as crimping. The contact illustrated has a positioning shoulder 38 from which a shank portion 39 extends forwardly to a taper 41 terminating in a reversely facing shoulder 42 on the head portion 43 of the contact, which carries the forwardly projecting cylindrical contact pin 44.

The connector plug 11 also includes a multi-part dielectric insert including an anti-deflection disc 51 held within the connector shell by a locking ring 52, with a resilient sealing grommet 53 bonded to the rear face of the disc and a sealing member 54 similarly bonded on its front face, but in the plug there is also provided a so-called "hard front" body member 55 formed of hard, rigid, smooth-surfaced insulating material. As shown, the body 55 is of generally cylindrical shape, and extends from a generally flat front face 56 to a rearward face 57 which may bear against or be bonded to the sealing member 54. As illustrated, the body member 55 has a rearwardly and outwardly extending flange 58 engaging a rearwardly facing shoulder 59 on the inside of the plug shell 13 so that the parts 51, 54 and 58 may be held clamped in pressure relationship by the locking ring 52.

The anti-deflection disc 51 of the plug is also provided with one or more contact retention clips 61. These clips may be identical to the clips 28 of the receptacle and are best illustrated in FIGURES 5 and 6, wherein it will be seen that each individual clip 61 consists essentially of a short tubular sleeve 62 having a segmental mounting flange 63 adapted to be molded into the anti-deflection disc 51 or 27 or secured between plural laminations thereof as shown in FIGURE 5. The sleeve 62 is longitudinally split, preferably by four or five slots 64 which extend from a point near the mounting flange to the forward end of the sleeve. These slots divide the sleeve into several independently flexible segments 65, each of which is provided with an inwardly inclined latch tooth 66 to engage a coacting shoulder of a contact, as later described. Each of the segments 65 of the clip has a forward extending operating member or trigger 67, preferably having a cam surfaced tip inclined outwardly, as will hereinafter appear.

As best seen in FIGURE 1, the several parts of the dielectric insert of the plug are apertured in alignment with each of the contact retention clips 61 to provide elongated contact cavities 71 extending from the wire-sealing risers 72 longitudinally through the parts 53, 51, 54 and 55 of the insert, except that in the case of the plug, the forward end of each contact cavity 71 has a restricted limiting orifice 73 dimensioned to receive the pin 44 of the male contact, but to encircle it so closely as to preclude insertion of an oversize pin. The orifice 73 is provided, however, with a tapered mouth 74, the angular walls of which act as a guide or funnel to facilitate insertion of the pin contacts into the receptacle. The walls of the mouth portions of each contact cavity also intersect the smooth, flat front face 56 of the body member 55 in a manner to provide peripheral ridges 76 surrounding each of the contact cavities. It will thus be seen that when the connector is coupled, the pressure exerted by the screw-threaded coupling ring 17 will press the body member 55 tightly against the resilient sealing element 29, establishing an overall seal across the front face of the plug body with individual peripheral sealing ridges around each of the individual contact cavities. A peripheral seal around the entire contact assembly is also provided by a small forwardly projecting peripheral flange 77 at the outer edge of the face 56 of the body member 55.

Immediately behind the limiting orifice 73 of each contact cavity, the body 55 is provided with a counterbore 78 to house the sleeve-type contacts of the plug. These sleeve contacts of the plug are similar to the pin contacts of the receptacle in that they have a rearward

sleeve 81 to receive the insulating layer 82 of the individual flexible conductors 83 which extend into and are secured within the sleeve 84 at a point behind the collar 85. The shank 86 and taper 88 of the sleeve contact are also similar to the corresponding parts of the pin contact, to provide a rearwardly facing shoulder 89 similar to the rearwardly facing shoulder 42 and arranged to be engaged by the several latching teeth 66 on the contact retention clip 61. Thus, the forward cylindrical portion 90 of the sleeve contact may be any one of several types, so long as the forward end thereof is apertured to receive the pin 44.

The counterbores 78 of the plug body are of considerably larger diameter than the forward sleeve portions 90 of the individual contacts used therein, so that each cavity has a longitudinal slideway or channel 91, adapted to loosely receive a tubular release member 92 having a tapered rearward end 93 underlying each of the several trigger portions 67 on the contact retention clip 61.

The forward end of each release tube 92 normally assumes a position as shown in FIGURE 1, where it lies immediately behind, but outside of the dimensional limits of the restricted orifice 73 of the contact cavity. The tapered mouth 74 of each contact cavity is, however, provided with one or more latch release keyways, preferably in the form of radial slots 94 (FIGURE 2) comprising extensions of the latch release channel 91. In the preferred form of the invention illustrated these keyways are of width sufficiently less than the diameter of the pins 44 and corresponding apertures 73 as to preclude acceptance of an oversize pin, and are sized to extend radially at least beyond the inner diameter of the release tube 92, so that any individual tube may be selectively forced rearwardly by insertion of a properly shaped contact removal tool. A simple form of such a tool is shown in FIGURE 4, wherein the tool 95 is provided with a multiplicity of fins 97 corresponding in dimensions and orientation to the slots 94. Preferably, however, the tool is also provided with a slideable center pin 96 having an operating collar 98 so that, when the tool is properly inserted in the contact cavity, the fins 97 function to force the sleeve 92 rearwardly until its cam surfaces 93 expand the retention clips and simultaneously release the several latch teeth 66 thereof from the contact shoulder 89. This leaves the entire contact assembly free to move rearwardly, either by pulling on the individual conductors 83 or preferably by operating the collar 98 to force the pin 96 into the sleeve of the contact and push the contact rearwardly, as best shown in FIGURE 8.

It is believed obvious that with the form of connector illustrated, the contacts of both the plug and the receptacle may be put in place individually from the rear of each connector insert and may likewise be individually removed, by access to the front of the insert only. In the case of both the plug and the receptacle, mounting of the contacts is easily accomplished simply by inserting the leading end of each contact into a cavity in the rear grommet of the plug or receptacle and sliding the contact forward with an appropriate tool (not shown) until the plural latch teeth of the collet-type contact retention clip snap into position behind the locking shoulder of the contact. In the case of the plug contacts, this action carries the release tube 92 to its forwardmost position due to a light friction drag existing between the sleeve portion 90 of the contact and the release tube. This friction may be created in any convenient way, as by a spring finger 99 pierced from the wall of the tube and biased inwardly to bear against the cylindrical surface of the contact sleeve (FIGURE 3).

Removal of any individual contact is equally simple. In the case of the receptacle, it is only necessary to slip a sleeve-like tool (not shown) on the contact pin 44 and slide it back over the head portion 43 of the contact, so that the leading edge of the tubular tool engages the several triggers 67 of the contact retention clip and flexes

them outwardly in a manner to release the latch teeth **66** thereof and allow the contact to be drawn rearwardly from the connector insert.

In the case of the connector plug, the restricted pin-limiting apertures **73** and tapered mouth portions **74** of the "hard front" plug body **55** are so formed as to permit easy insertion of property sized pin contacts **44** and, in fact, to guide the forward tips of such contacts into prefectly mating alignment with the sleeves **90** as the plug is coupled to the receptacle. The apertures **73** are sized to prevent insertion of an oversize pin in the contact sleeves **90**, however, as seen in FIGURE 2, from which it is apparent that the dimensional limits of the apertures (the inner diameter of the arcuate portions forming the orifice **73**) corresponds to the maximum diameter of the contact pin, although the radial keyway slots **94** extend beyond these dimensional limits to permit actuation of the sleeve **92** by insertion of a properly keyed latch release tool. Thus, the latch release tool **95** and the latch release tube **92** coact to form latch releasing instrumentalities extending from the forward face **56** of the dielectric insert to the latching means comprising the teeth **66** of the contact retention clips **61**.

The mechanical advantages of the connector outlined above are accomplished in the present invention, however, without sacrifice of electrical excellence, and by an arrangement that provides unusually great reliability in operation. It should first be observed that while the dielectric inserts of both the plug and receptacle consist of several individual parts, these coact in a manner whereby the interfacing surfaces may be permanently bonded to each other so that the resilient grommet and resilient sealing members positioned on the opposite sides of each of the anti-deflection discs **27** and **51** coact to encapsulate the retention clips and latching mechanisms surrounding each individual contact so that all contacts are effectively isolated from each other without air voids permitting the formation of electrical leakage paths.

Upon coupling of the plug and receptacle the contact pins are normally guided in a manner to enter the sleeves of the contacts in accurate alignment, but the arrangement is such that, should one or more of the pin contacts be so deformed as to fail to enter its proper aperture, it cannot possibly establish an intermittent connection. It follows that any defects will invariably be detected during preflight check-out of the circuitry, assuring what has come to be known as "go-no-go" reliability.

It will also be seen (FIGURE 1) that the face portion and tapered mouth apertures of the connector plug are formed so that, as the plug is tightened into the receptacle, concentration of pressure occurring at the peripheral ridges **76** surrounding each of the contact apertures accomplishes an effective vapor seal whereby each contact cavity and its keyways are electrically isolated from all other contacts. Similarly, the marginal flange **77** of the hard front dielectric is embedded into the sealing member **29** to isolate the entire group of contacts from the connector shell.

I claim:

1. In an electrical connector, a dielectric body having a front face consisting of hard, rigid insulating material; said body having at least one contact cavity extending longitudinally therethrough, and latching means within said cavity; with each said cavity having a tapered mouth at the forward end thereof leading to a restricted orifice of fixed dimensions: said cavity also having an enlarged counterbore extending rearwardly from said orifice with at least one narrow radial keyway slot extending outwardly from said restricted orifice and entering said counterbore; said counterbore in said body containing a sleeve contact therein, with said sleeve contact having a shoulder adapted to be engaged by the aforesaid latching means, and being of substantially smaller diameter than the counterbore to provide a slideway channel therebetween; at least one latch releasing member permanently housed in the aforesaid channel and longitudinally shiftable therein, while engageable with the latching means and extending therefrom to a location adjacent to and accessible from the keyway on the front face of the body.

2. In an electrical connector, a dielectric body having a front face consisting of hard, rigid insulating material; said body having at least one contact cavity extending longitudinally therethrough, and latching means within said cavity; with each said cavity having a tapered mouth at the forward end thereof leading to a restricted orifice of fixed dimensions: said cavity also having an enlarged counterbore extending rearwardly from said orifice with at least one narrow radial keyway slot extending outwardly from said restricted orifice to the edge of the tapered mouth, and entering said counterbore; said counterbore in said body containing a sleeve contact therein, with said sleeve contact having a shoulder adapted to be engaged by the aforesaid latching means, and being of substantially smaller diameter than the counterbore to provide a slideway channel therebetween; at least one latch releasing member permanently housed in the aforesaid channel and longitudinally shiftable therein, while engageable with the latching means and extending therefrom to a location adjacent to and accessible from the keyway on the front face of the body: said latch releasing member comprising a sleeve received within the aforesaid counterbore of the contact cavity and slidable on but frictionally secured to the forward portion of said sleeve contact.

3. In an electrical connector comprising a plug and receptacle, each having a tubular metal shell adapted to couple in telescoping relation with the other; said plug and receptacle each having a dielectric insert including a relatively thin, rigid disc with at least one retention clip for mounting telescoping pin and sleeve contacts uniting the plug and the receptacle; with a yieldale resilient grommet on the rearward face of each of said discs and a yieldable resilient sealing member on the forward face of each of said discs coacting to encapsulate the retention clips thereon; the combination of a front face piece of the dielectric body consisting of hard, rigid insulating material; said piece having a rearward surface bearing against the sealing member of the plug and having at least one contact cavity extending longitudinally therethrough and leading to a closed-entry orifice closely fitting the diameter of the aforesaid pin but having a larger counterbore extending rearwardly from said orifice; with at least one keyway in the front face piece; each of said counterbores in said body containing an aforesaid sleeve contact therein, with said sleeve contacts of substantially smaller diameter than the counterbores to provide a slideway therebetween; said sleeve contacts having a shoulder adapted to be engaged by at least one latching device carried by an aforesaid contact retention clip; together with at least one latch releasing member permanently housed in the aforesaid slideway and longitudinally shiftable therein, while engageable with a trigger portion of the latching device and extending therefrom to a location accessible from the front face of the body, to release said latching device and permit removal of the contact; said latch releasing member having a forward end normally projecting beyond the forward end of the contact to a location adjacent the mouth of the contact cavity and underlying at least a portion of the aforesaid keyway therein.

4. In an electrical connector comprising a plug and receptacle, each having a tubular metal shell adapted to couple in telescoping relation with the other; said plug and receptacle each having a dielectric insert including a relatively thin, rigid disc with at least one retention clip for mounting telescoping pin and sleeve contacts uniting the plug and the receptacle; with a yieldable resilient grommet on the rearward face of each of said discs and a yieldable resilient sealing member on the forward face of each of said discs coacting to encapsulate the retention clips thereon; the combination of a front face piece of the dielectric body consisting of hard, rigid insulating ma-

terial; said piece having a rearward surface bearing against the sealing member of the plug and having at least one contact cavity extending longitudinally therethrough, with said cavity having a tapered mouth at the forward end thereof leading to a closed-entry orifice having a minor dimension closely fitting the diameter of the aforesaid pin contact and a major dimension substantially greater; but having a larger counterbore extending rearwardly from said orifice; with at least one narrow radial keyway slot in the tapered mouth, and a smooth, flat forward face with a peripheral edge surrounding the mouth of each entrance orifice and adapted to bear against the resilient sealing member of the receptacle of the connector to isolate each contact cavity; and a marginal flange on said body engageable with said sealing member to isolate the entire face thereof from the shell; each of said counterbores in said body containing an aforesaid sleeve contact therein, with said sleeve contacts of substantially smaller diameter than the counterbores to provide a slideway therebetween; said sleeve contacts having a shoulder adapted to be engaged by at least one latching device carried by an aforesaid contact retention clip together with at least one latch releasing member permanently housed in the aforesaid slideway and longitudinally shiftable therein, while engageable with a trigger portion of the latching device and extending therefrom to a location accessible from the front face of the body, to release said latching device and permit withdrawal of the contact rearwardly through the aforementioned resilient grommet; said latch releasing member comprising a sleeve within the aforesaid counterbore of the contact cavity and slideable on but frictionally secured to the forward portion of said sleeve contact; said sleeve having a forward end normally projecting beyond the mouth of the contact cavity and underlying at least a portion of the aforesaid radial keyway slot therein.

5. In an electrical connector comprising a plug and receptacle, each having a tubular metal shell adapted to couple in telescoping relation with the other; said plug and receptacle each having a dielectric insert surrounding at least one electrical contact of telescoping type and including a relatively thin, rigid disc carrying at least one retention clip for mounting said telescoping contacts uniting the plug and the receptacle, with a yieldable resilient grommet on the rearward face of each of said discs and a yieldable resilient sealing member on the forward face of each of said discs coacting to encapsulate the contacts and retention clips thereon; the combination of a front

piece for one of said dielectric inserts consisting of hard, rigid insulating material; said front piece having at least one contact aperture extending longitudinally therethrough and having a rearward face bearing against one of the aforesaid sealing members and a front face adapted to bear against the other of said resilient sealing members of the connector; with each said contact aperture having an enlarged tapered mouth at the front face with a peripheral edge indenting the resilient sealing member to isolate each contact cavity from the others and a marginal flange on said front piece engageable with said sealing member to isolate the entire face thereof from the shell.

6. In an electrical connector comprising a plug and receptacle, each having a tubular metal shell adapted to couple in telescoping relation with the other; said plug and receptacle each having a dielectric insert surrounding at least one electrical contact of telescoping type and including a relatively thin, rigid disc carrying at least one retention clip for mounting said telescoping contacts uniting the plug and the receptacle, with a yieldable resilient grommet on the rearward face of each of said discs and a yieldable resilient sealing member on the forward face of each of said discs coacting to encapsulate the contacts and retention clips thereon; the combination of a front piece for one of said dielectric inserts consisting of hard, rigid insulating material; said front piece having at least one contact aperture extending longitudinally therethrough and having a rearward face bearing against one of the aforesaid sealing members and a front face adapted to bear against the other of said resilient sealing members of the connector; with each said contact aperture having a peripheral edge indenting the resilient sealing member to isolate each contact cavity from the others.

References Cited

UNITED STATES PATENTS

2,352,618	7/1944	Daenz	339—193
2,691,147	10/1954	Sutton et al.	339—217
2,762,206	9/1956	Knohl	339—217
2,944,241	7/1960	Londell	339—258 X
3,170,752	2/1965	Van Horssen	339—217
3,221,292	11/1965	Swanson et al.	339—217

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