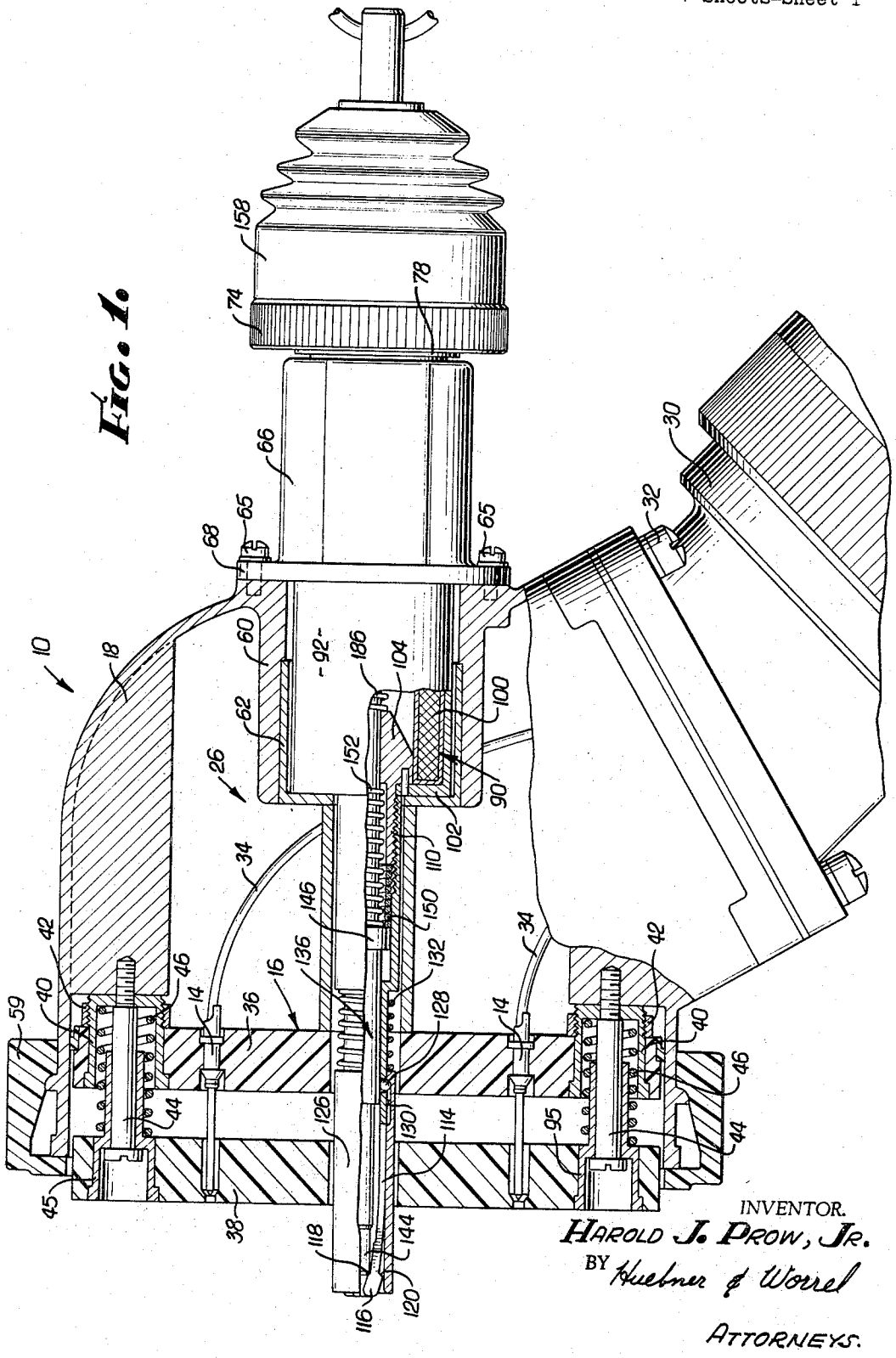
Aug. 8, 1967 H. J. PROW, JR 3,335,391

UMBILICAL CONNECTOR LOCK MECHANISM

Filed Feb. 3, 1964 7 Sheets-Sheet 1

FIG. 1.



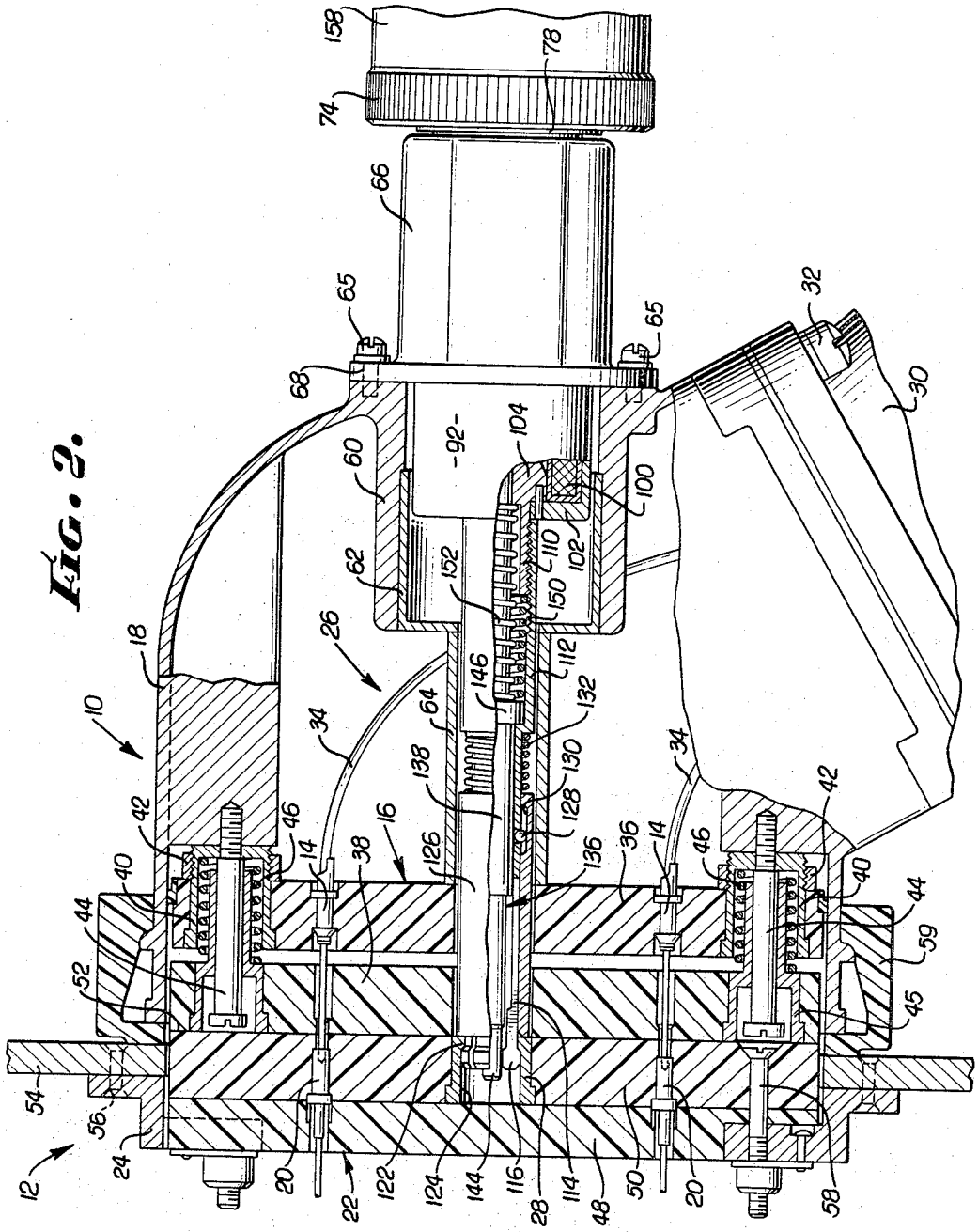
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UMBILICAL CONNECTOR LOCK MECHANISM

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FIG. 2.



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UMBILICAL CONNECTOR LOCK MECHANISM

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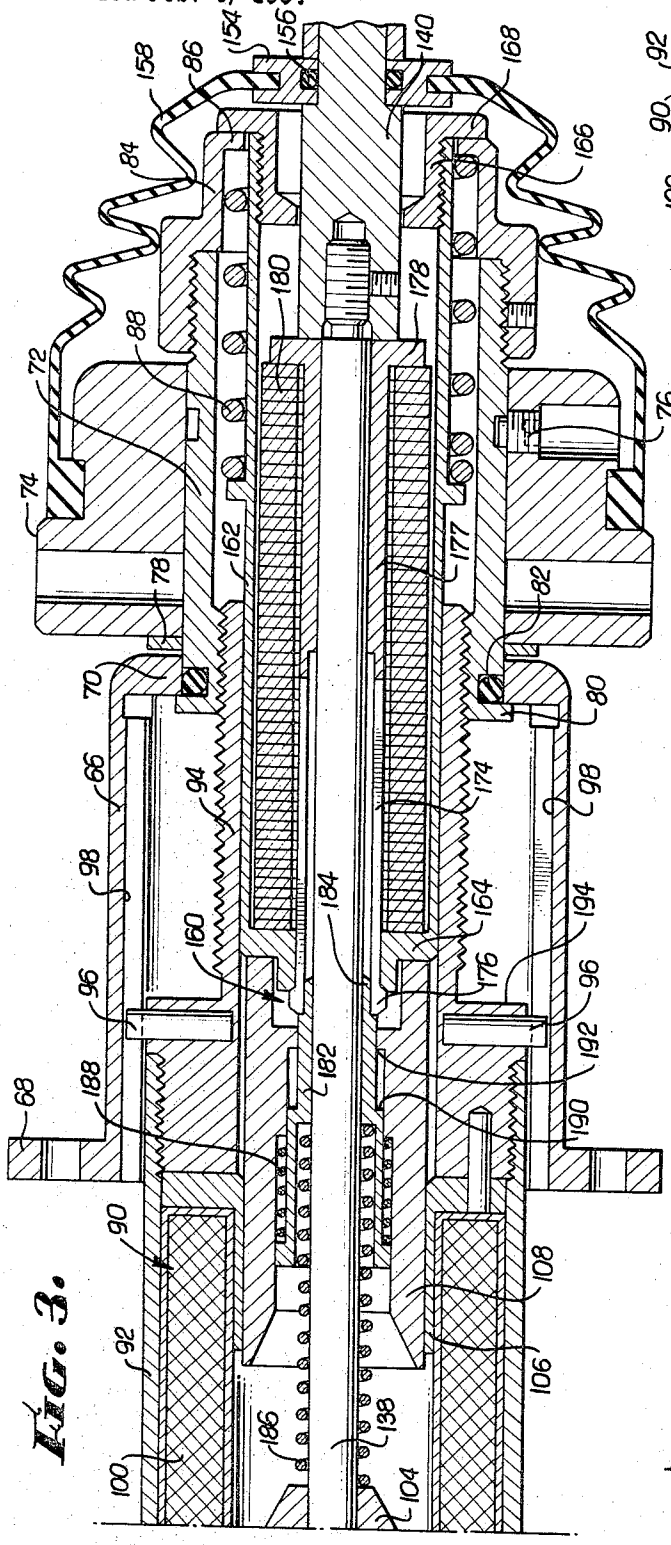


FIG. 3.

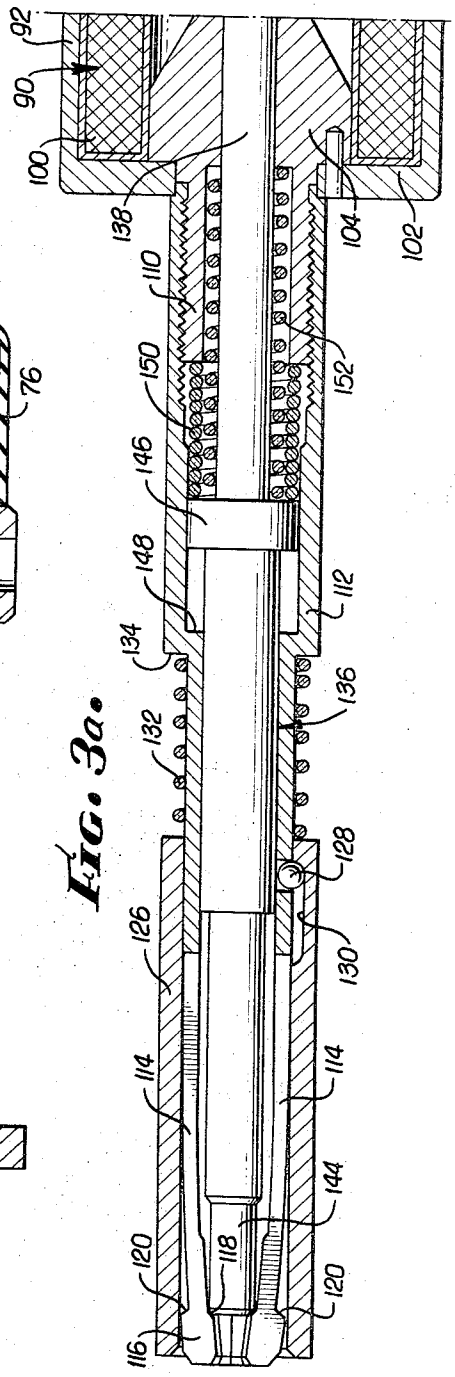


FIG. 3a.

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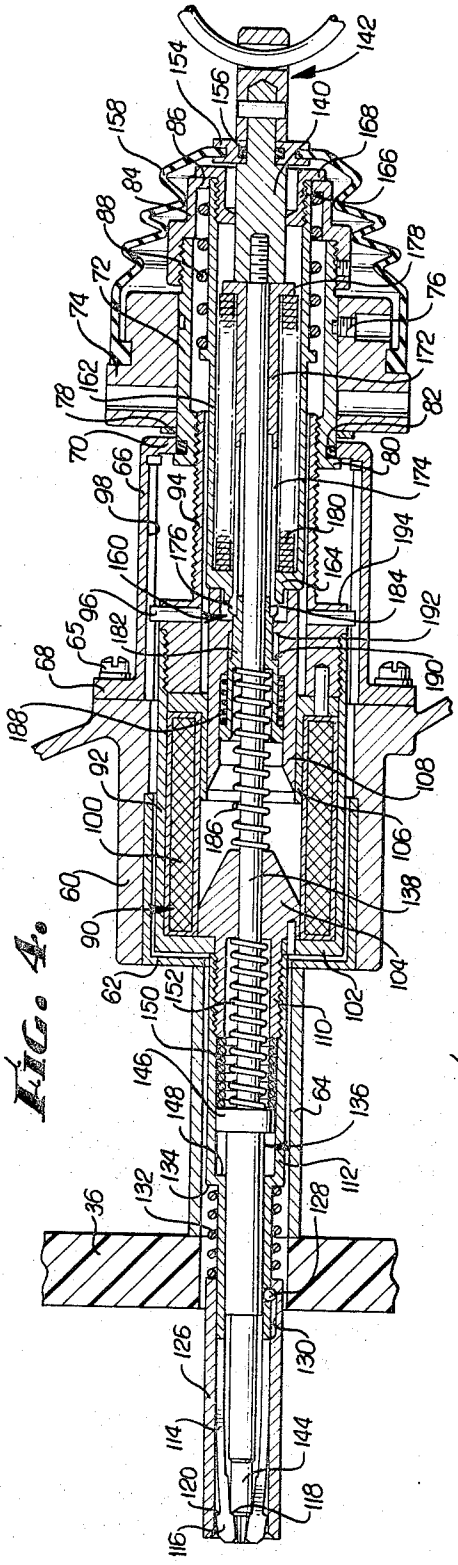


FIG. 4.

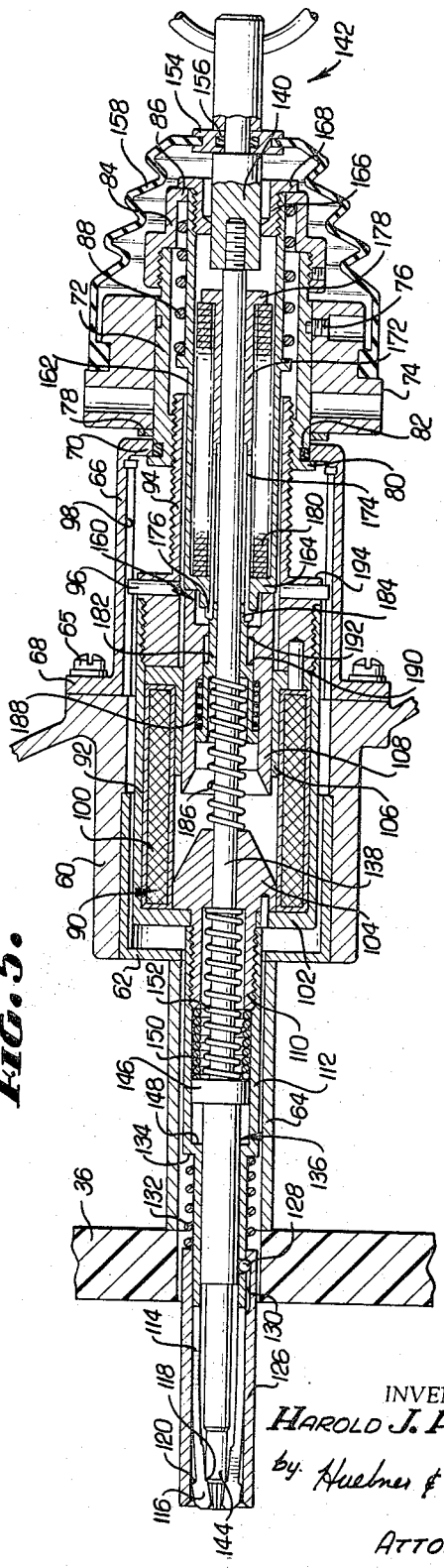


FIG. 5.

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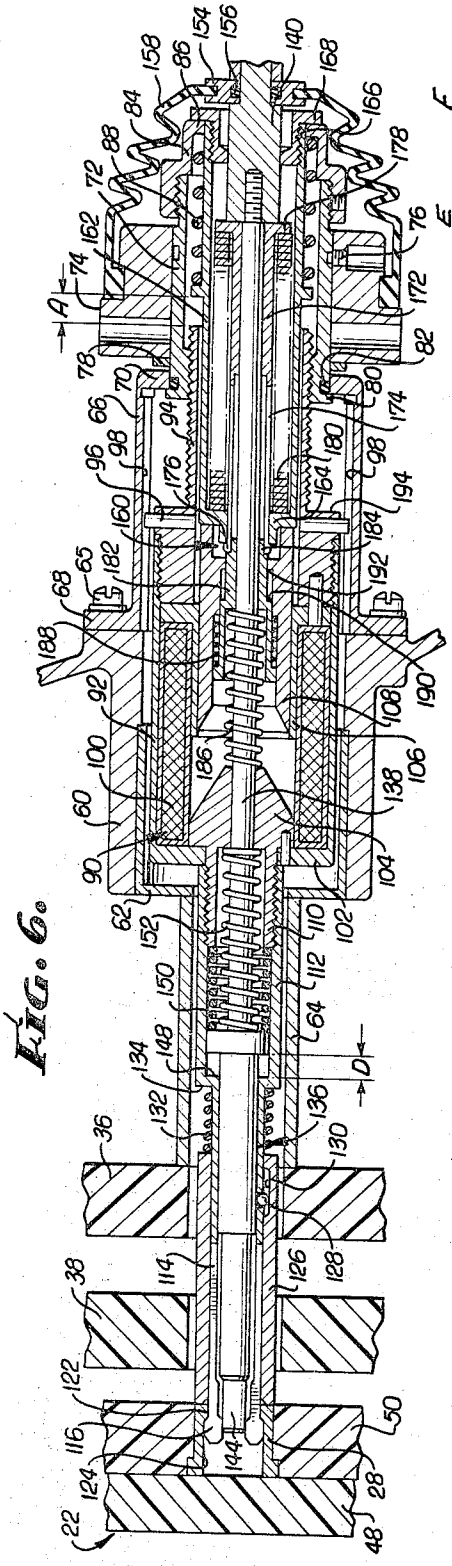


FIG. 6.

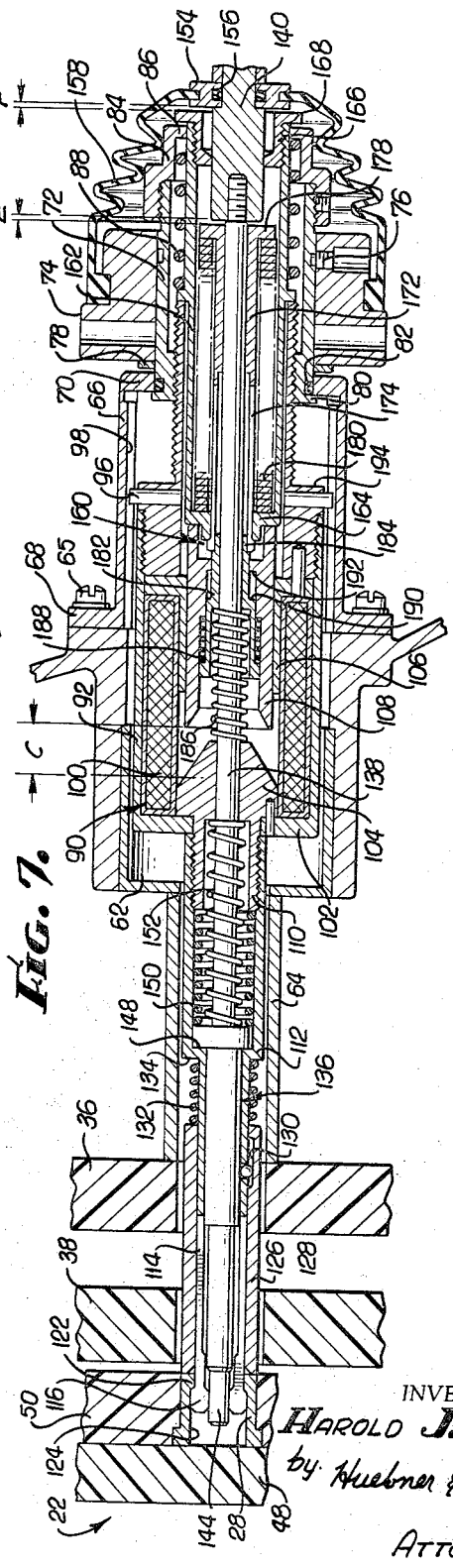


FIG. 7.

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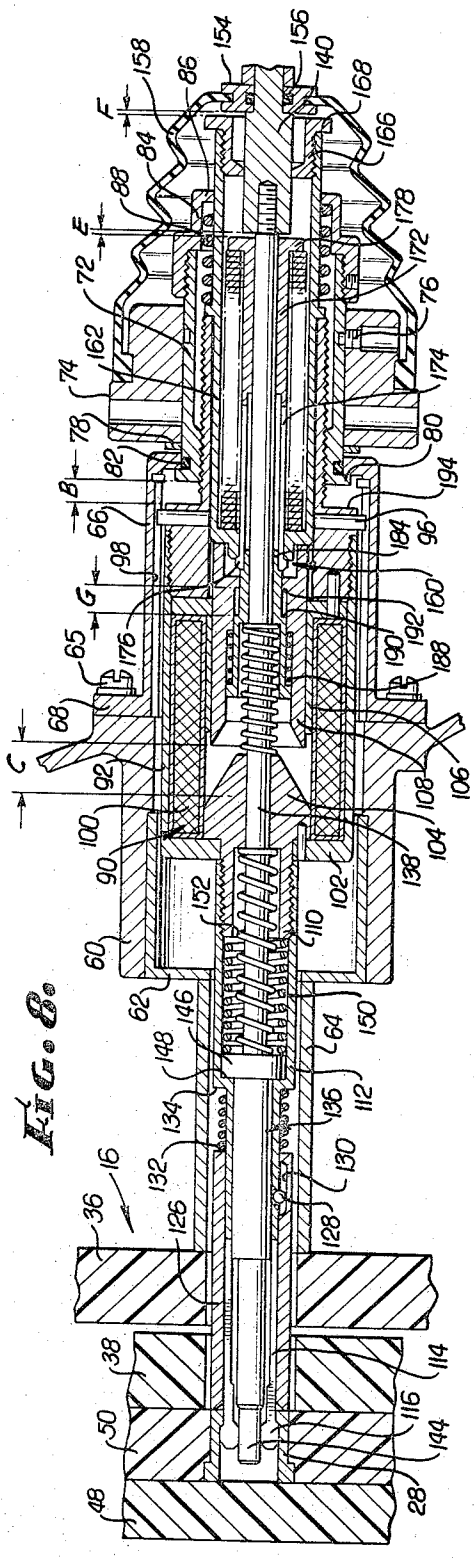


Fig. 8.

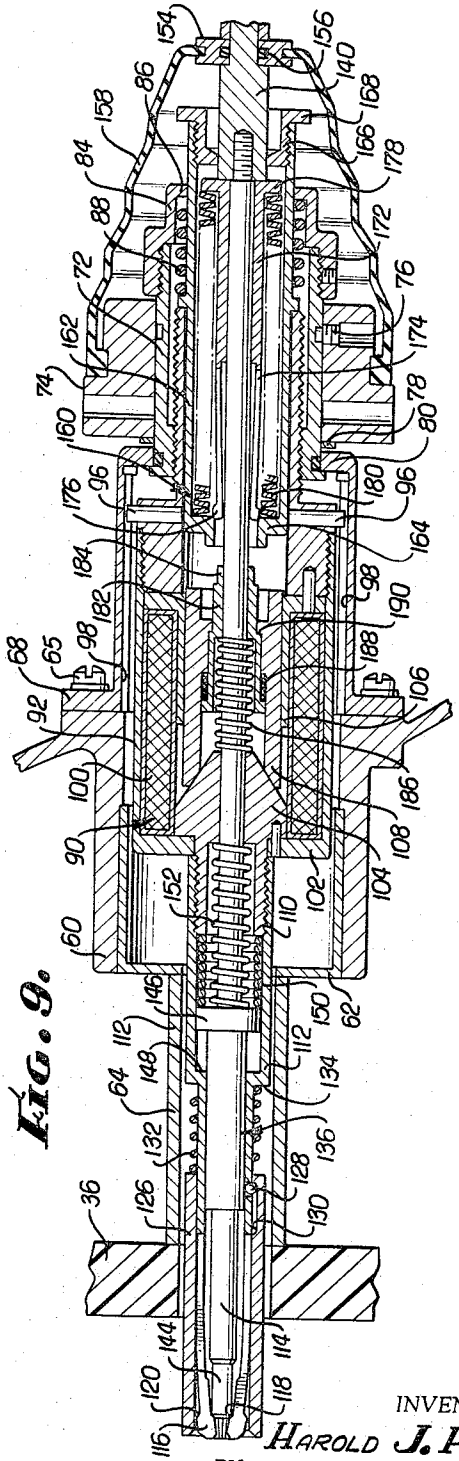


Fig. 9.

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UMBILICAL CONNECTOR LOCK MECHANISM

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FIG. 10.

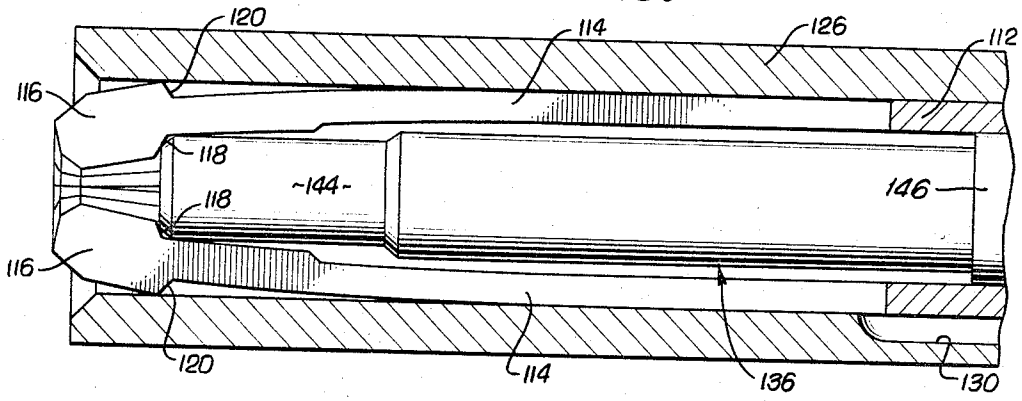


FIG. 11.

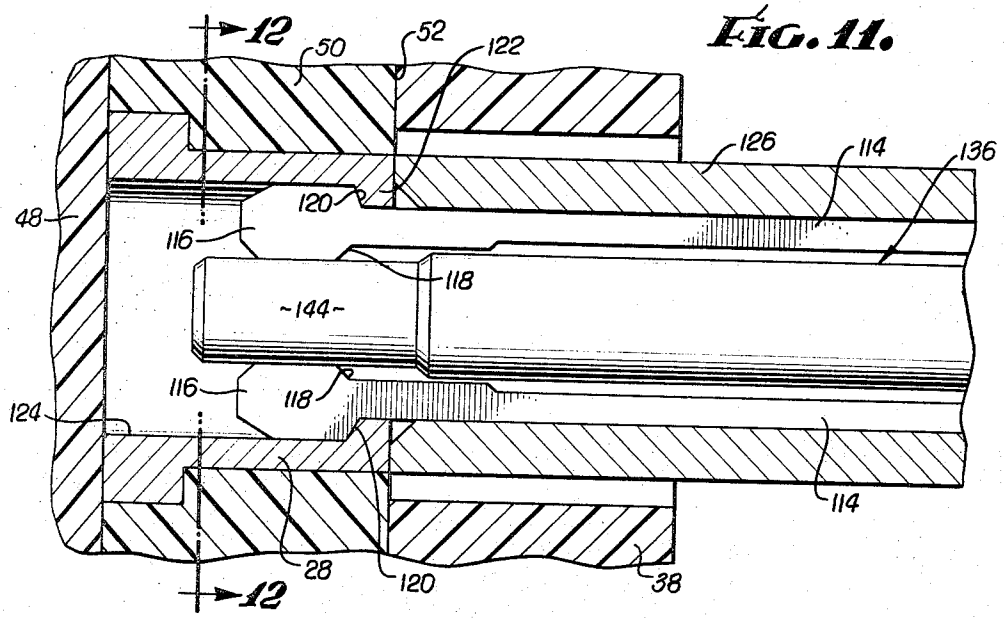
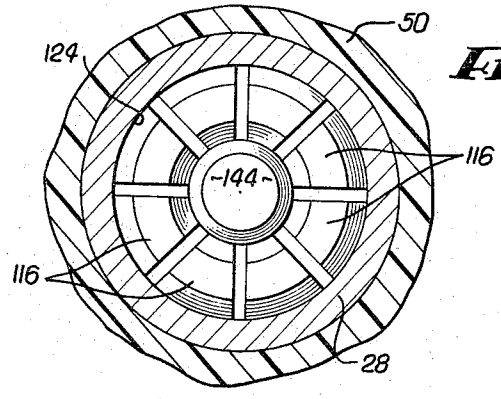


FIG. 12.



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United States Patent Office

3,335,391

Patented Aug. 8, 1967

3,335,391

UMBILICAL CONNECTOR LOCK MECHANISM

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Filed Feb. 3, 1964, Ser. No. 341,857
18 Claims. (Cl. 339—45)

This invention relates to electrical connectors, and more particularly to quick disconnect umbilical type electrical connectors that include a plug member which is releasably locked in mating engagement with a receptacle member to complete one or more electrical circuits.

While umbilical type electrical connectors are employed for various purposes, one principal use is to provide electrical communication with a guided missile prior to launching, the umbilical connector separating upon launching of the missile. It is a requirement of such umbilical connectors that they have releasable locking structure which positively locks the plug and receptacle connector members together and is virtually immune to accidental release induced by vibration or shock, yet which is quickly and positively released upon the application of a release impulse, such as an electrical impulse.

One type of releasable locking structure which has been found useful for umbilical connectors is referred to as a "tang-lock," comprising a "tang" member having an annular array of spring fingers or tangs on one connector member, and a lock ring or catch in the other member, the tang fingers entering the catch and being locked therein by a shaft or other suitable member which is axially movable within the tang and between the tang fingers. However, most prior art tang-lock devices of this general type have had several serious disadvantages.

One problem has been the likelihood of accidental premature release of the tank-lock caused by vibration or shock. Another problem has been to obtain sure and positive release upon the application of a release impulse. It is frequently desirable to employ a solenoid-actuated release mechanism for triggering release of the tang-lock. However, the locking forces on the tang-lock are usually so high that the solenoid is not alone sufficient to insure positive release.

In view of these and other problems in the art it is an object of the present invention to provide an umbilical connector lock-release mechanism embodying a primary tang-lock and a pilot release mechanism associated with the primary tang lock for storing energy which, when released, drives the primary tang-lock structure from its locked to its released position.

Another object of the invention is to provide an umbilical connector lock-release mechanism embodying a primary tang-lock structure and an associated pilot release mechanism adapted to contain stored spring energy for positively driving the primary tang-lock from its locked to its released position, wherein when the pilot release mechanism is cocked its moving parts become locked together to form a single unit in which the energy required to unlock the primary tang-lock is securely contained until released by energization of an associated solenoid circuit.

A further object of the present invention is to provide an umbilical connector lock-release mechanism of the character described wherein both the primary tang-lock and the pilot release unit are guarded against accidental movement induced by vibration or shock by means of a

plurality of springs having different resonant frequencies.

According to the present invention the umbilical plug and receptacle connector members are releasably locked together by means of a primary tang-lock having means associated therewith for drawing the plug and receptacle members into tight interengagement. The primary tang-lock is releasable by movement of a lock shaft that is axially slideable within the primary tang and which is biased to its lock position by multiple spring means with different resonant frequencies to guard against accidental release from vibration and shock. A pilot release mechanism is associated with the lock shaft and contains stored spring energy which, when released, drives the lock shaft to the release position permitting separation of the plug and receptacle members. This pilot release mechanism, like the lock shaft, is effectively secured against vibration and shock by non-coincidentally resonant, multiple spring means. The pilot release mechanism is actuated by solenoid means, and release of the stored spring energy of the pilot release mechanism is accomplished by introducing an electrical impulse to the solenoid means that causes movement of a comparatively light triggering armature which forms part of the pilot release mechanism. The only structure which is subject to motion induced by vibration, shock, or the designed electro-magnetic attraction is the relatively light triggering armature, and this is provided with space in which it can move as a result of vibration or shock without triggering the pilot release mechanism, and is also provided with multiple spring means which guards against indavertent triggering.

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;

FIGURE 1 is a side elevational view, partly in section, illustrating an umbilical connector plug member embodying lock mechanism according to the present invention.

FIGURE 2 is a view similar to FIGURE 1, wherein the plug connector member is operatively interengaged with a mating receptacle connector member.

FIGURES 3 and 3*a* together comprise an enlarged, axial section, with portions in elevation, of the lock mechanism of the present invention, with the primary tang fully extended prior to engagement thereof in the catch of the mating receptacle member.

FIGURE 4 is a view similar to FIGURES 3 and 3*a* but on a smaller scale, illustrating the parts of the lock mechanism in the same relative positions as in FIGURE 3, and also illustrating additional housing and insulator structure of the plug connector member.

FIGURE 5 is a view similar to FIGURE 4, but with the primary tang and lock shaft moved slightly rearwardly to make room for forward shifting of the lock shaft upon engagement of the primary tang with the catch of the receptacle connector member.

FIGURE 6 is a view similar to FIGURE 5, with the primary tang in the same longitudinal position in the lock mechanism as in FIGURE 5, but with the primary tang engaged in the catch of the receptacle connector member and the lock shaft shifted forwardly between the enlarged forward tips of the primary tang fingers to lock the primary tang in the catch.

FIGURE 7 is a view similar to FIGURE 6, but with the primary tang shifted to the rear in the plug connector

member to the extent that the lock shaft has moved to its forwardmost or full locking position relative to the primary tang and the solenoid armature-anvil spacing has become set.

FIGURE 8 is a view similar to FIGURE 7, but with the primary tang moved rearwardly in the plug connector member to draw the plug and receptacle members tightly together into their fully interengaged relationship, and with the lock mechanism fully set for the release operation.

FIGURE 9 is a view similar to FIGURE 8, but illustrating the lock mechanism and associated portions of the plug connector member only, with the lock mechanism in its released position.

FIGURE 10 is an enlarged, fragmentary axial section, partly in elevation, illustrating the primary tang, lock shaft and tang sleeve in their disengaged condition as also shown in FIGURES 1, 3, 4, 5 and 9.

FIGURE 11 is a view similar to FIGURE 10, but illustrating the primary tang engaged in the receptacle catch, as also shown in FIGURES 2 and 8.

FIGURE 12 is a cross-sectional view along the line 12—12 in FIGURE 11.

Referring to the drawings, and at first particularly to FIGURES 1 and 2, the lock mechanism of the present invention is principally contained in the plug member **10** of an umbilical electrical connector, which mates with a receptacle member **12**.

The plug **10** contains a plurality of pin contacts **14** supported in plug insulation body **16** which is mounted in plug shell **18**. The receptacle includes a plurality of socket contacts **20** supported in receptacle insulation body **22** so as to be in axial alignment and mateable with the pin contacts **14**. The receptacle insulation body **22** is mounted in receptacle shell **24**. Mating of pin contacts **14** with socket contacts **20** completes a plurality of independent electrical circuits. It is to be understood that if desired the pin contacts may be provided in the receptacle member and the socket contacts in the plug member, or other types of contacts may be employed.

Engagement of the plug member **10** with the receptacle member **12** is accomplished by a lock-release mechanism broadly designated **26** which extends axially through the plug shell **18** and insulation body **16** and releasably engages a catch or lock ring **28** in the receptacle member. The catch **28** is in axial alignment with the lock-release mechanism **26** and is centrally supported in receptacle insulation body **22**. The present invention is embodied in the lock-release mechanism **26**, and will be described in detail after a further brief description of the environmental structure.

A cable entrance housing **30** is fastened by screws **32** to the plug shell **18** at an angle oblique to the axis thereof, and provides means for connection with a cable having conductor wires **34** which enter shell **18**. Most of the wires **34** are connected with the pin contacts **14**, but one or more may be employed for actuating the solenoid trigger for the lock mechanism.

The plug insulation body **16** comprises a fixed rear insulation block **36** within which the pin contacts **14** are mounted, and an axially movable front insulation block **38** having bores through which the forward contacting portions of the pin contacts extend. The rear insulation block **36** is mounted on a plurality of cup-shaped support members **40** and secured thereon by respective threaded collars **42**. A screw **44** fastens each of the support members **40** to plug shell **18**.

The movable front insulation block **38** is supported by a plurality of support sleeves **45** which are slidable on the respective screws **44**. The front insulation block **38** is biased toward a forwardmost position, forwardly separated from the rear insulation block, by means of a spring **46** disposed between each support member **40** and the respective support sleeve **45**, the forwardmost position of front block **38** being determined by the heads of screws **44**.

The receptacle insulation body **22** includes a rear insulation block **48** and a front insulation block **50**, a front face portion **52** of block **50** projecting through an opening in a support panel **54** which may comprise the skin of an aircraft or missile or the like. Receptacle shell **24** is secured to support panel **54** by means of rivets **56** or other suitable fasteners, and receptacle insulation blocks **48** and **50** are secured in receptacle shell **24** by means of bolts **58** or other suitable fasteners. It is to be noted that the catch **28** is disposed in front insulation block **50**.

Suitable polarizing means (not shown) is disposed on the connector members to insure proper orientation thereof when they are interengaged. A resilient sealing sleeve **59** is mounted on plug shell **18** and is engageable between the plug shell and the support panel **54** to provide a moisture seal therebetween.

The plug shell **18** includes a cylindrical internal portion **60** extending inwardly from the rear end of the shell, and this internal portion **60** has a cupped liner **62** therein. A sleeve **64** extends from the base of liner **62** to the rear plug insulation block **36**. The lock-release mechanism **26** of the present invention is supported at the rear end of plug shell **18** by a plurality of screws **65** or other suitable fasteners, and extends into the internal shell portion **60** and through liner **62**, sleeve **64** and central openings in the plug insulation blocks **36** and **38**, with the front end of lock-release mechanism **26** projecting forwardly of insulation block **38** so as to be releasably engageable in the receptacle catch **28**.

Referring now particularly to FIGURES 3, 3*a* and 4, lock-release mechanism **26** includes a generally cylindrical housing **66** having a forward mounting flange **68** for attachment to the rear end of plug shell **18** by screws **65**. Housing **66** has an in-turned rear flange **70**.

Rotatably mounted in the housing flange **70** is a tubular adapter **72** which extends rearwardly from housing **66**. Adapter **72** has a handwheel **74** secured thereon by a set screw **76**. The adapter **72** and handwheel **74** are prevented from axially moving relative to housing **66** in one direction by a washer **78** between the handwheel and housing flange **70**, and in the other direction by a lip **80** at the forward end of adapter **72**. An O-ring seal **82** is provided between adapter **72** and housing flange **70**.

Fixedly mounted on the rear end of adapter **72**, as by threaded engagement, is a spring retaining sleeve **84** having an inwardly flanged rear end **86** for retaining a spring **88**.

Mounted within the internal portion **60** of the plug shell and partly within the housing **66** is solenoid **90** which is adapted to trigger the release of the lock mechanism **26**. The solenoid includes a housing **92** having a reduced diameter rearward extension **94** that is externally threaded, with radially extending guide pins **96** riding in longitudinal grooves **98** within the housing **66**. By means of pins **96** the entire solenoid housing including the extension **94** is secured against rotation but is permitted to move axially within the main housing **66** of the lock-release mechanism. The external threads on solenoid housing extension **94** are engaged by internal threads on the rotatable tubular adapter **72**, whereby the solenoid housing may be drawn rearwardly or pushed forwardly by rotation of the handwheel **74**.

Solenoid **90** includes a winding **100** having suitable electrical connections (not shown) for receiving an electrical actuating impulse.

The solenoid housing **92** has an in-turned flange **102** at its front end within which solenoid anvil **104** is secured, the anvil having a tubular frusto-conical nose extending into the cavity within solenoid winding **100**. A guide sleeve **106** is supported within the other end of winding **100** for slidable mounting of a light-weight solenoid armature **108** having a rearward configuration complementary to that of anvil **104**.

The anvil **104** has a tubular forward extension **110** upon which primary tang tube **112** is threadedly mounted.

The primary tang tube has forwardly extending spring fingers or tangs **114** with enlarged ends **116** which have rearwardly facing inner and outer shoulders **118** and **120**, respectively. The receptacle catch or lock ring **28** has a forward annular constriction **122**, with an annular recess **124** behind this constriction. The enlarged ends **116** of the tang fingers are adapted to be pushed through the constriction **122** of the catch and into the annular recess **124**, where they are spread outwardly and releasably locked behind the constriction **122** by means of the lock shaft hereinafter described in detail.

Longitudinally slidably mounted over the forward portion of the primary tang tube **112** is tang sleeve **126** which is permitted limited axial movement by a ball detent **128** that is disposed in a hole in the tang tube and rides in a longitudinal internal groove **130** in the sleeve **126**. Tang sleeve **126** is biased toward its forwardmost position, which is its position in FIGURES 3*a* and 4, by a spring **132** which engages the rear end of sleeve **126** and a forwardly facing shoulder **134** on the primary tang. In this forwardmost position of tang sleeve **126** it is engaged over the enlarged forward ends of the tang fingers so that the fingers are constricted and prepared for engagement within the receptacle catch **28**. When sleeve **126** is shifted rearwardly, as by engagement against the forward edge of receptacle catch **28**, the enlarged ends **116** of the spring fingers are released so that they can spread outwardly in the catch.

The lock shaft assembly is broadly designated by the reference numeral **136**, and includes lock shaft **138** which extends through primary tang tube **112** and through the solenoid **90** and tubular adapter **72**. The lock shaft assembly further includes lock shaft extension **140** which is fixedly secured to and extends rearwardly from the rear end of lock shaft **138**, and a clevis assembly **142** secured to the rear end of the lock shaft extension. Lock shaft **138** has a reduced diameter forward locking portion **144** which engages against the inner shoulders **118** of the tang fingers when the tang sleeve **126** is in its forward position as shown in FIGURES 3*a* and 4, and which is adapted to slide between the enlarged ends of the tang fingers when the tang fingers are freed from restraint by the sleeve **126** upon insertion of the tang fingers into the receptacle catch as shown in FIGURES 2, 6, 7, 8, 11 and 12. When the reduced forward portion **144** of the lock shaft is thus disposed between the enlarged forward ends of the tang fingers it positively locks the enlarged finger ends in the receptacle catch **28**.

The lock shaft **138** also includes an annular collar **146** which is adapted to engage against a rearwardly facing shoulder **148** within the tang tube **112** to define the forwardmost position of the lock shaft within the primary tang.

Lock shaft **138** is forwardly biased by a pair of springs **150** and **152** having different resonant frequencies, these springs bearing against the lock shaft collar **146** at one end and against anvil **104** at their other ends.

A collar **154** is rotatably mounted on lock shaft extension **140** and is sealed with respect thereto by means of O-ring seal **156**. The entire rear end of the lock-release mechanism **26** is sealed by means of bellows seal **158** which is secured at its forward end to the handwheel **74** and at its rearward end to the collar **154**.

The pilot release mechanism is broadly designated by the reference numeral **160**. This mechanism is shown in its cocked position in FIGURES 3, 4, 5, 6, 7 and 8, and is shown uncocked in FIGURE 9. When cocked, the moving parts of pilot release mechanism **160** are locked together to form a single unit in which the energy required to unlock the primary tang lock is contained until released by energization of the solenoid **90**.

The pilot release mechanism includes a release tube **162** which is disposed within tubular adapter **72** and its attached spring retaining sleeve **84**, and extends within the solenoid housing extension **94**. Release tube **162** has a constricted forward end **164**, and at the rear is provided with an end ring **166** which may be threadedly secured within the rear end of tube **162**. End ring **166** has an outwardly directed flange **168** which is engageable against the inwardly flanged rear end **86** of spring retaining sleeve **84** to limit forward travel of release tube **162**. The lock shaft extension **140** extends through end ring **166** in slidable relationship therewith. Release tube **162** has an external flange intermediate its ends against which the forward end of spring **88** abuts, spring **88** biasing release tube **162** forwardly toward its forwardmost positions shown in FIGURES 3, 4, 5 and 6. Release tube **162** will remain in this forwardmost position until engaged and moved rearwardly by the solenoid housing extension **94** when the latter is drawn rearwardly by rotation of handwheel **74**.

Disposed within release tube **162** and immediately surrounding the rearward end portion of lock shaft **138** is a tang tube **172** having forward tangs or fingers **174** that are spaced slightly outwardly from shaft **138**. The tangs **174** have enlarged forward ends **176** which, in the cocked condition of the pilot release mechanism, are locked against the constricted forward end **164** of the release tube. Tang tube **172** has a radially outwardly directed flange **178** at its rearward end. Disposed radially between release tube **162** and tang tube **172**, and longitudinally between the constricted forward end **174** of the release tube and the rearward flange **178** of the tang tube are "Belleville" spring washers **180** which are tightly compressed in the cocked condition of the pilot release mechanism wherein the enlarged ends **176** of the tangs **174** are lodged in front of the consticted forward end of the release tube, but which drive the tang tube **172** rearwardly within the release tube **162** when the ends of the tangs **174** are released.

The enlarged ends **176** of tangs **174** are held in their spread or locked positions as shown in FIGURES 3, 4, 5, 6, 7 and 8 by means of a release sleeve **182** which is slidably engaged about lock shaft **138** immediately forward of the tang tube **172**. Release sleeve **182** has a rearwardly projecting lip **184** which, in the cocked condition of the pilot release mechanism, extends under the enlarged ends **176** of tangs **174** to prevent rearward movement of tang tube **172** relative to release tube **162**. The release sleeve **182** is rearwardly biased in this cocked position by means of a spring **186** which acts between a forwardly facing shoulder of release sleeve **182** and the rearward end of solenoid anvil **104**.

A further spring **188** considerably weaker than spring **186**, is engaged between a rearwardly facing shoulder on release sleeve **182** and a forwardly facing shoulder on the solenoid armature **108** for biasing the armature **108** rearwardly with respect to the release sleeve. The release sleeve **182** and solenoid armature **108** have normally spaced, opposing shoulders **190** and **192**, respectively, and when the solenoid armature **108** is driven forwardly by magnetic action upon electrical energization of solenoid **90**, against the biasing force of spring **188**, the slack between shoulders **190** and **192** is taken up and impact of armature **108** against release sleeve **182** as the shoulders engage, plus further forward magnetic pull on armature **108**, will drive release sleeve **182** forwardly against the biasing force of spring **186** so as to slide the lip **184** of the release sleeve forwardly out from under the enlarged tang ends **176**, whereby the tangs **174** are permitted to flex inwardly so that the "Belleville" spring washers **180** can drive tang tube **172** rearwardly against lock shaft extension **140** to drive the lock shaft **138** rearwardly.

A full cycle of operation of the present invention will now be described.

FIGURE 9 illustrates the lock-release mechanism in its uncocked condition immediately after separation of the plug and receptacle connector members, and while the solenoid is still electrically energized. Thus, solenoid

armature **108** has been moved forwardly against the force of springs **188** and **186** and rests against solenoid anvil **104**. Release sleeve **182** has been moved forwardly by armature **108** so as to release tangs **174**, and the spring washers **180** have driven tang tube **172** and lock shaft **138** rearwardly, lock shaft **138** becoming latched behind the inner shoulders **118** of the primary tang, the primary tang fingers being constricted by tang sleeve **126**.

In order to cock the pilot release mechanism **160** which is shown uncocked in FIGURE 9, the handwheel **74** is rotated anti-clockwise as viewed from the rear, which screws the solenoid housing extension **94** forwardly in the lock-release mechanism, housing **66** thus moving solenoid **90** and primary tang **112** forwardly, while at the same time the lock shaft springs **150** and **152** will move the lock shaft **138** forwardly, and spring **88** will move release tube **162** forwardly. The forward movement of the lock shaft will move the pilot tang tube **172** forwardly because of the abutment of the lock shaft extension **140** against tang tube **172**. Since the solenoid is no longer energized, the armature **108** is released from anvil **104**, and spring **186** shifts release sleeve **182** rearwardly relative to the aforesaid forwardly moving structure until its rearwardly projecting lip **184** engages against the front ends of the tangs **174** of tang tube **172**, which are at this time constricted within the forward end **164** of release tube **162**.

As the principal parts of the lock mechanism are thus being moved forwardly by rotation of handwheel **74**, the flange **168** on end ring **166** of release tube **162** will bottom against the spring retaining sleeve **84** and thus further forward movement of release tube **162** is prevented. However, continued rotation of handwheel **74** will continue to move the solenoid, primary tang and lock shaft forwardly, and the abutment between lock shaft extension **140** and tang tube **172** will cause forward movement of tang tube **172** within release tube **162**, whereby the spring washers **180** will be compressed. When the tang tube **172** has moved forwardly sufficiently within release tube **162** so that the enlarged tang ends **176** clear the constricted forward end **164** of the release tube, the tangs **174** are free to spring outwardly, or be cammed outwardly, and spring **186** will drive the release sleeve **182** rearwardly relative to the tang tube **172** so that the rearwardly projecting lip **184** of the release sleeve will slide under the tang ends **176** to complete the cocking of the pilot release mechanism by locking the release tube **162** and tang tube **172** together with the spring washers **180** tightly compressed.

At this time the parts of the lock release mechanism will be in the relative positions shown in FIGURES 3, 3*a* and 4. It is to be noted that the collar **154** on lock shaft extension **140** has moved forwardly to a position closely adjacent to the flange **168** on release tube end ring **166**. In addition to cocking the pilot release mechanism **160**, the forward movement of the parts caused by thus rotating handwheel **74** has resulted in projection of the primary tang forwardly of the front plug insulation block **38** as shown in FIGURE 1, preparatory to engagement with the receptacle member.

To complete preparation of the lock-release mechanism for engagement thereof with the catch in the receptacle, the handwheel **74** is rotated clockwise, looking from the rear, approximately four revolutions, which shifts the structure from the position shown in FIGURE 4 to that shown in FIGURE 5. What occurs is that the solenoid housing extension **94**, the solenoid housing **92** and the primary tang **112** are shifted slightly rearwardly, and at the same time the lock shaft **138** is moved to the rear because its forward end is trapped by the compressed ends **116** of the primary tang. However, the release tube **162**, and hence the pilot release mechanism **160**, are held stationary by spring **88**, so that the lock shaft will shift rearwardly through the pilot release mechanism, and the collar **154** on the lock shaft extension **140** will become spaced rearwardly from the flange **168** on the release tube end ring **166**. The lock-release mechanism is now fully prepared for engagement thereof with the catch **28** in the receptacle connector member.

FIGURE 6 illustrates engagement of the plug with the receptacle. The plug is positioned relative to the receptacle so that primary tang **112** is axially aligned with receptacle catch **28** and the plug is then pressed forwardly. The tang sleeve **126**, which holds the forward ends of the tang fingers compressed, encounters the face of receptacle catch **28** and remains stationary thereagainst as the primary tang is moved forwardly. This relative motion causes the enlarged tang ends **116** to clear the tang sleeve **126** and enter the receptacle catch **28**. The enlarged tang ends **116** pass through the forward constriction **122** of the catch and expand into the annular recess **124**. The lock shaft **138** is then free to move forwardly under the influence of its springs **150** and **152** from its position of FIGURE 5 to its position of FIGURE 6. The lock shaft moves forwardly sufficiently so that the forward locking portion **144** of the lock shaft enters the bearing surface area between the enlarged tang finger ends **116**, whereby the tang is prevented from collapsing and the plug is securely locked to the receptacle. Forward travel of the lock shaft **138** is limited at this time by engagement of the lock shaft extension **140** against the rear end of pilot tang tube **172**.

Between FIGURES 6 and 7 the handwheel **74** has been further rotated in a clockwise direction as viewed from the rear, thus shifting the solenoid housing and primary tang rearwardly relative to the lock-release mechanism housing **66**, adapter **72** and release tube **162**, the latter being held fixed by spring **88**. Since the front end of lock shaft **138** is no longer gripped by shoulders **118** of the primary tang fingers, the lock shaft **138** will remain stationary while the primary tang shifts rearwardly with respect thereto, having the effect of projecting the forward locking portion **144** of the lock shaft relatively forwardly with respect to the primary tang and hence into positive locking engagement within the enlarged tang ends **116** as shown in FIGURE 7.

As rearward movement of the primary tang thus progresses, its rearwardly facing shoulder **148** will engage collar **146** on the lock shaft to pick up the lock shaft and move it rearwardly with the primary tang. This relative movement between the primary tang and the lock shaft is indicated by reference to gap D in FIGURE 6 between shoulder **148** and collar **146**, this gap being closed between FIGURES 6 and 7.

Gap A between the rear end of solenoid housing extension **94** and the flange **170** on release tube **162** is closing at the same time gap D is closing, and just after gap D closes gap A will also close. Since gap D between the primary tang and the lock shaft closes before gap A closes, small gaps E and F will open up between pilot tang tube **172** and lock shaft extension **140** on the one hand, and release tube end ring **166** and collar **154** on the other hand. Closing of gap A means that further clockwise rotation of handwheel **74** looking from the rear will cause release tube **162** to move rearwardly with the solenoid housing and primary tang, whereby gap C between the solenoid armature and anvil becomes fixed for solenoid operation requirements.

The clockwise rotation of the handwheel between FIGURE 6 and FIGURE 7 has, by moving the primary tang rearwardly in the plug shell, drawn the plug and receptacle connector member closer together.

Between FIGURE 7 and FIGURE 8 the handwheel has been further rotated in a clockwise direction as viewed from the rear, causing the entire lock-release mechanism **26** to move rearwardly as a unit, with the exception of housing **66**, handwheel **74**, adapter **72** and spring retaining sleeve **84**, and during this movement the spring **88** becomes relatively tightly compressed. At the time the front insulation block **50** of the receptacle has been drawn into

engagement against the front insulation block **38** of the plug, and block **38** has been moved rearwardly against the force of springs **46**, the pin contacts **14** being engaged in the respective socket contacts **20**. The handwheel is thus rotated until the plug and receptacle members have become fully engaged as shown in FIGURES 2 and 8.

At this time further motion of the lock-release mechanism would still be possible, as indicated by the presence of gap B between the front end of adapter **72** and the rearwardly facing shoulder **194** on the solenoid housing extension. However, subsequent torque applied to the handwheel will thereafter merely cause tensile stresses in lock components which are opposed by compressive loads in plug and receptacle components.

In the fully locked condition of the parts as illustrated in FIGURES 2 and 8, the lock shaft **138** is held in position by the biasing forces of the two lock shaft springs **150** and **152** which have different resonant frequencies, so that even if one of these two springs is rendered ineffective by vibrations at its resonant frequency, the other will remain effective to hold the lock shaft forward in its locking position.

The mass of the pilot release mechanism **160** is prevented from acting upon the lock shaft during vibration or shock since the entire pilot release unit is secured by the tightly compressed spring **88** against the now fixed solenoid housing extension **94**. Even if the relatively heavy and tightly compressed spring **88** were endered ineffective by a critical resonant frequency, the resonating frequency of the spring **88** is different from the resonant frequencies of both of the lock shaft springs **150** and **152**, so that the lock shaft springs would both still be effective, and the combined force of both lock shaft springs would be sufficient to prevent any displacement of the mass of the lock shaft plus that of the pilot release mechanism.

The solenoid armature **108** may be considered as a part of the pilot release mechanism **160** insofar as rearward movement thereof from vibration or shock is concerned, armature **108** being effectively restrained against rearward movement by abutment against release tube **162**, which in turn is restrained by the strong, tightly compressed spring **88**, and would, if necessary, be further restrained by the two lock shaft springs **150** and **152**. The armature spring **188** will take up most vibration or shock impulses tending to move the armature forwardly, since the armature is permitted to move forwardly a distance corresponding to gap G of FIGURE 8, which is the normal distance between the opposing shoulders **190** and **192** on release sleeve **182** and armature **108**, respectively. Even if the vibration or shock were so great as to move the relatively light-weight armature **108** forward a sufficient distance to close gap G, which is not likely, further forward movement would be effectively halted by the strong opposition of spring **186** which holds the release sleeve **182** in its locked position. The spring **186** is much stronger than the spring **188**, and springs **186** and **188** have different resonant frequencies.

However, when the solenoid is energized, the magnetic attraction urging the armature forwardly is sufficient in gap C to overcome the force of the relatively small armature spring **188**. Since the strength of the magnetic attraction is inversely proportional to the square of the distance, the considerably stronger second spring **186** does not interfere with continued closing of gap C once gap G has been closed and the armature has engaged the release sleeve **182**. Thus, the magnetic attraction of the energized solenoid will readily overcome the successive and combined forces of springs **188** and **186** to permit forward shifting of release sleeve **182**, although accidental forward shifting of this sleeve from vibration or shock is highly unlikely.

FIGURE 9 shows the lock-release mechanism **26** in its fully released condition. Release is accomplished by energizing the solenoid **90** when the structure is in the condition shown in FIGURE 8, whereby solenoid armature **108** is moved forwardly against the biasing force of its spring **188**, the armature picking up the release sleeve **182** and moving it forwardly. The armature will continue to move forwardly, carrying the release sleeve **182**, until the armature strikes the solenoid anvil **104**, at which time the release sleeve **182** will have been shifted forward sufficiently to withdraw its lip **184** out from under the pilot tang ends **176**, whereby the pilot tang tube **172** is released relative to release tube **162**, and the spring washers **180** will drive tang tube **172** rearwardly. Because of the engagement between the rear end of tang tube **172** and the forward end of lock shaft extension **140** the tang tube **172** will drive lock shaft **138** rearwardly so that its forward locking portion **144** will clear the primary tang finger ends **116**. The primary tang fingers are then free to deflect radially inwardly, allowing the entire plug to be ejected from the receptacle by the plug springs **46** which had become tightly compressed during the final rotation of the handwheel between FIGURES 7 and 8. As soon as the primary tangs clear the receptacle catch **28** as the plug is being ejected from the receptacle, the tang sleeve **126** will shift forwardly over the enlarged ends **116** of the primary tang fingers to hold the fingers collapsed. Rotation of the handwheel in an anti-clockwise direction looking from the rear will again shift the lock-release mechanism to the condition shown in FIGURES 3 and 4.

While the instant 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.

What I claim is:

1. An electrical connector which comprises a pair of interengageable connector members each having a contact, the contacts being mateable upon interengagement of the members to complete an electrical circuit through the connector, and primary locking means releasably locking the members together comprising a catch in one member and lock mechanism in the other member releasably engageable with said catch, said lock mechanism including lock structure movable from a locking position to a release position and a plurality of spring members having different resonant frequencies in said lock mechanism biasing said lock structure toward its locking position, and pilot release mechanism in said other member comprising normally stressed, resilient energy storage means, pilot locking means releasably locking said energy storage means in its stressed condition, and shoulder means engageable with said lock structure and movable by said energy storage means upon the release of said pilot locking means to drive the lock structure from its locking position to its release position.

2. An electrical connector as defined in claim **1** which includes a further spring member biasing said shoulder means in a direction opposed to its direction of movement for releasing the lock structure, said further spring member having a different resonant frequency than said plurality of spring members.

3. An electrical connector which comprises a pair of interengageable connector members each having a contact, the contacts being mateable upon interengagement of the members to complete an electrical circuit through the connector, and primary locking means releasably locking the members together comprising a catch in one member and lock mechanism in the other member releasably engageable with said catch, said lock mechanism including a tang tube having a plurality of spring fingers that are expandable into locking engagement with said catch and contractible for removal from said catch, lock shaft structure axially slidable in said tang tube between a locking position holding the fingers expanded and a release position permitting the fingers to contract, and pilot

release mechanism in said other member comprising normally stressed, resilient energy storage means, pilot locking means releasably locking said energy storage means in its stressed condition, and shoulder means engageable with said lock shaft structure and movable by said energy storage means upon the release of said pilot locking means to drive the lock shaft structure from its locking position to its release position.

4. An electrical connector as defined in claim 3 which includes a plurality of spring members having different resonant frequencies in said lock mechanism biasing said lock shaft structure toward its locking position.

5. An electrical connector as defined in claim 3 wherein said pilot locking means comprises a pair of telescopically arranged tubular members through which said lock shaft structure longitudinally extends, said energy storage means comprising compression spring means disposed between said tubular members so as to bias them longitudinally with respect to each other, said tubular members being releasably engageable with each other for releasably holding said energy storage means in its stressed condition, said shoulder means being associated with one of said tubular members for movement therewith by said energy storage means upon release of said tubular members.

6. An electrical connector as defined in claim 5 wherein one of said two tubular members comprises a pilot tang tube having a plurality of spring fingers that are releasably engageable with the other tubular member.

7. An electrical connector as defined in claim 6 which further includes a release sleeve longitudinally slidable over said lock shaft structure between a locking position in which it holds said pilot tang fingers in engagement with said other tubular member and a release position in which it releases said pilot tang fingers.

8. An electrical connector as defined in claim 7, wherein said pilot release mechanism includes a normally unenergized solenoid having an armature engageable with said release sleeve upon energization of the solenoid to move said release sleeve from its locking position to its release position.

9. An electrical connector which comprises a pair of interengageable connector members each having a contact, the contacts being mateable upon interengagement of the members to complete an electrical circuit through the connector, and primary locking means releasably locking the members together comprising a catch in one member and lock mechanism in the other member releasably engageable with said catch, said lock mechanism including a primary tang tube having a plurality of spring fingers that are expandable into locking engagement with said catch and contractible for removal from said catch, lock shaft structure axially slidable in said primary tang tube between a locking position holding the fingers expanded and a release position permitting the fingers to contract, and pilot release mechanism in said other member comprising a pilot tang tube and a release tube which are telescopically arranged and through which said lock shaft structure longitudinally extends, spring energy storage means disposed between said pilot tang tube and said release tube so as to bias them longitudinally with respect to each other, said pilot tang tube having a plurality of spring fingers releasably engaged with said release tube for releasably holding said energy storage means in a stressed condition, one of said pilot tang and release tubes having shoulder means engageable with said lock shaft structure to drive said lock shaft structure from its locking position to its release position upon release of said pilot tang spring fingers from said release tube.

10. An electrical connector according to claim 9, wherein said release tube is radially outwardly disposed relative to said pilot tang tube.

11. An electrical connector according to claim 10, wherein said shoulder means is on said tang tube.

12. An electrical connector according to claim 10, wherein said release tube and pilot tang tube have respective inwardly and outwardly directed flanges thereon, and said energy storage means comprises a plurality of frusto-conical spring washers radially disposed between said pilot tang and release tubes and longitudinally compressed between said flanges.

13. An electrical connector according to claim 9, which includes a plurality of spring members having different resonant frequencies in said lock mechanism biasing said lock shaft structure toward its locking position.

14. An electrical connector according to claim 9, which includes a first spring member in said lock mechanism biasing said lock shaft structure toward its locking position, and a second spring member biasing one of said pilot tang and release tubes in the same direction that said first spring biases the lock shaft structure, said first and second spring members having different resonant frequencies.

15. An electrical connector according to claim 14, which includes a plurality of said first spring members having different resonant frequencies.

16. An electrical connector which comprises a pair of interengageable connector members each having a contact, the contacts being mateable upon interengagement of the members to complete an electrical circuit through the connector, and primary locking means releasably locking the members together comprising a catch in one member and lock mechanism in the other member releasably engageable with said catch, said lock mechanism including a primary tang tube having a plurality of spring fingers that are expandable into locking engagement with said catch and contractible for removal from said catch, lock shaft structure axially slidable in said primary tang tube between a locking position holding the fingers expanded and a release position permitting the fingers to contract, and pilot release mechanism in said other member comprising a pilot tang tube and a release tube which are telescopically arranged and through which said lock shaft structure longitudinally extends, spring energy storage means disposed between said pilot tang tube and said release tube so as to bias them longitudinally with respect to each other, said pilot tang tube having a plurality of spring fingers releasably engaged with said release tube for releasably holding said energy storage means in a stressed condition, one of said pilot tang and release tubes having shoulder means engageable with said lock shaft structure to drive said lock shaft structure from its locking position to its release position upon release of said pilot tang spring fingers from said release tube, a release sleeve longitudinally slidable over said lock shaft structure between a locking position in which it holds said pilot tang fingers in engagement with said release position in which it releases said pilot tang fingers, a normally unenergized solenoid having an armature engageable with said release sleeve upon energization of the solenoid to move said release sleeve from its locking position to its release position, first spring means comprising a plurality of spring members having different resonant frequencies biasing said lock shaft structure toward its locking position, and second spring means biasing said release sleeve toward its locking position.

17. An electrical connector as defined in claim 16 which includes third spring means having a different resonant frequency than said first spring means, said third spring means biasing one of said pilot tang and release tubes in the same direction that said first spring means biases the lock shaft structure.

18. An electrical connector as defined in claim 17 wherein said solenoid armature and release sleeve have opposed, normally spaced abutment surfaces thereon, and fourth spring means that is weaker than said second spring means and is engaged between said release sleeve and said solenoid armature to normally position said ar-

mature relative to said release sleeve with said abutment surfaces in spaced relationship, the solenoid when energized providing sufficient magnetic force on said armature to overcome the force of said fourth spring means whereby said armature moves until said abutment surfaces engage, said solenoid then providing sufficient magnetic force on said armature to overcome the force of said second spring means whereby said armature will move said release sleeve from its locking position to its release position.

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