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(54) Electromechanical high load separation device

(57) An electromechanical high load separation device for providing a reliable means of separation for high-load, mission-critical applications, e.g., deployment of solar panels and high-gain antennas on a satellite. The load separation device provides a structural support for a bolted joint that can be remotely scparated by transmitting an electrical signal without the use of explosive initiators. When a separation or deployment is desired, a power supply is remotely triggered to transmit an electrical signal to the separation device. This signal will energize both or either one of the two spools, which would cause them to separate. This in turn allows spring-loaded plungers to drive through the spools, resulting in mechanical actuation. The actuation will physically release a threaded rod and its attachment, completing its function.

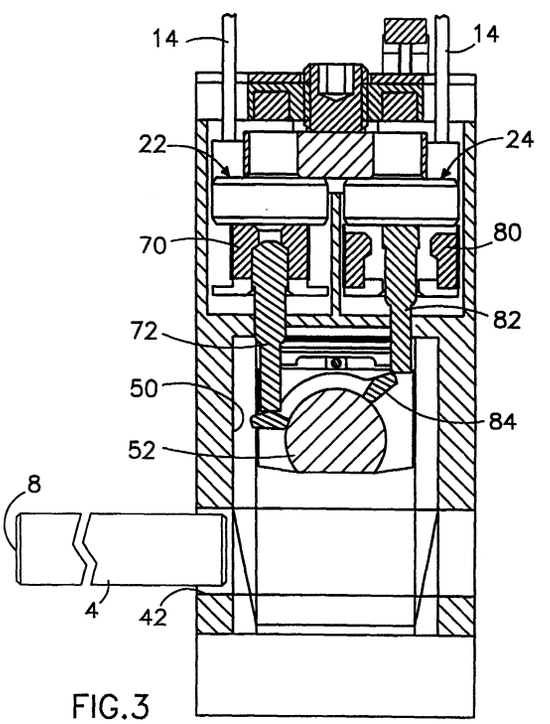

FIG.3

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Description

[0001] The present invention generally relates to the field of separation mechanisms. More particularly, the present invention relates to the field of electromechanical separation devices for high load separation operations, high load mission critical applications or the like.

[0002] Specifically, prior art separation devices are well known in the art and are widely used in the aerospace, manufacturing and construction industries. The purpose of utilizing separation devices is to provide a release in a quick releasible manner of an external attached structure without damaging the external structure.

[0003] The following fifteen (15) prior art patents are found to be pertinent to the field of the present invention:

1. United States Patent No. 1,027,481 issued to Huff on May 28, 1912 for "Releasing Hook for Life Boats and the Like" (hereafter the "Huff Patent");
2. United States Patent No. 1,190,491 issued to Dunn on July, 11, 1916 for "Coupling" (hereafter the "Dunn Patent");
3. United States Patent No. 1,929,869 issued to Hassner on October 10, 1933 for "Quick Change Chuck" (hereafter the "Hassner Patent");
4. United States Patent No. 3,012,811 issued to Sandrock on December 12, 1961 for "Gripping Tool" (hereafter the "Sandrock Patent");
5. United States Patent No. 3,109,677 issued to Hoover, Sr. on November 5, 1963 for "Self-Releasing Grappling Device" (hereafter the "Hoover Patent");
6. United States Patent No. 3,718,951 issued to Pasbrig on March 6, 1973 for "Rope Clamp" (hereafter the "Pasbrig Patent");
7. United States Patent No. 3,810,671 issued to Jeffery on May 14, 1974 for "Jettison Device For Helicopter Load Carrying System" (hereafter the "Jeffery Patent");
8. United States Patent No. 3,795,420 issued to Preston, Jr. on March 5, 1974 for "Lift Coupling" (hereafter the "Preston Patent");
9. United States Patent No. 3,877,343 issued to Newell *et al.* on April 15, 1975 for "Stores Carriers" (hereafter the "Newell Patent");
10. United States Patent No. 4,017,112 issued to Delest on April 12, 1977 for "Device For Releasing A Load From Its Support" (hereafter the "Delest Patent");
11. United States Patent No. 4,258,888 issued to Sawn on March 31, 1981 for "Quick Releasing High Strength Connector" (hereafter the "Sawn Patent");
12. United States Patent No. 4,810,017 issued to Knak *et al.* on March 7, 1989 for "Safety Clutch" (hereafter the "Knak Patent");
13. United States Patent No. 5,064,235 issued to Lessard on November 12, 1991 for "Automatic Sling Device" (hereafter the "Lessard Patent");
14. United States Patent No. 5,131,705 issued to Gluck on July 21, 1992 for "Device For Remote-Controlled Grasping And Coupling" (hereafter the "Gluck Patent"); and
15. United States Patent No. 5,312,147 issued to Rudoy *et al.* on May 17, 1994 for "Electromechanical High Load Separation Apparatus With A Smooth Release" (hereafter the "Rudoy Patent").

[0004] The Huff Patent discloses a releasing hook for life boats and the like. The releasing hook assembly includes two gripping jaws which are bounded by a sleeve. The sleeve is biased by a spring to hold two gripping jaws close to each other for gripping the head portion of a stem. The sleeve can be pulled against the spring force to allow the separation of the two gripping jaws, to thereby release the stem.

[0005] The Dunn Patent discloses a coupling tube which includes a series of internal jaws. The internal jaws are biased by a coil spring for coupling an inserted head portion of a wire. To release the wire, an external sleeve is inserted into the tube to separate the internal jaws so that the head portion of the wire can be pulled out.

[0006] The Hassner Patent discloses a quick change chuck. The quick change chuck assembly includes two locking levers which are bounded by a slidable ring. The slidable ring has internal cam surfaces engagable with the two locking levers. The slidable ring is biased by a coil spring for closing the locking levers to lock an inserted collar. When the slidable ring is slid against the spring force, its internal cam surfaces force the two locking levers to open for releasing the collar.

[0007] The Sandrock Patent discloses a gripping tool. The gripping tool has two grasping members which are pivotally mounted on the tool and operable by the up and down movement of a plunger. The plunger has a necked down portion for allowing the two grasping members to move closer or apart, depending on the moving direction of the plunger.

[0008] The Hoover Patent discloses a self-releasing grappling device. The grappling device includes two separable jaws for grappling a lifting lug. An external releasing sleeve attached to the lifting lug is utilized for engaging the two separable jaws and forcing them to open to release the lifting lug.

[0009] The Pasbrig Patent discloses a rope clamp. The clamp assembly includes two elongated clamping members which are bound by a clamping body and biased by a shackle spring. The elongated clamping members are further connected to a spring biased sleeve which can be shifted to allow the clamping members to move relatively with respect to the clamping body, so that the two clamping members are separated which allows the clamped rope to release.

[0010] The Jeffery Patent discloses a jettison device for a helicopter load carrying system. It comprises an

explosively operated mechanism for both jettisoning the load held by a hook at the end of a pendant and simultaneously cutting the hook retrieval cable.

[0011] The Preston Patent discloses a lift coupling. A remote operation is utilized with the lift coupling.

[0012] The Newell Patent discloses a carrier assembly. The carrier assembly includes two jaws with integral cams. The carrier assembly further includes rollers which can engage on the cam to close or open the jaws.

[0013] The Delest Patent discloses a device for releasing a load from its support. It comprises two clamping jaws for the load mounted inside a sleeve formed with openings and movable in relation to the sleeve under the combined action of the load and of a spring whose action is applied in the opposite direction to the load.

[0014] The Sawn Patent discloses a quick releasing high strength connector. The connector assembly includes a plurality of spring biased over-center dogs for holding a load. The over-center dogs are pivotally mounted and engaged by a spring biased latching ring to lock the load. By pulling a release cable the latching ring can be lifted up to allow the over-center dogs to rotate for releasing the load.

[0015] The Knak Patent discloses a safety clutch.

[0016] The Lessard Patent discloses an automatic sling lock. The sling lock assembly includes two locking pawls which are respectively controlled by two actuating rods. The actuating rods are connected to a same butt plate which is biased by a spring.

[0017] The Gluck Patent discloses a remote-controlled grasping and coupling device. The grasping and coupling device includes two pivotally mounted load latches for holding an electrical plug connection. A slidable outer ring is provided for binding the two load latches. The outer ring can be lifted up by a pair of forks to allow the load latches to rotate for releasing the electrical plug connection to a storage station.

[0018] The Rudoy Patent discloses an electromechanical high load separation apparatus with a smooth release for attaching to an external structure and releasing the external structure in a smooth releasable manner without damaging the external structure.

[0019] Therefore, it is highly desirable to have a very efficient and also very effective design and construction of an improved electromechanical high load separation device which can be used in various applications, particularly in the aerospace industry.

[0020] According to the present invention, there is provided a separation device for attaching to a structural element, the separation device comprising a housing, a ramp mounted within said housing, and at least two jaws resting on said ramp, the separation device further characterized by:

a. a locking bar positioned on said at least two jaws, and attachment means in turn attached to said structural element, compressing said at least two jaws together for holding the attachment means thereto;

b. rocking means positioned on said locking bar;

c. at least two actuator means for respectively operating at least two plungers, each actuator means having a spool being operable by control means for allowing both or either one of the at least two plungers to respectively move through said each spool, the at least two plungers positioned on said rocking means for balancing said rocking means on said locking bar; and

d. when neither one of said at least two actuator means is actuated, said locking bar and said at least two jaws retain said attachment means, and when both or either one of said at least two actuating means is actuated, said rocking means is forced to move by the unbalancing of said at least two plungers which allows said locking bar to move away from said at least two jaws, thereby allowing said at least two jaws to fly away from each other and release said attachment means which in turn releases said structural element.

[0021] The present invention is a separation device for providing a reliable means of separation for example of high-load mission-critical applications, e.g., deployment of solar panels and high-gain antennas on a satellite or the like. The load separation device is preferably an electromechanical high load separation device which may provide a structural support for a bolted joint that can be remotely separated by transmitting an electrical signal or other type of signal without the use of explosive initiators. When a separation or deployment is desired, a power supply or control means can be remotely triggered to transmit an electrical signal to the separation device. This signal will energize both or either one of the two spools, which would cause them to separate in milliseconds. This in turn will allow spring-loaded plungers, for example, to drive through the spools, resulting in mechanical actuation. The actuation will, for example, physically release a threaded rod and its attachment, completing its function.

[0022] Preferably the present invention provides an electromechanical high load separation device which utilizes only non-explosive initiators (NEIs) that can be remotely controlled by electrical signals or other suitable type of signals.

[0023] Most preferably a pair of high-strength non-explosive initiators (NEIs) is utilised. Each NEI may have a spool which is made of hardened steel that can absorb up to 2,000 lb. of compression load induced by a plunger and provides much higher load capability.

[0024] In a preferred embodiment of the present invention the separation device includes shock absorbers which are preferably made out of energy-absorbing aluminum foam material and as a result, the aluminum foam material will be crushed and provides much better compression than prior art shock absorbers which are

made out of rubber material.

[0025] It is also preferred that the present invention includes a rocker that can preferably be rocked in a lateral direction relative to a pivot point. The rocker may be balanced by two plungers and two non-explosive initiators (NEIs) and if both or either one of the two NEIs is actuated, both or either one of the two plungers will penetrate through a spool and the rocker will rock in a rocking motion in order to release a threaded bolt, for example, so that the separation device satisfies the redundancy requirement of the actuating operation.

[0026] In a further preferred embodiment of the present invention an electromechanical high load separation device includes a three-piece separation and locking bar assembly wherein an upper locking bar portion moves upwardly when both or either one of the NEIs is activated and therefore causes the upper locking bar portion to move upwardly. The entire three piece separation and locking bar assembly may be prestressed and may have a threaded bolt where the threads are at an angle of approximately 60 ° screwed into the separation and locking bar assembly. In such an embodiment when the upper locking bar portion is moved upwardly, the other two oppositely disposed bottom jaw portions of the separation and locking bar assembly fly outwardly at an angle and release the threaded bolt. The threaded bolt preferably releases in a transverse direction to the motion of the plungers through the spools.

[0027] For a better understanding of the invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:-

FIG. 1 is a top plan view of the present invention electromechanical high load separation device;

FIG. 2 is a cross-sectional view taken along line 2-2 of FIG. 1, through plungers of the present invention electromechanical high load separation device in its unfired condition;

FIG. 3 is a similar view shown in FIG. 2, through the plungers of the present invention electromechanical high load separation device in its fired condition;

FIG. 4 is a cross-sectional view taken along line 4-4 of FIG. 1, through bushings of the present invention electromechanical high load separation device in its unfired condition;

FIG. 5 is a similar view shown in FIG. 4, through the bushings of the present invention electromechanical high load separation device in its fired condition; and

FIG. 6 is an enlarged perspective view of an upper locking bar portion of a separation and locking bar assembly with two plungers positioned thereto and balanced on a rocker.

[0028] Although specific embodiments of the present invention will now be described with reference to the drawings, it should be understood that such embodiments are by way of example only and merely illustrative of but a small number of the many possible specific embodiments which can represent applications of the principles of the present invention. Various changes and modifications obvious to one skilled in the art to which the present invention pertains are deemed to be within the spirit, scope and contemplation of the present invention as further defined in the appended claims.

[0029] Described briefly, the present invention is a separation device, preferably a high load separation device and most preferably an electromechanical high load separation device. A preferred embodiment of the high load separation device includes a housing, a pair of non-explosive initiators (NEIs), a pair of plungers, a pair of springs, a rocker, a pair of shock-absorbers, a three-piece separation and locking bar assembly, and a threaded load attachment bolt. The three piece separation and locking bar assembly has an upper locking bar portion which moves upwardly when both or either one of the NEIs is activated and therefore causes the upper locking bar portion to move upwardly. The threaded load attachment bolt has threads which are at an angle of approximately 60° screwed into the three-piece separation and locking nut so that when the upper locking bar portion is moved upwardly, the other two oppositely disposed bottom jaw portions of the three-piece separation and locking bar assembly fly away from each other at an angle and release the threaded load attachment bolt. In this case, the threaded load attachment bolt releases in a transverse direction to the motion of the plungers through the spools.

[0030] Referring to Figure 1, there is shown at 10 a top plan view of the present invention electromechanical high load separation device which has a generally rectangular shaped housing 11 and a base 12.

[0031] Figures 2 and 3 show respective cross-sectional views through plungers 72 and 82 of the present invention electromechanical high load separation device 10 in its unfired (unreleased) condition and in its fired (released) condition. Referring to Figures 1, 2, 3, 4 and 5, the housing 11 includes a top end 13, a bottom end 15, a sidewall 17, and an interior hollow chamber 50. A cover plate 20 is sized to fit and attached to the top end 13 for enclosing the interior hollow chamber 50 of the housing 12 and the cover plate 20 is secured to the top end 13.

[0032] There are provided a pair of non-explosive initiators (NEIs) 22 and 24 located adjacent to the top end 13 of the housing 12. The two NEIs 22 and 24 are independently and remotely controlled by electrical, optical or other suitable type of signals. The NEI 22 has a spool 70 for retaining and supporting a plunger 72, and the NEI 24 also has a spool 80 for retaining and supporting a plunger 82. Control cables 14 may be respectively connected to the two NEIs 22 and 24 for transmitting electrical signals or other suitable type of signals from a power supply or control means (not shown). Located adjacent to the bottom end 15 of the housing 11, there

is a transverse aperture 42 which extends into the interior hollow chamber 50 of the housing 11.

[0033] Figures 4 and 5 show respective cross-sectional views through bushings 44 and 46 of the present invention electromechanical high load separation device 10 in its unfired (unreleased) condition (Figure 4) and in its fired (released) condition (Figure 5). Referring to Figures 2, 3, 4, 5 and 6, the load attachment bolt 4 has a generally elongated body with a threaded proximal end 6 and a distal end 8, where the proximal end 6 is located within the hollow chamber 50 of the housing 11 and threadedly engaged with a three piece separation and locking bar assembly 16, and the second end 8 is inserted through the transverse aperture 42 and extends out from the housing 11 for attaching to the external structure (not shown). The three piece separation and locking bar assembly 16 includes an upper locking bar portion 18 and two oppositely disposed bottom jaw portions 26 and 28. The upper locking bar portion 18 moves upwardly when spools 70 and/or 80 are activated and therefore causes a lower engagement surface 30 to move upwardly. The entire three piece separation and locking bar assembly 16 is prestressed and by having the threaded bolt 4 where the threads are at an angle of approximately 60° screwed into the three piece separation and locking bar assembly 16 when the lower nut surface 30 of the upper locking bar portion 18 is moved upwardly, the other two oppositely disposed bottom jaw portions 26 and 28 of the separation and locking bar assembly 16 fly away from each other at an angle and release the load attachment bolt 4.

[0034] Referring to Figures 4 and 5, the two bottom jaw portions 26 and 28 slidably rest on a ramp 32 which is mounted within the interior hollow chamber 50 and located adjacent to the bottom end 15 of the housing 11. The upper locking bar portion 18 and the two bottom jaw portions 26 and 28 confine the load attachment bolt 4 from separating from the high load separation device 10. To separate the load attachment bolt 4 from the electromechanical high load separation device 10, the upper locking bar portion 18 has to move up, and the other two oppositely disposed bottom jaw portions 26 and 28 fly away from each other at an angle along the ramp 32 and release the load attachment bolt 4.

[0035] Referring to Figures 2, 3, 4, 5 and 6, the energy for providing the upward motion between the locking bar portion 18 and the two bottom jaw portions 26 and 28 is stored in compression springs 90 and 92. The compression springs 90 and 92 are respectively mounted and surround bushing sleeves 36 and 38 which house bushings 44 and 46. The bottom ends of the bushings 44 and 46 are attached to the upper surface of the upper locking bar portion 18 at opposite locations 40 and 48. The compression springs 90 and 92 are under compression when the electromechanical high load separation device 10 is in the unfired condition (see Figure 4). The containment of the compression springs 90 and 92 is accomplished by the two NEIs 22 and 24 through a rocker 84, the spools 70 and 80, and the two plungers 72 and 82. The rocker 84 has two arch shaped parallel arms 86 which are connected to two opposite flat ends 88 on which the bottom ends of the two plungers 72 and 82 rest and balance.

[0036] The purpose of utilizing two NEIs 22 and 24, and two plungers 72 and 82 with the rocker 84 is to provide redundancy of actuating operation for backup and safety operations.

[0037] Referring to Figure 6, the upper locking bar portion 18 is provided with a circular support 52 for supporting the rocker 84, so that the rocker 84 can be rocked in a lateral direction relative to a pivot point without the risk of slipping off the circular support 52. The two plungers 72 and 82 are symmetrically engaged with the flat ends 88 of the rocker 84 to retain and balance the rocker 84 onto the circular support 52 of the locking bar portion 18 of the separation and locking bar assembly 16. The two plungers 72 and 82 maintain the upper locking bar portion 18 of the three piece separation and locking bar assembly 16 from being moved upwardly by the compression springs 90 and 92, maintaining the upper locking bar portion 18 and the two bottom jaw portions 26 and 28 in the unfired condition (see Figure 2 and 4).

[0038] Referring to Figures 2 through 6, when both or either one of the two NEIs 22 and 24 is actuated, spools 70 and 80 are disengaged and allow the plungers 72 and 82 to move upwardly through the respective centers of the disengaged spools 70 and 80. The plungers 72 and 82 in turn allow the upper locking bar portion 18 to move upwardly through action of the bushings 44 and 46 and the compression springs 90 and 92, liberating the two bottom jaw portion 26 and 28 to the fired condition (see Figure 3 and 5). The spool 70 of the NEI 22 is engaged and resists the movement of the plunger 72, but the spool 80 of the NEI 24 is disengaged and allows the movement of the plunger 82 to penetrate through the spool 80 (see Figure 3). Because the rocker 84 is pivotally supported, it allows the upward movement of the upper locking bar portion 18 of the separation and locking bar assembly 16 even though only one of the two NEIs 22 and 24 is actuated. This arrangement satisfies the requirement for redundancy of actuating operation. In the event this single actuation fails to release the load attachment bolt 4, the NEI 22 can be actuated so that the spool 70 becomes disengaged, thereby permitting the plunger 72 to move through the spool 70 to permit the upper locking bar portion 18 of the separation and locking bar assembly 16 to move upward and release the load attachment bolt 4. This redundancy feature thereby provides a duplicate operation to help prevent system failure.

[0039] Referring to Figures 4, 5 and 6, to reduce the shock from the possible impact of the separation and locking bar assembly 16, a pair of shock absorbers 60 and 62 are positioned and secured on top of the upper locking bar portion 18 of the separation and locking bar

assembly 16 at opposite locations 40 and 48. The shock absorbers 60 and 62 operate by restricting the impact of the separation and locking bar assembly 16 and are made of energy-absorbing aluminum foam material, and as a result, the aluminum foam material will be crushed and provides much better compression. The aluminum foam shock absorbers 60 and 62 which are generally rectangular or square in overall shape absorb far more energy than prior art rubber shock absorbers.

[0040] The present invention electromechanical high load separation device has many advantageous features including: (a) it utilizes the NEIs, so that the separation of the separation and locking bar assembly 16 will not disturb any other adjacent highly sensitive components; (b) it can be remotely controlled by electrical, optical or other type of suitable signals; (c) it satisfies the redundancy requirement of the actuating operation by employing a rocker to provide duplicate operation to reduce system failure; (d) it has a structure which is capable of tolerating very high tensile loads; (e) it has a very compact design and is very lightweight; and (f) it can be utilized in various applications such as high-load mission-critical applications, e.g., deployment of solar panels and high-gain antennas on a satellite or the like.

[0041] Defined in detail, the present invention is an electromechanical high load separation device for attaching to an external structure and releasing the external structure under remote control signals, the electromechanical high load separation device comprising a housing having a top end, a bottom end and a sidewall extending downwardly from the top end to the bottom end to form an interior hollow chamber, the sidewall having an aperture thereto located adjacent to the bottom end, a ramp within said interior hollow chamber and mounted on said bottom end of said housing and a load attachment bolt having a threaded proximal end and a distal end, the distal end inserted through said aperture at said sidewall of said housing and extending out from said housing for attaching to said external structure, the electromechanical high load separation device further characterized by: (a) a separation and locking bar assembly mounted within said hollow chamber of said housing and including an upper locking bar portion and two oppositely disposed bottom jaw portions, where the two bottom jaw portions slidably rest on said ramp and the upper locking bar portion is positioned above and compresses the two bottom jaw portions to form an unreleased condition such that said threaded proximal end of said load attachment bolt is threaded into the unreleased condition for retaining said proximal end of said load attachment bolt thereto; (b) a rocker having a pair of arch shaped arms connected to a pair of flat ends, where the pair of arch shaped arms movably position on a circular support of said upper locking bar portion of said separation and locking bar assembly; (c) a pair of non-explosive initiators (NEIs) symmetrically mounted within said hollow chamber and located adjacent to said top end of said housing for respectively operating two plungers, each NEI having a spool being operable by said remote control signals for allowing both or either one of the two plungers to move upwardly through said each spool, the two plungers symmetrically contacting said pair of flat ends of said rocker for balancing said rocker against said circular support of said upper locking bar portion of said separation and locking bar assembly which is biased upwardly by bushings and spring means; (d) when neither one of said pair of NEIs is actuated, said separation and locking bar assembly retains said load attachment bolt thereto, and when both or either one of said pair of NEIs is actuated by said remote control signals, said rocker is forced into a rocking motion by the unbalancing of said plungers which allows said upper locking bar portion to move upwardly by said bushings and said spring means, and said two oppositely disposed bottom jaw portions of said separation and locking bar assembly fly away from each other at an angle and release said load attachment bolt which in turn releases said external structure; and (e) means for cushioning potential impact resulting from the upward movement of said upper locking bar portion of said separation and locking bar assembly.

[0042] Defined broadly, the present invention is a high load separation device for attaching to an external structure and releasing the external structure under remote control signals, the high load separation device comprising a housing having a top end, a bottom end and a sidewall extending from the top end to the bottom end to form a chamber, the sidewall having an opening thereto, a ramp within said chamber and mounted on said bottom end of said housing, and an attachment bolt having a first end and a second end, the second end inserted through said opening of said housing and extending out from said housing for attaching to said external structure, the high load separation device further characterized by: (a) a pair of bottom jaws slidably resting on said ramp and located adjacent to each other; (b) an upper locking bar mounted within said hollow chamber and positioned above and compressing said pair of bottom jaws to an unreleased condition such that said first end of said attachment bolt is threaded into the unreleased condition for retaining said first end of said attachment bolt; (c) a rocker movably positioned above said upper locking bar; (d) at least two non-explosive initiators (NEIs) mounted within said hollow chamber and located adjacent to said top end of said housing for respectively operating at least two plungers, each NEI having a spool being operable by said remote control signals for allowing both or either one of the at least two plungers to move upwardly through said each spool, the at least two plungers contacting said rocker at opposite locations for balancing said rocker against said upper locking bar which is biased upwardly by bushings and spring means; and (e) when neither one of said at least two NEIs is actuated, said upper locking bar and said pair of bottom jaws retain said attachment bolt in said unreleased condition, and when both or either one of said at

least two NEIs is actuated by said remote control signals, said rocker is forced into a rocking motion by the unbalancing of said at least two plungers which allows said upper locking bar to move upwardly by said bushings and said spring means, and said pair of bottom jaws fly away from each other at an angle and release said attachment bolt which in turn releases said external structure.

[0043] Defined more broadly, the present invention is a load separation device for attaching to an external structure, the load separation device comprising a housing, a ramp mounted within said housing, and at least two oppositely disposed jaws resting on said ramp, the load separation device further characterized by: (a) a locking bar positioned on said at least two jaws and compressing said at least two jaws for retaining attachment means thereto, the locking bar biased by spring means; (b) rocking means movably positioned on said locking bar; (c) at least two non-explosive initiators (NEIs) mounted within said housing for respectively operating at least two plungers, each NEI having a spool being operable by control means for allowing both or either one of the at least two plungers to respectively move through said each spool, the at least two plungers contacting said rocking means for balancing said rocking means against said locking bar; and (d) when neither one of said at least two NEIs is actuated, said locking bar and said at least two oppositely disposed jaws retain said attachment means, and when both or either one of said at least two NEIs is actuated, said rocking means is forced to move by the unbalancing of said at least two plungers which allows said locking bar to move by said spring means, and said at least two oppositely disposed jaws fly at an angle outwardly and release said attachment means which in turn releases said external structure.

[0044] Defined even more broadly, the present invention is a separation device for attaching to a structural element, the separation device comprising a housing, a ramp mounted within said housing, and at least two jaws resting on said ramp, the separation device further characterized by: (a) a locking bar positioned on said at least two jaws, and attachment means in turn attached to said structural element, compressing said at least two jaws together for holding the attachment means thereto; (b) rocking means positioned on said locking bar; (c) at least two actuator means for respectively operating at least two plungers, each actuator means having a spool being operable by control means for allowing both or either one of the at least two plungers to respectively move through said each spool, the at least two plungers positioned on said rocking means for balancing said rocking means on said locking bar; and (d) when neither one of said at least two actuator means is actuated, said locking bar and said at least two jaws retain said attachment means, and when both or either one of said at least two actuating means is actuated, said rocking means is forced to move by the unbalancing of said at least two plungers which allows said locking bar to move away from said at least two jaws, thereby allowing said at least two jaws to fly away from each other and release said attachment means which in turn releases said structural element.

[0045] Of course the present invention is not intended to be restricted to any particular form or arrangement, or any specific embodiment, or any specific use, disclosed herein, since the same may be modified in various particulars or relations without departing from the spirit or scope of the claimed invention hereinabove shown and described of which the apparatus or method shown is intended only for illustration and disclosure of an operative embodiment and not to show all of the various forms or modifications in which this invention might be embodied or operated.

[0046] The present invention has been described in considerable detail in order to comply with the patent laws by providing full public disclosure of at least one of its forms. However, such detailed description is not intended in any way to limit the broad features or principles of the present invention, or the scope of the patent to be granted. Therefore, the invention is to be limited only by the scope of the appended claims.

Claims

1. A separation device for attaching to a structural element, the separation device comprising a housing, a ramp mounted within said housing, and at least two jaws resting on said ramp, the separation device further characterized by:

    a. a locking bar positioned on said at least two jaws, and attachment means in turn attached to said structural element, compressing said at least two jaws together for holding the attachment means thereto;

    b. rocking means positioned on said locking bar;

    c. at least two actuator means for respectively operating at least two plungers, each actuator means having a spool being operable by control means for allowing both or either one of the at least two plungers to respectively move through said each spool, the at least two plungers positioned on said rocking means for balancing said rocking means on said locking bar; and

    d. when neither one of said at least two actuator means is actuated, said locking bar and said at least two jaws retain said attachment means, and when both or either one of said at least two actuating means is actuated, said rocking means is forced to move by the unbalancing of said at least two plungers which allows said locking bar to move away from said at least two

jaws, thereby allowing said at least two jaws to fly away from each other and release said attachment means which in turn releases said structural element.

2. The separation device in accordance with Claim 1, further comprising means for cushioning potential impact resulting from the movement of said locking bar.

3. The separation device in accordance with Claim 2, wherein said cushioning means are shock absorbers attached at opposite ends of said locking bar.

4. The separation device in accordance with Claim 3, wherein said shock absorbers are made of foam aluminum material.

5. The separation device in accordance with any preceding claim, further comprising spring means for biasing said locking bar.

6. The separation device in accordance with Claim 5, wherein said spring means are compression springs respectively surrounding bushing sleeves which house said bushings.

7. The separation device in accordance with any preceding claim, wherein said attachment means includes a threaded bolt.

8. The separation device in accordance with any preceding claim, wherein said each actuator means includes a non-explosive initiator.

9. The separation device in accordance with any preceding claim wherein the jaws are oppositely disposed.

10. The separation device in accordance with any preceding claim wherein the rocking means is moveably positioned on the locking bar.

11. The separation device in accordance with any preceding claim wherein the structural element is an external structure.

12. An electromechanical high load separation device for attaching to an external structure and releasing the external structure under remote control signals, the electromechanical high load separation device comprising a housing having a top end, a bottom end and a sidewall extending downwardly from the top end to the bottom end to form an interior hollow chamber, the sidewall having an aperture thereto located adjacent to the bottom end, a ramp within said interior hollow chamber and mounted on said bottom end of said housing and a load attachment bolt having a threaded proximal end and a distal end, the distal end inserted through said aperture at said sidewall of said housing and extending out from said housing for attaching to said external structure, the electromechanical high load separation device further characterized by:

a. a separation and locking bar assembly mounted within said hollow chamber of said housing and including an upper locking bar portion and two oppositely disposed bottom jaw portions, where the two bottom jaw portions slidably rest on said ramp and the upper locking bar portion is positioned above and compresses the two bottom jaw portions to form an unreleased condition such that said threaded proximal end of said load attachment bolt is threaded into the unreleased condition for retaining said proximal end of said load attachment bolt thereto;

b. a rocker having a pair of arch shaped arms connected to a pair of flat ends, where the pair of arch shaped arms movably position on a circular support of said upper locking bar portion of said separation and locking bar assembly;

c. a pair of non-explosive initiators (NEIs) symmetrically mounted within said hollow chamber and located adjacent to said top end of said housing for respectively operating two plungers, each NEI having a spool being operable by said remote control signals for allowing both or either one of the two plungers to move upwardly through said each spool, the two plungers symmetrically contacting said pair of flat ends of said rocker for balancing said rocker against said circular support of said upper locking bar portion of said separation and locking bar assembly which is biased upwardly by bushings and spring means;

d. when neither one of said pair of NEIs is actuated, said separation and locking bar assembly retains said load attachment bolt thereto, and when both or either one of said pair of NEIs is actuated by said remote control signals, said rocker is forced into a rocking motion by the unbalancing of said plungers which allows said upper locking bar portion to move upwardly by said bushings and said spring means, and said two oppositely disposed bottom jaw portions of said separation and locking bar assembly fly away from each other at an angle and release said load attachment bolt which in turn releases said external structure; and

e. means for cushioning potential impact resulting from the upward movement of said upper locking bar portion of said separation and locking bar assembly.

13. The electromechanical high load separation device in accordance with Claim 12, wherein said cushioning means are shock absorbers attached at opposite ends of said upper locking bar portion of said separation and locking bar assembly.

14. The electromechanical high load separation device in accordance with Claim 13, wherein said shock absorbers are made of foam aluminum material.

15. The electromechanical high load separation device in accordance with Claims 11 to 14, wherein said spring means are a pair of compression springs respectively surrounding a pair of bushing sleeves which house said bushings.

16. A high load separation device for attaching to an external structure and releasing the external structure under remote control signals, the high load separation device comprising a housing having a top end, a bottom end and a sidewall extending from the top end to the bottom end to form a chamber, the sidewall having an opening thereto, a ramp within said chamber and mounted on said bottom end of said housing, and an attachment bolt having a first end and a second end, the second end inserted through said opening of said housing and extending out from said housing for attaching to said external structure, the high load separation device further characterized by:

a. a pair of bottom jaws slidably resting on said ramp and located adjacent to each other;
b. an upper locking bar mounted within said hollow chamber and positioned above and compressing said pair of bottom jaws to an unreleased condition such that said first end of said attachment bolt is threaded into the unreleased condition for retaining said first end of said attachment bolt;
c. a rocker movably positioned above said upper locking bar;
d. at least two non-explosive initiators (NEIs) mounted within said hollow chamber and located adjacent to said top end of said housing for respectively operating at least two plungers, each NEI having a spool being operable by said remote control signals for allowing both or either one of the at least two plungers to move upwardly through said each spool, the at least two plungers contacting said rocker at opposite locations for balancing said rocker against said upper locking bar which is biased upwardly by bushings and spring means; and
e. when neither one of said at least two NEIs is actuated, said upper locking bar and said pair of bottom jaws retain said attachment bolt in said unreleased condition, and when both or either one of said at least two NEIs is actuated by said remote control signals, said rocker is forced into a rocking motion by the unbalancing of said at least two plungers which allows said upper locking bar to move upwardly by said bushings and said spring means, and said pair of bottom jaws fly away from each other at an angle and release said attachment bolt which in turn releases said external structure.

17. The high load separation device in accordance with Claim 16, further comprising means for cushioning potential impact resulting from the upward movement of said upper locking bar.

18. The high load separation device in accordance with Claim 17, wherein said cushioning means are shock absorbers respectively attached at said opposite locations of said upper locking bar.

19. The high load separation device in accordance with Claim 18, wherein said shock absorbers are made of foam aluminum material.

20. The high load separation device in accordance with any of Claim 16 to 19, wherein said spring means are compression springs respectively surrounding bushing sleeves which house said bushings.

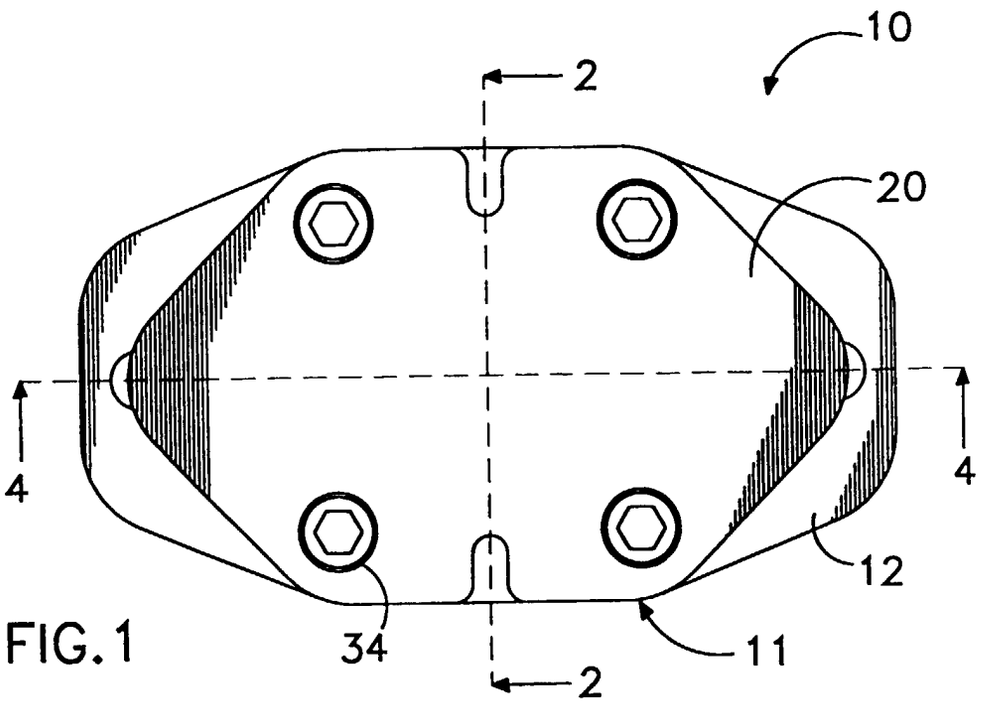

FIG. 1

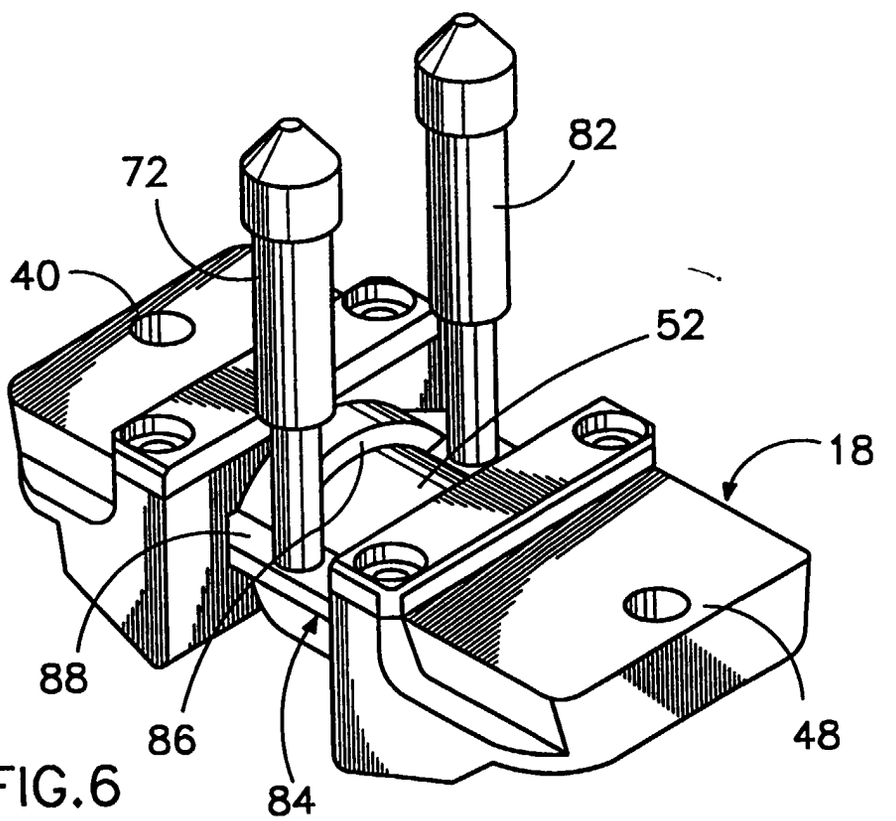

FIG. 6

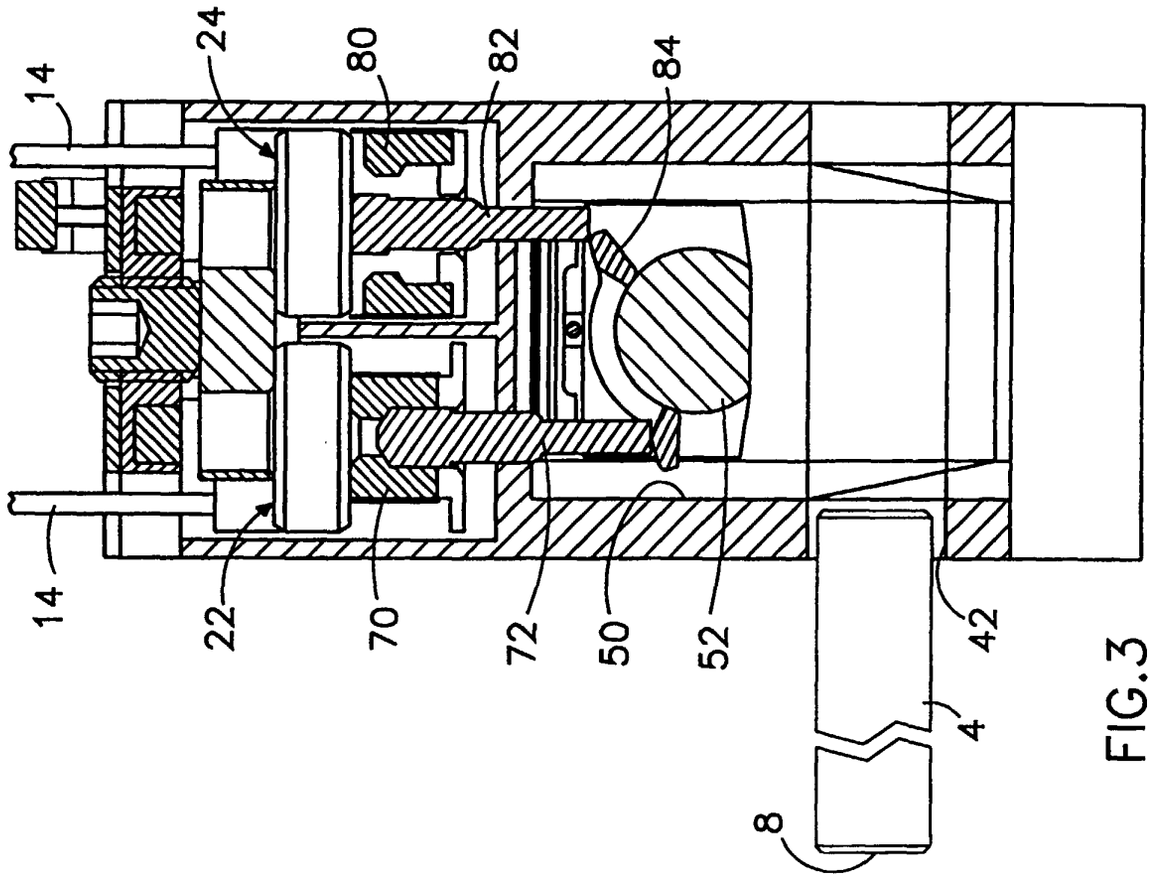
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FIG.3

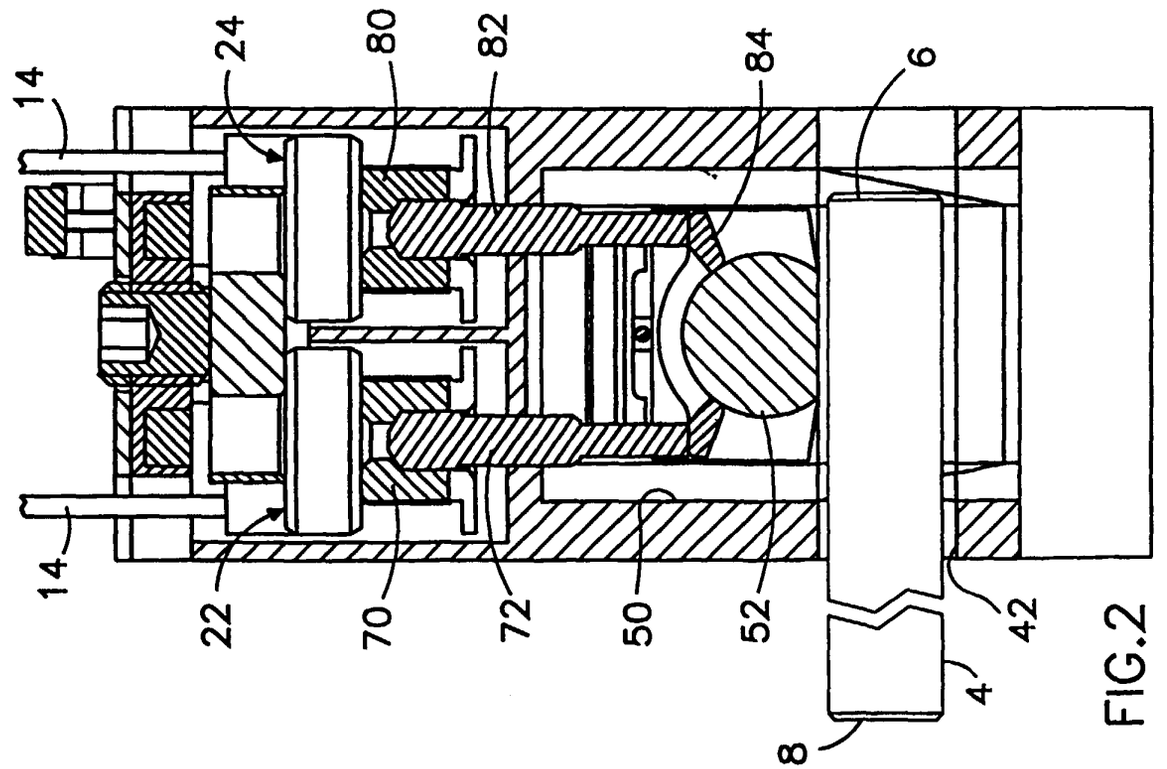
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FIG.2

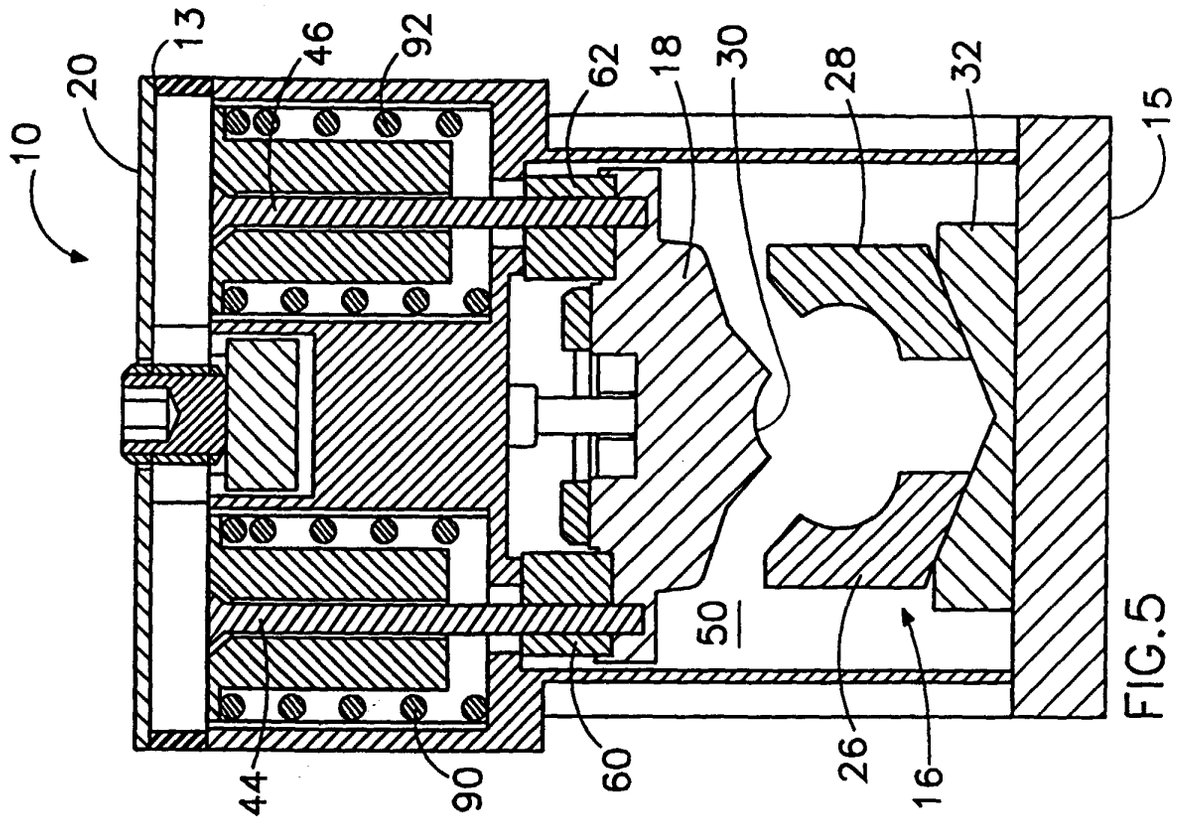
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FIG.5

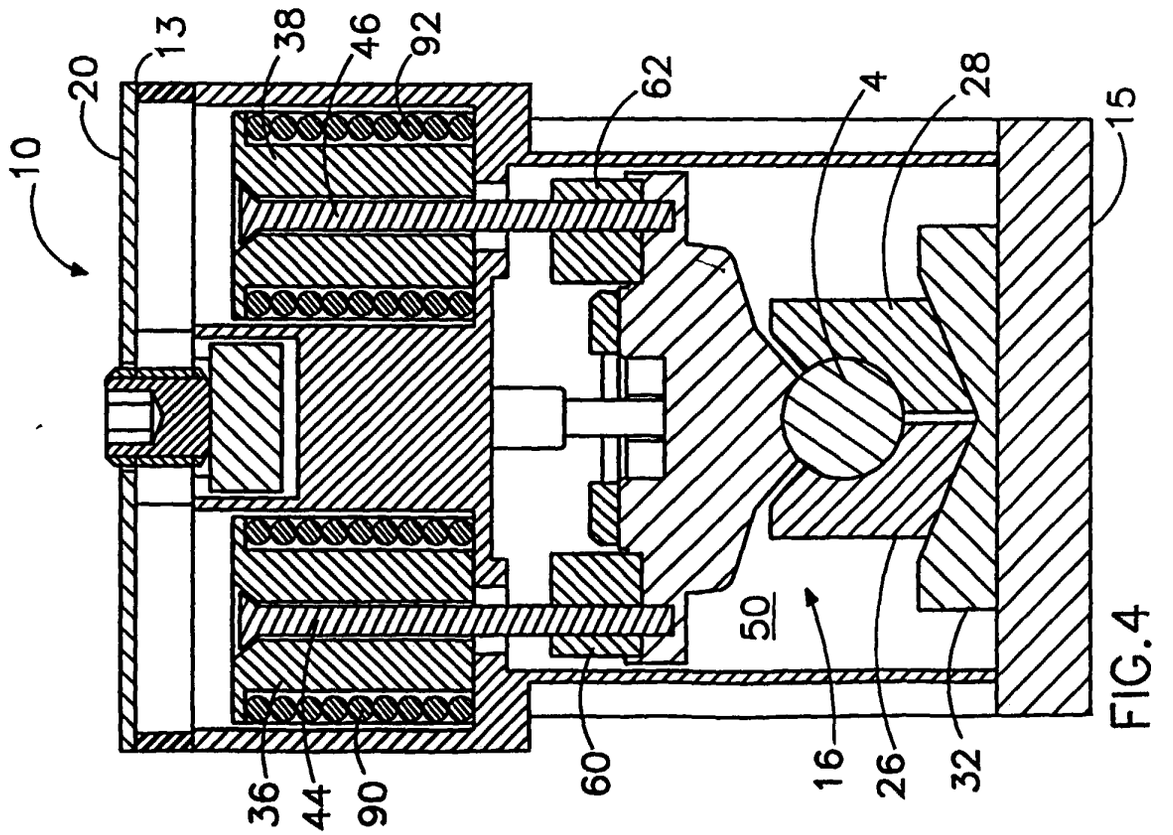
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FIG.4