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Grove et al.

[11] **3,809,113**

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[54] **SPHERE HANDLING APPARATUS AND METHOD**

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[52] **U.S. Cl.** ..... **137/268,** 15/104.06 A

[51] **Int. Cl.** **F17d 3/00**

[58] **Field of Search** ..... 137/268, 242, 312, 554; 15/104.06 A; 251/318; 277/2

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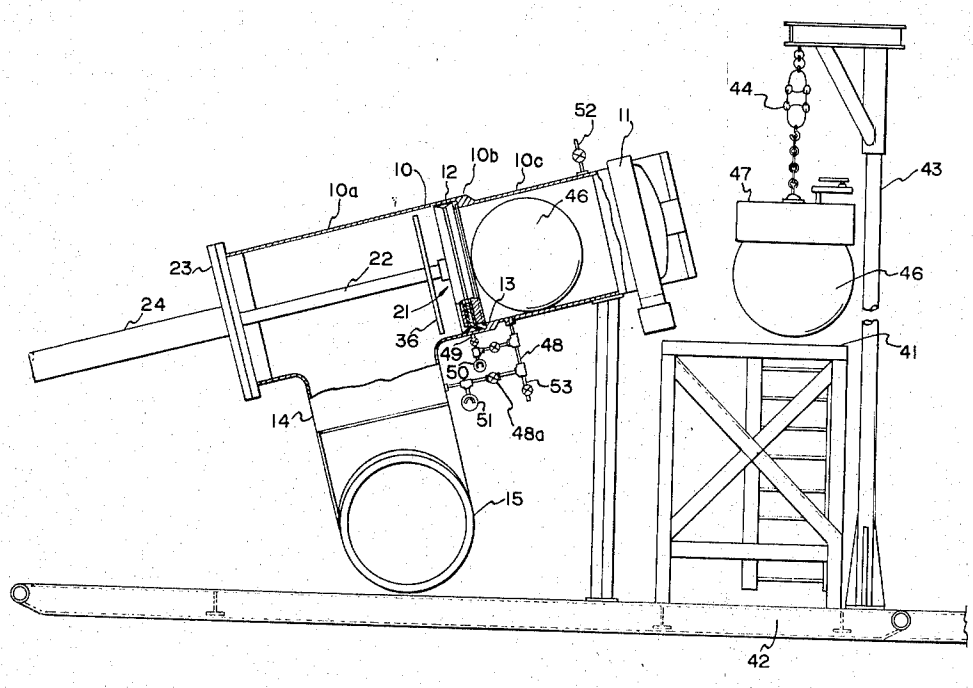
Primary Examiner—Henry T. Klinksiek
Assistant Examiner—Robert J. Miller

[57] **ABSTRACT**

Sphere handling apparatus for use with pipe lines carrying fluid under pressure and serving to introduce or remove a sphere or other clean-out device. It makes use of an inclined hollow body connected to the line and adapted to contain a sphere. The interior of the body is divided into two spaces that are separated by a closure movable by power means between closed and open positions for enabling the two spaces to be sealed with respect to each other or to be placed in communication to enable a sphere to move from one space to the other. The closure is sealed with respect to a sleeve that forms a part of the body and is disposed intermediate the two spaces. Preferably bypass means is provided to enable an operator to connect the two spaces for pressure equalization. Also means is provided for detecting leakage past the closure. Preferably the sealing means between the closure and the sleeve is of the double resilient cup type. One embodiment is used for launching and another for retrieving spheres.

6 Claims, 7 Drawing Figures



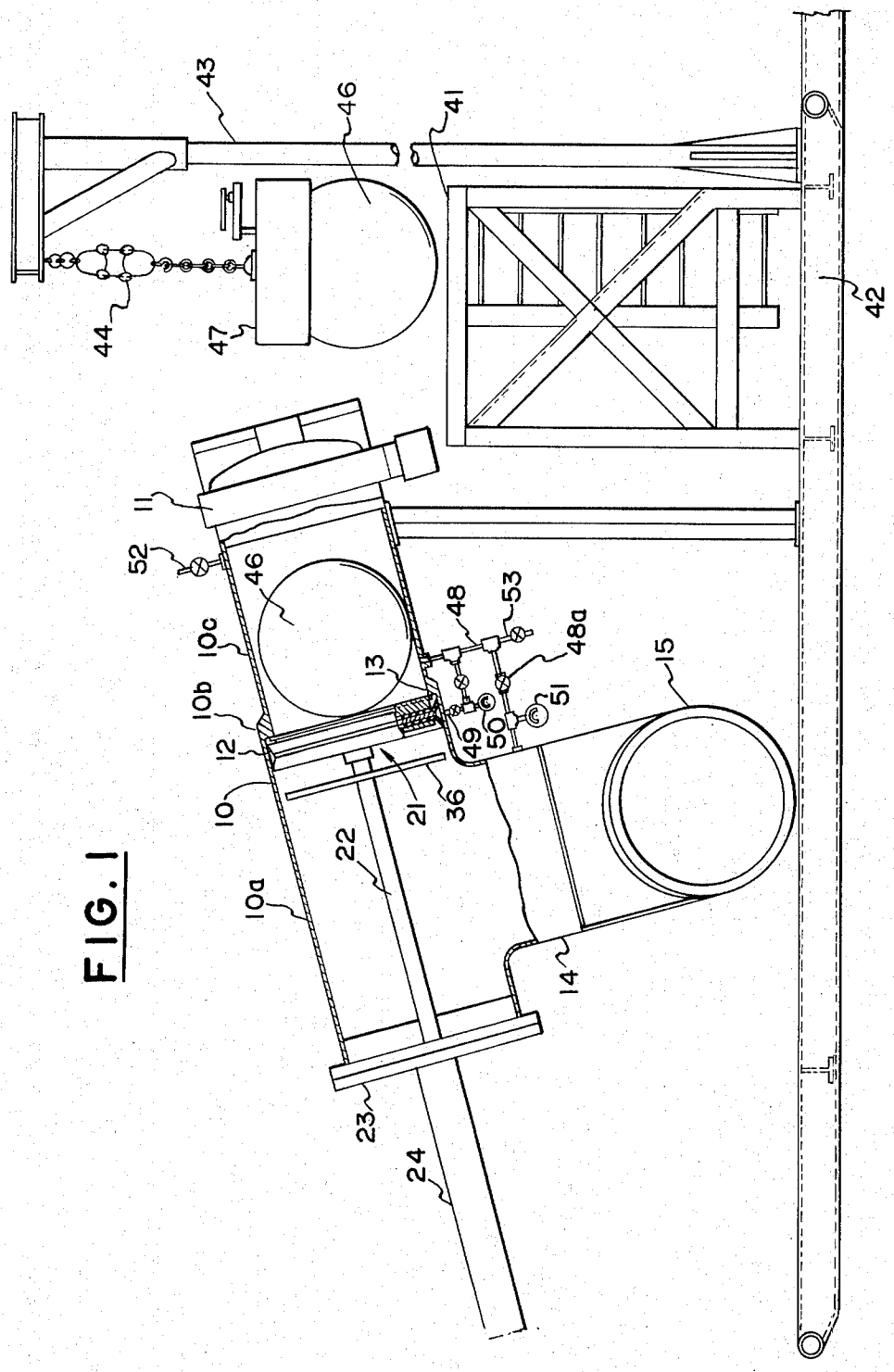

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FIG. 1

FIG. 2

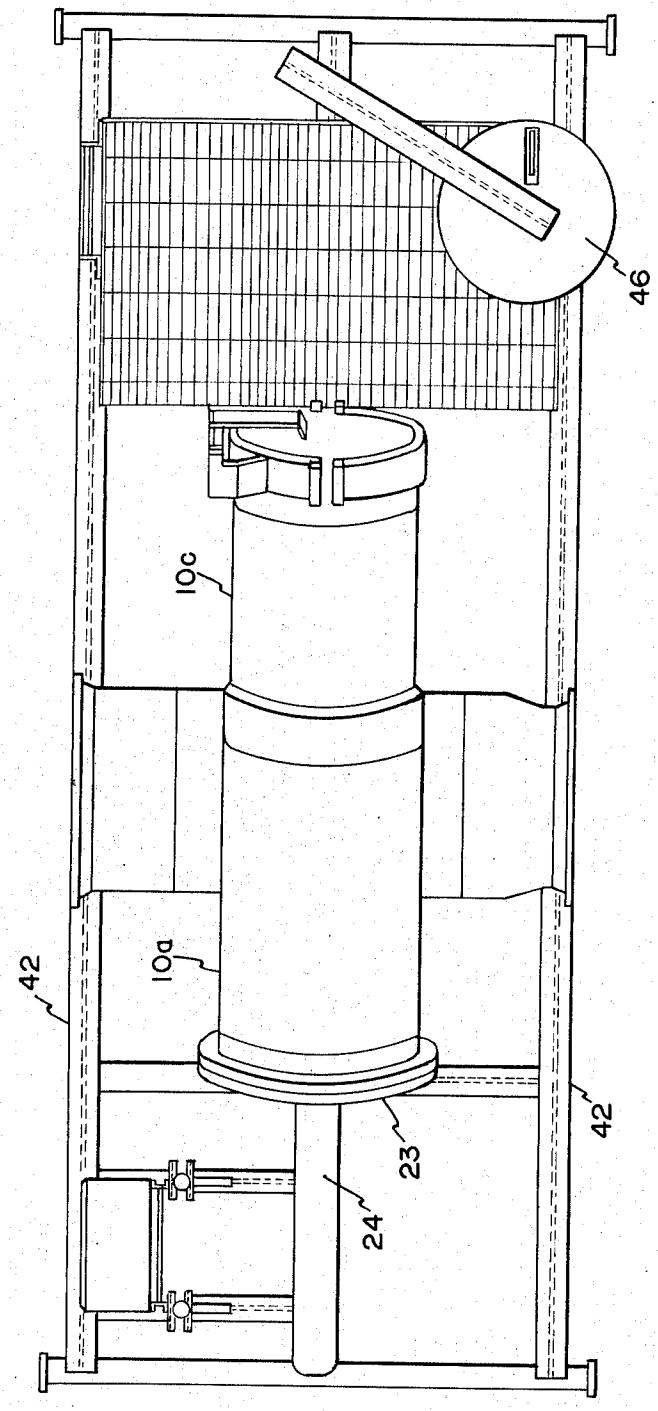
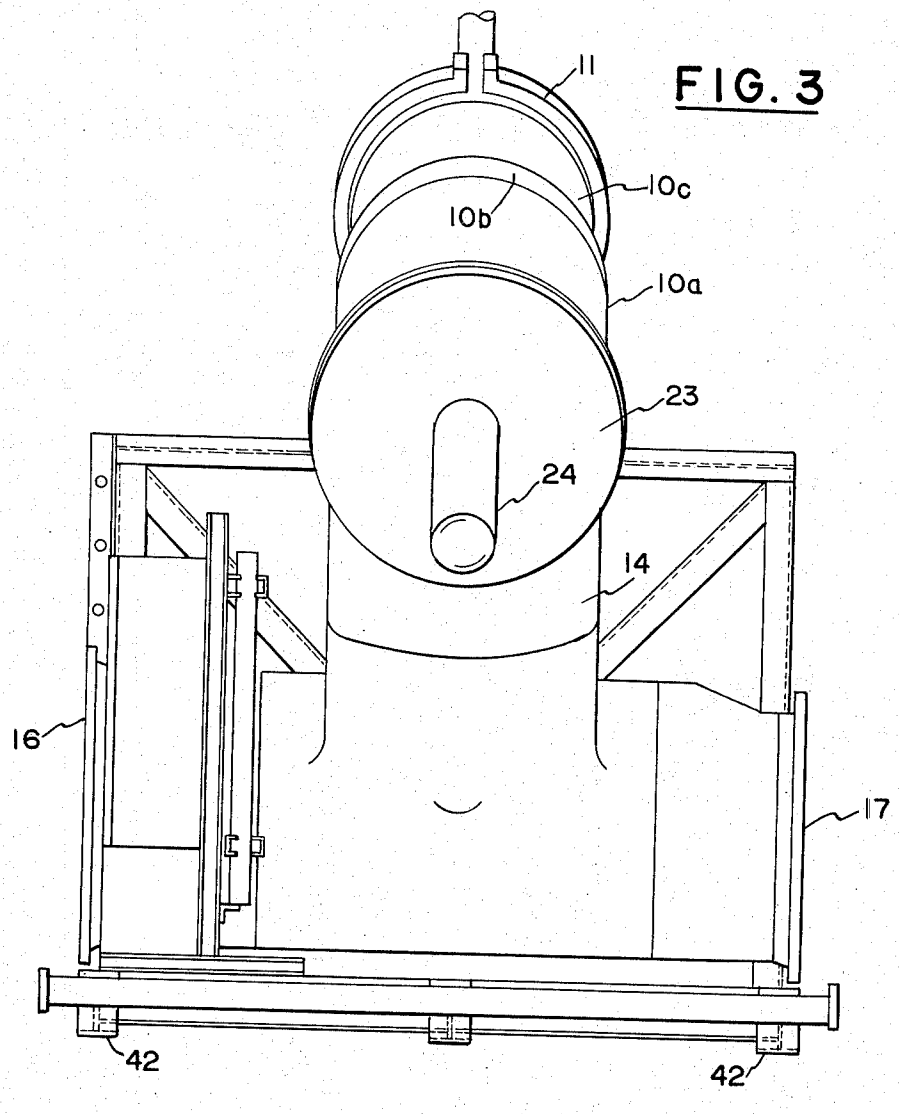


FIG. 3



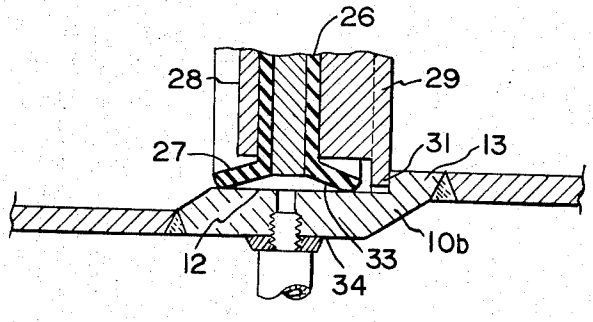
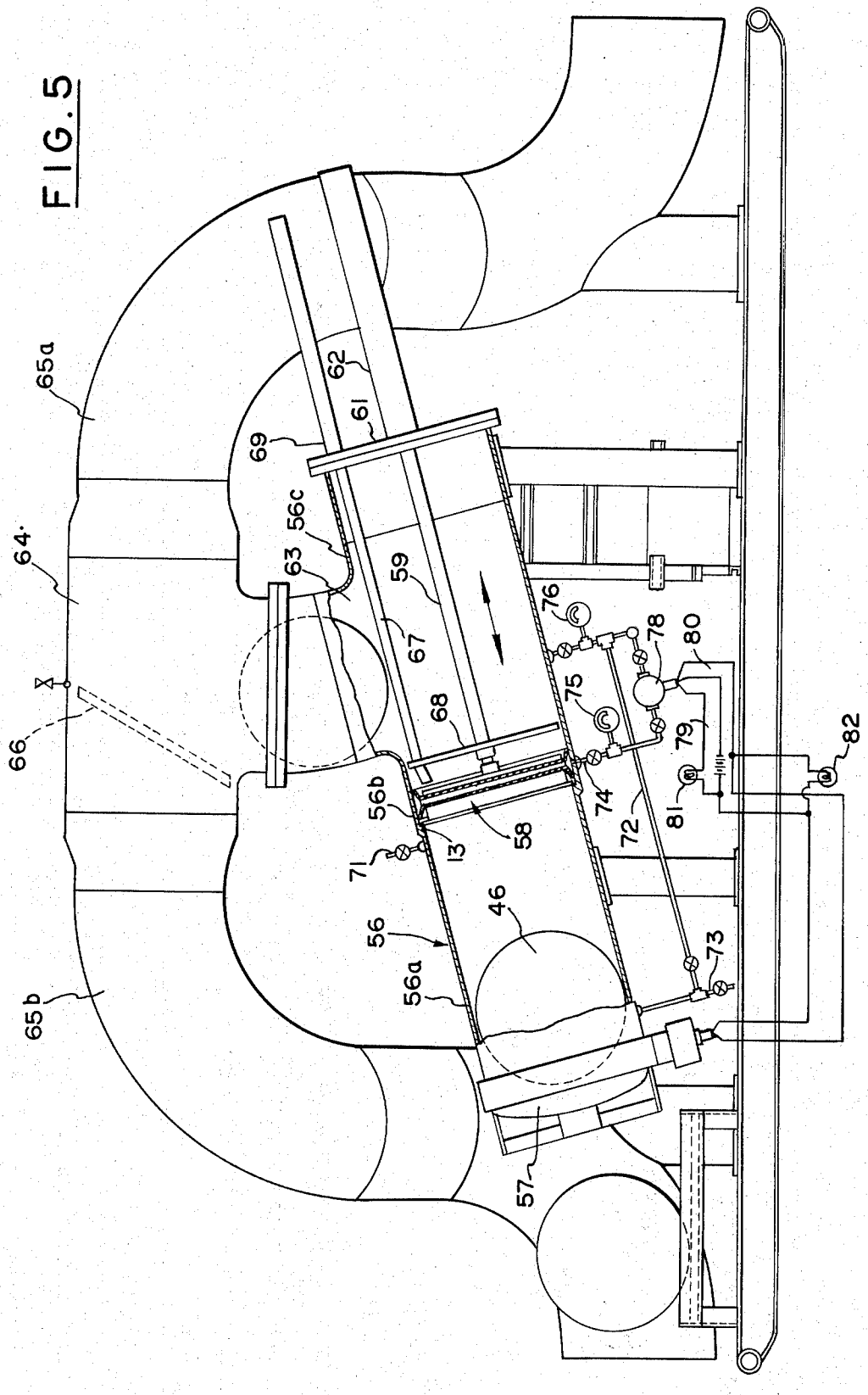


FIG. 4

FIG. 5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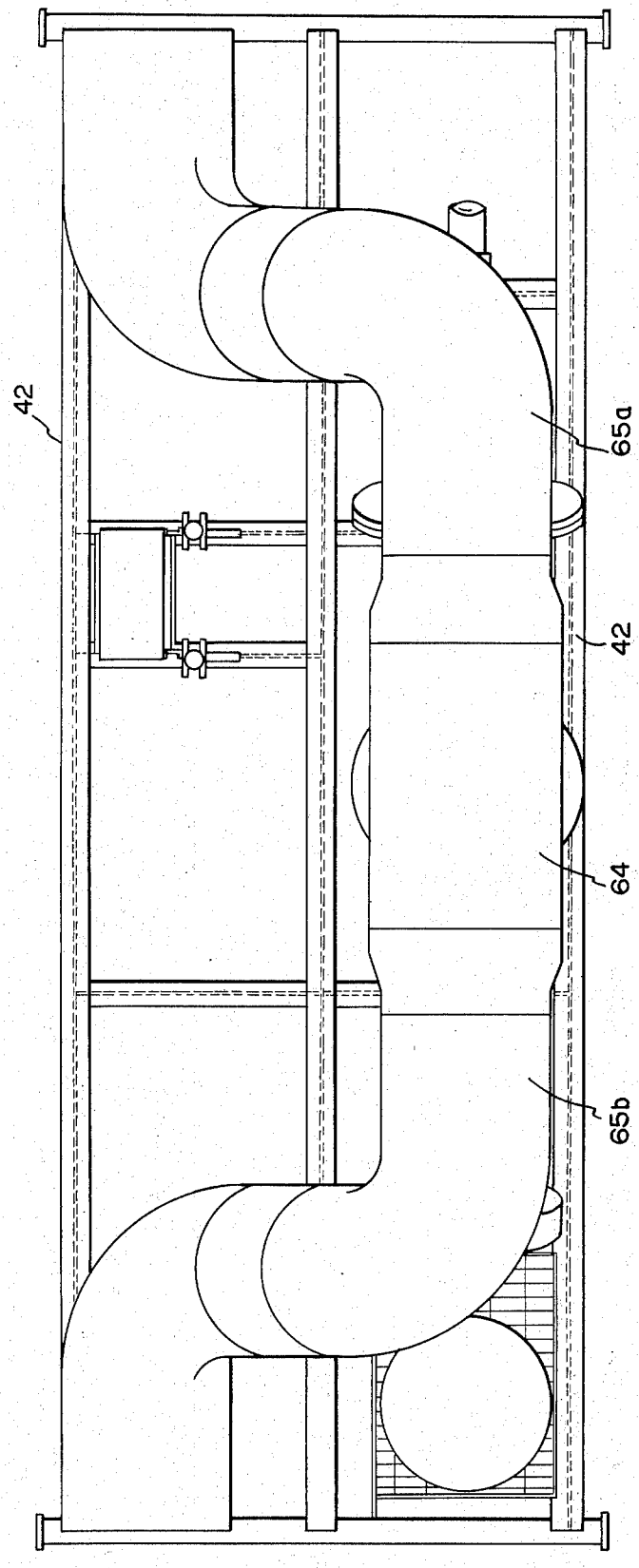

FIG. 6

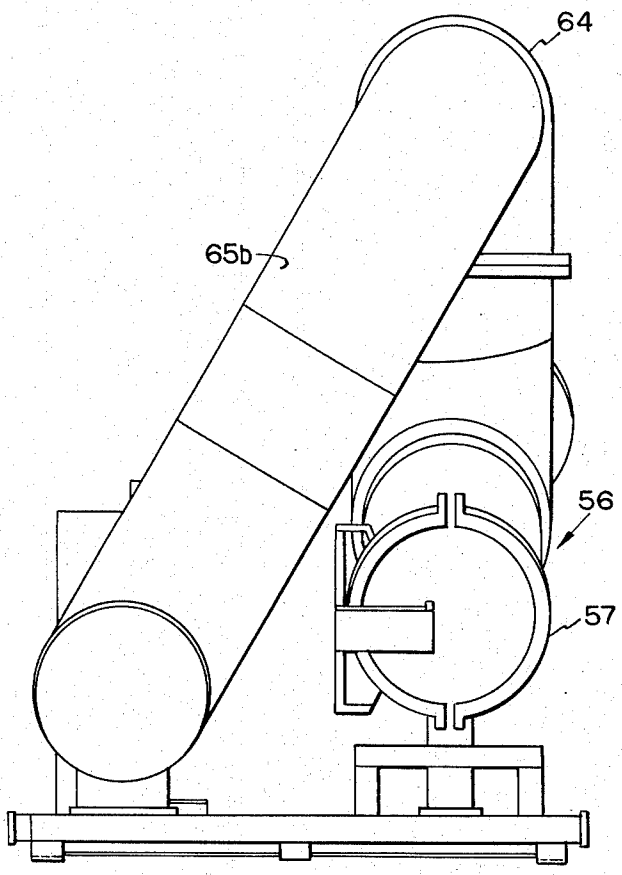

FIG. 7

SPHERE HANDLING APPARATUS AND METHOD

BACKGROUND OF THE INVENTION

This invention relates generally to sphere handling apparatus for use with pipe lines which convey fluids such as petroleum, petroleum products, water and fuel gas. Particularly, it enables spheres to be introduced into or removed from a pipe line.

In the operation of pipe lines for conveying fluids under pressure as referred to above, it is customary to cause spheres to be flow-propelled through the line to aid in removing undesirable accumulations, such as sand, congealed fractions or condensates. Many spheres used for this purpose are made of synthetic rubber with a relatively smooth exterior surface. However, other forms of flow propelled devices are used, including plugs or spheres made of resilient foam and surfaced with abrasive material. Various sphere launching and retrieval apparatus have been used for this purpose. In general, they employ a hollow body adapted to accommodate one or more spheres and connected to the line through one or more valves, e.g., a gate or ball valve (see U.S. Pat. No. 3,664,356). Such prior apparatuses have a number of disadvantages. Particularly, they have been expensive to manufacture due largely to the cost of the valves employed. They have also been subject to operating difficulties due to the massive character of the valves and the forces required for their operation. In addition, they have lacked simple means for detecting a leak past the sealing means employed. Leaks in such equipment may endanger an operator and may produce serious spillage of petroleum and like products.

All of the foregoing difficulties and disadvantages are intensified for the higher operating pressures and line sizes, as for example, line pressures of the order of 400 to 1,200 p.s.i., and pipe diameters of from 40 to 48 inches. For such services, the spheres or other cleanout devices must be relatively large in diameter and thus difficult to handle and susceptible to injury. Also the fluid forces involved are relatively high, particularly when the full differential between the line pressure and atmospheric is applied to an operating member, such as the gate of a valve.

SUMMARY OF THE INVENTION

In general it is an object of the invention to provide improved apparatus for the handling of spheres used in connection with pipe lines, including sphere launching and retrieval operations, and which is simple in construction and operation.

Another object of the invention is to provide such sphere handling apparatus with improved means for preventing leakage during sphere handling operations, and for detecting such leakage if it should occur.

Another object of the invention is to provide sphere handling apparatus requiring a minimum of power for its operation.

In general, the present invention consists of a hollow body disposed in an inclined position, with the upper and lower portions of the body having openings greater than the diameter of the sphere. The body includes a cylindrical shaped sleeve disposed between the openings which cooperates with a reciprocating internal closure to form a seal between the two body portions. Preferably the closure makes use of sealing means of

the double resilient sealing cup type, which interfit and establish sealing engagement with the inner periphery of the sleeve. A reciprocating rod extends into the body and has its inner end attached to the closure. Power means is disposed exteriorly of the body for reciprocating the rod. Maintenance of a seal between the closure and the sleeve is determined by reference to the difference between the pressure in the space between the sealing cups and the line pressure.

Additional objects and features of the invention will appear from the following description in which the preferred embodiments have been set forth in detail in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a side elevation partly in section, illustrating the invention incorporated in a sphere launching device.

FIG. 2 is a plan view of FIG. 1.

FIG. 3 is an end view of FIG. 1.

FIG. 4 is an enlarged detail in section showing the sealing cups and the engagement with a cooperating sleeve.

FIG. 5 is a side elevational view partly in section illustrating the invention incorporated in a sphere retrieval apparatus.

FIG. 6 is a plan view of the apparatus shown in FIG. 5.

FIG. 7 is an end view of FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The sphere launching apparatus shown in FIGS. 1 – 3 consists of a body **10** which may be made by metal fabrication methods and which has an internal diameter somewhat greater than the diameter of the spheres being handled. The apparatus is mounted adjacent a pipe line into which the sphere is to be launched. The upper end of the body **10** is provided with a removable closure **11**, preferably one of the hinged door type provided with a locking pin for locking it in closed position. The body is shown formed in three portions or sections **10***a*, **10***b* and **10***c*, which are secured together as by welding. Portion **10***a* may be the upper part of a tee as illustrated in FIG. **1**, part **10***c* is a cylindrical pipe section, and part **10***b*, which is intermediate the parts **10** and **10***c*, is a short section or sleeve having an inner cylindrical surface **12**. In machining the sleeve **10***b* to provide the surface **12**, it is desirable to provide an annular shoulder **13** for reasons to be presently explained.

The lower extension **14** of the part **10***a* is connected to the tee **15** which has aligned inlet and outlet ends **16** and **17**. When the apparatus is installed adjacent a pipe line, it is customary to provide an upstream connection to inlet **16** and a downstream connection to outlet **17**.

Within the body there is a closure **21** which is carried by the inner end of the reciprocable rod **22**. This rod extends to the exterior through the closure plate **23** and is connected to a suitable exterior power operator **24**, such as one of the double acting hydraulic cylinder-piston type. A suitable hydraulic system is provided for energizing the operator **24**, and this may be controlled manually, or automated, or controlled from a remote station.

The closure 21 has sealing means of the double resilient seal cup type. Thus as illustrated in FIG. 1, taken together with the enlarged FIG. 4, cup-like sealing members 26 are provided which have peripheral and oppositely directed flange portions 27. These members are made of suitable resilient material, such as a synthetic rubber or elastomer. They are retained between annular clamping members 28 and 29, both of which are secured to the rod 22. Member 29 preferably includes a rim portion 31 which is of larger diameter, the periphery of which can be provided with a rim cushioning formed of suitable material such as resilient rubber or elastomer. This arrangement aids in guiding the closure 21 when it is moved into the sleeve 12. The flange portions 27 provide sealing engagement with the inner peripheral surface 12 of the sleeve 10*b*. When the closure is retracted from the sleeve, the flange portions 27 assume a somewhat larger relaxed diameter, but when moved into the sleeve 10*b*, some radial contraction occurs. The space 33 between the flange portions 27, when the closure is within the sleeve 10*b*, is in communication with port 34 for a purpose to be presently described. The inner end of the rod 22 may also be provided with a member 36 which is in the form of a disk having a diameter somewhat smaller than the internal diameter of the body 10. This disk may serve as a stop for the retracted position of the closure, and it may also serve as a guide for movement into the retracted position. With respect to the projected position of the closure, shown in FIG. 1, the shoulder 13 serves as a stop.

The apparatus may also include means for conveniently handling relatively large spheres and for introducing them into the body. Thus a platform 41 is shown on the supporting frame or skids 42, and a hoist standard or column 43 is shown with hoist means 44. The spheres 46 may be engaged by the suction pickup head 47 which in turn connects with the hoist means 44. With the closure 11 swung open, a sphere can be lifted and introduced into the body, after which the head 47 is disengaged, the sphere permitted to move down by gravity to the position shown in FIG. 1, and then the closure 11 reclosed and locked.

Exterior piping is shown connected to the body as follows. A bypass pipe 48 has one connection with the body section 10*c*, and another connection with the body section 10*a*. A valve 48*a* in this bypass may be opened to permit pressure equalization. Another pipe 49 is shown connected with the port 34 of the sleeve 10*b*, and connects with pressure indicating means, such as the pressure gauge 50.

Also a pressure gauge 51 is shown connected to bypass line 48 to indicate the pressure within the body section 10*a*. The upper part of the body portion 10*c* is also provided with a valve controlled atmospheric vent 52. In addition, a pipe 53 is shown connected with the bypass pipe 48 and is valve controlled to enable draining the body section 10*c*.

Operation of the apparatus shown in FIGS. 1 – 4 to carry out a sphere launching cycle is as follows. Initially the positioning of the parts may be as shown in FIG. 1. The pressure within the body sections 10*a* and 10*c* is equal by virtue of communication through the equalizing bypass 48. A sphere may be within the body section 10*c* in readiness for launching. The closure 21 is within and sealed with respect to the sleeve 10*b*. To launch the sphere 46, the bypass 48 remains open and power is supplied to the operator 24 to start movement of the closure 21 from the position shown in FIG. 1 to a fully retracted position. During the initial part of this movement the closure 21 is retracted from the sleeve 10*b*, and this may be accompanied by some surging of liquid through the bypass 48. As the closure is being retracted, the sphere 46 follows it by gravity, and when the closure 21 has reached a position which frees the sphere for launching, it moves downwardly by gravity into the tee 15 and is propelled into the line by fluid flow. The closure 21 is then returned to the sealing position shown in FIG. 1.

Assuming now that one wishes to introduce another sphere into the body section 10*c*, the bypass valve 48*a* is closed, vent 52 to the atmosphere is opened and drain line 53 opened to permit liquid to flow into a suitable tank or reservoir. During this time the full line pressure is applied to closure 21, and it is important to avoid any leakage. At the time closure 21 is moved into the sleeve 10*b*, its flange portions 27 are flexed in a radial direction, thereby causing the pressure within the space 33 to be substantially reduced. This reduced pressure can be visually noticed by observing gauge 49, and by comparing the reduced pressure reading with the pressure of the line as indicated by gauge 51. If any leakage should occur past the closure 21, the pressure within the space 33 immediately rises to line pressure, thus indicating a defective seal. After completely draining fluid from the body section 10*c*, the vent and drain 52 and 53 are closed, and the hinged closure 11 opened to accept the sphere. After the sphere has been hoisted and introduced into the body section 10 *c*, the hinged closure 11 is locked shut, and thereafter the bypass valve 48*a* is opened to permit line fluid to enter the body section 10*c*. While fluid is being introduced, it is necessary to permit the vent 52 to remain open until section 10*c* is completely filled. Thereafter, vent 52 is closed and some bypassing of liquid continued to effect complete equalization between the pressure within body portion 10*c* and the line pressure. The apparatus is now in condition for launching another sphere in the manner previously described.

The apparatus described above has a number of features not possessed by conventional sphere handling apparatus adapted to launch spheres. Both the construction and mode of operation are relatively simple. A seal is established between the two sections of the body by the relatively simple internal closure 21, which is moved between open and closed positions by the external operator. While line pressure is applied to this closure during the operating cycle, it is not applied while the closure is being retracted or projected, and therefore the forces and power requirements are relatively low. The apparatus is realtively compact because of the small space required for the closure 21 and the sleeve 10*b* with which it cooperates. The closure of the double resilient cup type provides an effective seal, and if any leakage should occur by virtue of some defect, the operator is apprised of the same before attempting a launching operation. The apparatus is particularly adapted for the handling of relatively large spheres, as for example, spheres ranging in diameter from 30 to 48 inches or greater.

The apparatus shown in FIGS. 5, 6 and 7 is suitable for carrying out sphere retrieval operations.

The apparatus shown in FIGS. 5 – 7 serves to remove spheres from pipe lines. It consists of a body 56 which

again is made in three sections 56*a*, 56*b* and 56*c*. The body is annular in cross-section and of an internal diameter greater than that of the spheres being handled. The end of the body is provided with a hinged closure 57 which can be unlocked and swung to open position for the removal of a sphere. The sleeve 56*b* and the associated closure assembly 58 can be the same as described above in connection with FIGS. 1 – 4. It is likewise carried by the operating rod 59 which extends to the exterior through the plate 61 and is operatively connected with the power operator 62.

The body section 56*c* is provided with an upper side opening 63 and is coupled to a tee 64 which is inserted into the main line 65. Bars 66 are inserted in the tee 64 to deflect spheres downwardly into the opening 63. For the position of the parts shown in FIG. 5, movement of a sphere into body portion 56*c* is blocked by a member 67 in the form of a bar which extends across the opening 63 and is carried by the operating rod 59. Thus one end of rod 67 is shown secured to member 68, which in turn is secured to the rod 59, and the other end is shown slidably extending through an opening in the plate 61 and accommodated within the exterior closed tube 69. Member 68 is substantially the same as the member 36 of FIG. 1.

The body 56 is provided with the valve controlled atmospheric vent 71, and a bypass line 72 connects with the lower portion of the body portion 56*a* and with the body portion 56*c*. A valve controlled drain pipe 73 may connect with the bypass 72. Line 74 corresponds with line 49 of FIG. 1 and serves to connect the space between the sealing cups with the pressure gauge 75. The additional gauge 76 measures the pressure in the upper part of the body.

Operation of the apparatus shown in FIGS. 5 – 7 is as follows. When a sphere arrives at the tee 64 from the upstream line 65*a*, it engages the bars 66 which deflects the sphere downwardly through the opening 63 into the upper body part 56*c*. With the closure 58 sealed within the sleeve 56*b*, as illustrated in FIG. 5 the sphere comes to rest against the bar 67. Before attempting to remove the sphere the operator makes certain, by reference to gauges 75 and 76, that closure 58 is not leaking, and pressures within body portions 56*a* and 56*c* are equalized by opening the bypass 72. To remove the sphere from the line, the operator 62 is energized to move the closure 58 toward the right as viewed in FIG. 5 to its fully retracted position. During the initial part of this movement, the closure is withdrawn from the sleeve 56*b*, thus placing the two body portions 56*a* and 56*c* in direct communication. When movement toward the retracted position of the closure has proceeded sufficiently far whereby the sphere is free to move downwardly, it initially moves into the body portion 56*c* and then rolls downwardly by gravity to a position against the hinged closure 57 as shown in FIG. 5. The operator 62 is now energized to return the closure 58 to the position shown in FIG. 5 in sealing engagement with the sleeve 56*b*, and at that time the operator observes the readings of the gauges 74 and 75 to determine whether or not the differential pressure is sufficient to indicate proper sealing. Normally, to indicate proper sealing this differential will be of the order of something in excess of 10 p.s.i. If gauges 74 and 75 indicate a proper seal, the operator then commences to drain the lower body portion 56*a* by opening the vent 71 and the drain 73. As this draining of liquid is commenced, the full line pressure is applied to the internal closure 58, and the operator again makes certain that no leakage is occurring by observing the pressure differential indicated by the gauges 74 and 75. When all of the liquid has been drained from the lower body portion 56*a*, the closure 57 is opened and the sphere removed. Thereafter, closure 57 is shut and locked, and the pressure within the body portions 56*a* and 56*c* is equalized by opening the bypass line 72. The apparatus is now in condition to receive another sphere. In both the embodiments one portion of the body (i.e., 10*c* of FIG. 1 and 56*c* of FIG. 5) forms a sphere receiving space, and the other body portion (i.e., 10*a* of FIG. 1 and 56*a* of FIG. 5) form a space into which the sphere is transferred after moving the internal closure to a position which enables the sphere to gravitate downwardly. After such transfer the sphere in FIG. 1 is launched into the line while in FIG. 5 it is removed.

In the operation of both embodiments care should be taken to make certain that no leakage is occurring past the inner closure at the time the external hinged closure is opened. In FIG. 5 means is shown to insure against opening of the hinged closure if leakage is occurring. Thus a differential pressure responsive device 78 has fluid connections with bypass line 72 (i.e., the interior of body portion 56*c*) and line 75 (i.e., the space between the cup flanges when inner closure 58 is within sleeve 56*b*). This device 75 may be a differential pressure operated switch having two sets of electrical contacts operated by a movable fluid pressure operated member which separates two closed fluid chambers. These chambers are connected to the two fluid pressure sources. In FIG. 5 two circuits 79 and 80 are controlled by the electrical contacts, and each circuit may be provided with signal lamps 81 and 82. One lamp (e.g., 81) can be energized when no differential pressure exists or when the differential pressure is so low that a leak is indicated. Lamp 82 is energized when the differential pressure is such that a good seal is indicated. Circuit 80 is also shown connected to lock release means incorporated in the locking mechanism of the hinged closure 57. With this arrangement the operator cannot open closure 57 if the differential pressure (or absence of differential pressure) is such that circuit 80 is not energized. It will be evident that the same arrangement can be incorporated with the apparatus of FIG. 1.

We claim:

1. Sphere handling apparatus for use with a pipe line carrying fluid under pressure and serving to remove or introduce a sphere or clean-out device, a generally cylindrical hollow body disposed in an inclined position, the upper and lower end portions of the body having openings greater than the diameter of the sphere to be handled, one of said openings being an access opening that is aligned with the axis of the body, an access opening closure removably secured to the corresponding end portion of the body and serving to close one of said openings, the body between the openings having an internal diameter greater than that of the sphere, a cylindrical sleeve fixed in the body between said body portions, the sleeve being sealed with respect to the body, an operating rod extending axially into one end of the body, a closure assembly carried by the inner end of the rod and adapted to have a sealed fit with the inner surface of the sleeve, power means exterior of the body for reciprocating the rod and closure assembly between

one operating position in which the closure assembly is within the sleeve and sealed with respect to the same and a second position in which the closure assembly is spaced axially from the sleeve, and valve controlled bypass means providing controlled pressure equalizing communication between the body spaces and also surging of fluid to accommodate movements of the assembly within the sleeve.

2. Apparatus as in claim 1 in which the closure assembly has resilient sealing means of the double sealing cup type.

3. Apparatus as in claim 1 in which the upper portion of the body has an upwardly extending connection with the line whereby a sphere in the line may move downwardly out of the line by gravity and into the upper portion of the body, said access opening closure being secured to the lower end portion of the body.

4. Apparatus as in claim 1 in which the lower portion of the body has a downwardly extending connection with the line whereby a sphere from within the body may move downwardly into the line, said access closure being secured to the upper portion of the body.

5. Apparatus as in claim 1 in which the means for sealing the closure assembly within the sleeve is of the double resilient sealing cup type and in which means is provided for detecting the difference between the pressure between the sealing cups and the line pressure.

6. Apparatus as in claim 1 together with releasable locking means for the access opening closure, and means responsive to leakage past the closure assembly for retaining said locking means in locked condition.

* * * * *