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PERIPHERAL TANG LOCK FOR QUICK DISCONNECT UMBILICAL CONNECTOR

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FIG. 2.

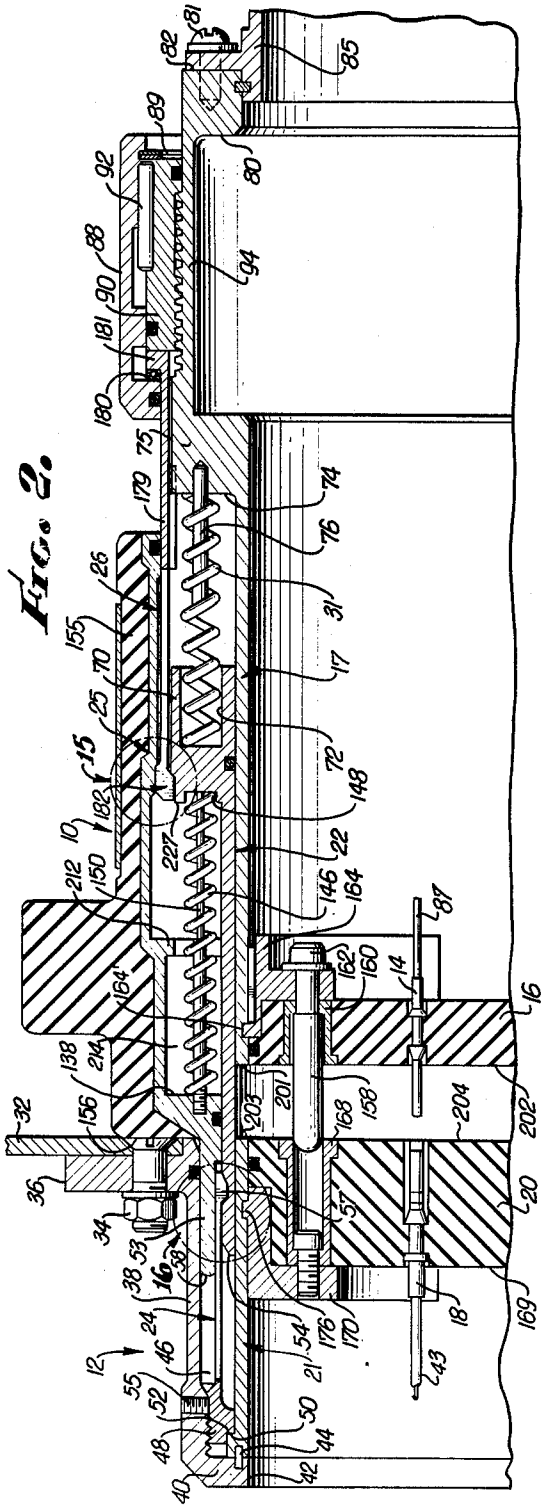
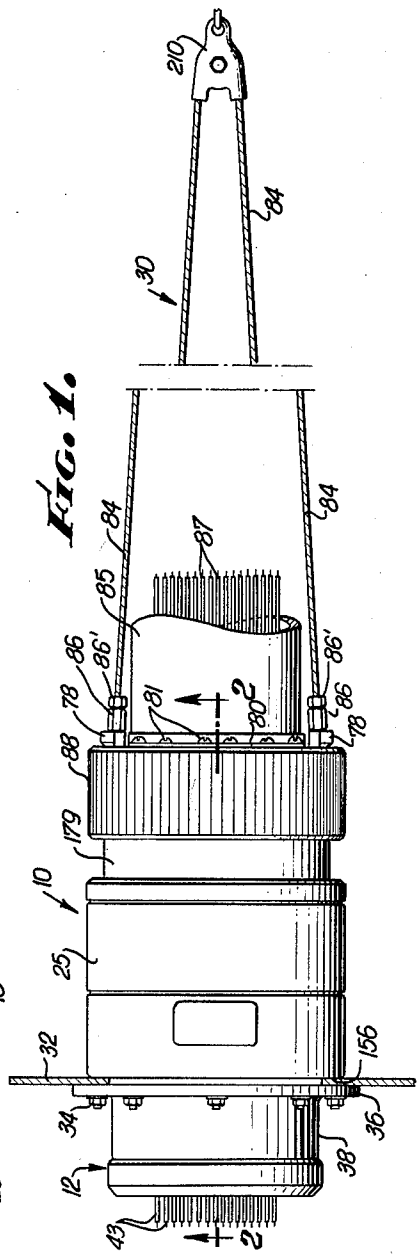


FIG. 1.



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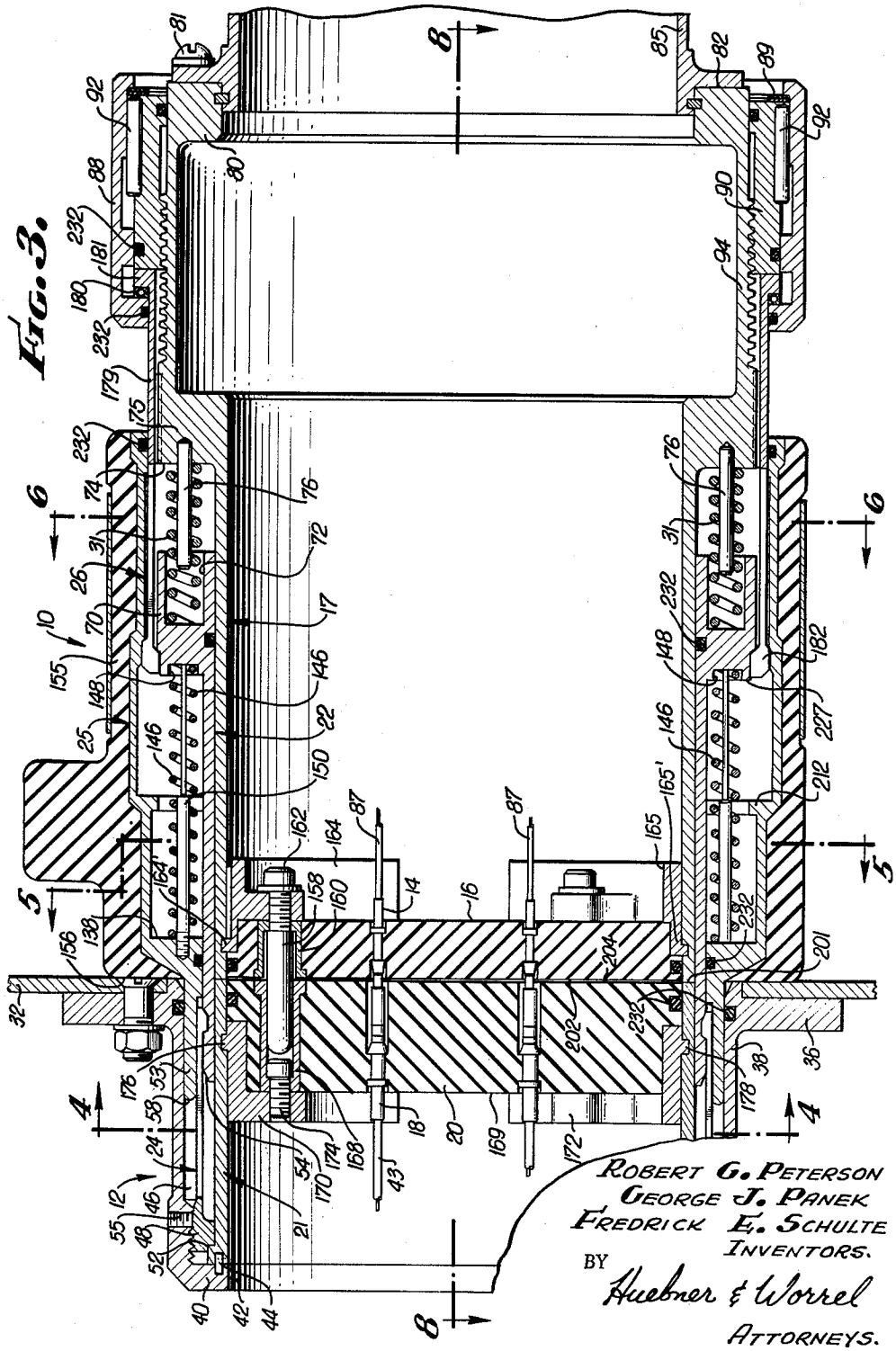
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FIG. 3.



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PERIPHERAL TANG LOCK FOR QUICK DISCONNECT UMBILICAL CONNECTOR

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FIG. 4.

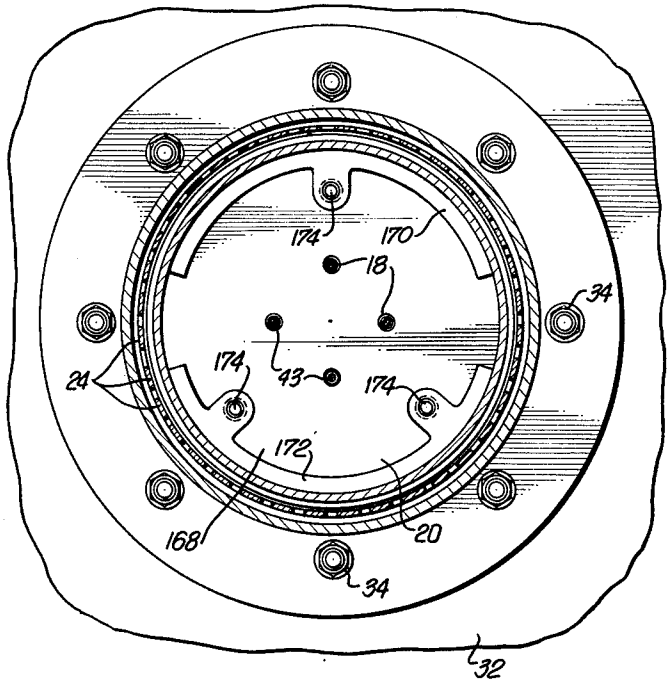
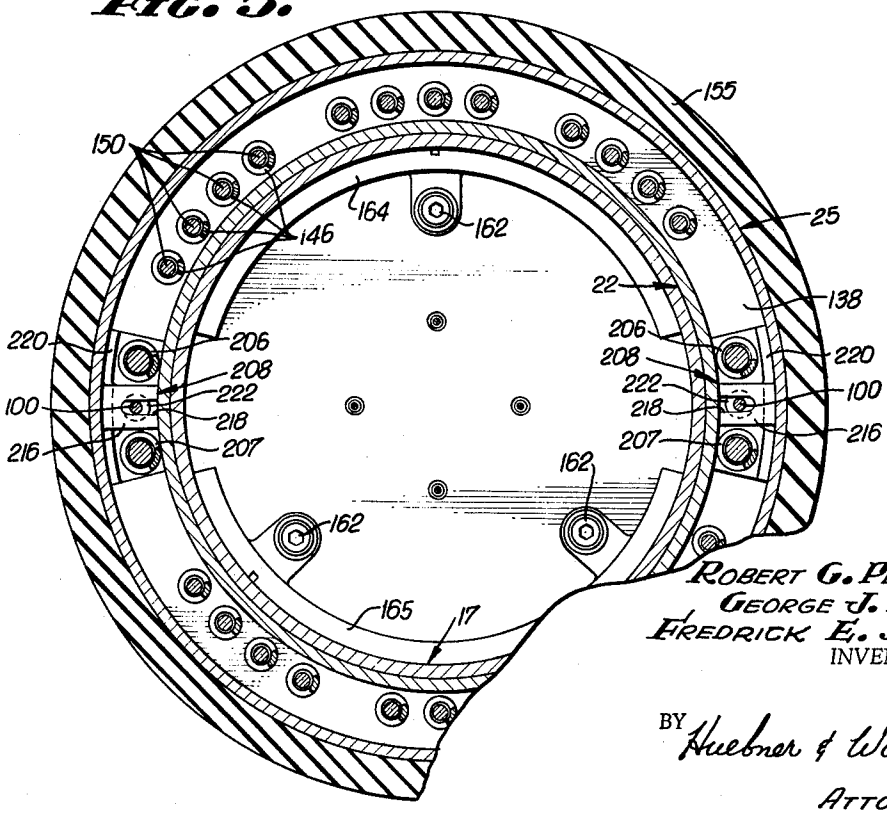


FIG. 5.



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FIG. 6.

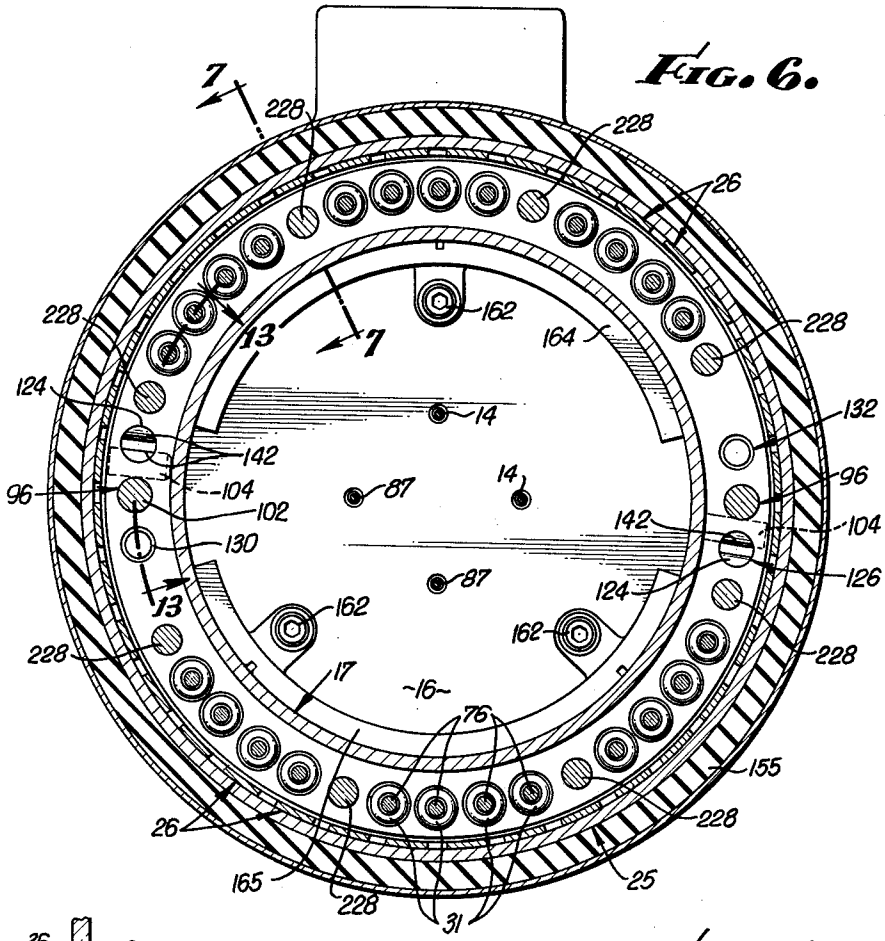
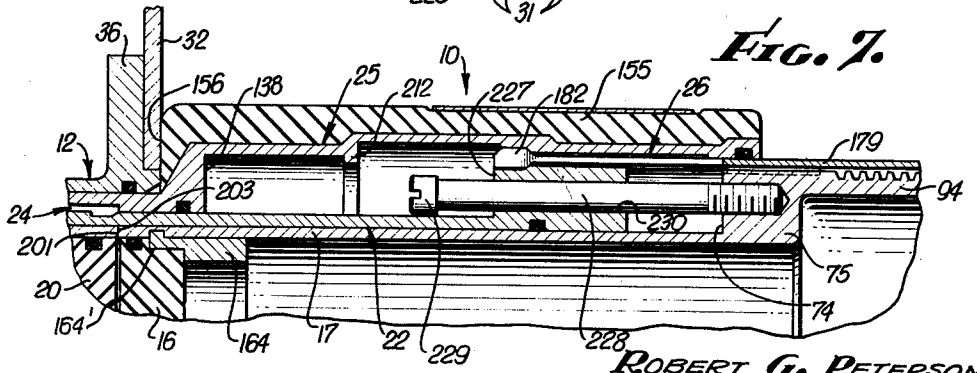


FIG. 7.



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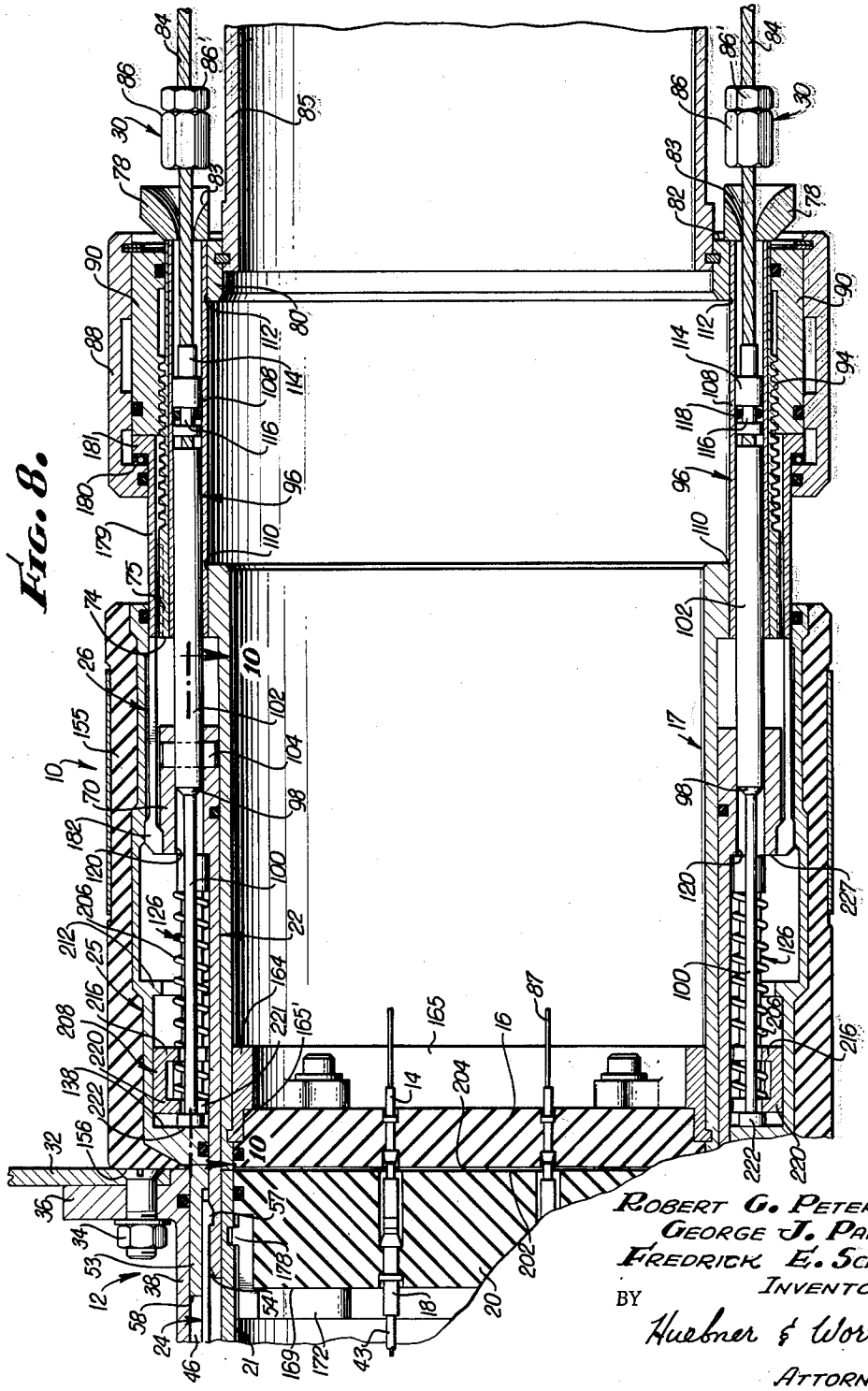
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FIG. 8.



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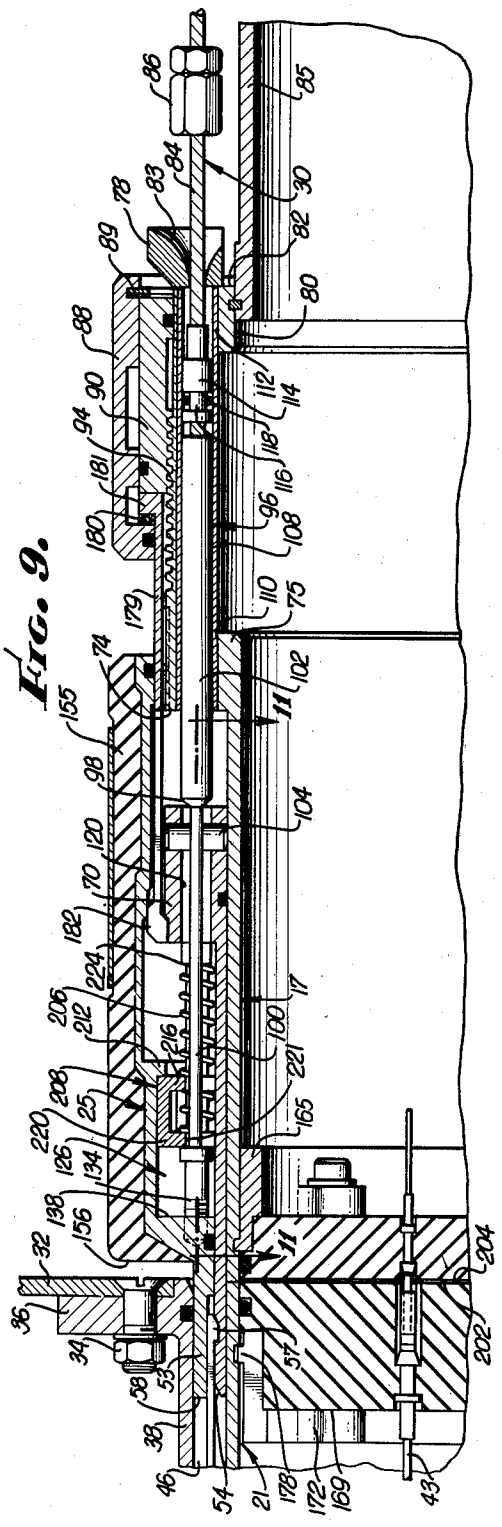


FIG. 9.

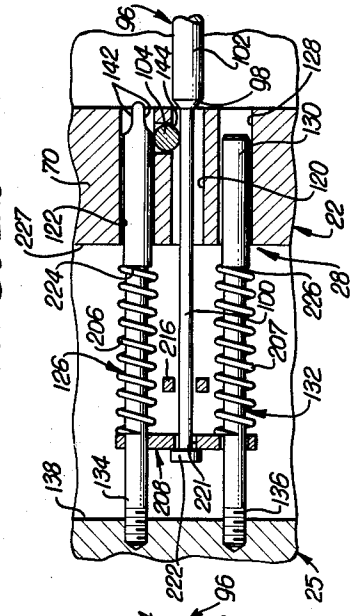


FIG. 11.

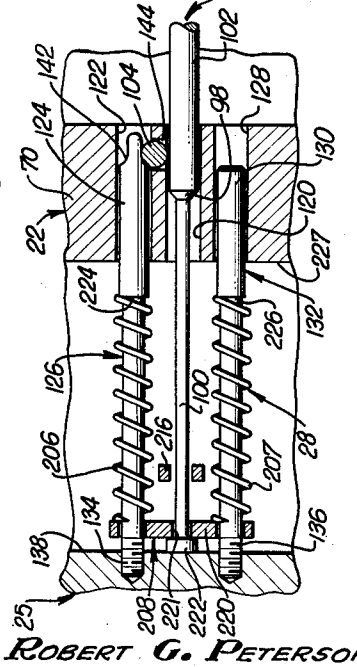


FIG. 10.

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PERIPHERAL TANG LOCK FOR QUICK DISCONNECT UMBILICAL CONNECTOR

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FIG. 12.

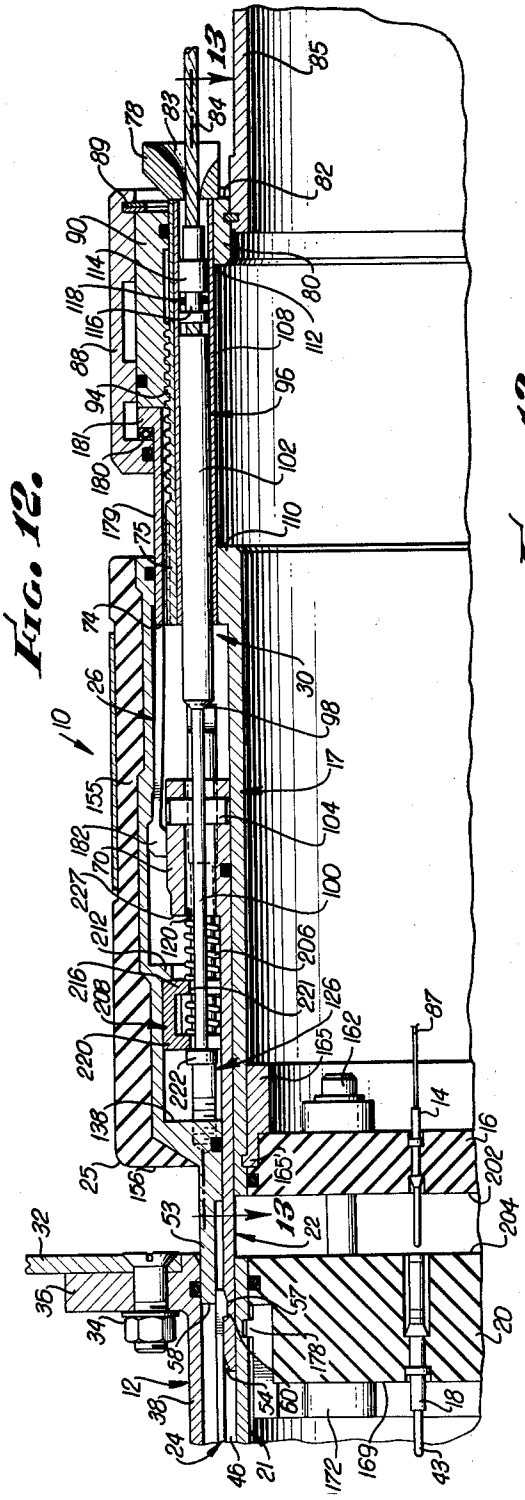
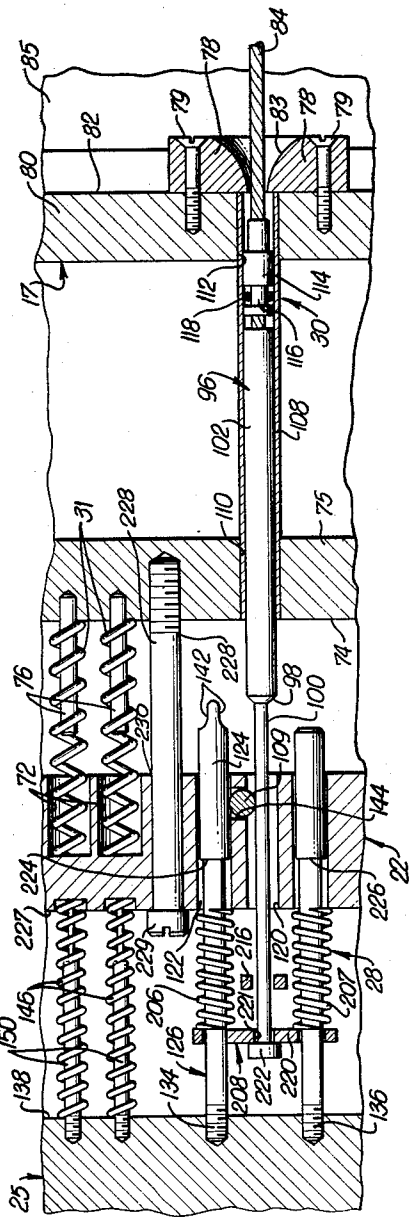


FIG. 13.



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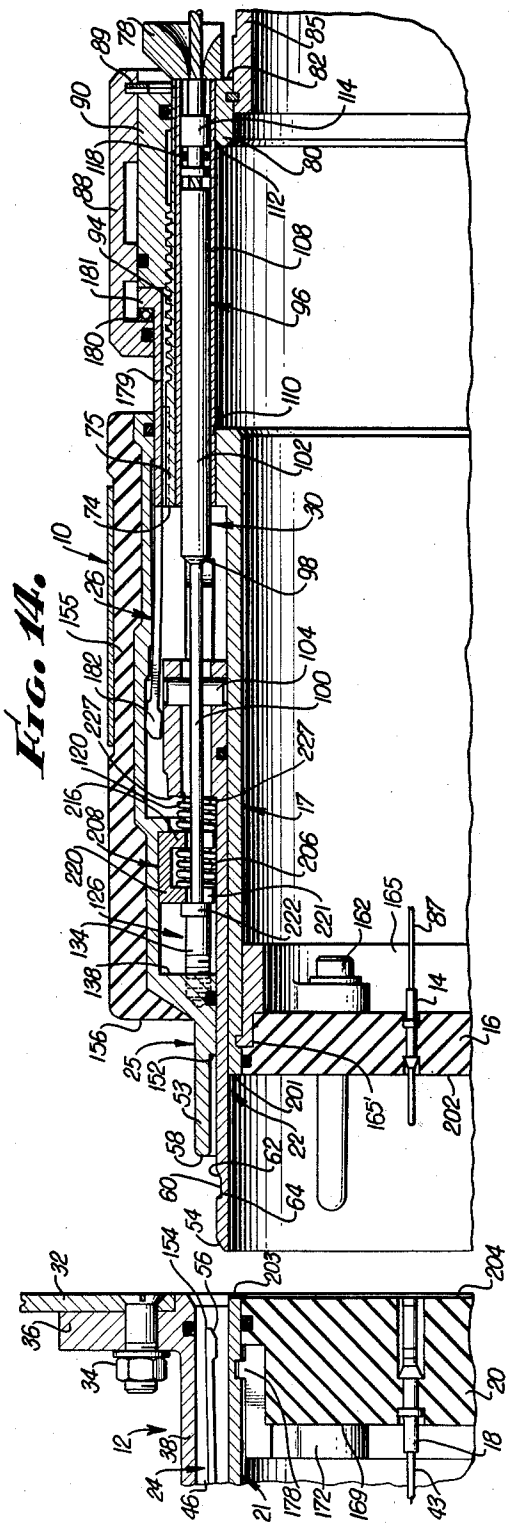


Fig. 14.

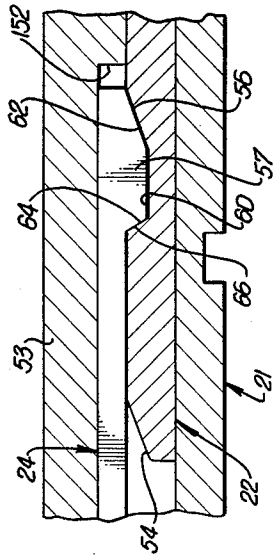


Fig. 16.

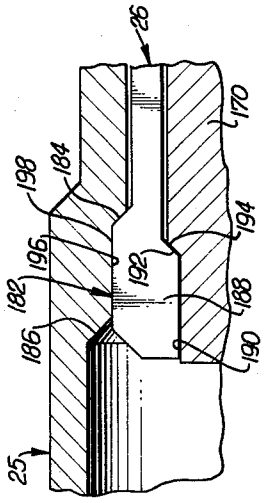


Fig. 15.

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United States Patent Office 3,156,513 Patented Nov. 10, 1964

3,156,513

PERIPHERAL TANG LOCK FOR QUICK DISCONNECT UMBILICAL CONNECTOR

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Filed Jan. 26, 1962, Ser. No. 169,711
17 Claims. (Cl. 339—45)

This invention relates to electrical connectors and more particularly to umbilical electrical connectors that include a plug member engageable with a receptacle member to complete a plurality of electrical circuits, and which members have embodied therein structure that releasably locks the members together and ejecting means, for separating the members, which is resistant to certain forces that exert their influence on the structure; and to preclude premature separation of the members an auxiliary or secondary lock is provided.

Umbilical electrical connectors have a number of uses and one of the most prominent is the use of such connectors with remotely launched aircraft including missiles, rockets, airplanes, target drones and the like. Also umbilical electrical connectors are employed with ground captive vehicles such as land sleds that are used as auxiliary test vehicles for preflight testing of instruments to be used in the aircraft. The aircraft may be either manned or unmanned, air breathing or non-air breathing, and may be of the type that is used in support of national defense or purely for peaceful purposes such as research and development. Further, the aircraft may be of the class that is used in ground-to-ground, ground-to-air, air-to-ground, air-to-air, ground-to-space, space-to-ground, space-to-space, or space-to-air operations.

Due to the nature of the propulsion systems that have been incorporated into the present day aircraft, launching of these aircraft is often done remotely, i.e., ground crew personnel are located at a safe distance from the launching site. Umbilical electrical connectors provide a means of connection and communication between the ground crew personnel and the aircraft and it is these essential connectors to which the present invention is devoted.

An object of this invention is to provide an electrical connector that includes a plug member having a plurality of contact terminals that mate with a corresponding number of complementary contact terminals of a receptacle member to complete a plurality of electrical circuits following the mechanical coupling of the plug member with the receptacle member, and which may be broken by separating the mating contact terminals from each other prior to the occurrence of a mechanical separation of the plug member from the receptacle member.

Another object of this invention is to provide an electrical connector of the character described wherein the members are releasably locked in mating engagement by a plurality of tangs or fingers arranged peripherally about insulator structure employed to support the contact elements in one member, the fingers being engageable with a catch peripherally disposed about insulator structure employed to support the complementary contact elements in the other member, to achieve a high lock tension capability and high resistance to side loads imposed by vibration.

A yet further object of this invention is to provide an

electrical connector of the character described wherein the connector members are releasably locked in mating engagement by one group of tangs or fingers arranged peripherally about insulator structure employed to support the contact elements in one member, the fingers being engageable with a catch peripherally disposed about insulator structure employed to support the complementary contact elements in the other member; and a second group of tangs or fingers are arranged peripherally about and are engageable with another catch to releasably lock the contact elements in mating engagement.

A specific object of this invention is to provide an electrical connector of the character described wherein separation of the contact elements is achieved by employing groups of ejection or release springs having different spring rates, whereby any particular vibration frequency will not by resonance decrease the spring force of more than one of the groups, and the remaining groups will remain effective to provide the required separation force.

A still further object of this invention is to provide an electrical connector of the character described wherein releasably locking the plug member to the receptacle member and releasably locking the contact terminals of one member to the contact terminals of the other member is achieved by an interrelated dual locking structure that resists inadvertent or accidental separations.

Further objects and advantages of this invention will appear during the course of the following part of this specification wherein the details of construction and mode of operation of a preferred embodiment are described with reference to the accompanying drawings, in which:

FIG. 1 is a side elevation view illustrating an umbilical electrical connector embodying the present invention;

FIG. 2 is an enlarged, sectional view taken on line 2—2 of FIG. 1, and illustrating the initial stage of engagement between the receptacle member and plug member of the connector;

FIG. 3 is an enlarged, sectional view similar to FIG. 2, but including more extensive detail and showing the receptacle member and plug member in final releasable locking engagement with a plurality of electrical circuits completed;

FIG. 4 is a reduced cross-sectional view taken on line 4—4 of FIG. 3;

FIG. 5 is a cross-sectional view taken on line 5—5 of FIG. 3, looking in the direction indicated;

FIG. 6 is a cross-sectional view taken on line 6—6 of FIG. 3;

FIG. 7 is a fragmentary sectional view taken on line 7—7 of FIG. 6 and illustrating a stop bolt located in the plug member;

FIG. 8 is a sectional view taken on line 8—8 of FIG. 3 and illustrating further details of the plug member and receptacle member in their fully engaged position;

FIG. 9 is a sectional view illustrating approximately one-half of the structure disclosed in FIG. 8 and showing the first stages of separation of the plug member from the receptacle member;

FIG. 10 is a cross-sectional view taken on line 10—10 of FIG. 8, and illustrating auxiliary or secondary locking structure in the locked position;

FIG. 11 is a cross-sectional view similar to FIG. 10, but taken on line 11—11 of FIG. 9 and illustrating the auxiliary locking structure in the released position;

FIG. 12 is a view similar to FIG. 9, but illustrating an advanced stage of separation of the plug member from

the receptacle member wherein the pin contact terminals are no longer engaged with the socket contact terminals, but mechanical engagement between plug member and receptacle member still exists;

FIG. 13 is an enlarged cross-sectional view taken on lines 13—13 of FIGS. 6 and 12;

FIG. 14 is a view similar to FIG. 12, but illustrating the positions of various components following complete separation of plug member from receptacle member;

FIG. 15 is an enlarged view of the encircled portion of FIG. 2 identified by the numeral 15; and

FIG. 16 is an enlarged view of the encircled portion of FIG. 2 identified by the numeral 16.

Referring to the drawings for a more comprehensive understanding of the invention, locking engagement of a plug member 10 with a receptacle member 12 and separation of plug member 10 from receptacle member 12 is accomplished preferably in stages.

A plurality of pin contact elements or terminals 14 are mounted in an insulator body 15 which is supported by a plug body 17, and these pin contact elements are, in an early stage of the connector engagement, axially aligned with socket contact elements or terminals 18 mounted in an insulator body 20 that is supported by a receptacle sleeve 21.

A preliminary stage of engagement is completed when cylindrical locking sleeve 22, peripherally disposed with respect to plug insulator body 16, mates with a first group of resilient tangs or fingers 24 peripherally arranged with respect to receptacle insulator body 20 to effect a mechanical coupling of the plug member with the receptacle member. Separation of the tangs from the locking sleeve is prevented by a spring-loaded reciprocal cylindrical retainer sleeve 25 of the plug member that circumscribes the locking sleeve.

The final stage of engagement of the plug member 10 with the receptacle member 12 is achieved when the pin contact elements or terminals 14 are brought into engagement with the socket contact elements or terminals 18. A second group of resilient tangs or fingers 26 peripherally arranged with respect to locking sleeve 22 are engageable with the retainer sleeve 25 and locking sleeve 22 to achieve a releasable locking together of the terminals. Mating of the pin contact terminals with the socket contact terminals completes a multiplicity of independent electrical circuits.

The retainer sleeve 25 may be responsive to certain frequencies of vibration which are capable of causing premature separation of plug member from receptacle member. To preclude this possibility a pair of auxiliary or secondary locks 28, directly associated with the retainer sleeve 25, are provided that are not responsive to the frequencies of vibration that effect the retainer.

Separation of the plug member 10 from the receptacle member 12 is accomplished in substantially a reverse order from the engagement. A lanyard assembly 30 is employed to effect the separation, and actuation of the lanyard assembly first serves to release the auxiliary locks 28. Further actuation of the lanyard assembly retracts retainer sleeve 25 sufficiently to release the second group of tangs 26 to permit the axial ejection or complete withdrawal of the pin contact terminals 14 from the socket contact terminals 18 by a plurality of release or ejection springs 31 peripherally arranged about the plug body 17, while the mechanical connection or coupling between plug member 10 and receptacle member 12 is maintained. The final stage of separation comprises a continuing actuation of the lanyard assembly 30 to effect a complete separation of locking sleeve 22 from the first group of tangs or fingers 24.

Some principal features of the fingers 24, peripherally arranged about receptacle sleeve 21 and mating with the locking sleeve 22, are a high lock tension capability and high resistance to excessive side loads imposed by vibration. This also applies to fingers 26 which are peripherally arranged about and matable with locking sleeve 22.

It is readily understood that the release or ejection springs 31 provide the energy for unlocking the second group of tangs or fingers 26 located in the plug member 10. When the mated plug member 10 and receptacle member 12 are subjected to high vibration levels these springs 31 must maintain enough force to accomplish release of the fingers 26 for disengagement of the contact terminals after the retainer 25 is retracted or drawn rearwardly by a pull on the lanyard assembly 30. To compensate for deflection or softening of the springs 31 at resonant frequencies, it is possible to incorporate springs of different spring rates which in effect provide different spring resonant frequencies. The present invention preferably incorporates three different spring rates in 24 release springs. This means that there are three groups of eight springs, each group having one specific rate. The spring size is so designed that a configuration of springs of two rates will produce enough force to release fingers 26 and disengage the contact terminals. In the event that the springs of one specific rate would deflect because of resonance under vibration, the remaining springs would maintain their force capability.

The primary locking device of the plug member 10 is the retainer sleeve 25. This retainer sleeve is a spring loaded mass and under certain conditions of shock or vibration this mass can move enough to unlock the fingers 24 which could result in premature release or pre-release of the entire connector.

To preclude this possibility, the secondary or auxiliary lock 28 is employed, which embodies considerably less mass than retainer sleeve 25 and which, until it is released itself, will stop any retraction of the retainer as a result of vibration or shock forces.

Referring, particularly, to FIGS. 1 and 2 which illustrate the initial stage of engagement of the plug member 10 with the receptacle member 12, the receptacle member 12 is mounted on the skin 32 of a vehicle, preferably an aircraft, by a plurality of fasteners 34 which extend through openings in the skin and openings in an external annular mounting flange 36 that is integral with and adjacent the forward end of a cylindrical receptacle shell 38. Integral with the rear end of the shell 38 is an inwardly extending annular flange 40, FIGS. 2 and 3, that defines an opening 42, for the wire leads 43 that are connected to the socket contact terminals 18. The receptacle sleeve 21, having a cylindrical configuration, is enclosed within the shell 38, in spaced relationship thereto and is secured to flange 40 by polarizing pins 44, FIGS. 2 and 4, which serve to properly axially align the sleeve within the shell. The combination of the shell and sleeve defines a cyindrical chamber 46 having a forwardly facing entrance which functions as an access passage for the locking sleeve 22 and the retainer sleeve 25.

The shell 38 is internally threaded adjacent flange 40 and the threads thereon are matable with threads on a ring 48 which is lodged within the chamber 46, FIGS. 2 and 3. Projecting axially forwardly from the ring and integral therewith are a plurality of spaced-apart fingers 24, preferably but not necessarily about thirty-six in number, which entirely circumscribe or are peripherally arranged about the sleeve 21 and are entirely disposed within the chamber 46 and therefore protected against damage. Proper positioning of the fingers 24 within the chamber 46 in order that they will resist the axial thrust of the locking sleeve 22 is achieved by the ring 48 having a rearwardly facing annular shoulder 50 thereon that abuts against a forwardly facing annular shoulder 52 on sleeve 21. Ring 48 is locked in position by a set screw 55.

An axial thrust on the plug member 10 toward the receptacle member 12 serves to introduce the forward end of the locking sleeve 22 and the forward end of a skirt 53 on the retainer sleeve 25 into the chamber 46 where an externally beveled edge 54 on the sleeve 22 abuts against

beveled edges 56 embodied in an inwardly extending projection 57 on each of the fingers 24, best seen in FIG. 16, causing the fingers to deflect radially outwardly from their natural position of repose and into the path of the forward edge 58 of the skirt 53 of the retainer sleeve 25. A continuing thrust on the plug member 10 forces the locking sleeve 22 rearwardly into the chamber 46 and the finger projections 57 ride over the locking sleeve 22 and hold back the retainer sleeve 25 until they are allowed to return toward their natural condition by springing into a catch in the form of an external annular groove 60 formed in the locking sleeve and best seen in FIG. 16.

Groove 60 has a configuration complementary to the configuration of the mating portion of the projections 57. Following mating of projections 57 with groove 60 which removes the fingers from the path of the skirt 53, the skirt is urged rearwardly in the receptacle in a manner hereinafter described in greater detail, over the fingers 24 to effect a locking of the fingers with the locking sleeve 22.

The groove 60 is defined by a forwardly facing inclined surface 62 that is complementary to the beveled forwardly facing edges 54 on the finger projections 57, and the groove 60 further embodies a rearwardly facing inclined surface 64 that is complementary to a rearwardly facing inclined edge 66 on the projections. The inclined surface 64 cams the projections 57 out of mating engagement with the groove 60 when the plug member 10 is separated from the receptacle member 12 in a maner to be hereinafter developed in greater detail.

The locking sleeve 22 is continually urged toward the forward end of the plug member 10 by compression springs 31, FIG. 2, but the limit of forward travel of the locking sleeve relative to the plug member is controlled by the tangs 26 which are normally in engagement with the locking sleeve 22 and which will be subsequently described in greater detail.

The compression springs 31, preferably, but not necessarily, twenty-four in number, are located at the rear end of the locking sleeve 22 where an annular collar 70, integral with the sleeve, includes a plurality of circumferentially arranged, rearwardly facing spring cavities 72, FIGS. 2 and 3, each of which is adapted to receive one end of the axially extending compression springs 31. The opposite end of each of the springs seats against a forwardly facing shoulder 74 of an annular flange 75 on the plug body 17. Support for each of the compression springs 31 is provided by a guide pin or roll-pin 76 which is encircled by a portion of a respective spring 31. One end of each guide pin is pressed into shoulder 74.

The ability of fingers 24 to hold the retainer sleeve 25 and prevent the skirt 53 from fully entering the chamber 46 during the preliminary engagement between the plug and receptacle members, as previously recited, depends on the position of the auxiliary lock 28 which is to be in the unlocked or release position during the preliminary engagement. The condition of the auxiliary lock depends on the position of the lanyard assembly 30 which controls the locking and release of the auxiliary lock. The position of the plug body 17 determines the position of the lanyard assembly 30 which is held by the plug body in a partially retracted position. The plug body 17 at this time is in its extreme rearward position in the plug connector member 10. Also, when the plug body 17 is thus rearwardly positioned to prevent locking of the auxiliary lock, the pin contact terminals 14 are not in mating engagement with the socket contact terminals 18, as may best be seen in FIGS. 1 and 2.

The ability of the plug body 17 to hold the lanyard assembly partially retracted is achieved by a pair of diametrically oppositely positioned lanyard bells 78 which, as shown in FIG. 13, are secured by fasteners 79 to an inwardly projecting annular flange 80 on the rear end 82 of the plug body 17. The lanyard bells each have a slotted opening 83 to accommodate a lanyard cable 84 and each engages a threaded collet clamp nut 86 on each lanyard

cable 84 when the plug body 17 is in the retracted position as best seen in FIG. 1. Each nut 86 is adjustable on its lanyard cable 84 and is locked by a respective threaded lock nut 86' which threadably mates with nut 86.

Also secured to flange 80 by fasteners 81 is a rearwardly extending cable adaptor or cylindrical sleeve 85 that provides a throat or opening through which electrical wire leads 87 pass, the leads being connected to pin contact terminals 14.

As a part of the initial preparation of the plug member 10 before any engagement thereof with the receptacle member 12, the plug body 17 is moved to its retracted or rearwardmost position in the plug member 10. Retraction of the plug body 17 is accomplished by the counterclockwise rotation of a ring 88, which is in circumscribing relationship adjacent the rear end of the plug body and which is connected to and causes the rotation of an internally threaded nut 90 having left-hand threads. Connection between the ring 88 and the nut 90 is made through a pair of opposed cylindrical keys 92, FIGS. 2 and 3. The threads of the nut are in mating engagement with external threads on a skirt 94 that spans the distance between flange 75 and flange 80 of the plug body 17. Clockwise rotation of the ring 88 will result in forward movement of plug body 17 in the plug member 10, and hence in mating engagement of the contact terminals as well as withdrawal of the lanyard bells 78 from engagement with nuts 86. This, in turn, will release the lanyard assembly 30 so that it will advance to its forwardmost position in the plug member which causes the auxiliary lock to be actuated to lock the retainer 25 in its forwardmost position in which it is superimposed over the fingers 24.

Adjacent the rear end of ring 88 and receivable in a groove therein is a locking ring 89 which is in abutting relationship to nut 86 and retains the nut in mating engagement with skirt 94.

The partially retracted position of the lanyard assembly 30 is imparted to a pair of opposed lanyard shafts 96, each of which is secured to a lanyard cable 84, and the position of the lanyard shafts determines whether the auxiliary lock 28 is in the release position or the lock position. Each lanyard shaft includes an inclined annular shoulder 98 that is at the juncture between an elongate forward portion 100 and an elongate rear portion 102, portion 102 having a greater diameter than portion 100. The annular shoulder 98 is employed to cam a cylindrical pin 104 into engagement to lock the auxiliary lock 28 and the rear portion 102 then holds the pin 104 in this locked position. However, with the partial retraction of the lanyard assembly 30, the reduced portion 100 is adjacent pin 104 to release the pin from the auxiliary lock 28, whereby the retainer sleeve 25 is unlocked and may be withheld by abutment against the tips of fingers 24 when the plug and receptacle connector members are first engaged.

Each of the lanyard shafts 96, best seen in FIGS. 8, 9, 12, 13 and 14, is slidably supported by an elongated bushing 108 which bridges the distance between a bore 110 in flange 75 and an axially aligned bore 112 in flange 80. Mounted on each of the lanyard cables 84 to the rear of portion 102 of each of the lanyard shafts 96 is a fitting 114, swaged to cable 84, which serves to position the cable centrally within the bushing. The fitting has an annular groove 116 which is adapted to receive an O-ring 118 which provides a moisture and dust seal.

The annular collar 70 on the locking sleeve 22 has a pair of opposed axial bores 120 therein, each of which accommodates a lanyard shaft 96.

The pair of opposed auxiliary locks 28, best seen in FIGS. 10, 11 and 13, are each located in the region adjacent to bores 120. Located adjacent to each bore 120 and parallel therewith is a bore 122 that receives one end, the rear end, 124 of a locking pin 126. On the side of bore 120 opposite bore 122 is another bore 128 that is parallel to bore 120 and receives the rear end 130 of a guide pin 132 that, with the assistance of locking pin 126,

guides the axial movement of the retainer sleeve 25. The forward ends 134 and 136 of locking pin 126 and guide pin 132, respectively, are threadedly secured to a rearwardly facing shoulder 138 of the retainer sleeve 25.

The rear end 124 of each locking pin 126 includes a pair of recesses 142, one of which is adapted to receive the respective pin 104, but pins 104 are released and withheld from engagement therewith when the lanyard assembly is partially retracted so as to unlock the retainer sleeve 25, as aforesaid. The pin 104 is laterally shiftable into and out of engagement with recess 142 in an opening 144 that communicates with bores 120 and 122.

Upon mating engagement of the projections 57 of fingers 24 with the groove 60, the fingers 24 are removed from interference with the movement of skirt 53 of the retainer sleeve 25. The skirt is then forced into a superimposed position over a portion of the fingers 24 to effect a locking together of the plug member 10 with the receptacle member 12. With the skirt 53 being in a superimposed position with respect to fingers 24, the finger projections 57 are prevented from being displaced from the annular groove 60 until the skirt is retracted in a manner to be hereinafter described.

Forcing of the skirt 53 to the locking position is accomplished by a plurality of circumferentially arranged, spaced apart retainer compression springs 146, preferably but not necessarily twelve in number, one end of each spring seating against shoulder 138 of retainer 25 and the opposite end of each spring is received in a shallow bore or cavity 148 in the annular collar 70 of locking sleeve 22. Each of the springs encircles a telescoping guide pin 150 having one end which is threadably secured to shoulder 138, and the opposite end of each pin bottoms in bore 148. Springs 146 are incapable of producing as much force as ejection springs 31, and for this reason springs 31 are capable of performing their function.

When the skirt 53 is at its forwardmost, locking position, fully inserted into chamber 46, a forwardly facing annular shoulder 152 on the skirt is proximate the extreme free end 154 of the fingers 24, best seen in FIGS. 14 and 16. Also, the retainer sleeve 25 is encased or covered with an elastomer material 155, preferably rubber, and this covering presents a forwardly facing shoulder 156 which abuts against the skin 32 of the aircraft.

Although the plug member 10 and the receptacle member 12 now are mechanically coupled together, the position of the plug body 17 has prevented mating of the pin contact terminals 14 with the socket contact terminals 18. However, when the mechanical coupling is achieved, axial alignment of the pin contact terminals with the socket contact terminals is accomplished, and this is done by the employment of a plurality of polarizing pins 158, FIGS. 2 and 3.

The polarizing pins 158 are each disposed within a forwardly facing bushing 160 mounted in insulator body 16, and the polarizing pins are secured in place by fasteners 162 which also serve to secure the insulator body 16 to a pair of partial rings or segments 164 and 165. Ribs or keys 164' and 165' integral with segments 164 and 165, respectively, are received in a groove 167 and secure the partial rings to plug body 17. The fit of insulator body 16 to the segments 164 and 165 forces the segments radially outward so that keys 164' and 165' are confined in groove 167.

The pin contact terminals 14 which are mounted in insulator body 16, may be arranged as densely as possible, if so desired, or in any manner considered suitable. The extreme free end of each pin terminal is considerably rearwardly disposed at all times with respect to the forwardmost, beveled edge 54 on the locking sleeve 22 and in this manner the pin contact terminals are always protected against damage.

With the mechanical coupling of the plug member 10 to the receptacle member 12 completed, the extreme forward free ends of the polarizing pins are inserted into

forwardly facing bushings 168 that are mounted in insulator body 20, FIGS. 2 and 3. The bushings, as well as the rear face 169 of the insulator body 20, are secured to a pair of partial rings or segments of rings 170 and 172 by fasteners 174. External ribs 176 and 178 are on the external sides of the respective segments 170 and 172, ribs 176 and 178 functioning as keys to secure said partial rings to the receptacle sleeve 21, as best seen in FIG. 3.

The socket contact terminals 18 are mounted in the insulator body 20 and a socket contact terminal is provided for each of the pin contact terminals 14.

Previously mentioned were the tangs or fingers 26 which serve to releasably lock the pin contact terminals 14 to the socket contact terminals 18. The locking position of the fingers 26 is established prior to the actual mating engagement of the terminals as may best be determined by referring to FIGS. 2 and 15.

The fingers 26, preferably but not necessarily thirty-six in number, are spaced apart, forwardly extending members that are integral with a cylindrical sleeve 179 that circumscribes a portion of the locking sleeve 22 and the plug body 17, and the fingers 26 are substantially entirely arranged about the periphery of the locking sleeve 22 and keyed to flange 75. On the rear end of the sleeve 179 is an annular external flange 181 that is disposed between the nut 90 and the ring 88, and between the flange 181 and the ring 88 is a thrust bearing 180. The keying of fingers 26 to flange 75 enables torque to be transmitted against flange 181 to accomplish translation of body 17.

The forwardmost end of each finger 26, best seen in FIG. 15, includes an enlargement 182 that embodies a rearwardly facing beveled edge 184 which is in the path of a forwardly facing inclined annular shoulder 186 that is a part of the retainer sleeve 25. The shoulder 186 abutting against the beveled edges 184 on each of the fingers 26 compensates for any bend which may occur in the fingers and cams the enlargements 182 radially inwardly where an inwardly extending portion 188 on each of the enlargements is received in a catch in the form of an annular groove 190 formed in the annular collar 70 of locking sleeve 22. In the absence of a bend in fingers 26, the fingers being resilient spring into groove 190. This springing is permitted to occur when the plug body 17 is retracted to its extreme rearward position in the plug member 10 when the plug member is being prepared for mating engagement with the receptacle member 12, at which time springs 31 are unloaded to an extent permitting springs 146 to overcome the frictional resistance between retainer sleeve 25 and lock sleeve 22 to drive retainer sleeve 25 forwardly to engage the enlargements 182 of fingers 26, and drive fingers 26 forwardly into registry with groove 190, camming enlargements 182 into groove 190.

The annular groove 190 embodies a forwardly facing annular shoulder 192 that abuts against a rearwardly facing beveled edge 194 on each of the fingers 26, and the forwardly facing shoulder 192 serves to cam the enlargements radially outwardly when separation of plug member 10 from receptacle member 12 occurs as will hereinafter be described in greater detail.

With inwardly extending portion 188 of fingers 26 completely lodged in groove 190, the retainer sleeve 25 is free to move to the position where the skirt thereof is at its forwardmost, locking position in chamber 46, and when this occurs the finger enlargements 182 are releasably locked in position by an inwardly facing annular surface 196 on the retainer sleeve 25 engaging the outer edge 198 on each of the enlargements 182.

With the skirt 53 of the retainer sleeve 25 in its forwardmost position completely disposed in chamber 46, and the enlargements 182 of the fingers 26 in the contracted position seated within groove 190, provision for releasably locking the pin contact terminals 14 to the socket contact terminals 18 is completed.

The final stage for completing a multiplicity of independent electrical circuits and locking the plug member **10** to the receptacle member **12** is bringing the pin contact terminals **14** into complete mating engagement with the socket contact terminals **18**. This is accomplished by rotating ring **88** clockwise, as previously mentioned, to cause the plug body **17** to travel axially forwardly toward the receptacle member **12**, which will result in the forward edge **201** of the plug body **17** abutting against the forward edge **203** of the receptacle sleeve **21**. An additional forward thrust obtained by the rotation of ring **88** places the fingers **26** under tension. The forward face **202** of the insulator body **16** is proximate to, but preferably not in abutting relationship with, the forward face **204** of insulator body **20**, and the pin contact terminals **14** enter into mating engagement with the socket contact terminals **18**, best seen in FIG. 3.

This final forward movement of plug body **17** causes the lanyard bells **78** also to move forwardly, releasing the lanyard assembly **30** which is biased forwardly by compression springs **206** and **207** seating against a pair of lanyard cages **208** which are connected to the lanyard shafts **96**, best seen in FIGS. 10, 11 and 13, and which will hereinafter be described in greater detail. Forward travel of lanyard shafts **96** brings annular shoulders **98** thereof into camming engagement with pins **104** to cause the pins to be received in the adjacent recesses **142** in locking pins **126**, thereby locking the retainer sleeve **25** against rearward travel.

The forward axial travel of the plug body **17** results in compressing and loading of the springs **31** which are employed for ejecting the pin contact terminals **14** from the socket contact terminals **18**, as previously recited. Springs **31** also introduce a tension in fingers **26**.

The lanyard assembly biasing springs **206** and **207** encircle locking pin **126** and guide pin **132**, respectively, and the resonant frequencies of these springs are below the vibration frequency band. The use of a low mass lanyard assembly **30** in the plug member **10** virtually precludes pre-release or premature release of the retainer sleeve **25** when the mated plug member **10** and receptacle member **12** are subjected to high vibration levels or shocks. To augment the performance of the auxiliary lock **28**, it is preferred that springs **206** and **207** be of different rates so that possible resonance in one spring at a harmonic frequency will not occur simultaneously in the other spring.

Separation of the pin contact terminals **14** from the socket contact terminals **18** and separation of the plug member **10** from the receptacle member **12** is accomplished in the reverse order given for engagement, by pulling on the lanyard cables **84** which are gathered at one end remote from the electrical connector by a fitting **210**, FIG. 1. The pull on the lanyard cables can be achieved in either one of two ways: by a direct pull on the lanyard cables; or the lanyard cables can be suitably anchored and the launching of the aircraft would achieve the same result.

When the lanyard cables **84** are pulled rearwardly, which, in turn, results in pulling the lanyard shafts **96** rearwardly, the first stage of separation occurs when rear portion **102** of each of the lanyard shafts clears pin **104** which may then be cammed laterally out of their locking positions by the locking pins **126**. The actual camming of the pins **104** is done when lanyard cages **208**, one being disposed on the forwardmost end of each lanyard shaft, engage an inwardly projecting annular lip **212** on the retainer sleeve **25** and commence retracting sleeve **25**.

The opposed lanyard cages **208** occupy a portion of a chamber **214** defined by the retainer sleeve **25**, rearwardly facing shoulder **138** of the retainer sleeve, the locking sleeve **22** and lip **212**. The lanyard cages each have a generally T-shaped configuration with the foot **216** of the cage having a slot **218** therein, FIG. 5, which accommodates portion **100** of the lanyard shaft, and the cap **220** of the cage also has a slot **221** therein to accommodate portion **100**. A disc-like enlargement or head **222** is integral with the extreme forward end of each of the lanyard shafts **96** and this disc serves to transmit the pull of the lanyard cable **84** to the respective lanyard cage **208**.

Prior to retainer sleeve **25** being retracted, the rear end of each spring **206** and **207** seats against an annular shoulder **224** or **226** on each of the locking pins **126** and guide pins **132**, respectively, FIGS. 10 and 11. When the auxiliary lock **28** is retracted in the manner illustrated in FIG. 13, the rear end of springs **206** and **207** seats against the forward face **227** of collar **70**.

It is to be noted that prior to lanyard cages **208** engaging lip **212**, portion **102** on the lanyard shafts **96** clears pins **104**. Following this clearance of pins **104**, a continuing pull on the lanyard cables **84** brings the lanyard cages into engagement with lip **212**. Retraction of the retainer sleeve to the position illustrated in FIG. 9 causes rearward travel of auxiliary locks **28** which serves to cam the pins **104** laterally to their release position.

Also, the continuous rearward pull on the lanyard cables results in surface **196** on the retainer sleeve clearing the outer edge **198** on each of the fingers **26**. In this condition, the ejection springs **31** are free to exert their force which accomplishes a dual purpose. First the force of the springs is exerted on the plug body **17** which is axially rearwardly propelled or ejected and which results in axially withdrawing the pin contact terminals **14** from the socket contact terminals **18** while a mechanical coupling of plug member **10** with receptacle member **12** is maintained. This method of separating the pin contact terminals from the socket contact terminals prevents damage thereto and to the polarizing pins. Since electrical circuit separation is accomplished before actual separation of the plug member **10** from the receptacle member **12**, danger of any possible explosion of fuel vapors by contact arcing is eliminated.

The rearward movement of the body **17** is employed to accomplish the second purpose. Since fingers **26** are carried rearwardly with body **17**, inclined shoulder **192** on the locking sleeve **22** cams the enlargements **188** on the fingers into the path of the retainer sleeve **25** so that the beveled edges **184** on each of the enlargements **188** engage the shoulder **186** on the retainer sleeve **25** and the springs **31** exert their force to further retract the retainer sleeve to the position illustrated in FIG. 12. However, rearward travel of the plug body **17** and structure associated therewith is limited by heads **229** on stop and alignment bolts **228** which extend through bores **230** in collar **70** of the locking sleeve **22**, best seen in FIGS. 7 and 13. One end of each of the bolts **228** is threadably secured to flange **75** of plug body **17** while the opposite end has the head **229** thereon which functions as the stop, as best seen in FIG. 13. The bolts **228** are also employed to align the locking sleeve **22** with the plug body **17**.

The final stage of separation of the plug member **10** from the receptacle member **12** is achieved by a continuing pull on the lanyard cables **84**. The lanyard cages **208** transmit the pulling force to the retainer sleeve **25** via lip **212** which results in retracting the skirt **53** of the retainer sleeve from the superimposed position over the fingers **24**. All the pulling force is now devoted to retracting the locking sleeve **22** which results in inclined surface **64** of the locking sleeve camming the enlargements **57** out of the groove **60** and deflecting the fingers **24**. Once the fingers are removed from the groove **60**, the locking sleeve **22** and retainer sleeve **25** may be retracted from the chamber **46** and the final separation of plug member **10** from receptacle member **12** is completed and the separation appears as in FIG. 14.

O-ring seals **232** are provided to prevent the entrance of moisture, dust and highly volatile fuels into the electrical connector, which could lower the efficiency of the electrical connector as well as create a hazardous condition of the type previously mentioned.

While the invention has been shown and described herein in what is conceived to be the most practical and preferred embodiment, it is recognized that departures may be made therefrom within the scope of the invention, which is therefore not to be limited to the details disclosed herein, but is to be accorded the full scope of the claims and so as to embrace any and all equivalent devices.

What is claimed is:

1. An electrical connector which comprises: a pair of interengageable members, each member having an insulator body unit; a contact element mounted in each body unit, said contact elements being in alignment and matable to complete an electrical circuit through the connector following interengagement of the members; a first means for releasably locking the members together, including a first catch on one of said members, peripherally disposed and normally relatively movable with respect to the one of said insulator body units associated with said one of said members, and a first releasable lock mechanism on the other of said members, and peripherally disposed with respect to the other insulator body unit and being releasably engageable with said first catch, said first releasable lock mechanism being arranged to be automatically engaged with said first catch by moving said members axially toward each other; a second means operable separably from said first means for releasably locking the contact elements together, including a second catch on said one of said members, and peripherally disposed with respect to said one insulator body unit, and a second releasable lock mechanism peripherally disposed with respect to and connected with said one insulator body unit, and being releasably engageable with said second catch to lock said one insulator body unit against separation movement relative to said first catch, said second releasable lock mechanism comprising an annular array of substantially parallel spring fingers.

2. An electrical connector which comprises: a pair of interengageable members, each member having an insulator body unit; a contact element mounted in each body unit, said contact elements being in alignment and matable to complete an electrical circuit through the connector following interengagement of the members; a first means for releasably locking the members together, including a first catch on one of said members, peripherally disposed and normally relatively movable with respect to the one of said insulator body units associated with said one of said members, and a first releasable lock mechanism peripherally disposed with respect to the other insulator body unit and being releasably engageable with said first catch; a second means for releasably locking the contact elements together and operable separately from said first means, said second means including a second catch on said one of said members, peripherally disposed with respect to said one insulator body unit, and a second releasable lock mechanism peripherally disposed with respect to and connected with said one insulator body unit, said second releasable lock mechanism beign engageable with said second catch to lock said one insulator body unit against separation movement relative to said first catch; and a movable retainer sleeve peripherally disposed with respect to and arranged to coact with said first and said second means to lock both of said means in their locked position and for precluding premature separation of said contact elements and premature separation of said members, said retainer sleeve being arranged to coact with both said means so that when said sleeve is moved from a position wherein both of said means are locked by said sleeve, said second means will be unlocked in sequence before said first means to provide for separation of said contacts before disengagement of said members.

3. An electrical connector which comprises: a pair of interengageable members, each member having an insulator body unit; a contact element mounted in each body unit, said contact elements being in alignment and matable to complete an electrical circuit through the connector following interengagement of the members; a first means for releasably locking the members together, including a first catch on one of said members, peripherally disposed and normally relatively movable with respect to the one of said insulator body units associated with said one of said members, and a first releasable lock mechanism peripherally disposed with respect to the other insulator body unit and being releasably engageable with said first catch; a second means for releasably locking the contact elements together, said second means being operable separately from said first means and including a second catch on said one of said members, peripherally disposed with respect to said one insulator body unit, and a second releasable lock mechanism peripherally disposed with respect to and connected with said one insulator body unit, said second releasable lock mechanism being engageable with said second catch to lock said one insulator body unit against separation movement relative to said first catch; a movable retainer sleeve peripherally disposed with respect to said first and second means and arranged to coact therewith for locking said first and said second means in their locking positions, and for precluding premature separation of said contacts and premature separation of said members, said retainer sleeve being arranged to coact with said first and said second means to effect unlocking of said second means in sequence before said first means when moved from a locking position to an unlocking position relative to said first and said second means to provide for separation of said contacts before disengagement of said members; and auxiliary locking means releasably engageable with said retainer sleeve to lock said sleeve in said locking position thereof, and resistant to vibrations that may affect the retainer sleeve.

4. An electrical connector which comprises: a pair of interengageable members, each member having an insulator body unit; a contact element mounted in each body unit, said contact elements being in alignment and matable to complete an electrical circuit through the connector following interengagement of the members; means for releasably locking the members together including a catch mechanism on one of said members peripherally disposed and normally relatively reciprocally movable with respect to the one of said insulator body units associated with said one of said members, and a releasable lock mechanism peripherally disposed with respect to the other insulator body unit and engageable with said catch mechanism, said one insulator body unit being arranged for limited disengagement movement while said releasable lock mechanism is engaged with said catch mechanism; movable retaining means on said one of said members arranged in a first position to lock said one insulator body unit in mated position and said releasable locking means in engaged position, and when moved to a second position to sequentially release said one insulator body unit before said releasable locking means, and resilient force producing ejecting means disposed between said one insulator body unit and said one of said members to automatically achieve ejection separation of said contacts when said movable retaining means is moved to said second position.

5. An electrical connector according to claim 4, wherein said force producing a ejecting means includes a plurality of compression springs having different resonant frequency rates resulting in certain of said springs being resistant to vibrations that affect certain other of said springs, less than the total number of said springs being effective to achieve the operation of ejection and separation.

6. An electrical connector according to claim 4, wherein said force producing ejecting means includes a plurality of compression springs peripherally disposed about said one of said insulator body units.

7. A multi-contact electrical connector comprising: a

plug member which embodies a cylindrical locking sleeve having a pair of annular grooves therein, one being adjacent the forward end thereof and one being adjacent the rearward end thereof; a receptacle member which embodies a ring having a plurality of forwardly extending resilient fingers integral therewith, each of said fingers having projections on the forward end thereof that are engageable with the annular groove in the forward end of said locking sleeve to achieve axial alignment and engagement of said plug member with said receptacle member; a reciprocal retainer sleeve circumscribing said locking sleeve and adapted to assume a superimposed position over said fingers to prevent premature separation of the locking sleeve and fingers when the plug member and receptacle member are interengaged; an insulator body unit disposed within said receptacle member and having a plurality of forwardly extending contact elements mounted therein; a reciprocal insulator body unit disposed within said plug member and having a plurality of forwardly extending contact elements mounted therein which are matable with the contact elements of the receptacle member, said insulator body unit being movable within said plug member between mated and unmated positions; means connected to the insulator body unit of the plug member and arranged to coact with said locking sleeve and said retainer sleeve, and operable to move said insulator body unit to said mated position for producing mating engagement of said contact elements following interengagement of said plug member and receptacle member, said means including a ring having a plurality of forwardly extending resilient fingers, each of which has an enlargement thereon that is receivable in said groove adjacent the rearward end of said locking sleeve and which serves as a releasable lock for said contact elements, said retainer sleeve being arranged to coact with said forwardly extending fingers on said ring and said locking sleeve to prevent release of said releasable lock when said retainer sleeve is in said superimposed position; an auxiliary lock engageable with said retainer sleeve and arranged to coact with said locking sleeve to lock said retainer sleeve in said superimposed position to prevent premature separation of said members and contacts; force producing ejecting means engageable with said insulator body unit of the plug member for ejecting the contact elements of the plug member from the contact elements of the receptacle member; and a lanyard assembly arranged to coact with said locking and retainer sleeves and engageable with the auxiliary lock to effect the locking and release thereof when the plug member and receptacle member are interengaged, a portion of said lanyard assembly being engageable by the insulator body unit of the plug member when said insulator body unit is in its unmated position, and being arranged to coact therewith to hold said auxiliary lock in a released position until the plug member and receptacle member are interengaged with the retainer sleeve being in the superimposed position over said fingers; said lanyard assembly being engageable with the retainer sleeve and arranged to coact therewith to produce a sequence of separation of first the contact elements and then the connector members.

8. A multi-contact electrical connector according to claim 7, wherein the fingers of the receptacle member are peripherally disposed about the insulator body unit of the receptacle member to produce a high lock tension capability and high resistance to excessive side loads imposed by vibration.

9. A multi-contact electrical connector according to claim 7, wherein the auxiliary lock is of less mass than the retainer sleeve and therefore substantially free of the influence of frequencies of vibration that may affect the function of the retainer sleeve.

10. A multi-contact electrical connector according to claim 7, wherein the force producing ejecting means includes a plurality of compression springs divided into groups, each group having a different resonant frequency rate than the other groups which results in certain of said springs being free of the influence of frequencies of vibration that may affect the function of certain other springs, the ejecting force that is required in the connector being less than the total number of springs available.

11. A multi-contact electrical connector according to claim 7, wherein the groove adjacent the forward end of said locking sleeve embodies an inclined surface complementary to an inclined edge on each of the respective finger projections that cams the projections out of mating engagement with the groove when separation of the plug member and receptacle member occurs.

12. A multi-contact electrical connector according to claim 7, wherein said retainer sleeve includes an inclined shoulder complementary to a first inclined edge on each of the enlargements in mating engagement with the groove adjacent the rearward end of said locking sleeve, and the groove adjacent the rearward end of said locking sleeve embodies an inclined surface complementary to a second inclined edge on each of the respective enlargements, whereby the inclined surface of the groove cams the enlargements out of the groove and the first inclined edge into abutting engagement with the inclined surface on the retainer sleeve to effect partial withdrawal of the retainer sleeve from the superimposed position over the fingers of the receptacle member when separation of plug member and receptacle member occurs.

13. A multi-contact electrical connector according to claim 7, wherein said lanyard assembly embodies a lanyard cage that abuts against a projection on said retainer sleeve when said lanyard assembly is actuated to produce withdrawal of said retainer sleeve from the superimposed position over the fingers of said receptacle member and to produce separation of said locking sleeve with the fingers of said receptacle member.

14. An electrical connector which comprises: a pair of interengageable members, each member having a contact unit mounted therein, said contact units being in alignment and matable to complete an electrical circuit through the connector when the members are interengaged, the contact unit mounted within one of said members being reciprocally movable relative thereto between mated and unmated positions relative to the other contact unit while said members are interengaged; releasable locking means for locking said members together in interengaged relationship and for locking said contact units in mated position, said locking means being operable to release said contact units in sequence before said members are released from locked interengaged relationship; and contact unit separation means in said one of said members and in engagement with said one contact unit, and arranged to separate said contact units when said locking means is operated to release said contact units, said separation means comprising a plurality of spaced springs having different resonant frequency rates.

15. An electrical connector as defined in claim 14 wherein said springs are coil compression springs.

16. An electrical connector as defined in claim 14 wherein said springs are coil compression springs arranged parallel to each other and to the axis of said contact units.

17. An electrical connector which comprises: a pair of interengageable members, each member having a contact unit mounted therein, said contact units being matable to complete an electrical circuit through the connector when the members are interengaged; and releasable locking means for locking the members together in interengaged relationship, said locking means including a catch means on one of said members, a latch means on the other of said members engageable with said catch means, and a third member on said one of said members movable between a retaining position and a release position for alternately retaining said catch means and said latch means in engagement, and releasing said catch means and said

latch means for separation, respectively; and a plurality of spaced springs having different resonant frequency rates carried by said one of said members and arranged to exert force in the same direction on said third member for biasing said third member toward said retaining position.

References Cited in the file of this patent

UNITED STATES PATENTS

2,324,891	Thumim	July 20, 1943
2,434,740	Glaser et al.	Jan. 20, 1948
2,566,993	Parsons	Sept. 4, 1951
2,710,384	Dupre et al.	June 7, 1955
2,724,093	Preston	Nov. 15, 1955
2,735,993	Humphrey	Feb. 21, 1956
2,756,085	Hochstadt	July 24, 1956
2,853,690	Madison	Sept. 23, 1958
2,892,991	Beebee et al.	June 30, 1959
2,983,893	Jackson	May 9, 1961
2,987,691	Ross	June 6, 1961
3,043,925	Wilson	July 10, 1962
3,063,032	Brush	Nov. 6, 1962
3,067,400	Fruh	Dec. 4, 1962

FOREIGN PATENTS

99,574	Austria	Apr. 10, 1925
843,859	Great Britain	Aug. 10, 1960