

[54] **EXPLOSIVE BOLT**

3,532,057 10/1970 Aubrey 102/7 X

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[57] **ABSTRACT**

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An explosive bolt which is initiated in response to a predetermined hydrostatic pressure including a percussion sensitive bolt filled with explosive having a hydrostatic pressure responsive detonator attached thereto. The detonator includes a plunger having a firing pin attached thereto, the plunger normally being constrained in a retaining sleeve by a ball detent. A piston is slidably positioned over the retaining sleeve and prevents the detent from releasing the plunger until the piston has moved under sufficient hydrostatic pressure. A spring is provided between the plunger and the piston which becomes compressed as the piston moves under pressure thereby providing a forward biasing to the plunger.

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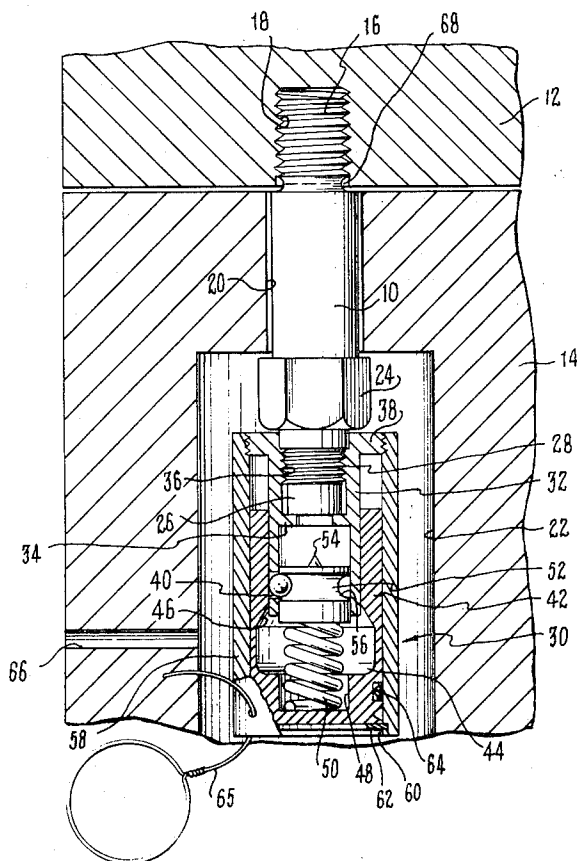
[58] Field of Search 89/1 B; 102/7, 10, 102/16

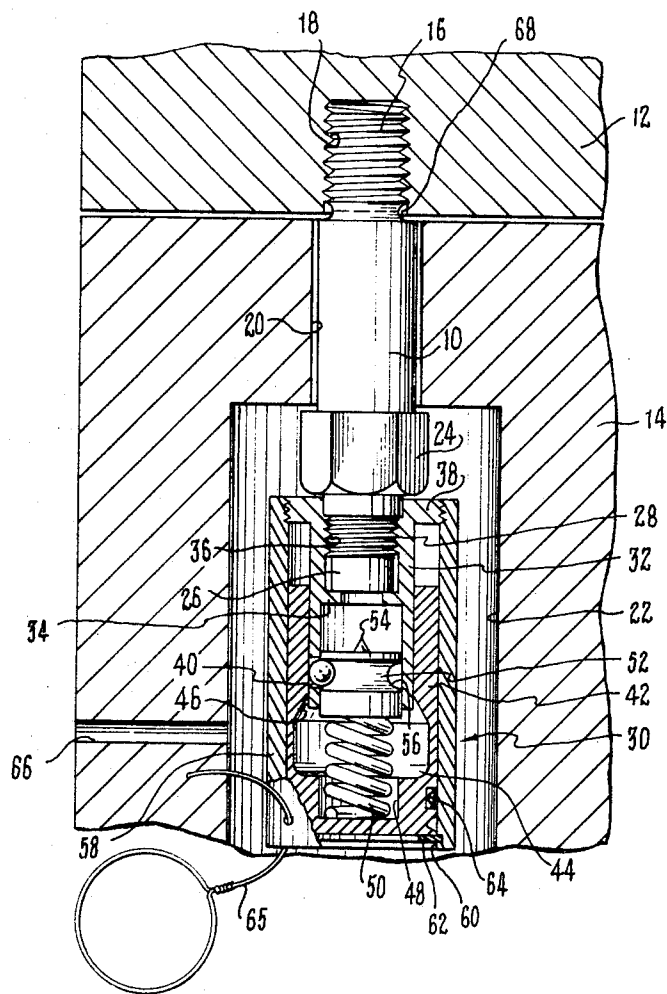
[56] **References Cited**

UNITED STATES PATENTS

3,087,369	4/1963	Butterfield	89/1 B
3,015,270	1/1962	Domingos, Jr. et al.	102/8 X
3,277,766	10/1966	Burkdoll	89/1 B X

1 Claim, 1 Drawing Figure





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EXPLOSIVE BOLT

BACKGROUND OF THE INVENTION

This invention relates generally to a separable fastener assembly, and more particularly to a fastener assembly adapted to separate in response to a predetermined hydrostatic pressure.

Generally, an underwater mine includes a mine case containing an explosive material and an anchor designed to rest on the ocean bottom and moor the mine case in position by virtue of a connecting cable. Before mines of this nature are laid, the two components, i.e., the mine case and the anchor, are in most instances rigidly fastened together in a unitary assembly. The assembly is normally jettisoned from a surface vessel and descends in the water until a predetermined depth is reached at which time the mine case separates from the anchor. The anchor continues its descent paying out the connecting cable and mooring is complete upon the anchor coming to rest on the ocean bottom. The mine case is positively buoyant and therefore remains moored at a depth determined by the length of the cable.

Separation of the mine case from its anchor is generally accomplished by the pressure actuation of a hydrostatic switch which, in turn, electrically initiates an explosive release mechanism by applying a battery voltage. In most instances, it is necessary to have an electric cable leading from the explosive release device into the anchor in order to be connected to the battery and hydrostatic switch. In the past, the necessity of the electric cable has presented a routing problem and further has presented a watertight connection problem.

Separable bolt assemblies have been known in the prior art. These bolt assemblies are usually electrically initiated from an external source. The use of such a separable fastener assembly for connecting a mine casing to an anchor involves many of the same problems described hereinabove. For example, electrical cable routing problems in addition to watertight sealing problems arise in the use of such fastener assemblies.

SUMMARY OF THE INVENTION

Accordingly, one object of this invention is to provide a new and improved connecting device for coupling a mine case to a mine anchor which will permit separation of the two components at a predetermined depth.

Another object of the invention is the provision of a new and improved separable fastener assembly.

Still another object of the present invention is to provide a new and improved separable fastener assembly which is initiated in response to exposure to a predetermined hydrostatic pressure.

A further object of the instant invention is to provide a new and improved explosive bolt assembly which is responsive to hydrostatic pressure.

A still further object of this invention is the provision of a hydrostatic pressure responsive explosive bolt assembly which is both easy and inexpensive to manufacture.

Briefly, in accordance with one embodiment of this invention, these and other objects are attained by providing a conventional explosive bolt with a detonator adapted to release a firing pin against a percussion sensitive section of the bolt only after attaining a predetermined depth in water. The detonator includes pressure

responsive piston means which act against a constrained plunger with increasing force in response to increasing hydrostatic pressure. When a predetermined depth is reached, the piston means has moved a predetermined distance causing a locking mechanism to release the restrained plunger. The plunger, now free to move under the force imparted thereto by spring bias means, moves against the percussion section of the explosive bolt thereby causing explosive initiation thereof with consequent fracturing of the bolt along a predetermined breakline.

BRIEF DESCRIPTION OF THE DRAWING

A more complete appreciation of the invention and many of the attendant advantages thereof will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawing wherein the FIGURE illustrates a side view of the separable fastener assembly in partial section connecting a mine casing to a mine anchor.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawing, a conventional explosive bolt 10 is shown connecting a mine casing 22 to a mine anchor 14. In the present embodiment, the bolt includes a threaded end portion 16 which is received in threaded bore 18 formed in casing 12. Anchor 14 has formed therein a clearance bore 20 alignable with the threaded bore 18 and opening into an enlarged cylindrical cavity 22 formed in the anchor. The bolt 10 has a head portion 24 integrally formed at one end thereof which cooperates with the cavity 22 in a snug fashion in order to rigidly secure the mine casing to the anchor. Extending beyond head portion 24 into cavity 22 is a conventional percussion cap 26 which is fastened to the head portion 24 by means of a threaded shank portion 28. The percussion cap 26 is filled with an explosive material which will be initiated upon its being struck by a firing pin.

The detonator section generally denoted as 30 includes a retaining sleeve 32 having an inwardly extending circumferential flange 34 formed approximately midway therein. The retaining sleeve 32 is connected to the threaded shank portion 28 of explosive bolt 10 by means of interiorly formed threads 36 formed at one end portion of the retaining sleeve. An exteriorly formed circumferentially extended flange 38 having threads formed on the outer surface thereof is integrally formed on the same end of retaining sleeve 32. A series of holes 40 (only one of which is shown) are circumferentially formed at the other end portion of retaining sleeve 32 for purposes which will become clearer hereinbelow.

Slidably positioned over the outer surface of the retaining sleeve 32 is a cup-shaped piston member 42. The upper portion of piston member 42, i.e., the portion in contact with retaining sleeve 32 has an internal diameter only slightly larger than the outer diameter of the retaining sleeve, thereby providing a snug sliding fit thereover. The lower portion of piston member 42 has interiorly formed therein a cylindrical recess 44 having a larger internal diameter than the upper portion of the piston member. The recess 44 communicates with the upper portion of the piston member by means of an inwardly formed beveled surface 46.

A reduced cylindrical recess 48 is formed within piston member 42 and communicates with enlarged recess 44 for receiving one end of a compression spring 50. The other end of the spring 50 contacts a plunger 52 which has a conventional firing pin 54 formed thereon. Spring 50 is normally in a slightly compressed state and therefore constantly exerts a force against plunger 52 in a direction towards percussion cap 26.

Plunger 52 is normally restrained in place against the force of spring 50 by a series of balls (only one of which is shown) which mutually cooperates with a circumferentially extending annular groove 56 formed in plunger 52 and holes 40 formed in retaining sleeve 32. The balls are prevented from moving outwardly through holes 40 by the inner surface of piston member 42.

A cylindrical shroud 58 snugly fits over piston member 42 and is threadedly connected to retaining sleeve by virtue of the threaded flange 38. The shroud 50 has a lip 60 formed at the end thereof which houses a retaining ring 62 in place. The retaining ring itself prevents the piston member 42 from being separated from the detonator section by virtue of the force exerted thereon by spring 50. An O-ring 64 is provided within an annular groove formed around the piston member and provides a fluid seal as will be described in greater detail hereinafter. Finally, a safety wire 65 passes through a hole formed in the shroud which is aligned with a groove in piston member 42 and, while so positioned, prevents the piston member from inadvertently being displaced and releasing the plunger 52.

In operation, the explosive bolt 10 secures the mine casing 12 to the mine anchor 14 by the threaded attachment of end portion 16 to the casing causing the head portion 24 to be rigidly positioned against the cavity 22 in the anchor. The detonator section 30 may be provided onto the bolt 10 immediately subsequent to fastening the bolt onto the apparatus or connection may be delayed until a time immediately prior to the time at which the mine is to be laid. Prior to laying the mine, wire 65 is removed. The mine anchor 14 is provided with a bore 66 opening from the external environment into cavity 22 which is otherwise closed to the external environment.

Upon entry into the water, the water begins to enter through bore 66 into cavity 22. As the hydrostatic pressure increases, piston member 42 is urged against the force of spring 50 in a direction towards a bolt 10. O-ring 64 provides a seal which insures that a pressure differential will be maintained between the exterior and interior areas of the piston member. As the piston member moves further, spring 50 is further compressed. When a predetermined depth has been

reached the enlarged recess 44 is positioned opposite to holes 44 formed in retaining sleeve 32. The recess 44 is of sufficient diameter to allow balls to fall thereinto and come out of contact with annular groove 56 in plunger 52. When this occurs, there is no longer any restraint preventing plunger 52 from moving in a forward direction under the force of spring 50. Thus, the firing pin 54 hits the percussion cap 26 and causes initiation of the explosive contained therein causing the bolt to fracture along breakline 68. Thus, the mine casing 12 is allowed to separate from the anchor 14.

Obviously, numerous modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described herein.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. Apparatus for separably joining a pair of assemblies comprising:

- an explosively filled bolt having a head portion at one end thereof;
- a percussion cap attached adjacent said head portion;
- a plunger normally fixed in spaced relationship to said percussion cap for detonating said explosively filled bolt;
- a hydrostatic pressure responsive ball locking mechanism including:
- a cylindrical retaining sleeve connected to said bolt for receiving said plunger and having at least one hole formed radially therethrough;
- a ball positioned within said at least one hole formed in said retaining sleeve
- an annular groove formed in said plunger normally cooperating with said ball;
- a piston member slidably disposed over said retaining sleeve having a head portion communicable with the external environment, and having a reduced inner diameter portion normally overlying and retain said ball in said groove and an enlarged inner diameter portion axially contiguous with said reduced inner diameter portion; and
- a compression spring positioned between said piston member and said plunger;
- whereby a predetermined hydrostatic pressure forces said piston to move inwardly, overcoming the force of said spring and causing said enlarged inner diameter to overlie and thereby release said ball from said annular groove whereupon said plunger impacts said percussion cap.

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