

April 29, 1952

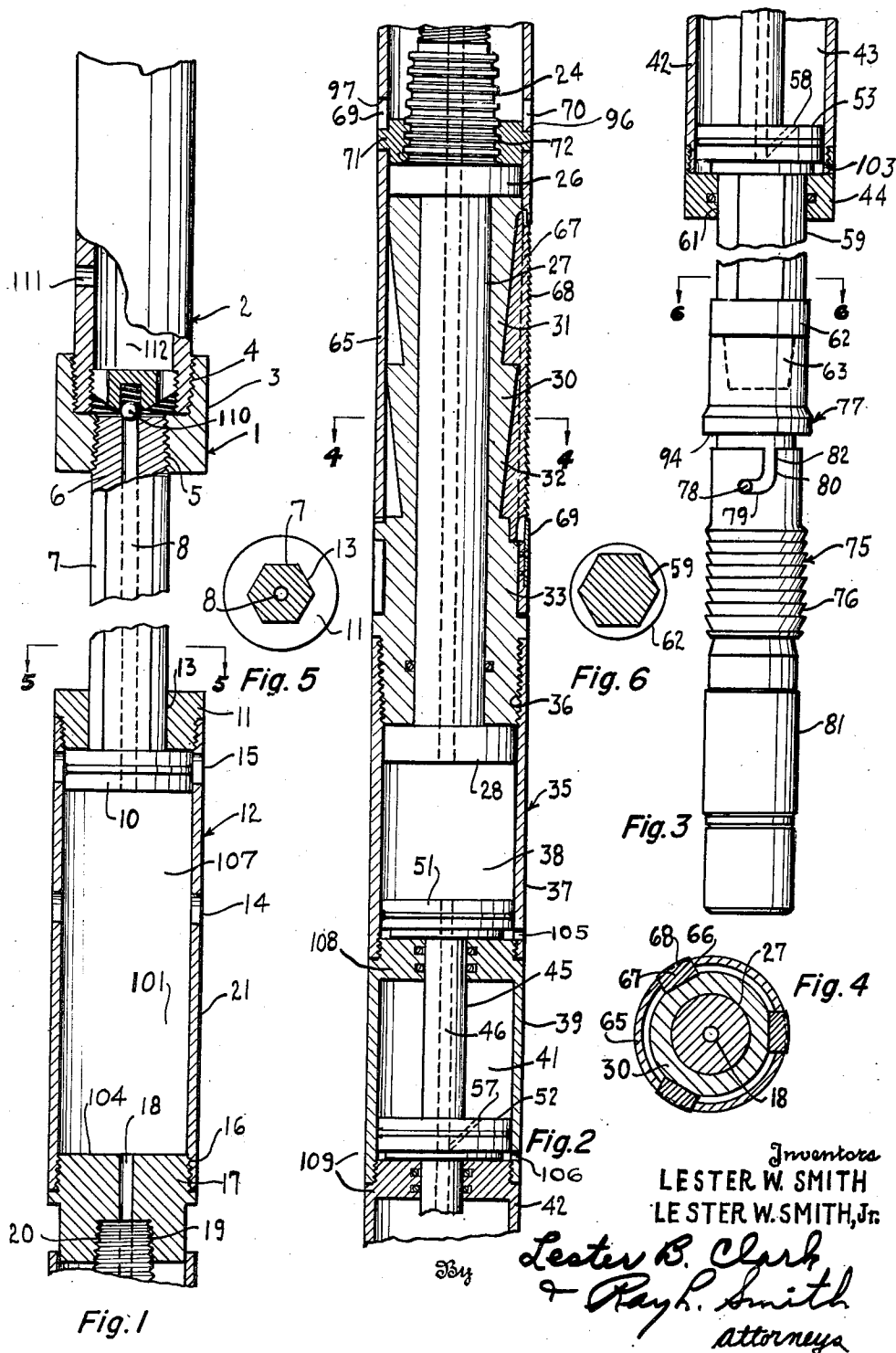
L. W. SMITH ET AL

2,595,014

HYDROSTATIC PULLING TOOL FOR WELLS

Filed Nov. 28, 1949

2 SHEETS--SHEET 1



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2 SHEETS—SHEET 2

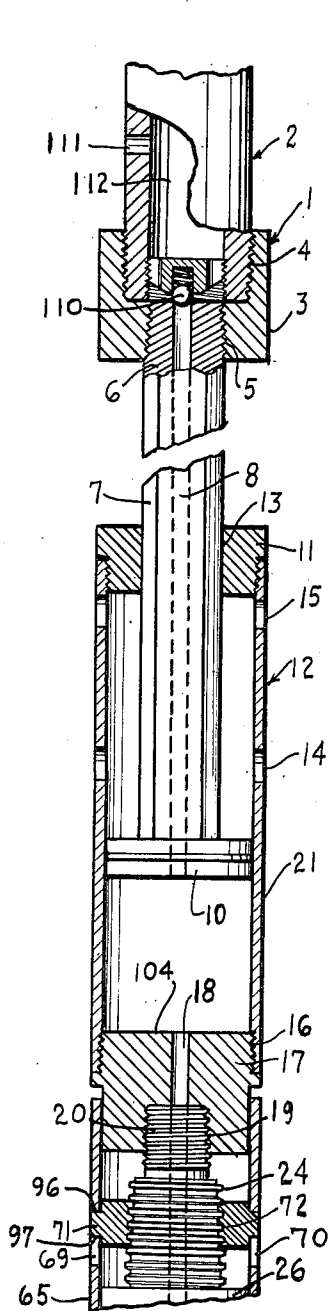


Fig. 7

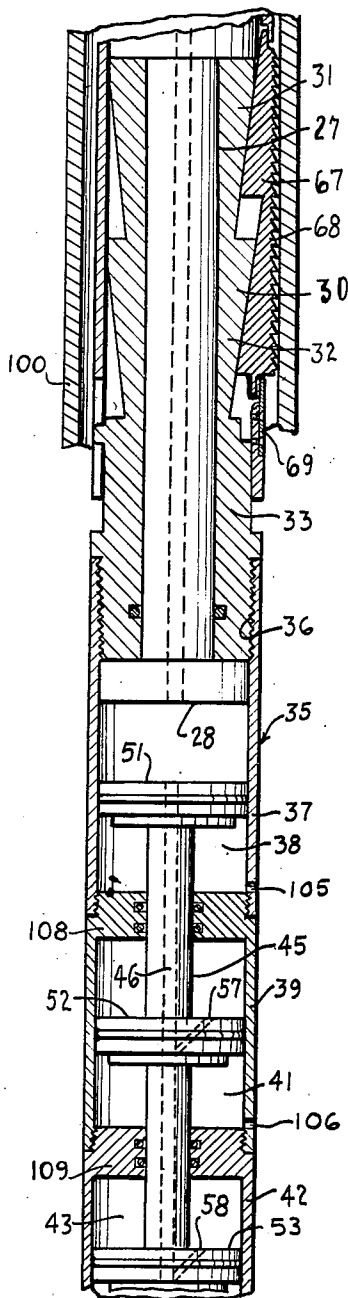


Fig. 8

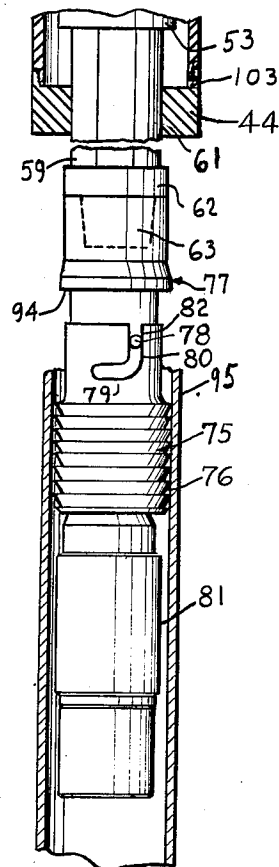


Fig. 9

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HYDROSTATIC PULLING TOOL FOR WELLS

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8 Claims. (Cl. 166-1)

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This invention relates to a pulling tool which is adapted to be anchored in the casing of a well bore and which is adapted to pull upward on a "fishing tool" connected to the lower end of the pulling tool when the fishing tool in turn is connected to a lodged object in the well.

It is an object of this invention to provide a pulling tool which is adapted to be anchored in the casing of a well bore and which may have a "fishing tool" connected to the lower end thereof and which may pull on the fishing tool, which, in turn, is connected to a lodged object.

It is another object of this invention to provide a pulling tool of this class which employs the hydrostatic pressure of the well to abet the pulling operation.

It is another object of this invention to provide a pulling tool of this class which is adapted for connection to a tubular string thereabove, so that the upward movement of the tubular string may create a vacuum within the pulling tool to be opposed by the hydrostatic pressure in the well.

It is yet another object of this invention to provide a pulling tool of this class which may be designed so that the pull exerted on a lodged object thereby is multiplied by the pull exerted at the top of the well upon the tubular string to which the pulling tool is connected.

It is a further object of this invention to provide a pulling tool of this class which has slips therein adapted to anchor the tool in the well casing and which is adapted to break the contact of the slips with the casing when it may be desired to move the tool.

It is another object of this invention to provide a pulling tool of this class which is adapted for connection to a lifting means thereabove, so that upward movement of the lifting means may create a vacuum within the pulling tool to be opposed by the hydrostatic pressure in the well.

It is still a further object of this invention to provide a pulling tool of this class which utilizes the contraction of a stretched pipe string to provide an excessive up-jarring force to dislodge an object connected therebelow when the vacuum in the tool is broken.

It is still another object of this invention to provide a pulling tool of this class which is adapted to be employed with a grapple, spear, or any other type of fishing tool which may be employed to grasp a lodged object.

Other and further objects of this invention will be obvious when the specification is considered in connection with the drawings, in which:

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Figure 1 is an elevation, part in section, showing the upper part of the tool as it is lowered into the well;

Fig. 2 is an elevation, part in section, showing the central portion of the tool as it is lowered into the well;

Fig. 3 is an elevation, part in section, showing the lower end of the tool and the spear attached thereto as these elements are lowered into the well;

Fig. 4 is a sectional plan view taken along line 4-4 of Fig. 2;

Fig. 5 is a sectional plan view taken along line 5-5 of Fig. 1;

Fig. 6 is a sectional plan view taken along line 6-6 of Fig. 3;

Fig. 7 is an elevation, part in section, of the upper part of the tool showing it in the process of lifting;

Fig. 8 is an elevation of the central portion of the tool, part in section, showing it in the process of lifting;

Fig. 9 is an elevation, part in section, showing the lower part of the tool and a spear attached thereto in the process of lifting.

The tool 1 is adapted for connection to a tubular string 2 by means of the cap 3, which is threadable onto the end 4 of the tubular string and which has a threaded box 5 therein to receive the threaded end 6 of a hexagonal piston rod 7. The piston rod 7 has a hollow bore 8 therethrough, and a check valve 10 in the bore 8 at the upper end thereof, and a piston 10 on the lower end thereof. This piston rod 7 is slidable in the cap 11 of the body 12 of the tool, which has the housing 21 as the upper element thereof; the cap 11 has a hole 13 therethrough, of hexagonal cross section, to receive the rod 7.

The housing 21 has ports 14 through its walls centrally thereof, and additional ports 15 through the walls thereof substantially adjacent the cap 11. The housing 21, in turn, is connected to a plug 17, as by threads 16. The plug 17 has a bore 18 therethrough and is threaded at 19 to receive the threaded pin 20, which is the upper element of the mandrel assembly. Below the pin 20 and connected thereto, there is a threaded section 24 which terminates in the collar 25; and below the collar 26 the tube 27 extends to the collar 28. The sleeve 30, comprising the wedge segments 31 and 32 and the base segment 33, is fitted around the tube 27 and rigidly connected between the collars 26 and 28.

The compartmented cylinder 35 is threaded at 36 to the base segment 33, and this cylinder com-

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prises in sequence the tube section 37, which forms the compartment 38; the tube section 39, which is threaded into the tube section 37 and which forms the compartment 41; and the tube section 42, which is threaded into the tube section 39 and which forms the compartment 43. The base plug 44 is threaded onto the tube section 42 to close the cylinder 35.

A piston rod 45, which has the bore 46 there-through, has the piston 51 thereon within the compartment 38; the piston 52 thereon, within the compartment 41; and the piston 53 thereon, within the compartment 43. There is a passage 57 in the piston 52 which places the compartment 41 in communication with the bore 46; and the passage 58 in the piston 53 places the compartment 43 in communication with the bore 46. The shaft 59, of hexagonal cross section, is rigidly connected to the under side of the piston 53 and extends through the hole 61 in the base plug 44 to its termination at the collar 62 and the pin 63.

A cage 65 extends around the sleeve 30, and, as shown in Fig. 4, has the slots 66 therein into which are fitted the slip segments 67, which have the jaws 68 thereon. Retainer plates, as shown at 69, are mounted on the cage 65 to restrain the slip segments 67 to limited outward motion, as shown in Fig. 8. The cage 65 has slots 69 and 70 therein to receive the ears 71 of the wing nut 72 which bear against the sides of the slots and restrain the wing nut 72 from rotation as the threaded section 24 may be rotated therein.

Any type of "fishing tool," as a grapple, spear, or overshot, may be threaded onto the pin 63; and in Fig. 3 a conventional spear 75 is shown. This type of spear is expanded by rotating the mandrel 77 thereof to the left so that the lug 78 thereon passes to the end of the horizontal leg 79 of the J-slot 80. Then the downward drop of the weighted sleeve 81 permits the vertical leg 82 of the J-slot to pass downward around the lug 78, with the result that the slips are moved outwardly, in a well known and conventional manner, to grasp the sides of an object, as shown in Fig. 9.

In operation, the tubular string 2 with the tool thereon is lowered into the well, the body 12 being suspended from the piston 10, as shown in Fig. 1. During this descent the pistons 51, 52, and 53 substantially rest on the horizontal bulkheads 103 and 109 and the base plug 44, respectively.

If a spear 75 is employed, as shown in Fig. 3, the lug 78 thereof should ride in the horizontal leg 79 of the J-slot as the spear descends. When the shoulder 94 of the spear mandrel 77 strikes an object, as the top of the lodged object 95, shown broken off in Fig. 9, this indicates to the operator at the top of the well that the spear 75 might be put into engagement with this object which it is sought to retrieve. Left-hand rotation is then imparted to the tubular string 2 at the top of the well, and this rotation moves the spear mandrel 77 and the lug 78 thereon to the bottom of the vertical leg 82 of the J-slot 80, and permits the spear sleeve 81 to drop downwardly, as shown in Fig. 9, to set the slips 76, as has been hereinabove described.

This left-hand rotation also moves the wing nut 71 upwardly on the threaded section 24 as the ears 71 thereof ride in the slots 69 and 70, and brings the top surfaces 96 of the ears 71 into contact with the cage shoulders 97 at the top of the slots 69 and 70. Further left-hand rotation moves the wing nut 71 upward on the threaded

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section 24, and this lifts the cage 65 so that slip segments 67 carried thereby are moved outwardly along the wedge segments 31 and 32 to set the slips to firmly grip the casing 100.

With the body 12 anchored in the casing 100 and with the spear slips 76 set in the "fish" or lodged object, the tubular string 2 is then lowered to position the piston 10 on the rod 7 at substantially the bottom of the chamber 101 within the housing 21. The hydrostatic fluid in the chamber 101 below the ports 14, as well as the fluid in the compartmented cylinder 35 therebelow, is generally forced upwardly through the bores 46, 18, and 8, and through the check valve 110 into the tubular string 2.

When the piston 10 rests substantially on the top 104 of the plug 17 the tubular string 2 is raised and the piston 10 moves upwardly and begins to create a vacuum in the chamber 101 below the piston 10. This upward movement also creates vacuum in the compartment 38 above the piston 51, and as passages 57 and 58 communicate with the bore 46, upward motion of the piston 10 also creates vacuum in the compartments 41 and 43.

The openings 105, 106, and 103 through the walls of tube sections 37, 39, and 42, respectively, permit hydrostatic fluid from the well, exterior of the tool, to enter into the compartments, and the pressure of this hydrostatic fluid acts on the lower sides of the pistons 51, 52, and 53. Obviously, since there is only a vacuum or partial vacuum acting upon the upper side of these pistons to oppose the force of the hydrostatic pressure fluid, the piston moves upwardly with great lifting force. This force measured in pressure in pounds per square inch multiplied by the areas of the under sides of pistons 51 and 52 plus the total cross section area of the piston 53 amounts to a tremendous total lift in pounds.

It should be noticed that as the piston 10 moves upwardly, hydrostatic fluid which passes into the chamber 101 through the ports 14 and 15 above the piston acts downwardly on the annular area surrounding the rod 17 on the top side of the piston 10. The reading of the weight indicator at the top of the well then is determined by the weight of the tubular string 2 plus the rod 7 and piston 10, plus the friction of the piston 10 within the housing 21, and plus the hydrostatic pressure multiplied by the cross-sectional area in inches of the annular area 107.

As the area 107, in design, may bear a definite ratio to the effective areas of the pistons 51, 52, and 53, against which hydrostatic pressure works, it can be seen that the total lifting force exerted by the tandem of pistons on the piston rod 45 may be a function or multiple of the lift indicated on the weight indicator at the top of the well.

This multiplied lifting force may loosen the "fish" or lodged object to which the spear 75 is connected, in which case the tubular string 2, with the tool 1, spear 75, and "fish" suspended therefrom, may be lifted from the well bore.

However, in case the lifting of the string 2 does not loosen the "fish," the string 2 may then be rotated to the right to move the nut 71 downwardly to the bottom of slots 69 and 70, and further rotation causes it to push the cage 65 downwardly to loosen the contact of the slip jaws 68 of the slip segments 67 with the casing 100. This right hand rotation should also loosen the slip jaws 76 of the spear 75 from the "fish."

In cases where the slip jaws 68 have become

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stuck to the casing 100 so that the slip segments 67 do not retract when the nut 71 pushes the cage 65 downwardly, then a further upward pull may be exerted on the string 2 until the piston 10 uncovers the parts 14 to break the vacuum in the chamber 101 and in the upper parts of compartments 38, 41, and 43. During the application of lifting force to the string 2, a considerable stretching of the pipe thereof will have been accomplished. When the vacuum is broken, the pipe of the string 2 will immediately undergo a contractive reaction and this will result in moving the piston 10 upwardly against the cap 11 of the housing 21 with a violent impact.

This impact, and the possible continued contraction of the pipe of the string 2, will drive the mandrel and wedge sections 31 and 32 thereof upwardly to withdraw the slip segments 67 and jaws 68 from the casing 100 so that they may drop down to the position of Fig. 2 under their own weight.

After the vacuum is broken, an additional jarring effect is obtained by the impact of the pistons 51, 52, and 53, on the partitions 108 and 109 and the base plug 44, respectively.

It is herein pointed out that whereas in the specification hereinabove, a tubular string is considered as the means below which the tool is connected, this invention is not thus limited, and a lifting means 2 need not necessarily be tubular and may be solid above the port 111 where the fluid from the bore 8 discharges into the space 112 within the lifting means.

Broadly this invention considers a pulling tool whereby the lift applied at the top of the well to release an object lodged therein may be multiplied by the employment of the hydrostatic fluid pressure of the well when such is opposed by created vacuum spaces.

What is claimed is:

1. A pulling tool for operation with and below a tubular string employed in well bores, said tool comprising, a housing, connection means between said housing and said string and rotatable therewith, a hollow mandrel connected to the lower end of said housing, a compartmented cylinder connected to the lower end of said mandrel, hollow piston means including a piston operable in each compartment and providing communication between the piston means bore and each compartment above the piston therein, said piston means extending below said cylinder for connection to means for grasping an object lodged in the well, an opening in each compartment to admit pressure fluid from the well bore, slip means on said mandrel operable upon rotation of said string to extend and grasp said well bore wall, said connection means including hollow piston means operable within said housing upon the lifting of said string to pull vacuum in the upper part of each compartment while pressure fluid enters each compartment through said openings opposite the vacuum side of each compartment whereby the lifting force applied to said string at the top of the well is multiplied in the lifting force applied to the lodged object.

2. A pulling tool for operation with and below a tubular string employed in well bores, said tool comprising, a body, connection means between said body and said string and rotatable therewith, compartments in the lower end of said body, hollow piston means including a piston operable in each compartment and providing communication between the piston means bore and each compartment above the piston therein, 75

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said piston means extending below said body for connection to means for grasping an object lodged in the well bore, an opening in each compartment to admit pressure fluid from the well bore, slip means on said body operable upon rotation of said string to grasp said well bore wall, said connection means including hollow piston means operable within said housing upon the lifting of said string to pull vacuum in the upper part of each compartment while pressure fluid enters each compartment through said opening opposite the vacuum side of each compartment whereby the lifting force applied to said string at the top of the well is multiplied in the lifting force applied to the lodged object.

3. A pulling tool for operation with and below a tubular string employed in well bores, said tool comprising, a body, connection means between said body and said string and rotatable therewith, compartments in the lower end of said body, hollow piston means including a piston operable in each compartment and providing communication between the piston means bore and each compartment above the piston therein, said piston means extending below said body for connection to means for grasping an object lodged in the well bore, an opening in each compartment to admit pressure fluid from the well bore, slip means on said body operable upon rotation of said string to grasp said well bore wall, a check valve in said connection means to permit pressure fluid to pass therethrough into said string, said connection means including hollow piston means operable within said housing upon the lifting of said string to pull vacuum in the upper part of each compartment while pressure fluid enters each compartment through said opening opposite the vacuum side of each compartment whereby the lifting force applied to said string at the top of the well is multiplied in the lifting force applied to the lodged object.

4. A pulling tool for operation with and below a tubular string employed in well bores, said tool comprising, a body, connection means between said body and said string and rotatable therewith, compartments in the lower end of said body, hollow piston means including a piston operable in each compartment and providing communication between the piston means bore and each compartment above the piston therein, said piston means extending below said body for connection to means for grasping an object lodged in the well bore, an opening in each compartment to admit pressure fluid from the well bore, slip means on said body operable upon rotation of said string to grasp said well bore wall, said connection means including hollow piston means operable within said housing upon the lifting of said string to pull vacuum in the upper part of each compartment while pressure fluid enters each compartment through said opening opposite the vacuum side of each compartment whereby the lifting force applied to said string at the top of the well is multiplied in the lifting force applied to the lodged object, there being ports in said body wall to break the vacuum when said second hollow piston means is lifted thereabove.

5. A pulling tool for operation with and below a tubular string employed in well bores, said tool comprising, a body, connection means between said body and said string and rotatable therewith, compartments in the lower end of said body, hollow piston means including a piston operable in each compartment and providing communication between the piston means bore and each

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compartment above the piston therein, said piston means extending below said body for connection to means for grasping an object lodged in the well bore, an opening in each compartment to admit pressure fluid from the well bore, slip means on said body operable upon rotation of said string to grasp said well bore wall, means on said body operable upon rotation of said string after said slips have been set to actuate the retraction of said slips, said connection means including hollow piston means operable within said housing upon the lifting of said string to pull vacuum in the upper part of each compartment while pressure fluid enters each compartment through said opening opposite the vacuum side of each compartment whereby the lifting force applied to said string at the top of the well is multiplied in the lifting force applied to the lodged object.

6. A pulling tool for operation with and below a lifting means employed in well bores, said tool comprising, a body, connection means between said body and said lifting means and rotatable therewith, compartments in the lower end of said body, hollow piston means including a piston operable in each compartment and providing communication between the piston means bore and each compartment above the piston therein, said piston means extending below said body for connection to means for grasping an object lodged in the well bore, an opening in each compartment to admit pressure fluid from the well bore, means on said body operable upon rotation of said lifting means to grasp said well bore wall, said connection means including hollow piston means operable within said housing upon the lifting of said lifting means to pull vacuum in the upper part of each compartment while pressure fluid enters each compartment through said opening opposite the vacuum side of each compartment whereby the lifting force applied to said lifting means at the top of the well is multiplied in the lifting force applied to the lodged object.

7. A pulling tool for operation with and below a lifting means employed in well bores, said tool comprising, a body, connection means between said body and said lifting means and rotatable therewith, compartments in the lower end of said body, hollow piston means including a piston operable in each compartment and providing communication between the piston means bore

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and each compartment above the piston therein, said piston means extending below said body for connection to means for grasping an object lodged in the well bore, an opening in each compartment to admit pressure fluid from the well bore, slip means on said body operable upon rotation of said lifting means to grasp said well bore wall, said connection means including hollow piston means operable within said housing, the lowering of said lifting means after the setting of said slip means forcing said hollow piston means downwardly in said housing to transfer fluid upwardly into said lifting means, valve means for preventing the return of fluid thus transferred upon the lifting of said lifting means, the lifting of said lifting means thereafter creating vacuum in the upper part of each compartment while pressure fluid enters each compartment through said opening opposite the vacuum side of each compartment whereby the lifting force applied to said lifting means at the top of the well is multiplied in the lifting force applied to the lodged object.

8. A pulling tool for operation with and below a tubular string employed in well bores, said tool comprising, a body, connection means between said body and said string and rotatable therewith, compartment means in the lower end of said body, hollow piston means including a piston operable in said compartment means, means providing communication between the piston means bore and said compartment means above the piston therein, said piston means extending below said body for connection to means for grasping an object lodged in the well bore, opening means in said compartment means to admit pressure fluid from the well bore, slip means on said body operable upon rotation of said string to grasp said well bore wall, said connection means including hollow piston means operable within said housing upon the lifting of said string to pull vacuum in the upper part of each compartment while pressure fluid enters said compartment means through said opening means opposite the vacuum side thereof whereby the lifting force applied to said string at the top of the well is multiplied in the lifting force applied to the lodged object.

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No references cited.