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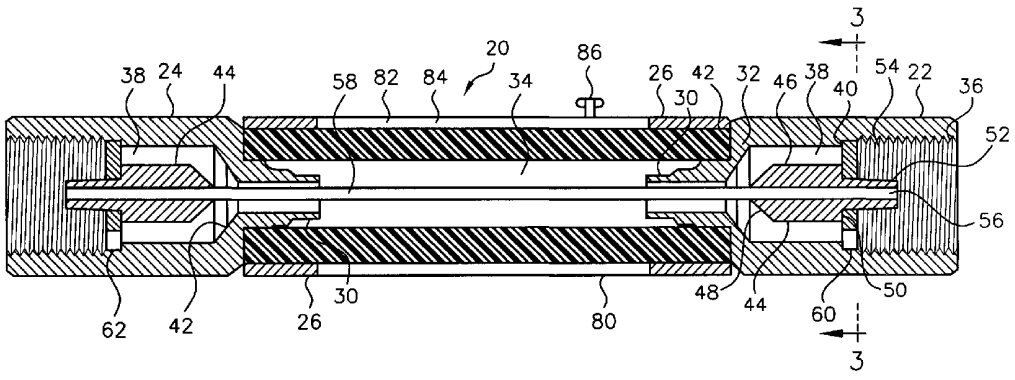
(54) Title: SAFETY SYSTEM FOR FLUID CONDUIT



(57) Abstract: A fluid conduit safety system which comprises valves (44) at each end of the conduit (20) which are connected by a relatively stiff cable (58). If the conduit (20) ruptures, the valves (44) close preventing discharge of fluid from the fluid supply and discharge of fluid from the container being filled while at the same time the cable (58) prevents the ends of the conduit (20) from whipping about and causing damage or injury. A second conduit (80) surrounds the first conduit (20) and forms a gap (82), filled with material via a valve (86), to indicate a fault in the first conduit (20) such as a tear or puncture.

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SAFETY SYSTEM FOR FLUID CONDUIT

FIELD OF THE INVENTION

This invention relates to high pressure fluid delivery systems and more particularly to a safety system for a conduit which is part of the high pressure delivery system.

BACKGROUND OF THE INVENTION

A prevailing problem in high pressure fluid delivery systems, such as those used to fill containers with compressed gases such as oxygen, nitrogen, carbon dioxide and the like is the risk that a conduit which is part of the fluid delivery system may fail.

Typically, these conduits are made of hardy flexible material, such as treated and reinforced rubber, neoprene, nylon, TEFLON, stainless steel and the like.

However, on occasion, the conduits fail by rupturing or splitting. When a hose ruptures, two hazards are present. First, the two pieces of the conduit which result from the rupture are free to whip around wildly under the force of the compressed gases which are being discharged through the ruptured conduit from the container being filled and from the discharge manifold of the fluid supply. Until the conduit can be constrained, substantial risk of injury to personnel and damage to equipment exists.

Further, a discharge of gas from the manifold and the container through the ruptured hose conduit can lead to a costly waste of gas, or even worse, can fill an environment with hazardous fumes.

It would be desirable to have a system which would restrain a ruptured high pressure conduit from whipping about, and at the same time would be capable of preventing gases from leaking from the conduit through the rupture.

SUMMARY OF THE INVENTION

With the foregoing in mind the invention relates to a fluid conduit safety system comprising a flexible conduit. A valve is at each end of the conduit. Each valve includes a valve seat and a valve body. The valve bodies are retained at fixed predetermined distance from each other which distance is slightly greater than the distance between the

valve seats so that in normal operation the compressed fluid can pass between the valve and valve seat at each end of the conduit.

If the conduit were to rupture or split, relative movement between the valves and the valve seats under the force of the compressed fluid will cause the valves at each end of the conduit to close thus blocking flow of the fluid.

In yet another aspect of the invention the valve bodies are retained at their predetermined distance from each other by an elongated cable that extends between them and through the conduit. Thus, if the conduit were to rupture, the cable would prevent the ends of the hose from whipping.

In yet another aspect, the invention relates to a method for stopping the flow of fluid through a conduit which has failed and preventing the conduit from whipping. It comprises the steps of providing a flexible conduit with a first valve member at each end of the conduit where the first valve members are spaced from each other a predetermined distance. A second valve member is provided adjacent each of the first valve members with means for retaining the second valve members a second predetermined distance from each other which second distance is greater than the distance between the first valve members. Means are provided for restraining the second valve members from moving relative to the conduit until the conduit fails whereupon the first and second valve members engage each other and block flow through the conduit.

BRIEF DESCRIPTION OF THE DRAWING

The invention will be better understood and further advantages and uses thereof will be readily apparent when considered in view of the following detailed description of an exemplary embodiment, taken with the accompanying drawing in which:

FIG. 1 is a schematic drawing of an apparatus for filling cylinder with compressed fluid under high pressure;

FIG. 2 is a view of a conduit constructed in accordance with a presently preferred form of the invention with the valves therein positioned to permit fluid flow;

FIG. 3 is a section view taken along lines 4—4 of FIG. 2;

FIG. 4 is a view similar to FIG. 3 but showing the valves positioned to block fluid flow;

FIG. 5 is a diagram of a fluid/gas transport vehicle delivering or receiving fluid/gas to or from a source/destination through fluid/gas conduit safety system in accordance with the present invention;

FIG. 6 is a cut away view of a breakaway connector for use with a fluid/gas conduit safety system in accordance with the present invention; and

FIG. 7 is a cut away view of a breakaway connector for use with a fluid/gas conduit safety system in accordance with the present invention; and

FIG. 8 is a cut away view of an additional embodiment of a fluid/gas conduit safety system in accordance with the present invention.

DETAILED DESCRIPTION

In FIG. 1 a delivery system for filling containers or other destinations with compressed fluids is illustrated as comprising fluid supply 10 such as a reservoir, or fluid compressing means, or the like. The supply 10 may be connected by a discharge manifold 12 to a plurality of containers 14 to which the fluid is to be transferred. Typically, the fluid destinations, such as containers 14 may be gas cylinders, bulk tankers or storage tanks which are well known in the art. Conduits 20 which may be elongated flexible members are connected between the discharge manifold 12 and the containers 14.

Typically, the conduits 20 are hoses made of reinforced neoprene, rubber, neoprene, nylon, TEFLON, stainless steel and the like so that they have a high degree of flexibility and are capable of withstanding the high pressures which they encounter from the compressed fluids that move through them. Conduits 20 may be non-flexible, depending upon the particular application.

In FIG. 2 one of the conduits 20 is shown in detail. The conduit 20 includes a housing 22 at one end and an identical housing 24 at its other end. The housings 22 and 24 are connectors which enable the conduit 20 to be connected other elements in the fluid handling system. Since the two housings are identical, the following detailed description of housing 22 will also suffice as a description of housing 24. Housing 22 is connected to conduit 20 by a ferrule 26 which cooperates with a complementary elongated cylindrical

hollow member 30 that extends from the end wall 32 of the housing 22 and into the passage 34 defined by the conduit 20.

As best seen in FIG. 2 the housing 22 is an elongated, hollow, cylindrical element which is connected by end wall 32 and member 30 to the conduit 20 and has threads 36 at its other end for connection to another element in the fluid handling system.

The housing 22 has an inner wall that includes a valve chamber 38 which is defined by a ledge 40 that faces away from end wall 32 and a tapered valve seat 42 that lies adjacent end wall 32. The tapered valve seat 42 lies between the ledge 40 and the end wall 32 and faces ledge 40.

As explained above, member 30 cooperates with the ferrule 26 to clamp the conduit 20 between them so that the housing 22 is securely connected to the conduit 20 for the receipt of and transmission of fluid under high pressure. It also serves as a cable guide as will be explained herein.

A valve body 44 is disposed in the valve chamber 38. Preferably, the valve body 44 includes an elongated, cylindrical member 46 having a tapered end 48 and a rear wall 50. The taper at end 48 corresponds to the taper of the valve seat 42 so that they can cooperate to prevent the flow of fluid when they are in engagement with each other.

A distal end 52 extends from the rear wall 50 of the valve body 40 and comprises an elongated stem-like member 54 of relatively small diameter relative to the elongated, cylindrical member 46. Stem-like member 54 extends away from the valve seat 40.

Each of the valve bodies 44 and stem-like members 54 include a longitudinally extending, axial passage 56 of relatively small diameter through which a relatively stiff cable 58 or other suitable flexible and bendable member of predetermined length can be received. The valve body 44 may be connected to the cable 58 by swaging, welding, or other suitable means so that the cable 58 cannot separated from the valve body 44 under the strong forces which will be present should the conduit 20 rupture. In an exemplary embodiment, cable 58 is positioned inside conduit 20 in a serpentine position.

Referring to FIGS. 2 and 3 valve body retainers 60 and 62 are provided in housings 22 and 24 respectively. Since the two retainers 60 and 62 are identical the

following detailed description of retainer 60 will also suffice as a description of retainer 62.

Referring to FIG. 3, retainer 60 is a disc that includes a generally annular central member 64 having a plurality of arms 66 extending radially outwardly from it. The center of the annular member 64 comprises an aperture 68.

Retainers 60 and 62 are disposed on ledges 40 in each housing 22 and 24. Each retainer is fixed on the ledge by being force fit, clamped, welded or secured by any suitable means that will hold it in place for a reason that will become apparent. The distance between the retainers 60 and 62 is about the same as the distance between the rear walls 50 of the valve bodies 44.

As best seen in FIG. 2 the member 30 and the stiffness of the cable 58 cause the valve bodies 44 to lie with their rear walls 50 against their respective retainers 60 and 62 with their respective stems 54 extending through the apertures 68.

Under normal operating conditions, compressed fluids flow through conduit 20, through the fluid passages 70 defined by the space between the arms 66 on each retainer 60 and 62 and the inner wall of the housings 22 and 24, and through the opening between each valve seat 42 and its respective valve body 44.

Since the cable 58 is confined by the wall of conduit 20, and is long enough arid sufficiently stiff to keep the valve bodies in engagement with the retainers 60 and 62, as is apparent from FIG. 2, neither valve body can move within its chamber since such movement is blocked by the retainer at the other end of the conduit.

Should the conduit 20 fail by either splitting or by rupture the valve bodies 44 and valve seats 42 will move into engagement with each other thereby stopping the flow through the conduit 20 at each of its ends as seen in FIG. 4. Accordingly, not only will discharge from the supply manifold be stopped, but also discharge from the container being filled will be stopped.

If the supply 10 or one of the containers 14 should fall during filling, the conduit 20 may fail. In this case the ends of the conduit will move with the item to which they are connected. Therefore, the valve seats 42 will be drawn away from each other and

into engagement with their respective valve bodies 44 since the cable 58 will be drawn taut by the movement the conduit ends away from each other.

If the supply 10 and containers 14 are fixed, they will not be displaced when the conduit fails. In this case the valve bodies 44 will be urged into engagement with their respective valve seats 42 due to the pressure differential across the valve bodies 44 in that there is still high pressure fluid in the supply 10 and container 14 bearing against the valve bodies 44. When conduit 20 fails, cable 58 is released from its confinement within the conduit and can flex to permit the valve bodies 44 to move toward the valve seats 42. Further, because the cable 58 extends through the conduit 20, it will serve as a guide for a ruptured conduit, thereby preventing the ends of the conduit from being whipped about by the discharging fluid. Still further, even if the cable were to fail as a result of the rupture, fluid flow will still be stopped at each end of the conduit since the cable 58 will not be holding the valve bodies 44 apart. It is significant to note that the advantages of the invention are achieved by a structure that is entirely within the conduit. Thus, there is no external apparatus that might be inadvertently snagged, damaged or destroyed thereby rendering the features of the invention unavailable when needed.

Still further, it is apparent that the device and method disclosed can be used with conduits of varying sizes and materials, both flexible and non-flexible.

In another embodiment (not shown) an external cable takes the place of or operates in conjunction with internal cable 58. In such an embodiment, the external cable would be connected through a sealed linkage to the valve bodies, the internal cable, and/or the connection point of internal cable 58 to valve body 44.

In still another embodiment (not shown), internal cable 58 is a pressurized tube that retains valve bodies 44 in an open position when pressurized. When the pressure in the pressurized tube drops below a predetermined amount, there is insufficient pressure to maintain valve bodies 44 in an open position. At that point, valve bodies 44 seat with valve seats 42, closing the valve.

In still another embodiment (not shown), an electronic circuit measures fluid/gas flow rate and/or pressure within the hose of conduit 20. When pressure or flow rate reaches a predetermined level, the electronic circuit signals a valve close condition. This

signal would activate a valve closing means to release any retaining member that was maintaining the valve bodies in the open position, such as by severing or contracting an internal cable 58, or depressurizing an internal pressurized tube. The predetermined level in such an embodiment could also be set to account for extreme changes in flow rate or pressure, if it was desired that such a condition should result in a valve closure. Such a system could provide a monitoring or early warning system for hose/system integrity.

In another embodiment (not shown), internal valve bodies 44 and valve seats 42 are replaced by an external valve. Such an external valve is a valve located outside or beyond housing 22. In such an embodiment, the external valve is actuated through a sealed linkage. Valve closure would result from the same conditions as described above with respect to internal valve bodies 44 and valve seats 42.

In another embodiment (not shown), only a single valve (valve body 44/valve seat 42) is used at a single end of the hose of conduit 20.

FIG. 5 shows a fluid/gas transport vehicle 85 connected to a source/destination container 14 through fluid/gas conduit safety system 20. Transport vehicle 85 can be delivering or receiving fluid/gas, depending upon the particular application.

In operation, a first end of fluid/gas conduit 20 is connected to a filling container 14, while the second end of fluid/gas conduit 20 is connected to a receiving container. The term filling container is meant to represent a filling source and the term receiving container is meant to represent a receiving destination, regardless of whether either or both is actually a container. The exact nature of the filling container and the receiving container depends upon the ultimate application. For example, the filling container may be a transport vehicle or connected through a hose or routing system before the connection is made to the fluid/gas conduit of the present invention. A similar situation may apply to the receiving container. In addition, the receiving container may be the actual use of the gas or fluid which is thus not actually contained.

Referring to FIGS. 6 and 7, a breakaway coupling system 90 is shown for use with the present invention. Breakaway coupling system 90 is used as an alternative form of coupling or connection to a pressurized fluid transfer or delivery system to that of the

threads 36 of housing 22 shown in the previous embodiments. While not expressly shown, the valve assemblies previously described are disposed inside of the housings 22.

Breakaway coupling system 90 is comprised of a barb 92, a fitting 94, a release collar 96, a snap ring 98 and ball bearings 100. O-rings 102 are also shown to provide a seal. Threads 36 are shown for mating with the delivery source and/or receiving destination of the pressurized fluid, similar to threads 36 shown and described with respect to previous embodiments.

Barb 92 is inserted into a hose, such as the hose of conduit 20. A plurality of ridges 104 may be formed on the surface of barb 92 to assist in securing barb 92 to hose 20. A securing means such as a crimped ferrule 106 or screw tightened securing ring (not shown) is used to secure hose 20 to barb 92. Barb 92 has grooves for o-rings 102b, 102c, and 102d. Fewer or greater number of o-ring grooves and corresponding o-rings may be used, depending upon the application. O-rings 102 act as seal to prevent leakage of pressurized fluid. Barb 92 also has an indentation or groove 110, in which a ball bearing 100 can sit. In an exemplary embodiment, 12 ball bearings 100 are used with a corresponding groove 110. Fewer or greater number of ball bearings 100 and corresponding indentations or groove 110 may be used, depending upon the application.

Barb 92 is inserted into a fitting 94. Fitting 94 provides the structural detail to mount breakaway system 90 to the delivery/destination equipment for the pressurized fluid. In the exemplary embodiment shown, threads 36 are shown. Other connection or coupling means may be used as understood by those skilled in the art. Fitting 94 has an opening for mating with barb 92. O-rings 102b and 102c form a seal against the internal walls of the barb receiving opening of fitting 92. Holes 112 extend through fitting 94 and have a diameter sufficient to receive ball bearings 100. If not blocked, ball bearings 100 can freely pass through holes 112. Holes 112 are designed to align with radiused groove 110 when barb 92 is fully inserted into fitting 94. Fitting 94 also has a groove for o-ring 102a. O-rings 102a and 102d are used to seal against release collar 96. A ramp sided groove 114 is for retaining a snap ring 98. Ramp sided groove 114 has inclined walls, wherein the inclination of the walls determines the release force necessary to overcome the retaining spring force of snap ring 98. The force necessary to allow a release

condition can be set or adjusted by varying the ramp angle of ramp sided groove 114 and/or the spring force of snap ring 98

Release collar 96 has a recess or clearance groove 116 for snap ring 98 and a recess or clearance groove 118 for ball bearing 100. When barb 92 is fitted within fitting 94 and the barb fitting combination is fitted within release collar 96, snap ring 98 is positioned in both clearance groove 116 and ramp sided groove 114, aligning and securing the components of breakaway system 90. Release collar 96 can slide laterally over fitting 94. In the exemplary embodiment, release collar 96 has a tapered or stepped internal cavity which allows fitting 94 to be inserted from one side only. Upon release, this prevents fitting 94 from being pulled out along with barb 92. Release collar 96 is mounted via a mounting means, such as a bracket (not shown) to the delivery and/or destination equipment.

Operation of breakaway system 90 is shown , first with respect to FIG. 14 with release collar 96 in the neutral or engaged position. In the neutral position, release collar 96 is positioned such that the inner wall of the opening in which fitting 94 is positioned presses against ball bearing 100, keeping ball bearing 100 pressed into groove 110 of barb 92. This downward force from the internal wall of fitting 94 maintains barb 92 locked to fitting 94, which is in turn, locked to release collar 96 by snap ring 98.

Upon a release condition, a force, such as the pulling of hose 20 away from fitting 94 (in the release direction), pulls on barb 92. Because barb 92 is locked to fitting 94 and release collar 96 is fixedly mounted to the delivery and/or destination equipment, the barb 92/fitting 94 combination will move laterally with respect to collar 96, from the neutral position shown in FIG. 14 to the release position shown in FIG. 13. In order for this movement to occur, the force pulling on barb 92 must be sufficient to overcome the snap ring force of snap ring 98. This force causes snap ring 98 to bear against the ramps of ramp sided groove 114. This cause the snap ring to expand and be forced out of ramp sided groove 114. This then allows fitting 94 to move relative to release collar 96. Once moved, ball bearings 100 and holes 112 become aligned with clearance grooves 118. Clearance grooves 118 allow ball bearings 100 to move out of engagement with grooves 110, freeing barb 92 from engagement with fitting 94.

Still another embodiment is shown in FIG. 8, with an outer, second hose 80 surrounding an inner, hose 20 from the safety hose system. Each of the inner and outer hoses is connected to a housing, such as connector housing 22. A gap or space (cavity) 82 is defined between inner hose 20 and outer hose 80. Gap 82 is filled with a material 84 which serves to indicate whether a hose fault, such as a tear or puncture in inner hose 50 has occurred. Outer hose 80 serves as an indicator of a problem or potential problem with hose 20. Pressurized gas can be sealed in gap 82 at the factory or pressurized by an optional separate fill valve shown as fill valve 86. Fill valve 86 may be disposed on the outer hose or on the housing, so long as it is in fluid communication with the cavity formed between the inner and outer hoses. A separate fill valve 86 allows the pressurized gas to be "topped off" to maintain pressure. A separate fill valve 86 also allows for the pressurized gas to be replaced, or if desired, replaced with a different pressurized gas. Such an indicator system is particularly useful where the hose failure has not caused a cut off condition, causing the valve bodies to seat, as described previously. Gap 82 is filled with a pressurized fluid/gas as material 84 that will indicate that a tear, cut, puncture or other breach of outer hose 80 has occurred. For example, a pinhole type puncture may not be sufficient to activate the valve seating. By using an outer, second hose with a pressurized gap, a leak in the primary inner hose will cause a pressure increase in the outer hose, causing it to deform. The deformation will be recognizable to the user. In still another embodiment, the hose material of the outer, second hose, changes color when stretched by the increase in pressure from the inner hose leak. This change in color may be more readily identifiable to the user, indicating the leak or inner hose failure.

In another embodiment, gap 82 is filled with a pressurized fluid/gas as material 84 that will indicate that a tear, cut, puncture or other breach of outer hose 80 has occurred. The pressurized gas can indicate this failure condition of outer hose 80 by being a distinct color that will be recognized by a user. Preferably such a pressurized gas will be a different color than any fluid being transported through the hose system. A pressurized gas may also be used that reacts with the fluid being transported through the hose system so that in the event of a hose failure. In this way, a first distinct color would be evident if there was only a failure with outer hose 80. A second distinct color would be evident if the pressurized gas was contaminated with the fluid being transported through the hose

system. In this way, the user could tell if there was an outer hose 80 failure or a failure of both inner hose 20 and outer hose 80.

In still an additional embodiment of the system shown in FIG. 9, gap 82 is filled with a sealing material that can seal a puncture, small tear, small cut or other minor breach of either hose 20 or hose 80. Such a sealing material would harden or flexibly harden to match the flexible properties of the respective hose when in contact with the either the fluid being transported through the hose system (in the case of a breach of hose 20) or by the outside air (in the case of a breach of outer hose 80). A sealing material of this type would preferably appear as a deformation (bump, irregularity, ridge, blob) or distinct color on the surface of outer hose 80 in the case of a breach of outer hose 80. A sealing material of this type, in conjunction with the material of outer hose 80 would preferably show a deformation in the shape of outer hose 80 in the event of a hose breach of inner hose 20 where there is no breach of outer hose 80. Because a hose system of the present invention is a safety system, it is desirable that an outer hose with a sealing material in gap 82 be used in conjunction with a cut off system, such as one of those described throughout this specification. In this way, the sealing material would only serve as a temporary fix to a minor hose breach problem, with the main cut off system still in place in the event that the hose breach problem worsened or was not temporarily solved by the sealing material. A sealing mechanism also controls the amount of gas that can leak into the atmosphere.

Thus, while the invention has been described with respect to a particular embodiment, it is apparent that other embodiments can be employed to achieve the intended results. Thus, the scope of the invention should not be limited by the foregoing description, but rather only by the scope of the claims appended hereto.

What is Claimed is:

1. A safety system for a fluid conduit comprising a flexible conduit having first and second ends,

first means at each end of said conduit defining a valve seat, said valve seats normally being a first predetermined distance from each other, and being movable away from each other when said conduit fails,

a valve body disposed at each end, said valve seats being disposed between said valve bodies, said valve bodies and said valve seats cooperating to define valves,

second means connected to said valve bodies for holding them apart a second distance which is greater than the distance between said valve seats,

third means disposed at each of said ends and cooperating with said second means for retaining said valve bodies against movement to permit fluid to flow through said conduit until said conduit fails, and

said second means is operative when said conduit fails and said valve seats move away from each other to retain said valve bodies at said second distance so that said valve seats move toward said valve bodies and close said valves, or if the distance between said valve seats does not change, to permit said valve bodies to move toward each other so that said valve bodies move toward said valve seats to close said valves.

2. A system as defined in claim 1 wherein said second means is connected between said valve bodies, and said valve bodies are disposed between said third means and said valve seats.

3. A system as defined in claim 2 wherein said second means comprises an elongated, stiff, yet flexible member that extends through said conduit.

4. A system as defined in claim 1 wherein said first means comprises a housing, said housing including means for connecting it to a conduit and a valve chamber, and fourth means, said fourth means being defined by said housing and being for retaining said third means in said housing.

5. A system as defined in claim 4 wherein said third means comprises a generally annular member that defines a plurality of fluid passages to enable fluid to flow

therethrough, and a portion of said third means is engagable with said valve bodies for supporting and guiding said valve bodies.

6. A system as defined in claim 5 wherein said portion of said third means includes an aperture.

7. A system as defined in claim 6 wherein said second means comprises an elongated, stiff, yet flexible cable extending through said conduit.

8. A system as defined in claim 5 wherein said housing includes an inner wall, said fourth means comprises a ledge defined by said inner wall, and said third means is supported by said ledge.

9. A safety system for a fluid conduit comprising a flexible conduit having first and second ends, first means comprising a housing at each end of said conduit, said housings defining valve seats and including means for connecting them to a conduit and a valve chamber, and said valve seats being a first predetermined distance from each other, a valve body disposed at each end, said valve seats being disposed between said valve bodies, an elongated, stiff, yet flexible member extending through said conduit and being connected to said valve bodies, third means comprising a generally annular member that defines a plurality of fluid passages to enable fluid to flow therethrough, said third means being disposed at each of said ends of said conduit and cooperating with said elongated, stiff, yet flexible member to retain said valve bodies at said a second distance which is greater than the distance between said valve seats to permit fluid to flow through said conduit until said conduit fails, a portion of said third means is engagable with said valve bodies for supporting and guiding said valve bodies, and fourth means, said fourth means being defined by said housing and being for retaining said third means in said housing.

10. A system as defined in claim 9 wherein said portion of said third means includes an aperture, said valve body including a valve body stem, and said valve body stem is slidably received in said aperture.

11. A safety system for a fluid conduit comprising a flexible conduit having first and second ends, first means at each end of said conduit defining a valve seat, said valve seats being a first predetermined distance from each other, a valve body disposed at each end, said valve seats being disposed between said valve bodies, second means

connected to said valve bodies for holding them apart a second distance which is greater than the distance between said valve seats, said second means being connected between said valve bodies and comprising an elongated, stiff, yet flexible member that extends through said conduit, third means disposed at each of said ends for retaining said valve bodies against movement toward their respective seats to permit fluid to flow through said conduit until said conduit fails, and said valve bodies are disposed between said third means and said valve seats.

12. A safety system for a fluid conduit comprising a flexible conduit having first and second ends, first means at each end of said conduit defining a first valve member, said first valve members normally being a first predetermined distance from each other, a second valve member disposed at each end, said first valve members being disposed between said second valve members, and said first and second valve members cooperate to define valves, second means connected to said second valve members for holding them apart a second distance which is greater than the distance between said first valve members until said conduit fails, third means disposed at each of said ends and cooperating with said second means for retaining said second valve members against movement toward their respective first valve members to permit fluid to flow through said conduit until said conduit fails, said second means is operative under first and second conditions to enable said valves to close when said conduit fails, said first condition being when the distance between said first valve members increases after said failure whereupon said second means causes said first valve members to move toward said second valve members, said second condition being when the distance between said first valve members does not change after said failure whereupon said second means flexes to enable said second valve members to move toward said first valve members.

13. A system as defined in claim 12 wherein said second means comprises an elongated, stiff, yet flexible member that extends through said conduit.

14. A system as defined in claim 12 wherein said third means comprises a generally annular member that defines a plurality of fluid passages to enable fluid to flow therethrough, and a portion of said third means is engagable with said valve bodies for supporting a guiding said valve bodies.

15. A system as defined in claim 13 wherein said second means comprises a cable that extends through said conduit.

16. A method for stopping the flow of fluid through a conduit which fails comprising the steps of providing a conduit having an inner wall, said conduit including means defining two valve seats which are spaced from each other a first distance, providing a valve body for each of said valve seats, retaining said valve bodies a second distance from each other by an elongated, stiff, yet flexible member that extends through said conduit and engages said inner wall, said second distance being greater than said first distance, and moving said valve seats and said valve bodies into engagement with each other under the force of said fluid when either said conduit, or said conduit and said elongated, stiff, yet flexible member fails.

17. A method as defined in claim 16 wherein said elongated, stiff, yet flexible member prevents the ends of the conduit from whipping when only said conduit fails.

18. A method for stopping the flow of fluid through a conduit which fails and for preventing the ends of the conduit from whipping comprising the steps of providing a flexible conduit, providing a first valve member at each end of said conduit, said first valve members being spaced from each other a first predetermined distance, providing a second valve member adjacent each of said first valve members, retaining said second valve members a second predetermined distance from each other, said second valve members being retained at said second predetermined distance by providing a elongated, stiff, yet flexible elongated member in said conduit and connecting each end of said elongated, stiff, yet flexible member to one of said second valve members, said second predetermined distance being greater than said first predetermined distance, and restraining said second valve members from moving relative to said conduit until said conduit fails whereupon said fluid causes said second valve members to engage said first valve members while said first valve members are still at second predetermined distance, and said elongated, stiff, yet flexible member is operative to prevent the ends of said hose from whipping when said conduit fails.

19. The method as defined in claim 18 including the step of providing a valve housing at each end of said conduit and said valve bodies and said valve seats are in said valve housings.

20. The method as defined in claim 18 wherein the fluid is a compressed gas.

21. A method for stopping the flow of fluid through a conduit which fails and for preventing the ends of the conduit from whipping comprising the steps of providing a flexible conduit, providing a valve seat at each end of said conduit, said valve seats being spaced from each other a first predetermined distance, providing a valve body adjacent each of said valve seats, retaining said valve bodies a second predetermined distance from each other by providing a elongated, stiff, yet flexible member in said conduit and connecting each end of said elongated, stiff yet flexible member to one of said valve bodies where the distance between said valve bodies is greater than the distance between said valve seats, and restraining said valve bodies from moving relative to said conduit until said conduit fails whereupon said elongated, stiff, yet flexible member enables said valve bodies and said valve seats to engage each other.

22. The method as defined in claim 21 including the step of providing a valve housing at each end of said conduit, and said valve bodies and said valve seats are in said valve housings.

23. The method as defined in claim 21 wherein the fluid is a compressed gas.

24. The method as defined in claim 21 wherein said elongated, stiff, yet flexible member enables said valve bodies and said valve seats to engage each other by flexing when said conduit fails so that said valve bodies can move toward said valve seats.

25. The method as defined in claim 21 wherein said elongated, stiff, yet flexible member enables said valve bodies and said valve seats to engage each other by becoming taut when said conduit fails so that said valve seats can move toward said valve bodies.

26. A safety system for a fluid conduit in accordance with claim 3, wherein said stiff yet flexible cable is positioned within said flexible fluid conduit in a substantially serpentine position.

27. A safety system in accordance with claim 1, further comprising a filling container connected to said first end of said flexible fluid conduit and a receiving container connected to said second end of said flexible fluid conduit.

28. A safety system in accordance with claim 27, wherein said receiving container is a bulk tanker.

29. A safety system for a fluid conduit in accordance with claim 1, wherein said second means comprises a tube.

30. A safety system for a fluid conduit in accordance with claim 29, wherein said tube has first and second ends, said second means further comprises pistons disposed at each end of said tube and a fluid or gas is pressurized within said tube.

31. A safety system for a fluid conduit in accordance with claim 1, wherein said fluid conduit is a first fluid conduit, further comprising:

a second outer fluid conduit having first and second ends attached to said first and second housings, respectively, said second outer fluid conduit surrounding said first fluid conduit;

a cavity defined by and between said first and second fluid conduits;

an indicator material located inside of said cavity to indicate a fault condition of said first or second fluid conduits; and

fluid flow cut off means for stopping fluid flow upon failure of said first fluid conduit.

32. A safety system for a fluid conduit in accordance with claim 31, wherein said indicator material is a pressurized gas.

33. A safety system for a fluid conduit in accordance with claim 31, wherein said indicator material is capable of sealing punctures, small tears or small cuts.

34. A safety system for a fluid conduit in accordance with claim 31, further comprising a fill valve in fluid communication with said cavity.

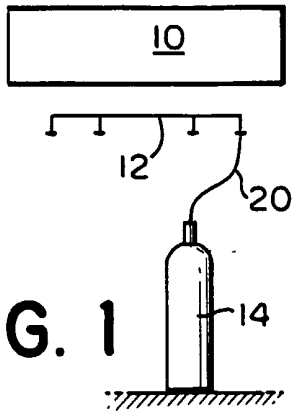

FIG. 1

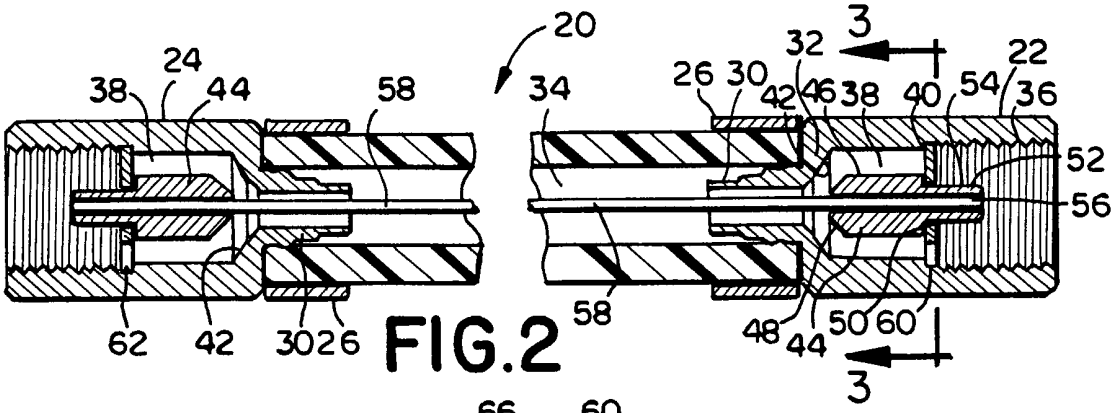

FIG.2

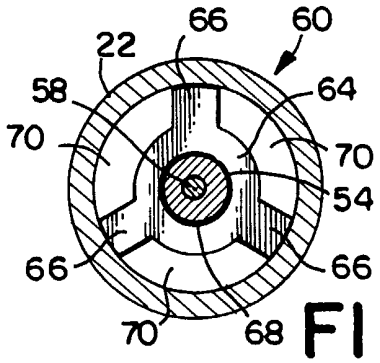

FIG. 3

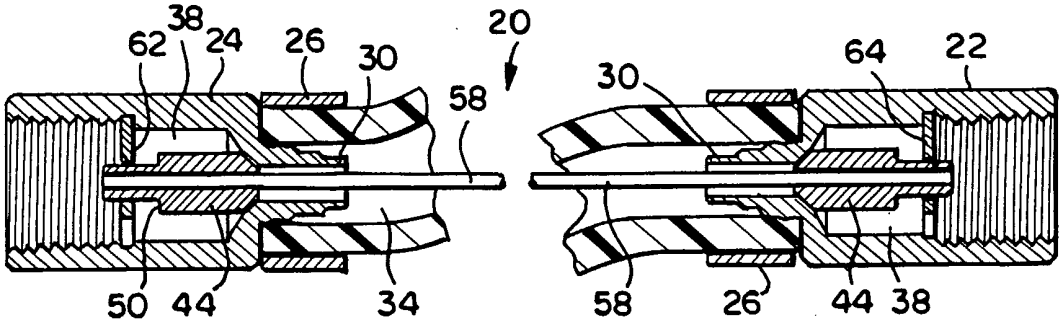

FIG. 4

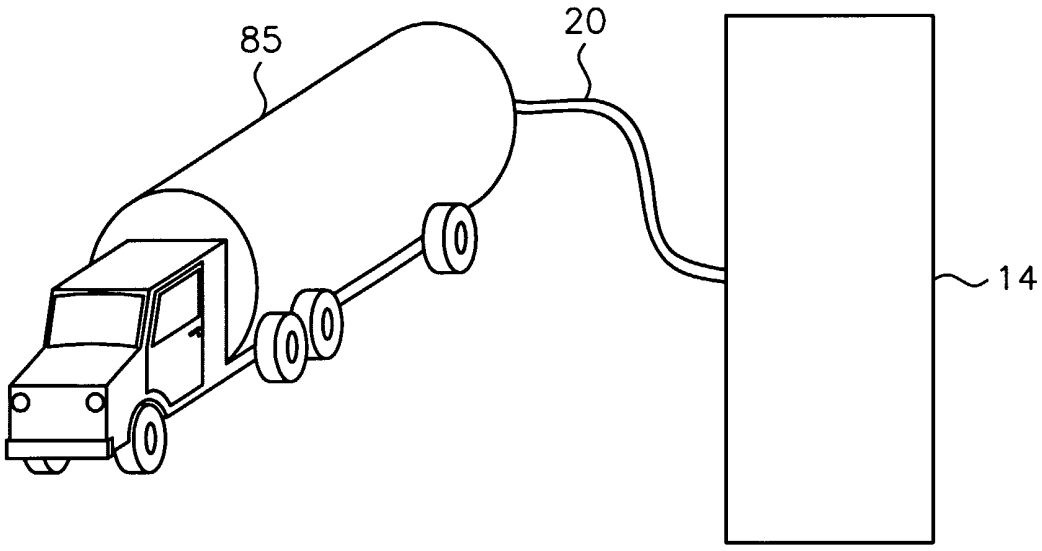

FIG. 5

FIG. 6

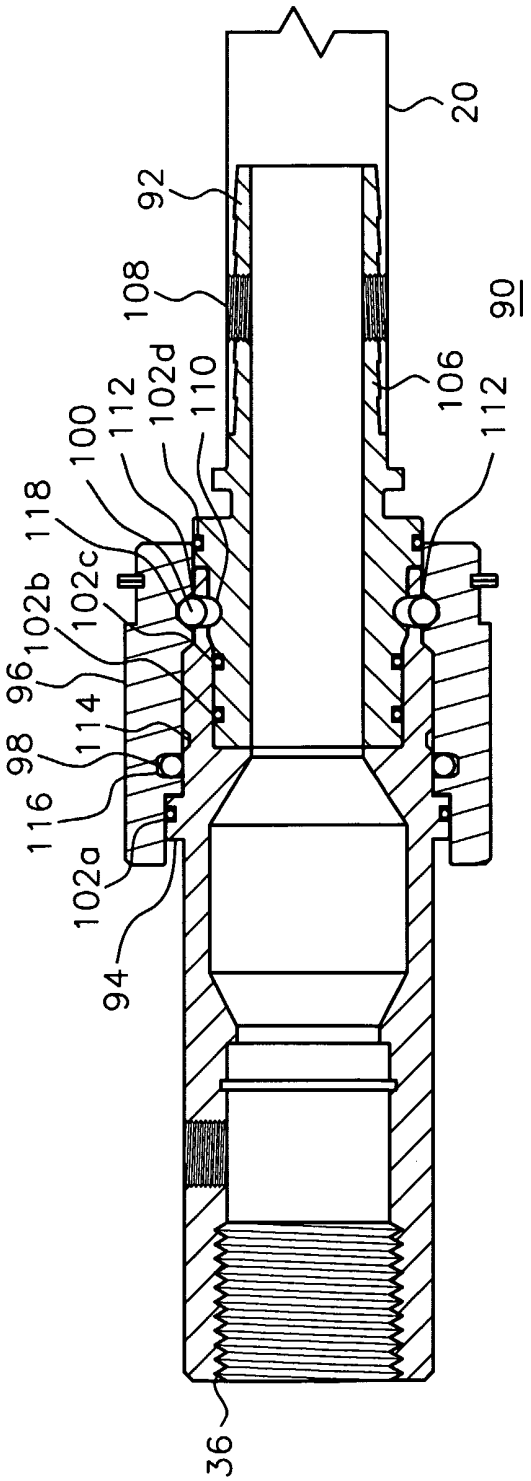
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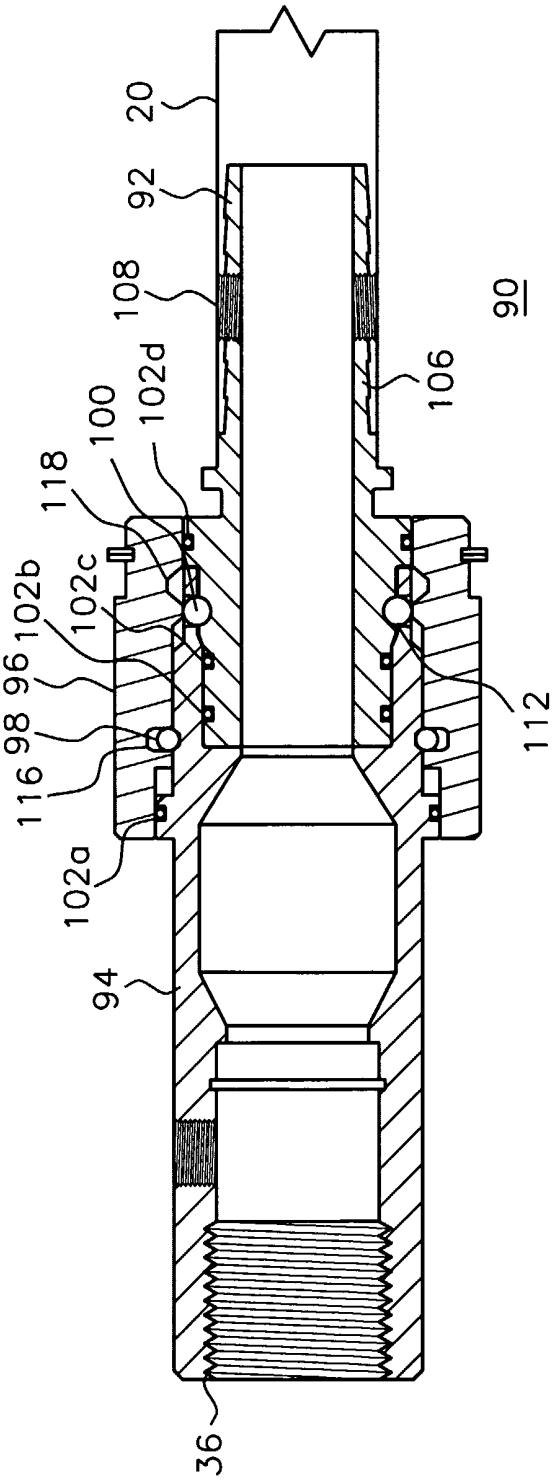
FIG. 7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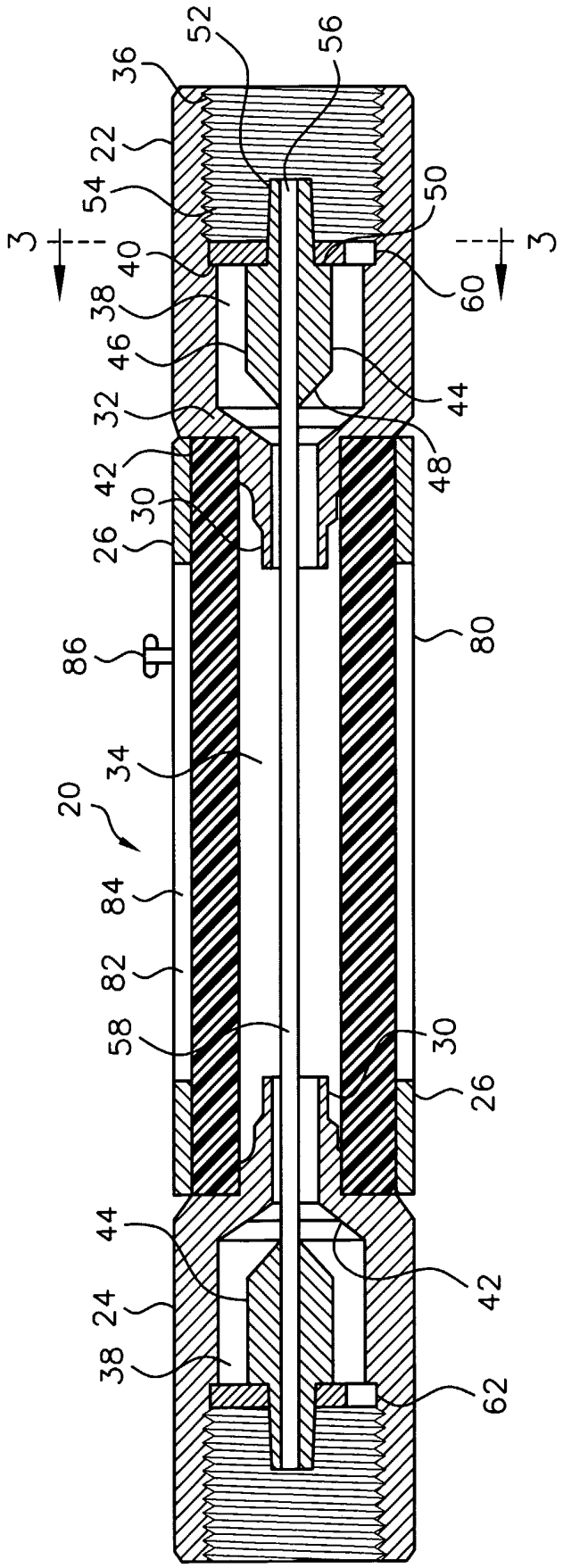
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FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/06278

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :F16K 17/40, 37/00
US CL :137/68.14, 68.18, 312; 138/97, 104; 73/40.5R
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 137/68.14, 68.18, 312, 614.04; 138/97, 104; 73/40.5R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,357,998 A (ABRAMS) 25 October 1994, see entire document.	1-25, 27, 28
Y		26, 31, 32, 34
Y	US 4,523,454 A (SHARP) 18 June 1985, see entire document.	31, 32, 34
Y	US 5,921,266 A (MEYER) 13 July 1999, see entire document.	31
A	US 345,156 A (LITTLE) 06 July 1886, see entire document.	1-25
A	US 2,607,227 A (BISCOE) 19 August 1952, see entire document.	1-25

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 14 MAY 2001	Date of mailing of the international search report 21 JUN 2001
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer J. Hurley for JOHN RIVELL Telephone No. (703) 308-2599

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US01/06278

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4,827,977 A (FINK Jr.) 09 May 1989, see entire document.	1-25
A	US 5,054,523 A (RINK) 08 October 1991, see entire document.	31-34