

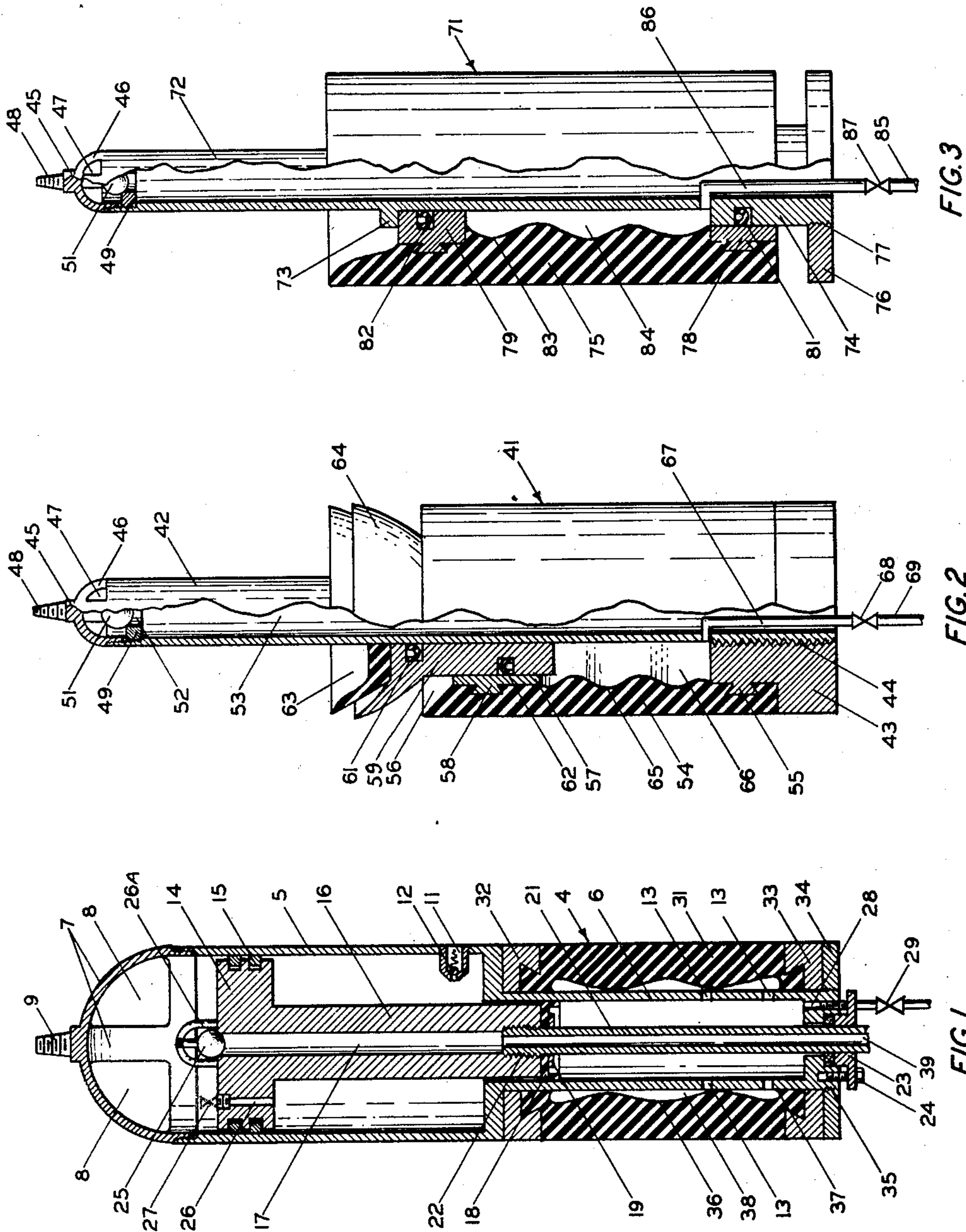
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SWAB FOR TAPERED CASING OR TUBING

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SWAB FOR TAPERED CASING OR TUBING

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This invention relates to swabs. In one specific aspect it relates to swabs which are self adjustable to fit and operate properly in a plurality of dimensions of pipe such as the casing or tubing of a well.

In modern practice in deep wells, it is advantageous and economical to use tapered strings of casing and tapered strings of tubing, with thinner tubing or casing for the center portion of the well and increasing the thickness of the walls of the casing or tubing toward the top and bottom of the well. In inserting tubing and casing in a well it is suspended from the derrick in a long string thousands of feet in length and the center portion of the string need not be as strong as the upper portion, which is supporting the lower portion, or as strong as the bottom portion which must withstand the hydrostatic collapse pressure. By making the center portion lighter, the upper portion has less to support. The only disadvantage in this system is that the inside diameter of the tubing or casing varies from small to large and back to small again as a swab travels up the well and the swab must adjust itself to the change in diameter. The tapering of the tubing is generally not uniform, but usually consists of running several hundred pipes of a certain thickness, and then running a similar number of the next thickness, and then the next thickness, etc., until sufficient tubing or casing has been assembled.

During the life of a well it is often necessary to swab the same either as a simple pumping operation, or for other purposes such as causing pressure changes on the formation to stimulate natural flow, or simply to remove liquids or mud from the well.

While satisfactory swabs have been produced which will work with high efficiency for long periods of time in a single internal diameter size of tubing or casing, these swabs have proved inefficient, or inoperative, or have rapidly broken down when used with tapered casing or with tubing having a plurality of internal diameters.

One object of the present invention is to provide an improved swab.

Another object is to provide a simple and easily operated swab having a minimum number of parts which are inexpensive to build and rugged in operation.

Another object is to provide a swab which will operate in a casing or tubing having a plurality of inside diameters.

Another object is to provide a swab which will

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automatically adjust itself to a wide variation in internal diameters of a pipe through which it is being pulled.

Another object is to provide a swab which uses the hydrostatic head of the liquid being lifted to seal the swab to the pipe.

Numerous other objects and advantages will be apparent to those skilled in the art upon reading the accompanying specification, claims and drawings.

In the drawings—

Figure 1 is an elevational, cross sectional view taken through the center of a swab embodying the present invention.

Figure 2 is an elevational view with parts broken away to show details of construction of a modified embodiment of the present invention.

Figure 3 is an elevational view with parts broken away of a third modified embodiment of the present invention.

In Figure 1, a swab generally designated as 4 is provided with a cylindrical body 5 having an extension 6 of reduced diameter. Body 5 is provided with a bail comprising arms 7 and openings 8. Bail 7 is provided with attachment means 9 by which it may be attached to the usual sinker weight (not shown) and preferably rope or cable (not shown). However, swab 4 can be operated on the end of a string of tubing (not shown), if desired, but of course operation on a cable, or wire line of some sort, is preferred.

Body 5 has a fluid outlet 11 controlled by check valve 12. Check valve 12 allows fluid to pass out of body 5 but does not permit fluid to enter body 5. Portion 6 of body 5 is provided with openings 13.

Slidable in body 5 is a piston member 14 which may be provided with piston rings or other packing, such as 15, if desired. Piston 14 has a reduced extension 16 and a passage 17 is provided therethrough. Extension 16 extends down into portion 6 and may be packed thereto by cup packing or other packing 18 secured in place by nut 19. A further extension of piston 14 is provided by pipe 21 which could be made integral with 16, but preferably is secured thereto by suitable fastening means 22. Pipe 21 extends below the lower end of 6 and the lower end of portion 6 may be provided with a stuffing box 23. Obviously close fits could be substituted for packing at 15, 18 and 23 without invention, but such close fits are not preferred because of increased expenses resulting

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therefrom. Stuffing box 23 may be adjusted by bolt 24.

Passage of fluid through bore 17 is controlled by gravity check valve 25 which may be retained in place by a suitable cage or other retaining means 26A. Access to the space inside of 5 is provided by passage 26 in piston 14 and passage 26 is normally closed by hand operated shut-off valve 27. Access to the space inside 6 is provided by passage 28 and passage 28 is controlled by hand operated shut-off valve 29.

A swab packer 31 consisting preferably of rubber portion 31 and metallic ends 32 and 33 securely holding the rubber 31 in place is placed around the outside of portion 6 and may be held in place by suitable retaining means 34 attached to 6 by suitable attaching means 35. While in some cases a simple cylindrical interior is sufficient it has been found preferable in such packers as 31 to corrugate the interior by horizontal corrugations 36 and it is advantageous to provide re-entrant self sealing lips 37 on the packer 31 at the top and bottom of the space 38 between parts 6 and 31.

The lower end of passage 17 opens into the well bore at 39. Passage 28 leads to the well bore through valve 29.

In Figure 2, a swab generally designated as 41 is shown consisting of a center cylindrical member 42 which is provided with an enlarged base 43 which may be integral but is preferably secured thereto at 44. The upper portion of 42 is secured to a bail 45 having arms 46 and openings 47. Bail 45 is provided with suitable securing means 48 for securing it to suitable operating means such as a sinker and rods, tubing or cables (not shown), a sinker and cable being preferred.

Preferably secured in the upper portion of 42 is a seat 49 on which is a gravity check valve 51 controlling flow through the opening 52 on seat 49 leading through space 53 inside of member 42. The bail 45 acts as a cage to prevent the loss of ball 51 which is too large to pass through openings 47 but cannot close the same to fluid flow.

Mounted on the exterior of the base 43 is a swab packer 54 secured thereto by such means as the annular dove tail flange 55. The upper end of packer 54 is provided with an upperly and outwardly directed lip 56 and the interior of the upper portion of the packer 54 may be lined with a suitable friction reducing and packing bushing 57 secured by suitable means 58 which may be similar to member 55.

Slidably mounted in bushing 57 (or if bushing is not present, in the top of packer 54) is an annular piston 59. Piston 59 may have a sealing fit with the exterior of part 42 and the interior of part 57, which sealing fit may be produced by annular U-shaped packing rings 61 and 62 respectively. Mounted or resting on the top of piston 59 is an upwardly and outwardly directed cup packer 63. While cup packer 63 may be eliminated in some instances it is regarded as preferable because it insures the proper movement of piston 59 and in addition has some swab action. As is customary with such cup packings 63, a backing or reinforcing lip 64 may be provided on the top of piston 59, if desired, to back up packing 63 and obviate it turning inside out.

While the inside of packer 54 may be cylindrical or of other shape it has been found preferable to corrugate the inner side of such packers with horizontal corrugations such as 65.

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Access to space 66 between member 42 and packer 54 is provided by means of conduit 67, and conduit 67 is controlled by manually operated shut-off valve 68. When open, conduit 67 leads to the well bore 69.

In Figure 3 a swab generally designated as 71 consists of a center cylindrical member 72 which may be provided at its upper end with parts 45, 46, 47, 48, 49 and 51 the same as in Figure 2. Cylindrical member 72 has an annular or top shoulder or flange 73 thereon and an enlarged based portion 74.

A swab packer 75 is mounted around member 72, and disengagement therefrom is preferably prevented by collar member 76 secured to 72 by suitable fastening means 77.

While packer 75 could directly engage bore member 74 and member 72 it is preferable to provide metallic friction reducing sealing means 78 and 79 which may be secured to packer 75 in the same manner as part 57 in Figure 2 was secured to packer 54. The packing effect between 78 and 74 and between 79 and 72 may be argued by annular U-shaped packing rings 81 and 82. Packer 75 is preferably provided with suitable horizontal corrugations 83 similarly to corrugations 65 of Figure 2.

Space 84 between packer 75 and member 72 communicates with the well bore at 85 by means of conduit 86 controlled by manually operated shut-off valve 87.

Operation

The operation of Figure 1 is as follows:

The space 38 and the space between 6 and 21 is filled with a suitable liquid such as water, oil or glycerin through conduit 28 raising piston 14 to the position shown, valve 27 being open to allow free movement of the piston. By holding the swab 4 in an inverted position and pumping piston 14 up and down any air in space 38 may be removed through lower openings 13 (at that time they are the upper most openings 13). When space 38 and the space between 6 and 21 is full of liquid, valve 29 is closed and then valve 27 is closed.

Swab 4 is placed in the well and a suitable sinker weight is attached to 9 and then a cable is attached to the sinker weight and the swab is lowered into the well. Going down the well some of the well fluid passes up around the outside of packer 31 and body 5 while other well fluid passes into 39 and up through passage 17 moving valve 25 off its seat and passing through openings 8.

When the bottom of the well is reached, or the swab reaches the place where it is desired to commence swabbing, the movement of the swab is reversed. As the swab travels upwardly liquid, or other fluid, above the swab passes down through the openings 8 and seats ball 25 on its seat closing passage 17. There being an upward pull on 9 from the cable and a downward push on the piston 14 from the liquid above the swab, piston 14 moves downward relative to 5 compressing any fluid and moving some of the liquid between 6 and 21 out through holes 13 into space 38 inflating packer 31 until it contacts the walls of the tubing, or casing, in which the swab is being operated. The fluid pressure tending to expand swab rubber 4 to conform to the casing or tubing diameter is a multiple of the pressure exerted on the top of piston 14 by virtue of the smaller area between 6 and 21 as compared to the area of 14. As a result of this pressure mul-

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tiplication it is possible to obtain the necessary expanding pressure to give sufficient flexibility and expansion to accommodate the full range of casing or tubing sizes used in any one well.

Pulling on 9 moves the swab upwardly, the swab carrying and supporting all the liquid above it, and packer 31 accommodating itself to the size of the tubing or casing with which it is in contact. Upon entering the smaller internal diameter pipe packer 31 is compressed and liquid is forced back through holes 13 into the space between 6 and 21 forcing piston 14 to move up a sufficient distance. If the internal diameter of the pipe increases, a reverse action will take place automatically accommodating swab 4 to the pipe in which it is operating.

The operation of Figure 2 is as follows:

Space 66 is filled with liquid through pipe 67 until the piston 59 is in the position shown. The filling preferably takes place in an inverted position so that any air may come out of pipe 67. When filled to the position shown, valve 68 is closed and swab 41 is turned into the position shown and inserted in a well with suitable operating means attached to 48 such as a sinker and a cable (not shown).

The swab is lowered into the well and well fluid passes up outside of packer 41 and through space 53 to lift ball 51 and passes out through space 47.

On the return trip liquid above cup 63 expands the same and liquid above lip 56 tends to expand the same into contact with the tubing, or casing, in which the swab 4 is operating.

Ball 51 is forced to its seat. Further lifting of 48 results in downward movement of piston 59 which reduces the spaces available for liquid 66, inflates packer 54 into contact with the pipe in which it is being operated.

Packer 54 automatically accommodates itself at the different internal diameters of the pipe, expanding in the larger and contacting in the smaller pipe with resulting downward or upward movement relative to the piston 59. Extra flexibility and expansion of 54 is accomplished by multiplying the expanding pressure through differential piston and cup area.

The operation of Figure 3 is as follows:

Space 84 is filled in the same manner as space 66 was filled in Figure 2.

On the trip down the well the operation is the same as Figure 2.

On the trip back up the well the top of packer 75 picks up the load of liquid above it, ball 51 seats, and the packer moves downwardly. As piston 74 is larger in diameter than piston 72 the liquid in 84 forces the packer 75 out into contact with the pipe the swab is in. Upon reaching a restricted pipe, the packer moves upward on 72 and vice versa for a larger pipe.

The principle of operation embodied in all three modifications shown in Figures 1 to 3 is that a large area, such as the top of 14, is depressed by the head of liquid above the swab causing a smaller area, such as the bottom of 16, to force liquid into the packer under a pressure superior to the head of liquid above the swab.

Numerous conventional changes in size, shape or arrangement of parts may obviously be made without departing from the spirit and substance of the present invention as defined in the claims.

It is recognized that if care is not used and judgment exercised in the rate of pulling these swabs or the amount of fluid lifted in each trip the pulling line may be overloaded, may break and a fishing job may result. To safeguard

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against this, a spring loaded type of relief valve may be used to replace valves 25 and 51 which would be so arranged that when the pressure exceeded a certain predetermined figure enough fluid would be released to relieve the strain.

Having described my invention, I claim:

1. A swab comprising in combination a supporting member, a hollow flexible packer secured to said supporting member, said packer being secured and disposed to provide a space inside said packer, a hydraulic fluid substantially filling said space, and a movable piston slidably disposed relative to said supporting member and having an upper piston head of greater area than its lower piston head, said upper head being disposed to receive the head of well liquid above said upper head and said lower head being disposed to apply said head of said well liquid from said upper head to an area of said hydraulic fluid in said space in said hollow packer which is smaller than the area of said upper head whereby the head of said well liquid above said upper head forces said packer into contact with the pipe in which the swab is operating at a pressure greater than said head of said well liquid.

2. A swab comprising in combination a supporting body, a hollow flexible packer mounted on said body, said packer being mounted and disposed to provide a space inside said packer, a hydraulic fluid substantially filling said space, a first piston of larger cross sectional area slidably disposed relative to said supporting body and adapted to receive on its face the weight of well liquid above said piston, a second piston of smaller cross sectional area slidably disposed within said hollow flexible packer having its head in contact with the hydraulic fluid filling said packer and being adapted to receive from said first piston the full force of the weight of well liquid above said swab and to transmit said force to said hydraulic fluid in said flexible hollow packer whereby the pressure on said hydraulic fluid is greater than the pressure exerted on the head of said first piston by said well liquid.

3. A swab comprising in combination a cylinder having a large upper end and a reduced lower end, a flexible packer mounted around said lower end, a piston having a large head fitting said upper end and a small head fitting said lower end, a space in said reduced lower end below said small head for a hydraulic fluid substantially filling said space, a conduit through said piston, a gravity check valve controlling flow through said conduit, said large upper end of said cylinder being provided with a passage connecting the interior of said upper end to the outside, a biased check valve controlling flow through said passage, said biased check valve being biased to prevent flow from the outside to the interior of said large upper end, a conduit between said reduced lower end and the space between said lower end and said packer, a conduit through said large head and a valve controlling the same, a conduit affording communication between the lower end and the atmosphere and a valve controlling the same, and means to attach said cylinder to an operating member.

4. A swab comprising in combination a cylinder having a large upper end and a reduced lower end, a flexible packer mounted around said lower end, a piston having a large head fitting said upper end and a small head fitting said lower end, a space in said reduced lower end below said small head for a hydraulic fluid substantially filling said space, a conduit through said piston, a

gravity check valve controlling flow through said conduit, a conduit between said reduced lower end and the space between said lower end and said packer, a conduit through said large head and a valve controlling the same, and means to attach said cylinder to an operating member.

5. A swab comprising in combination a cylinder having a large upper end and a reduced lower end, a flexible packer mounted around said lower end, a piston having a large head fitting said upper end and a small head fitting said lower end, said large upper end of said cylinder being provided with a passage connecting the interior of said upper end to the outside, a biased check valve controlling flow through said passage, said biased check valve being biased to prevent flow from the outside to the interior of said large upper end, a space in said reduced lower end below said small head for a hydraulic fluid substantially filling said space, a conduit between said reduced lower end and the space between said lower end and said packer, a conduit affording communication between the lower end and the atmosphere and a valve controlling the same, and means to attach said cylinder to an operating member.

6. A swab comprising in combination a cylinder having a large upper end and a reduced lower end, a flexible packer mounted around said lower end, a piston having a large head fitting said upper end and a small head fitting said lower end, a space in said reduced lower end below said small head for a hydraulic fluid substantially filling said space, a conduit through said piston, a gravity check valve controlling flow through said conduit, a conduit between said reduced lower end and the space between said lower end and said packer, a conduit affording communication between the lower end and the atmosphere and a valve controlling the same, and means to attach said cylinder to an operating member.

7. A swab comprising in combination a cylinder having a large upper end and a reduced lower end, a flexible packer mounted around said lower end, a piston having a large head fitting said upper end and a small head fitting said lower end, said large upper end of said cylinder being provided with a passage connecting the interior of said upper end to the outside, a biased check valve controlling flow through said passage, said biased check valve being biased to prevent flow from the outside to the interior of said large upper end, a space in said reduced lower end below said small head for a hydraulic fluid substantially filling said space, a conduit between said reduced lower end and the space between said lower end and said packer, a conduit through said large head and a valve controlling the same, and means to attach said cylinder to an operating member.

8. A swab comprising in combination a cylinder having a large upper end and a reduced lower end, a flexible packer mounted around said lower end, a piston having a large head fitting said upper end and a small head fitting said lower end, a space in said reduced lower end below said small head for a hydraulic fluid substantially filling said space, a conduit between said reduced lower end and the space between said lower end and said packer, and means to attach said cylinder to an operating member.

9. A swab comprising in combination a central supporting member having a conduit therethrough and a gravity check valve closing said conduit, an upstanding flexible cylindrical packer supported at its lower end by, and surrounding

said supporting member, a piston having a larger head above said packer and a smaller head inside said packer slidably disposed around said supporting member and inside said packer to form a closed space in said packer for a hydraulic fluid substantially filling said closed space, conduit means to give access to said space, valve means controlling said conduit means, and means to attach said supporting member to an operating member.

10. A swab comprising in combination a central supporting member, an upstanding flexible cylindrical packer supported at its lower end by, and surrounding said supporting member, a piston having a larger head above said packer and a smaller head inside said packer slidably disposed around said supporting member and inside said packer to form a closed space in said packer for a hydraulic fluid substantially filling said closed space, and means to attach said supporting member to an operating member.

11. A swab comprising in combination a central supporting member having a conduit therethrough and a gravity check valve closing said conduit, an upstanding flexible cylindrical packer supported at its lower end by, and surrounding said supporting member, a piston slidably disposed around said supporting member and inside said packer to form a closed space in said packer for a hydraulic fluid substantially filling said closed space, and means to attach said supporting member to an operating member.

12. A swab comprising in combination a central supporting member, an upstanding flexible cylindrical packer supported at its lower end by, and surrounding said supporting member, a piston slidably disposed around said supporting member and inside said packer to form a closed space in said packer for a hydraulic fluid substantially filling said closed space, conduit means to give access to said space, valve means controlling said conduit means, and means to attach said supporting member to an operating member.

13. A swab comprising in combination a central supporting member, an upstanding flexible cylindrical packer supported at its lower end by, and surrounding said supporting member, a piston slidably disposed around said supporting member and inside said packer to form a closed space in said packer for a hydraulic fluid substantially filling said closed space, and means to attach said supporting member to an operating member.

14. A swab comprising in combination a central supporting member having an upper small diameter and a lower larger diameter, said member having a conduit therethrough and a gravity check valve closing said conduit, a flexible cylindrical packer having an upper portion fitting said small upper diameter of said supporting member and a lower portion fitting said lower larger diameter of said supporting member, an annular internal cavity formed in said packer between said upper and lower portion for a hydraulic fluid substantially filling said internal cavity, conduit means to give access to said cavity, valve means controlling said conduit means, and means to attach said supporting member to an operating member.

15. A swab comprising in combination a central supporting member having an upper small diameter and a lower larger diameter, a flexible cylindrical packer having an upper portion fitting said small upper diameter of said supporting mem-

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ber and a lower portion fitting said lower larger diameter of said supporting member, an annular interval cavity formed in said packer between said upper and lower portion for a hydraulic fluid substantially filling said internal cavity, conduit means to give access to said cavity, valve means controlling said conduit means, and means to attach said supporting member to an operating member.

16. A swab comprising in combination a central supporting member having an upper small diameter and a lower larger diameter, said member having a conduit therethrough and a gravity check valve closing said conduit, a flexible cylindrical packer having an upper portion fitting said small upper diameter of said supporting member and a lower portion fitting said lower larger diameter of said supporting member, an annular internal cavity formed in said packer between said upper and lower portion for a hydraulic fluid substantially filling said internal cavity, and means to attach said supporting member to an operating member.

17. A swab comprising in combination a cen-

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tral supporting member having an upper small diameter and a lower larger diameter, a flexible cylindrical packer having an upper portion fitting said small upper diameter of said supporting member and a lower portion fitting said lower larger diameter of said supporting member, an annular internal cavity formed in said packer between said upper and lower portion for a hydraulic fluid substantially filling said internal cavity, and means to attach said supporting member to an operating member.

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