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R. G. PETERSON ET AL
AUXILIARY LOCKING DEVICE FOR QUICK DISCONNECT
UMBILICAL CONNECTOR

3,156,512

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FIG. 2.

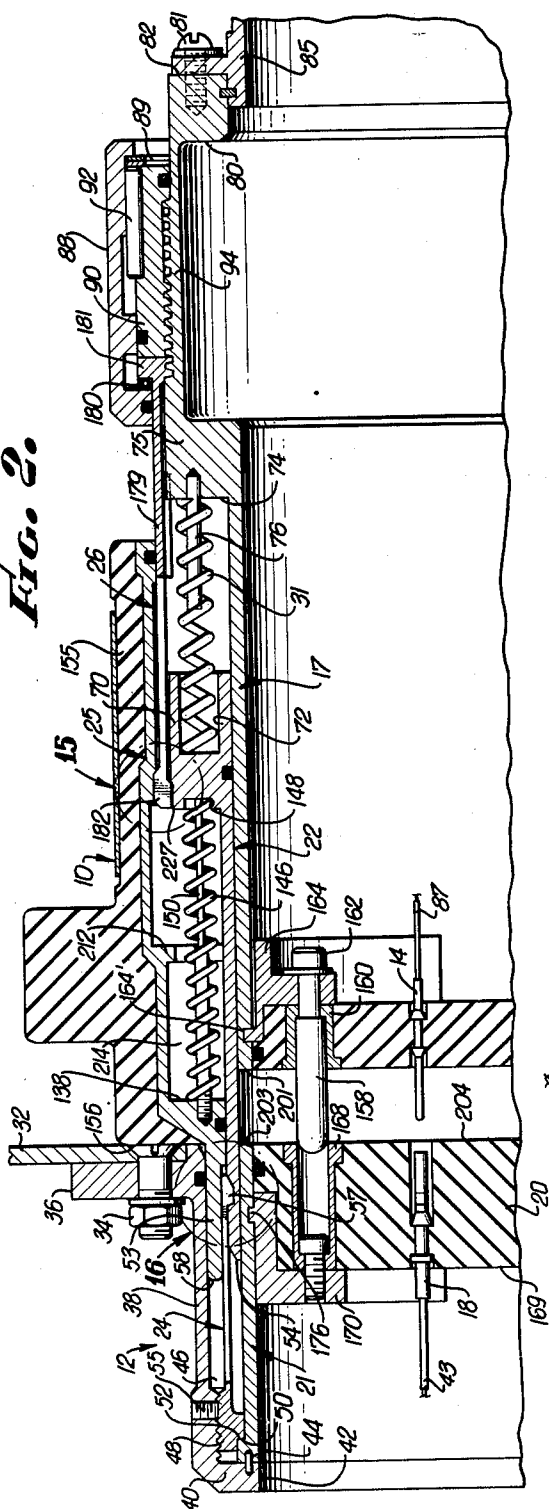
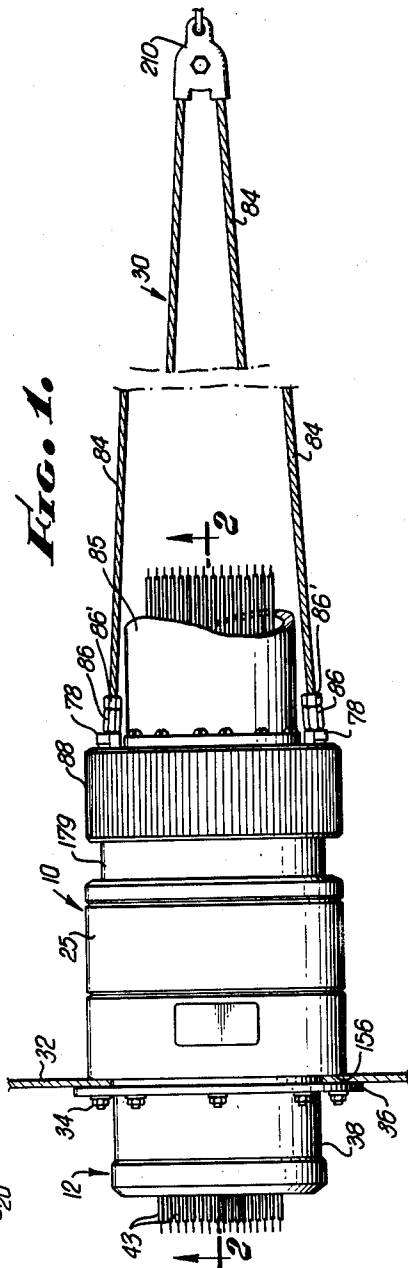


FIG. 1.

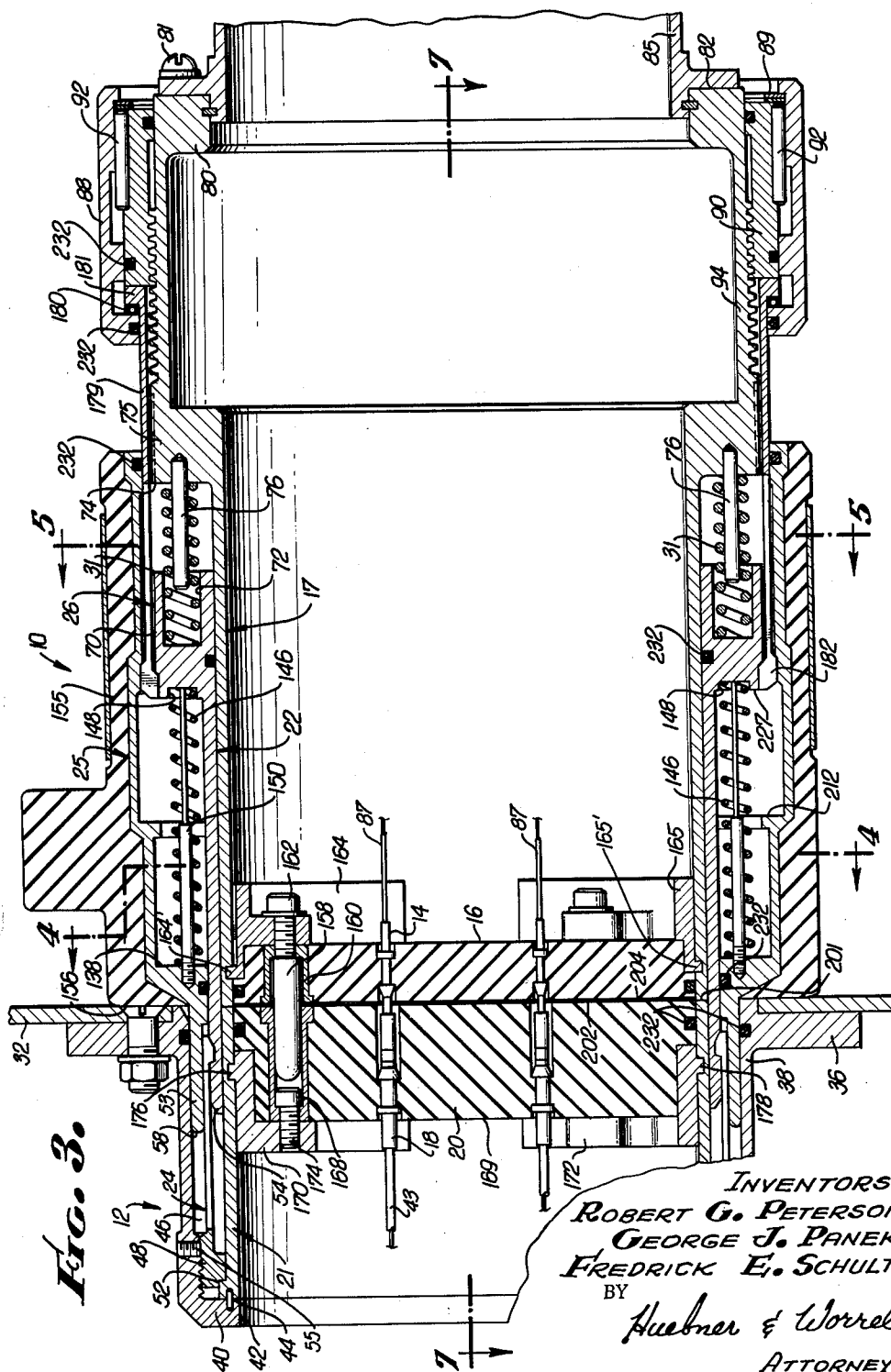


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FIG. 4.

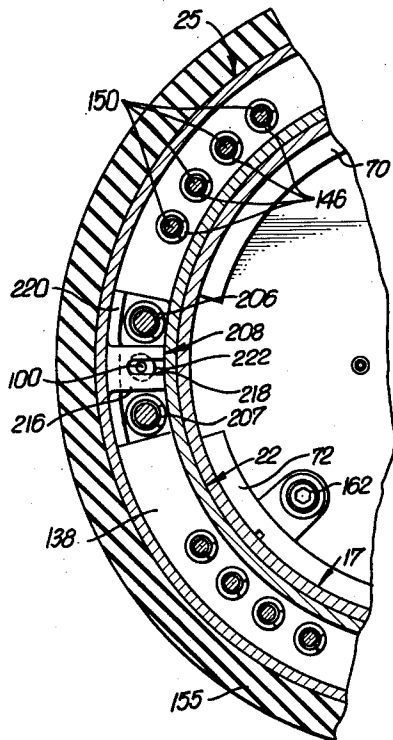


FIG. 5.

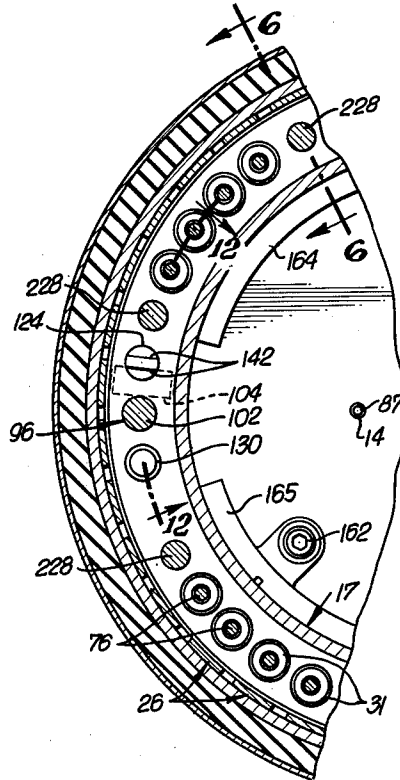
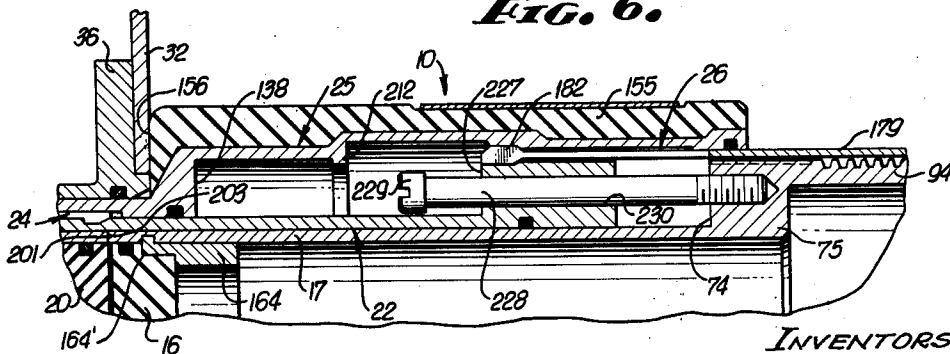


FIG. 6.



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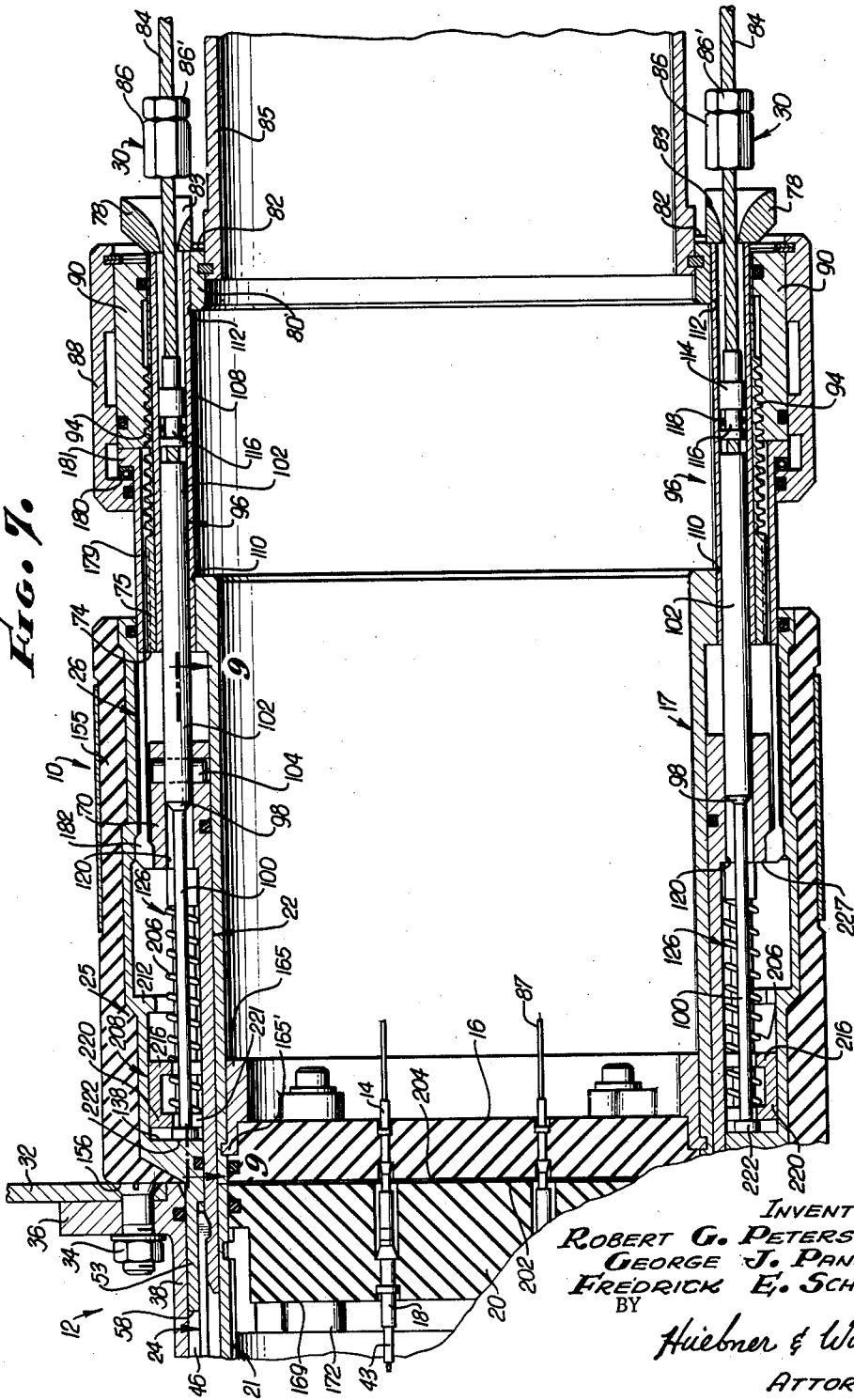
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Fig. 7.



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FIG. 8.

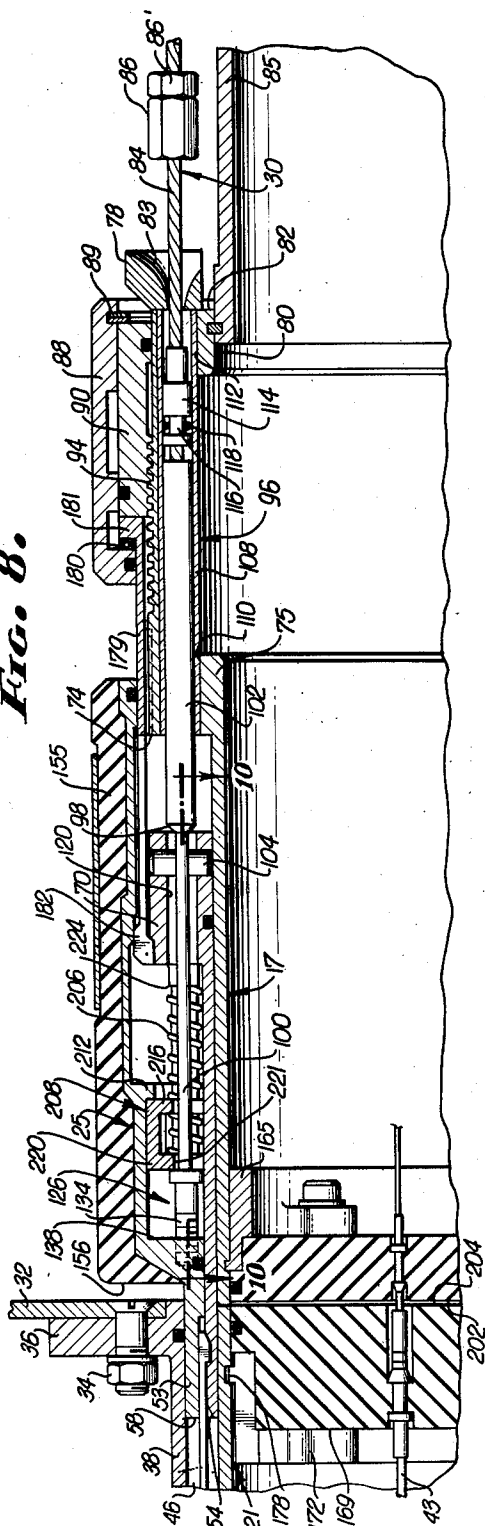


FIG. 10.

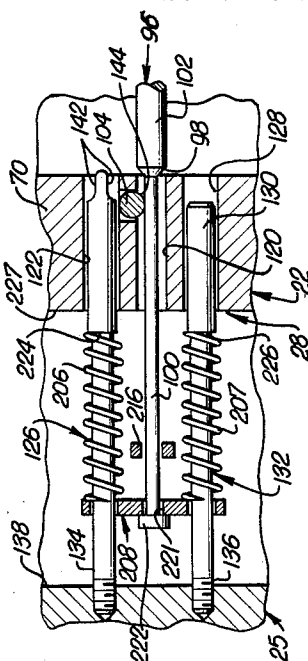
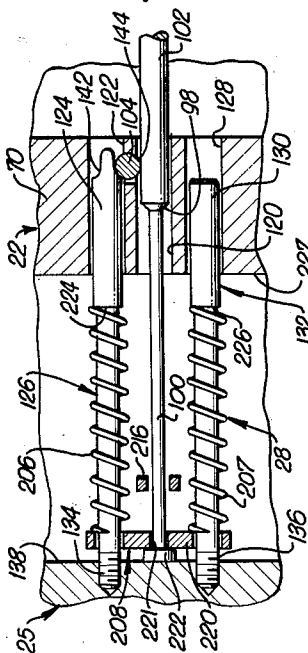


FIG. 9.



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FIG. 11.

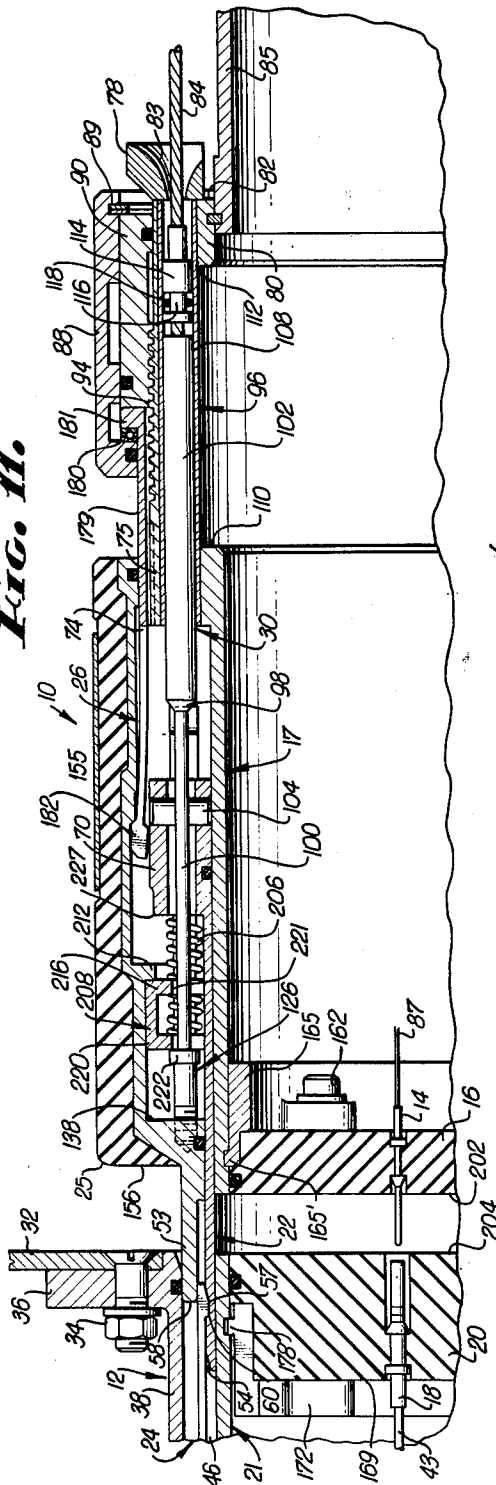
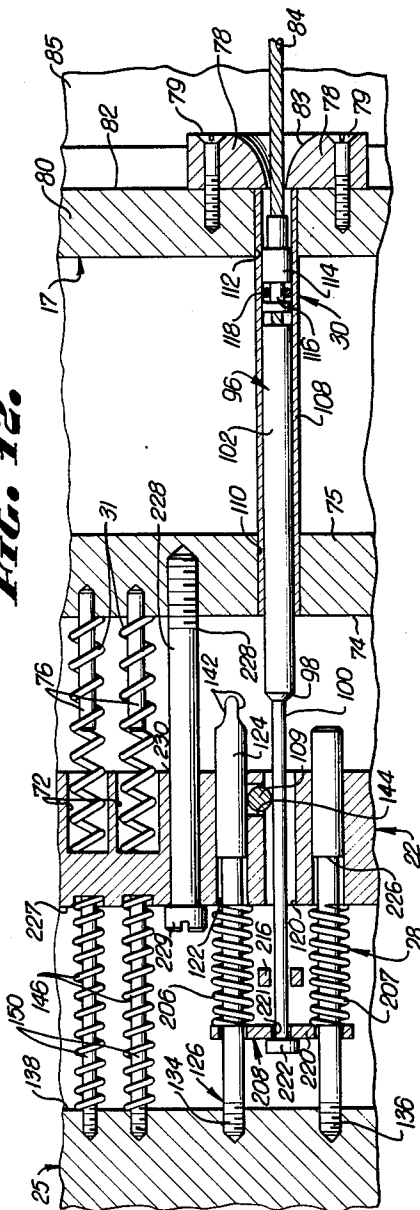


FIG. 12.



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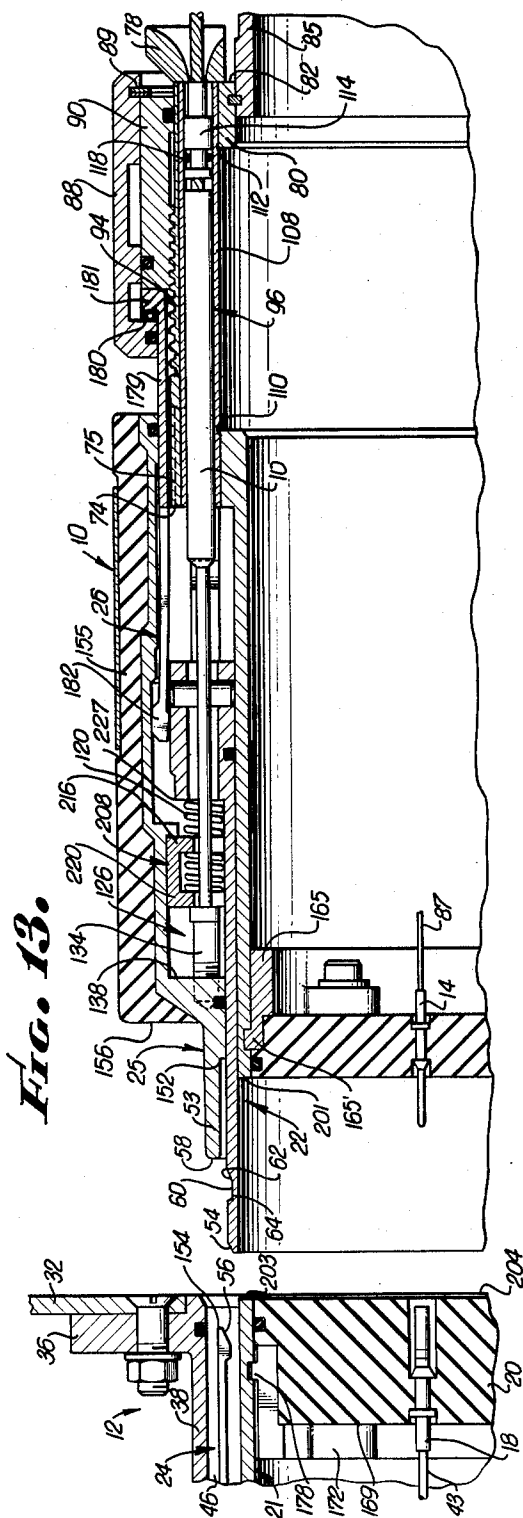


FIG. 15.

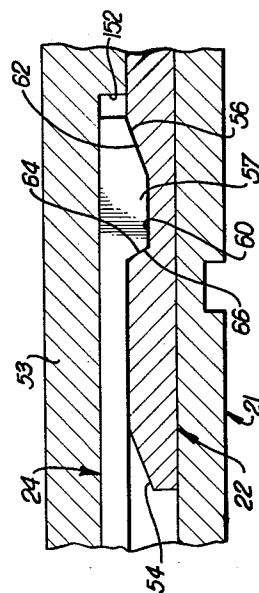
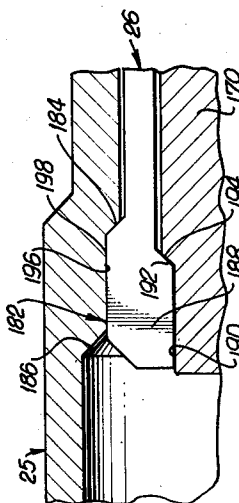


FIG. 14.



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AUXILIARY LOCKING DEVICE FOR QUICK DIS- CONNECT UMBILICAL CONNECTOR

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17 Claims. (Cl. 339-45)

This invention relates to electrical connectors, and more particularly, to umbilical electrical connectors that include a plug member which is releasably locked in mating engagement with a receptacle member to complete a plurality of independent electrical circuits; and to preclude premature separation of the members, an auxiliary or secondary lock is provided.

An object of this invention is to provide an auxiliary locking device that serves to preclude premature release of a primary locking structure which includes a retainer employed to releasably lock a plug member and associated contact elements in mating engagement with a receptacle member and associated contact elements, respectively, all of which are embodied in an umbilical electrical connector.

Another object of this invention is to provide an auxiliary locking device of the aforementioned character wherein the auxiliary locking device has considerably less mass than the retainer and is not subject to certain frequencies of vibrations and shocks that may affect the retainer to cause a premature separation of plug member from receptacle member in the absence of corrective structure embodied in the auxiliary locking device.

A yet further object of this invention is to provide an auxiliary locking device of the aforementioned character wherein release of the auxiliary locking device is achieved by the actuation of a low mass lanyard assembly which includes structure that insures locking of the auxiliary locking device and provides means whereby release of the auxiliary locking device occurs at the most strategic time and under the most desirable conditions.

A specific object of this invention is to provide an auxiliary or secondary locking device for an umbilical electrical connector wherein the connector includes a plug member having a plurality of contact elements mateable in releasable locking engagement with a corresponding number of complementary contact elements of a receptacle member to complete a plurality of independent electrical circuits following the releasable locking engagement of the plug member with the receptacle member, and premature separation of the locking engagement of the contact elements and the members is precluded by the aforementioned auxiliary locking device.

A more specific object of this invention is to provide an auxiliary or secondary locking device for an umbilical connector of the character described wherein the releasable locking engagement of the contact elements and the connector members is achieved by groups of fingers wherein one group of fingers engages a catch to releasably lock the members together and another group of fingers engages a catch to releasably lock the contact elements in mating engagement and a single retainer is employed as a primary locking device to retain the fingers of each group in their respective catches, and the auxiliary lock of the present invention serves to preclude premature release of the retainer.

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 elevational view, illustrating an umbilical electrical connector embodying the present invention;

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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 the plug member in final releasable locking engagement with a plurality of electrical circuits completed;

FIG. 4 is a fragmentary, cross-sectional view taken on line 4-4 of FIG. 3;

FIG. 5 is a fragmentary, cross-sectional view taken on line 5-5 of FIG. 3;

FIG. 6 is a fragmentary sectional view taken on line 6-6 of FIG. 5, and illustrating a stop bolt located in the plug member;

FIG. 7 is a sectional view taken on line 7-7 of FIG. 3, and illustrating further details of the plug member and receptacle member in their fully engaged position;

FIG. 8 is a sectional view illustrating approximately one-half of the structure disclosed in FIG. 7, and showing the first stages of separation of the plug member from the receptacle member;

FIG. 9 is a cross-sectional view taken on line 9-9 of FIG. 7, and illustrating auxiliary or secondary lock structure, of the present invention, in the locked position;

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

FIG. 11 is a view similar to FIG. 8, 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. 12 is an enlarged, cross-sectional view taken on line 12-12 of FIG. 5;

FIG. 13 is a view similar to FIG. 11, but illustrating the positions of various components following complete separation of plug member from receptacle member;

FIG. 14 is an enlarged view of the encircled portion of FIG. 2 identified by the numeral 14; and

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

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 16 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 mateable 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, FIG. 2, which serve to properly axially align the sleeve within the shell. The combination of the shell and sleeve defines a cylindrical 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 mateable 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, FIGS. 2 and 3. 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. 15, 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. 15.

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 manner 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, in-

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tegral 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. 12, 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 counter-clockwise 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 assem-

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bly 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 portion 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. 7, 8, 11, 12 and 13, 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 a 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 that 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. 9, 10 and 12, 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 threadably 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. 13 and 15. 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 are now 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 grooves 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 14.

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. 14, includes an enlargement 182 which 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. 9, 10 and 12, and which will hereinafter be described in greater detail. Forward travel of lanyard shafts 96 bring 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. 4, 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. 9 and 10. When the auxiliary lock 28 is retracted in the manner illustrated in FIG. 12, 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 continuous 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. 8 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 mem-

ber 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. 11. 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. 6 and 12. 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. 12. 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. 13.

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.

We claim:

1. A quick disconnect umbilical electrical connector having an auxiliary locking device, said connector comprising: a plug member and a receptacle; releasable lock means on said members engageable to lock them together in mating engagement; a contact element in the plug member mateable with a contact element in the receptacle member to complete an electrical circuit; a primary locking means slideably mounted on one of said members and movable to releasably lock said releasable lock means in mating engagement; and an auxiliary locking device arranged to coact with said primary locking means for releasably locking the primary locking means to preclude premature release of the releasable lock means, said auxiliary locking device comprising a member connected to said primary locking means; a first means carried by said one member and releasably engageable with said member connected to said primary locking means to preclude premature release movement of said primary locking means; and a second means carried by said one member and movable between a locking position in which it holds said first means in engagement with said member connected to said primary locking means, and a release position in which it permits release of said first means from said member connected to said primary locking means.

2. A quick disconnect umbilical electrical connector

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having an auxiliary locking device according to claim 1 wherein said member connected to said primary locking means includes an elongated shaft having a shoulder thereon that serves to cam said first means out of engagement therewith when said second means is in its release position.

3. A quick disconnect umbilical electrical connector having an auxiliary locking device according to claim 1 wherein said first means includes a cylindrical pin.

4. A quick disconnect umbilical electrical connector having an auxiliary locking device according to claim 1, wherein said second means includes a shaft having a shoulder thereon that serves to cam said first means into engagement with said member connected to said primary locking means.

5. A quick disconnect umbilical electrical connector having an auxiliary locking device according to claim 1, wherein said second means includes a reciprocal shaft having a first cylindrical portion and a second cylindrical portion; said second cylindrical portion having a greater diameter than said first portion and when in engagement with said first means serving to retain said first means in engagement with said member connected to said primary locking means, and said first portion when adjacent said first means serving to permit release of said first means from said member connected to said primary locking means.

6. A quick disconnect umbilical electrical connector having an auxiliary locking device, said connector comprising a plug member and a receptacle member; means on said plug and receptacle members engageable to releasably lock them together in mating engagement; a contact element in the plug member mateable with a contact element in the receptacle member to complete an electrical circuit; a primary locking means slideably mounted on one of said members and movable for releasably locking said releasable lock means in mating engagement; and an auxiliary locking device on said one member arranged to coact with said primary locking means for releasably locking the primary locking means to preclude premature release of the releasable lock means, said auxiliary locking device comprising a first member and a second member each being connected to said primary locking means and being slideable within said one member, and each being employed as a guide to guide the sliding movement of said primary locking means with respect to said plug and receptacle members, a first means carried by said one member and releasably engageable with said first member which precludes sliding of said primary locking means and consequent premature release of said releasable lock means; and a second means carried by said one member and movable between a locking position in which it holds said first means in engagement with said first member, and a release position in which it permits release of said first means from said first member; and means connected to said second means for effecting movement thereof.

7. A quick disconnect umbilical electrical connector having an auxiliary locking device according to claim 6, wherein said first and second members are a pair of parallel shafts.

8. A quick disconnect umbilical electrical connector according to claim 6, wherein said primary locking means and said auxiliary locking device have different vibration resonance characteristics.

9. A quick disconnect umbilical electrical connector according to claim 6, wherein the auxiliary locking device is of less mass than the primary locking means and therefore substantially free of the influence of shocks and frequencies of vibration that may affect the function of the primary locking means.

10. In a quick disconnect umbilical electrical connector having 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 mateable to complete an electrical circuit through the connector following interengagement of the

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members, means for releasably locking the members together including a catch peripherally disposed with respect to one insulator body unit and a releasable lock means peripherally disposed with respect to the other insulator body unit and being engageable with said catch, and a retainer movably mounted on one of said members and engageable with said first mentioned means and holding said releasable lock means and catch in engaged position; a plurality of auxiliary locking devices peripherally arranged in one of said members coacting with said retainer for releasably locking the retainer to preclude premature release of said retainer and separation of said members and contact elements, each auxiliary locking device comprising a first and a second shaft connected to said retainer and being slidable in a pair of parallel bores in said releasable lock means whereby said retainer is guided through its movement; said first shaft having a shoulder thereon; a pin releasably engageable with said shoulder; and a movable means in said one member engageable with said pin to releasably hold said pin in engagement with said shoulder.

11. A quick disconnect umbilical electrical connector having auxiliary locking devices according to claim 10, wherein said auxiliary locking devices are components of a lanyard assembly employed to effect release of said auxiliary locking devices, and disconnection of said connector.

12. A quick disconnect umbilical electrical connector having auxiliary locking devices according to claim 10, wherein said movable means includes a shaft having a first portion, a second portion and a cam surface between said portions whereby the cam surface cams said pin into engagement with said shoulder, said first portion holds said pin in engagement with said shoulder and said second portion permits the shoulder to cam the pin out of engagement therewith when said second portion is adjacent said pin.

13. A quick disconnect umbilical electrical connector having auxiliary locking devices according to claim 10, wherein said releasable lock mechanism includes a bore which is between said pair of bores and in which said movable means is guided through its movement, and said pin is disposed in an aperture that communicates with one of said pair of bores and with the bore in which said means is movable.

14. A quick disconnect umbilical electrical connector having auxiliary locking devices according to claim 10, wherein said auxiliary locking devices are in substantially diametrically opposed relationship in said one member.

15. In a quick disconnect umbilical electrical connector having a pair of interengageable members, a contact element mounted in each member, said contact elements being in alignment and mateable to complete an electrical circuit through the connector, releasable lock means on said members and engageable to secure said members together, and primary locking means slideable on one of said members for releasably locking said releasable lock means in mating engagement; an auxiliary locking device carried by said one member and arranged to coact with said primary locking means for releasably locking the primary locking means against sliding movement, whereby to preclude premature release of said releasable lock means and separation of said members and contact elements, said auxiliary locking device including a movable shouldered member connected to said primary locking means, a detent carried by said one member and movable between a first position, wherein the detent is engageable with said shoulder to lock said primary locking means against sliding movement on said one member when said primary locking means is positioned to lock said releasable lock means, and a second position, wherein the detent is free of the path of travel of said shouldered member to release said primary locking means for sliding movement into an unlocking position relative to said releasable

lock means, and an element carried by said one member and movable between a first position to hold said detent in its first position and a second position enabling said detent to move to its second position.

16. In a quick disconnect umbilical electrical connector having a pair of interengageable members, a contact element mounted in each member, said contact elements being in alignment and mateable to complete an electrical circuit through the connector, releasable lock means on said members and engageable to secure said members together, and primary locking means slideable on one of said members for releasably locking said releasable lock means in mating engagement; an auxiliary locking device carried by said one member and arranged to coact with said primary locking means for releasably locking the primary locking means against sliding movement whereby to preclude premature release of said releasable lock means and separation of said members and contact elements, said auxiliary locking device including a member connected to said primary locking means and having a shoulder thereon, a detent carried by said one member and releasably engageable with said shoulder, and a movable shaft carried by said one member, and having a cam surface and a portion engageable with said detent to hold said detent in engagement with said shoulder, said shaft being movable from a first position to engage said cam surface with said detent to cam said detent into a position engageable with said shoulder and to position said portion in engagement with said detent to hold said detent in engageable position with said shoulder to lock said primary locking means against sliding movement, and a second position where said portion is removed from its detent holding position, permitting said shoulder to cam said detent out of engagement therewith to release said primary locking means for sliding movement.

17. In a quick disconnect umbilical electric connector having a pair of interengageable members, a contact element mounted in each member, said contact elements being in alignment and mateable to complete an electrical circuit through the connector, releasable lock means on said members and engageable to secure said members together, and primary locking means slideable on one of said members for releasably locking said releasable lock means in mating engagement; an auxiliary locking device

carried by said one member, and arranged to coact with said primary locking means for releasably locking the primary locking means against sliding movement, whereby to preclude premature release of said releasable lock means and separation of said members and contact elements, said auxiliary locking device including a member connected to said primary locking means and having a shoulder thereon, a detent carried by said one member and releasably engageable with said shoulder, and a reciprocal shaft carried by said one member and engageable with said detent, said shaft having a first portion, a second portion and a cam surface between said portions, said cam surface being engageable with said detent to cam said detent into an engageable position with said shoulder and said first portion being engageable with said detent to hold said detent in engageable position with said shoulder to lock said primary locking means against sliding movement, said shoulder being arranged to cam said detent out of engagement therewith when said second portion is adjacent said detent to release said primary locking means.

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