United States Patent [19]

Mina et al.

[11] **3,808,579**

[45] **Apr. 30, 1974**

[54] **EXPLOSION PROOF CONNECTOR**

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[22] Filed: **Nov. 6, 1972**

[21] Appl. No.: **303,949**

[52] **U.S. Cl.** ..... **339/46**, 339/91 B, 285/316

[51] **Int. Cl.** **H01r 13/62**

[58] **Field of Search** ..... 339/89, 91, 90, 45, 46; 285/81, 277, 308, 316; 287/103, 104, 189.36, DIG. 5

[56] **References Cited**

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Primary Examiner—Bobby R. Gay
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[57] **ABSTRACT**

In an explosion proof connector, a raised annular lip is provided on the inner end of one connector shell, and the other shell of the connector is provided with a ball carrier supporting a ball for cooperation with the lip. A spring associated with the ball carrier is adapted to be compressed during a preliminary phase of coupling and uncoupling, and released to force the shells relative to each other during a final phase of such coupling and uncoupling, when the ball passes the lip. A control ring surrounding the ball regulates the compression of the spring during the preliminary phase.

14 Claims, 2 Drawing Figures

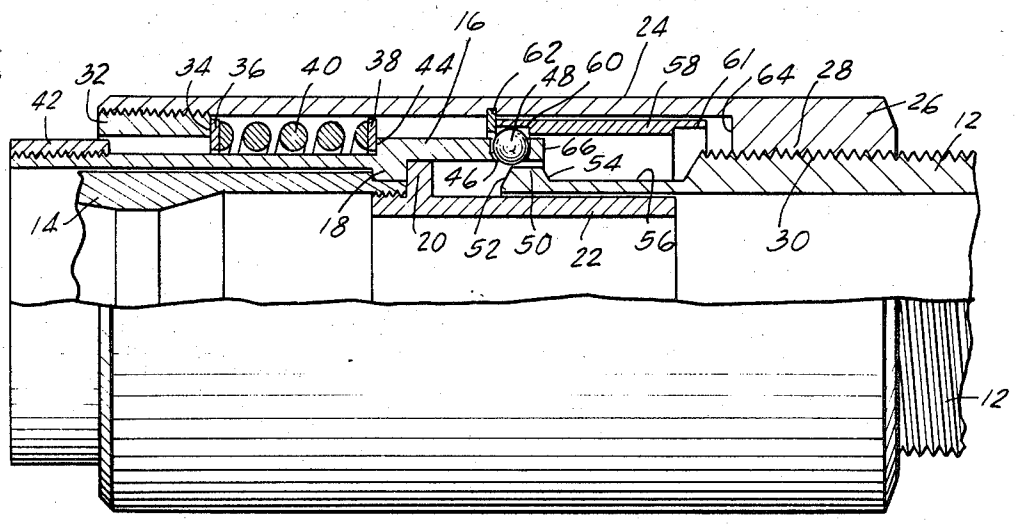

Fig. 1

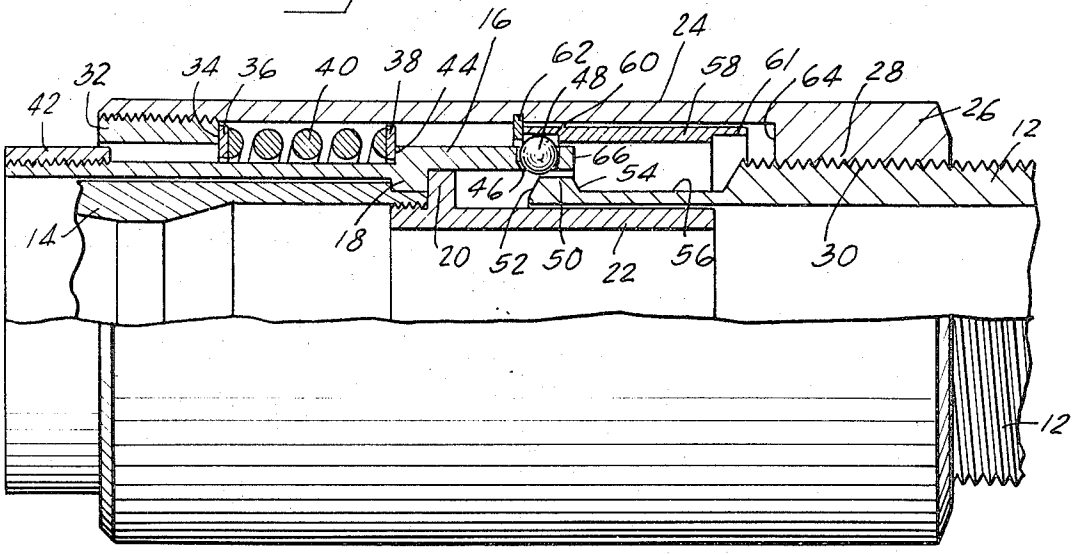
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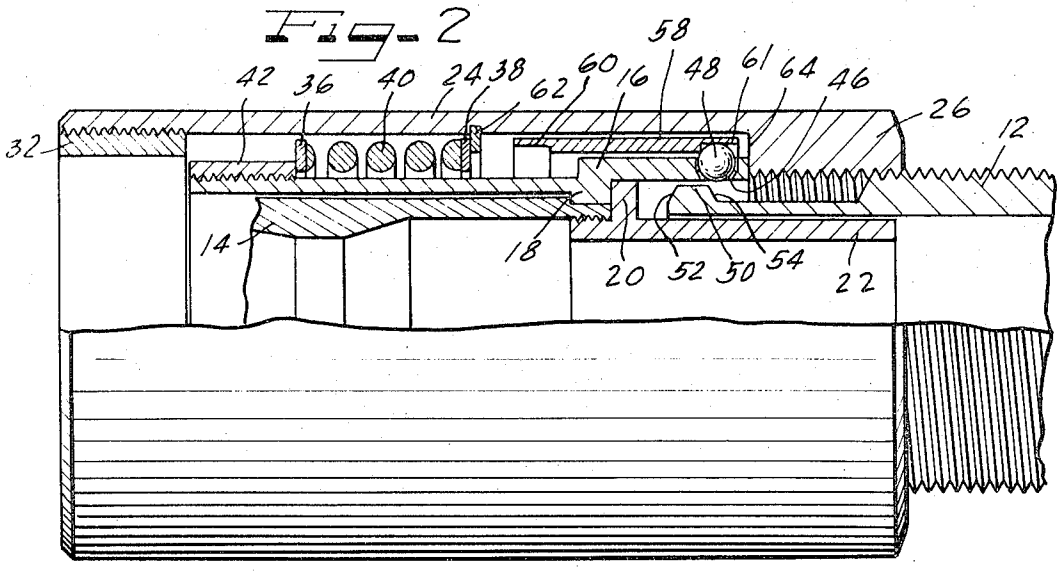
Fig. 2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EXPLOSION PROOF CONNECTOR

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an electrical connector, and more particularly to an explosion proof connector which can function as a quick connect and quick disconnect system.

2. The Prior Art

Explosion proof connectors have been developed in the past in which contact is made and broken quickly between the electrical contacts of the connectors, to limit as far as possible the formation of an arc between the electrical contacts which, if not quickly quenched, can damage the connector. One mechanism for accomplishing this is disclosed and claimed in the Nava et al. U.S. Pat. No. 3,312,928. Therein is described an explosion proof connector in which a garter spring surrounds a tubular body having an inclined shoulder. The spring is moved longitudinally along the body during connection and disconnection, and the spring releases energy as it passes the shoulder, such energy being made available to force the parts of the connector together during connection, and to force them apart during disconnection. While the apparatus of the Nava et al. patent performs eminently satisfactorily, it is relatively difficult to establish a specific force to be developed by the garter spring. It is therefore desirable to provide a structure in which the connecting force and the disconnecting force may be specified precisely, in order to provide a connector with precisely defined specifications.

SUMMARY OF THE INVENTION

In one embodiment of the present invention there is provided a connector having a plug shell, a receptacle shell, and a coupling nut adapted to selectively threadably connect the plug shell and the receptacle shell together, the receptacle shell having an outwardly extending lip at its end facing the plug shell, a ball carried by said plug shell adapted to cooperate with said lip to block relative movement of said shells, a compression spring mounted relative to said plug shell and said coupling ring for compression during a preliminary phase of connection or disconnection, and a control ring associated with said ball for allowing said ball to pass said lip when said spring has been compressed by a predetermined amount, and for allowing said spring to be released and exert a force for urging said shells relative to each other.

BRIEF DESCRIPTION OF THE DRAWINGS

Reference will now be made to the accompanying drawings in which:

FIG. 1 is a longitudinal cross-section of an illustrative embodiment of the present invention, with the parts thereof shown at a moment prior to connection of the two connector parts; and

FIG. 2 is a longitudinal cross-section similar to FIG. 1 but showing the parts at a moment before disconnection of the connector parts.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring first to FIG. 1, the connector 10 incorporates a receptacle shell 12 and a plug shell 14, each of which is a tubular body of circular cross-section, and

each of which supports internaly thereof an insert member bearing a group of electrical contacts. The contacts of the two inserts are adapted to cooperate with each other to complete electrical circuits when the shells 12 and 14 are brought into assembled or coupled relation with each other.

A ball carrier 16 surrounds the plug shell 14, and a radially inwardly extending flange 18 of the ball carrier 16 is trapped between a shoulder on the outer part of the plug shell 14, and a radially outwardly extending flange 20 of an inner part 22 of the plug shell threadably secured to the outer part. The ball carrier 16 is thus rigidly secured to the plug shell 14.

A coupling nut 24 is mounted for rotation relative to the ball carrier 16, and is formed generally in the shape of a hollow circular cylindrical tube having a thickened end section 26 which extends radially inwardly from the interior surface of the remainder of the nut 24. Threads 28 are provided on the interior of the end section 26, which threads cooperate with corresponding threads 30, provided on the exterior of the receptacle shell 12.

The end of the coupling nut 24 associated with the plug shell 14 has an outer retaining ring 32 secured to the interior thereof by means of cooperating threads on the exterior of the outer retaining ring 32 and on the interior of the coupling nut 24. The inner end 34 of the outer retaining ring 32 abuts a washer 36 which surrounds the ball carrier 16, and prevents it from moving longitudinally outwardly along the ball carrier 16 when the parts are in the position shown in FIG. 1. A second washer 38 also surrounds the plug shell 14, and ball carrier 16. A compression spring 40, which surrounds the ball carrier 16 between the two washers 36 and 38, is maintained in position by them and serves to urge the two washers apart.

As used hereinafter, the term "outwardly," when applied to longitudinal movement of either of the two shells or a member supported on them, refers to movement away from the opposite shell, whereas the term "inwardly" refers to movement of the shells toward each other.

An inner retainer ring 42 is threadably connected to the outer surface of the ball carrier 16, and limits the longitudinal outward movement of the washer 36, relative to the ball carrier 16, when the coupling nut 24 is moved outwardly on the ball carrier 16, as when the connector is disassembled. The ball carrier 16 has a shoulder 44, encircling its radially outer surface, abutting the washer 38 so as to maintain the spring 40 in position. The inward end section of the carrier 16 has an aperture 46 in which a ball 48 is supported. The aperture 46 is sized to permit the radially inner end of the ball to project beyond the inner surface of the carrier 16, but the ball 48 is prevented from passing through the carrier 16 because the aperture 46 is not large enough to permit this.

The inward end of the receptacle shell 12 is provided within a raised annular lip 50 defined between two sloping shoulders 52 and 54. A relatively wide annular groove 56 lies adjacent the shoulder 54.

A control ring 58 is disposed inwardly of the coupling nut but surrounds the inward end of the receptacle shell 12. The control ring 58 is formed with a circular cylindrical outer surface, and an inner surface which is cylindrical except for the provision of two annular grooves 60 and 61, at each end thereof. The depth of

the grooves 60 and 61 is sufficient to allow the ball 48 to occupy a position radially outward of the lip 50 when the connector parts are in the position illustrated in FIG. 1. The ungrooved middle part of the control ring 58 is thick enough to prevent the ball 48 from occupying a position radially outward of the lip 50. The control ring 58 is maintained in the position shown in FIG. 1 by a snap ring 62 engaged in an annular groove on the radially inward side of the coupling nut 24, and a shoulder 64 formed at the inward extremity of the enlarged end section 26 of the coupling nut. The control ring 58 is capable of sliding, relative to the coupling nut 24, a limited amount, between the snap ring 62 and the shoulder 64. When the parts of the connector are uncoupled, the spring 40 expands to its fullest extent with the inward ends of the retaining rings 32 and 42 both abutting the washer 36. The ball 48 is at this time juxtaposed with the middle ungrooved portion of the control ring 58.

The position of the parts illustrated in FIG. 1 is that assumed at a moment prior to connection, after the coupling nut 24 has been partially threaded onto the shell 12. This condition is reached by threading the coupling nut 24 onto the receptacle shell 12 by rotating the same, by which action the ball 48 is brought into engagement with the inward edge of the raised lip 50, and urged outwardly, relative to the coupling nut 24, until it reaches the groove 60, in which position it is shown in FIG. 1. The relative motion between the ball 48 and the coupling nut 24 compresses the spring 40, and when the ball 48 enters the groove 60, the spring 40 is fully compressed, the washer 36 having been moved inwardly relative to the carrier 16, by the outer retaining ring 32. As the ball enters the groove 60, it bears against the shoulder formed at the side of the groove 60, and urges the control ring 58 inwardly, until its inner end comes to a stop against the shoulder 64. This movement of the control ring 58 is slight, and the spring 40 is only slightly released by this action. The ball 48 then rests on the lip 50 near the sloping shoulder 54. Further rotation of the coupling nut 24 causes the ball 48 to move inwardly past the lip 50, and the ball 48 then escapes into the groove 56, and the spring 40 is thereby released, and forces the carrier 16 inwardly until it reaches its rest position with the ball 48 near the mid portion of the control ring 58. The friction between the contacts, however, prevents the ball 48 from quite reaching that position. The plug shell 14 moves with the carrier 16, and the force of the spring 40 is thereby made available to bring about a quick connection between the electrical contacts carried by the insert (not shown) within the plug shell 14 and the corresponding insert (not shown) carried by the receptacle shell 12. This force is a known quantity because it is related by Hook's constant to the amount of compression of the spring 40. The compression of the spring 40 is a constant factor because it is equal to the distance between the position of the ball 48 at rest, near the middle of the control ring 58, and its position at release, which corresponds to the length of the control ring 58.

When the coupling is effected in the manner described above, the spring 40 is effective to make a quick connection between the various electrical contacts. The connection between the shells 12 and 14 may be made tighter, if desired, by rotating the coupling nut further, to compress the spring 40 and to increase the connection force to any desired level.

The disengagement process is illustrated in FIG. 2. As the coupling nut 24 is unthreaded from the shell 12, the spring 40 is unloaded by outward movement of the retaining ring 32, until the washer 36 reaches the inward end of the retaining ring 42. Thereafter, the spring 40 is again compressed, by the action of the snap ring 62, which urges the washer 38 outwardly. The ball 48 remains stationary, relative to the receptacle shell 12, until the shoulder 64 engages the inward end of the carrier 16, or, if the friction between the electrical contact is not too great, the ball moves outwardly until it is stopped by the lip 50, after which the spring 40 is compressed as the coupling nut 24 is rotated. Eventually the position illustrated in FIG. 2 is reached, in which the ball 48 is received within the groove 61, and the electrical contacts have been brought to a condition in which they are nearly separated, but still fully in electrical contact with each other, and the friction of the contacts is not sufficient to overcome the force of the spring 40. Then the ball 48, urged against the shoulder formed at the edge of the grove 61, shifts the control ring 48 outwardly until it is stopped against the lock ring 62, with the ball 48 resting on the lip 50, adjacent the sloping shoulder 52. The electrical contacts, although moved somewhat more as the ball 48 moves onto the lip 50, remain connected electrically. Further rotation of the coupling nut 24 allows the ball 48 to escape beyond the lip 50, and the spring 40 is released, urging the carrier 16 toward its rest position, in which the ball 48 is juxtaposed with the mid portion of the control ring 58. This movement separates the electrical contact members, and the force of the spring 40 is so great that the contact members are rapidly separated, quenching any arc which may be formed almost immediately.

Even if the friction between the electrical contact members is so great as to prevent the ball 48 from moving outwardly to engage the lip as the spring 40 is loaded, the shoulder 64 engages the inward end of the carrier 16, and urges the carrier 16 outwardly until the moment of release, and by that time the contact members have been separated sufficiently to permit the force of the spring easily to overcome any remaining resistance.

The force exerted by the spring in separating the contact members is a constant factor because the spring is compressed by an amount equal to the distance between the position of the ball 48 at rest, and the position of the ball 48, relative to the coupling nut 24, at the instant of release.

Apparatus constructed in accordance with the present invention is effective to make a quick connect and quick disconnect of electrical contacts carried by the plug shell and receptacle shell, and the force with which the shells are urged relative to each other may be readily designed to any specifications, by selecting a spring with the appropriate Hook's constant, and/or a control ring of the appropriate size. The structure of the present invention may be employed with a variety of different types of electrical contact members, but when the embodiment of FIGS. 1 and 2 is employed, the contact members are preferably of the pin and socket type, in order to insure that the contacts remain in conductive relationship while the ball moves outwardly prior to release of the spring.

The present invention may be employed in a system in which the release force during connection is different from the release force during disconnection; by selecting a spring **40** of a length such that the rest position of the ball **48** is not at the mid point of the control ring **58.** If the rest position of the ball **48** is more toward the inward end of the control ring **58,** the connecting force is greater than the disconnecting force, and if the rest position of the ball **48** is more toward the outward end of the control ring **58,** the disconnecting force is greater. The size of the control ring may also be varied as desired. A longer control ring, with less axial movement than that shown in the drawings, gives larger forces operating on the contact shells, because there is less release of the spring as the ball shifts the position of the control ring prior to release. If a control ring of shorter axial length is used, the shifting of the ring prior to release allows the ball to completely clear the lip **50,** so that the release of the spring occurs at an earlier instant in the operation of effecting connection or disconnection.

From the foregoing, it will be appreciated that, in both connection and disconnection, the spring **40** is loaded during a preliminary phase of the operation, and then released in order to complete the connection, or to complete the disconnection, as the case may be.

The final phase, in which the spring is released, is initiated when the ball **48** passes the lip **50.**

Since the ball **48** functions simply as a blockable member, which can be blocked by the lip **50** except when the control ring **53** is a predetermined position in relation thereto, the ball may, if desired, be omitted, providing that the member **16** is provided with an enlarged section in place of the ball, which can be blocked by the lip **50** in cooperation with the control ring **53,** and which can pass the lip **50** when the control ring **53** is properly positioned. In this case the inward portion of the member **16** which overlies the inner part of the shell **14** must be sufficiently flexible to allow the enlarged section to enter the groove **56,** and is preferably then formed as a relatively thin arm extending inwardly from the tubular outward portion of the member **16** which surrounds the outer part of the shell **14,** rather than in the tubular form of the embodiment shown in the drawings. A plurality of such arms may be provided, angularly spaced equally apart. Also, in the embodiment shown in the drawings, a plurality of balls may be employed, angularly spaced equally around the carrier **16.**

Although the lip **50** has been described above as being annular in shape, its function may instead be performed by one or more projections extending radially outwardly from the end of the receptacle shell **12,** one for each ball **48** and in axial alignment therewith, expecially when the two shells **12** and **14** have means such as keys and keyways, for example, to insure the angular alignment of the shells during connection.

What is claimed is:

1. In a connector having a plug shell, a receptacle shell and a coupling nut, said coupling nut surrounding the end portions of both of said shells and being mounted for rotation relative to a first of said shells and having threads adapted to cooperate with corresponding threads on a second of said shells, the combination comprising a projection extending radially outwardly from the end of said second shell, a blockable member secured to said first shell and extending toward said second shell, said projection adapted to intercept said blockable member and prevent relative movement between said shells, a resilient member interconnected between said first shell and said coupling nut and adapted to be resiliently deformed in response to longitudinal movement between said coupling nut and said first shell when said blockable member is intercepted by said projection, and a control surface disposed on the interior surface of said coupling nut surrounding said blockable member for allowing said blockable member to pass said projection when said control nut is in a predetermined position in relation to said first shell, releasing said resilient member for urging said two shells to move relative to each other.

2. Apparatus according to claim **1,** wherein said projection comprises an annular lip extending radially outwardly from the end of said second shell.

3. Apparatus according to claim **2,** wherein said annular lip is defined between two shoulders forming an obtuse angle at their intersections with said lip.

4. Apparatus according to claim **2,** including an annular groove disposed on said second shell adjacent said lip.

5. Apparatus according to claim **1,** wherein said blockable member comprises a ball carrier member secured to said one shell, said ball carrier member comprising an arm extending toward said second shell, said arm having an aperture extending radially therethrough, and a ball disposed in said aperture and adapted to bear against said projection.

6. Apparatus according to claim **5,** wherein said aperture has a radially inner portion with a diameter smaller than that of said ball, whereby said ball is prevented from passing radially inwardly through said aperture.

7. Apparatus according to claim **6,** wherein said ball is adapted to be blocked between said projection and said control surface, said control surface having a shoulder adapted to cooperate with said projection to block said ball from passing said projection.

8. Apparatus according to claim **7,** including a surface on said projection adapted to hold said ball radially outwardly against said control surface, said ball being adapted to move radially inwardly in said aperture to free said ball from said shoulder when said coupling nut is moved to a position, relative to said projection, which enables a portion of said ball to move inwardly from said surface of said projection.

9. Apparatus according to claim **1,** wherein said resilient member comprises a compression spring.

10. Apparatus according to claim **9,** wherein said compression spring surrounds said first shell and is surrounded by said coupling nut, said first shell having a first pair of shoulders disposed at opposite ends of said spring, and said coupling nut having a second pair of shoulders disposed at opposite ends of said spring, whereby said spring is uncompressed when said first pair of shoulders is aligned with said second pair of shoulders, but is compressed when said coupling nut is moved longitudinally in either direction relative to said first shell.

11. Apparatus according to claim **1,** wherein said control surface comprises an elongate portion projecting radially inwardly from said coupling nut toward said blockable member, said blockable member being free to pass said projection when the said elongate portion of said surface is moved longitudinally away from a position surrounding said projection.

12. Apparatus according to claim 11, including a tubular control ring mounted within said coupling nut in longitudinal sliding relationship therewith, said control surface being formed on the radially interior surface of said control ring.

13. Apparatus according to claim 12, wherein said control ring has an annular groove on its radially inner surface adjacent each end thereof, said blockable member being free to pass said projection when said control ring is positioned with one of said grooves juxtaposed with said projection.

14. Apparatus according to claim 13, including a snap ring disposed in an annular groove in the interior surface of said coupling nut, said control ring being disposed between said threads and said snap ring.

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