Dec. 1, 1959 E. L. POTTS 2,915,126

HYDRAULIC PULLING TOOL

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Fig. 1

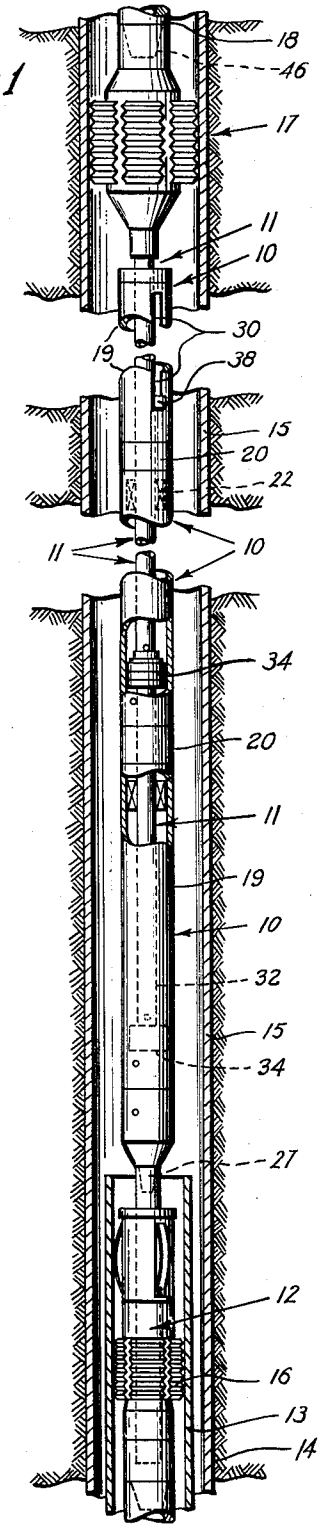


Fig. 8

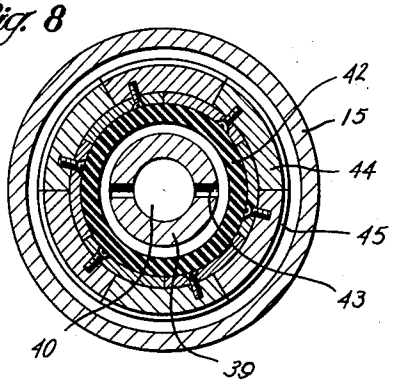
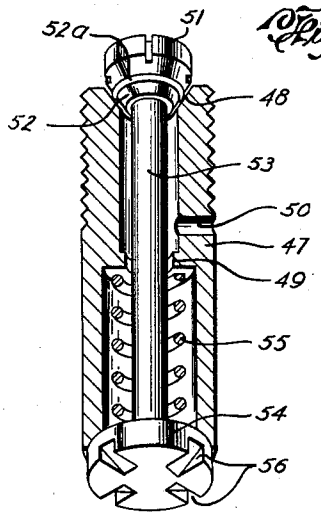


Fig. 9



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Fig. 2

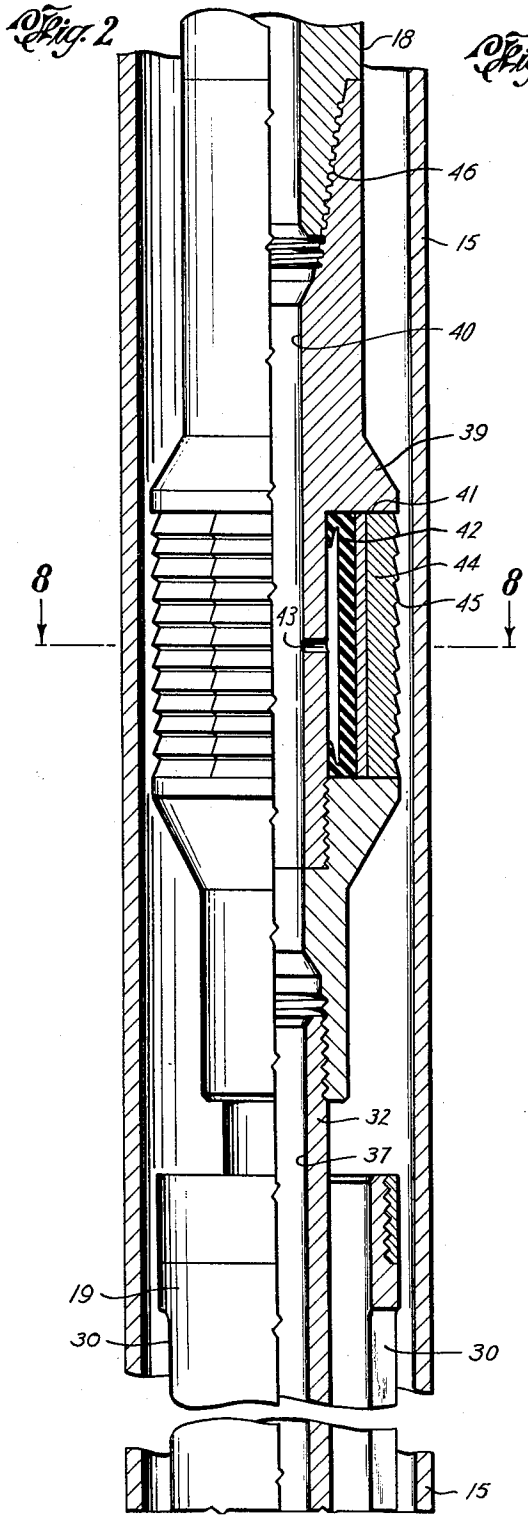
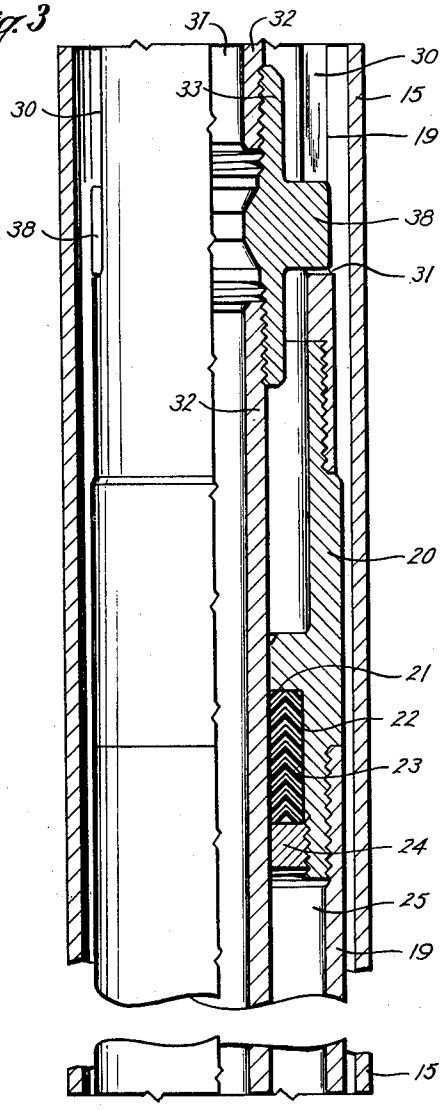


Fig. 3



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Fig. 4

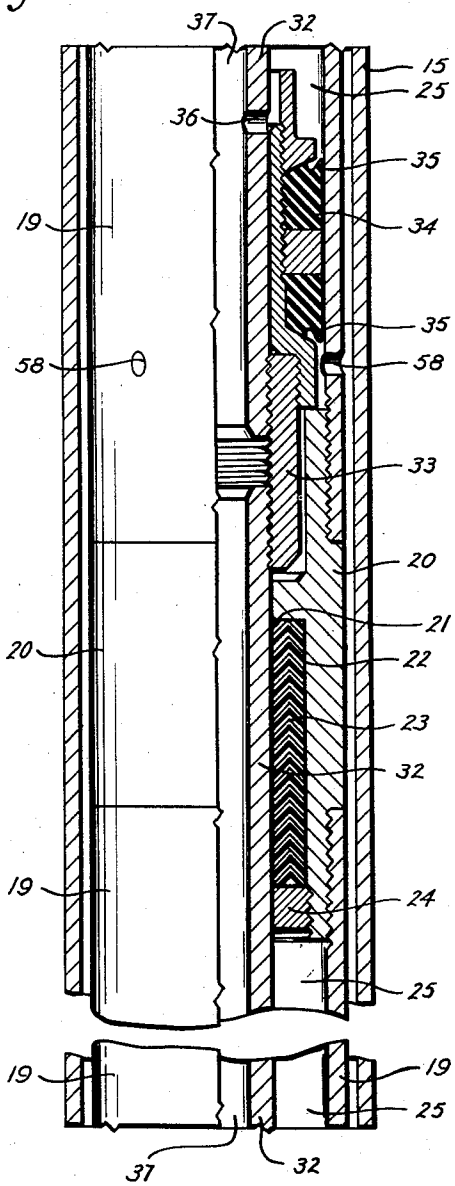
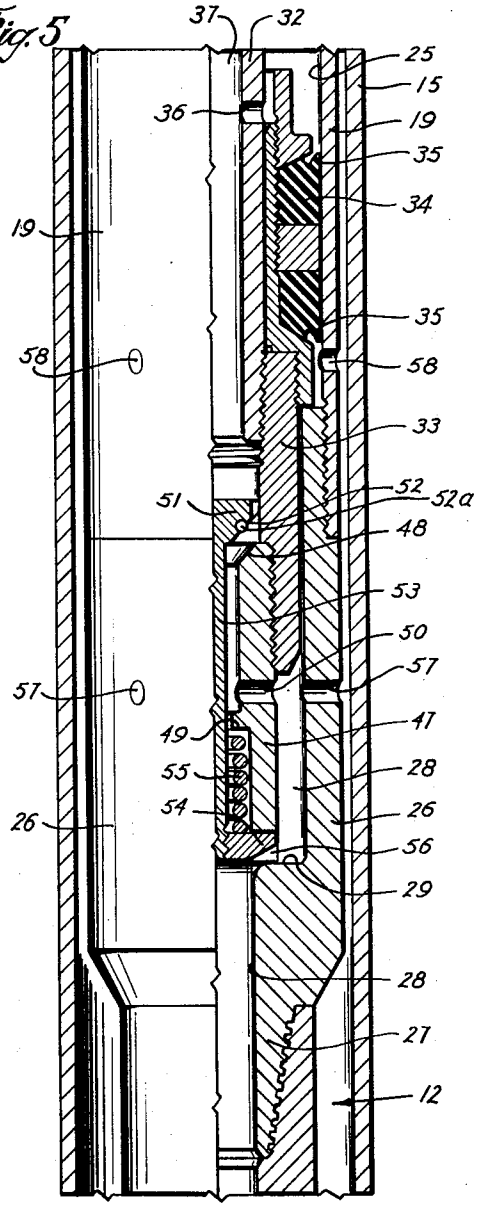


Fig. 5



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Fig. 6

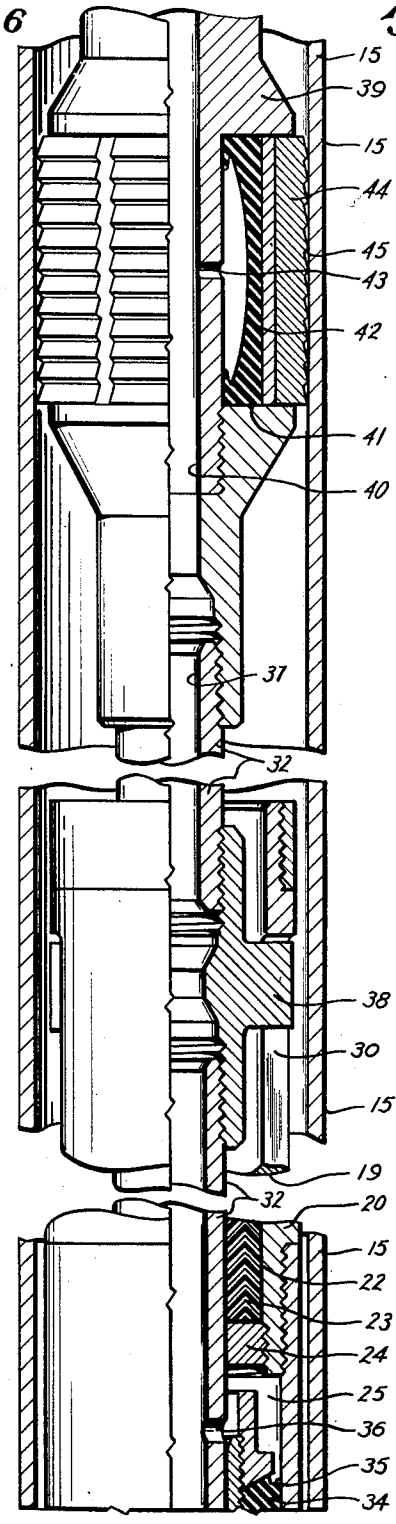
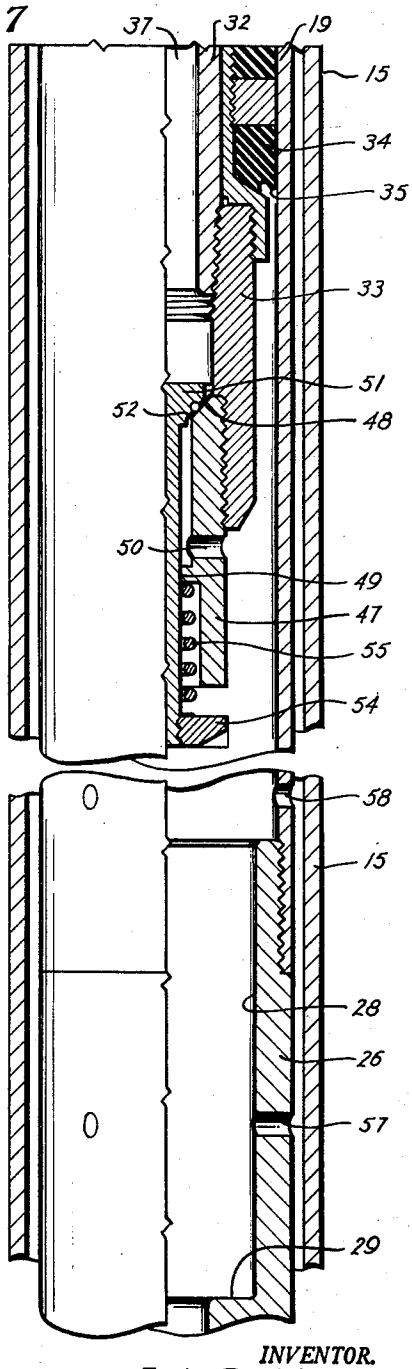


Fig. 7



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United States Patent Office 2,915,126
Patented Dec. 1, 1959

2,915,126

HYDRAULIC PULLING TOOL

Ernest L. Potts, Houston, Tex., assignor, by mesne assignments, to Cicero C. Brown, Houston, Tex.

Application January 18, 1950, Serial No. 139,267

9 Claims. (Cl. 166—98)

This invention relates to a pulling tool and particularly to a pulling tool of a type adapted to pull liners, screens, stuck pipe or other stuck object from a well.

A principal object is to provide an improved pulling tool of the type described which is hydraulically operated.

Another object is to provide a pulling tool composed of telescopically engaged sections, movable relatively to each other by hydraulically operated means, the inner section having anchoring means for anchoring its upper end to a well casing, and the outer section being provided with a grapple means for connecting its lower end to an object which is to be pulled from the well.

A more specific object is to provide a pulling tool in which the anchoring means for anchoring the outer section to a well casing is actuated by the same hydraulic pressure employed to actuate the tool.

A further specific object is to provide in a hydraulically operated pulling tool of the type described, a pressure relief means which serves also to provide a signal to indicate completion of the pulling stroke of the tool.

Other and more specific objects and advantages of this invention will become apparent from the following detailed description when read in conjunction with the accompanying drawings which illustrate a useful embodiment in accordance with this invention.

In the drawings:

Fig. 1 is a view showing the pulling tool inserted in a well and connected to a stuck pipe which is to be pulled, the parts being shown in the positions occupied at the completion of a pulling stroke;

Figs. 2, 3, 4 and 5, together, constitute a longitudinal quarter-sectional view of the pulling tool, showing the several parts in their respective positions when being lowered in the well;

Figs. 6 and 7, together, constitute a view generally similar to that shown in Figs. 2, 3, 4 and 5, but showing the parts in the positions occupied during active pulling operations;

Fig. 8 is a cross-sectional view along line 8—8 of Fig. 2; and

Fig. 9 is a perspective view, partly in longitudinal section, of the relief valve elements of the device.

Referring first to Fig. 1, the pulling tool comprises a tubular outer shell, designated generally by the numeral 10, and a tubular inner stem, designated generally by the numeral 11 which are arranged for relative telescopic movement. The lower end of shell 10 has connected thereto a suitable grapple means 12, which may be any one of the various conventional grappling or fishing tools commonly employed in wells. The particular grapple means, illustrated by way of example, is a conventional pipe spear which is adapted to be inserted in the bore of a tubular object 13, such as a pipe or liner which is stuck in a well bore 14 which is lined with the usual steel casing 15. Grapple means 12 is provided with the usual toothed slips 16 which are designed to

be forced outwardly into engagement with the inner wall of the object by suitable manipulation of the spear in accordance with conventional practice, in order to thereby anchor shell 10 rigidly to the stuck object. The upper end of stem 11 which extends from the upper end of shell 10 is provided with an anchor means, designated generally by the numeral 17, which is designed to anchor the upper end of stem 11 to casing 15, and is connected to an operating pipe string 18, which extends to the surface.

Shell 10 is composed of a series of tubular cylinders 19 which are coupled together by means of screw couplings 20 each of which is provided with an inwardly extending annular shoulder 21 which closely surround stem 11 to permit relative sliding movement between the stem and shell. The annular spaces beneath shoulders 21 between the couplings and the exterior of stem 11 form stuffing boxes 22 in which compressible packing 23 is installed, the packing being compressed by means of annular gland nuts 24 which are screwed into the lower ends of the stuffing boxes into compressive relation with the packing to urge the packing against shoulders 21 and to thereby expand it into fluid-tight sealing relation with the exterior of stem 11. The annular spaces between stem 11 and cylinders 19 extending longitudinally between each pair of couplings 20 define piston chambers 25. A tubular coupling member or sub 26 is screwed into the lower end of the lowermost cylinder 19 and is provided at its lower end with an externally threaded tool joint pin 27 for connecting shell 10 to the grappling means 12. Sub 26 is provided with an axial bore 28 for conduct of fluid passing through the tool. An upwardly facing internal shoulder 29 is provided in sub 26 toward its lower end for purposes to be described hereinafter. The uppermost one of cylinders 19 is provided with angularly spaced elongated slots 30 cut in opposite walls of the cylinder extending longitudinally thereof from a point just below the upper end of this cylinder to a point somewhat above the first of the couplings 20. Lateral recesses 31 are provided at the lower ends of slots 30.

Stem 11 is composed of a series of tubular sections 32 connected together by collars 33. Those of the sections 32 which extend through the several piston chambers 25 are provided with annular cup-shaped sealing rings 34 which are fixedly attached to the stem sections at the upper edges of collars 33. Sealing rings 34 are constructed of rubber or other suitable resilient material and are provided at their outer peripheral edges with outwardly flaring flexible lips 35 which are adapted to slidably seal with the walls of the respective cylinders 19. A plurality of angularly spaced radial ports 36 are provided in the wall of stem sections 32 at points just above each of the sealing rings 34 to provide communication between the respective piston chambers 25 and the axial bore 37 which extends throughout stem 11. Collar 33 connecting the two uppermost stem sections 31 is provided with outwardly projecting lugs 38, equal in number to slots 30, and are adapted to extend into slots 30 to provide a longitudinally slidable connection between stem 11 and cylinder 10, but when in registration with recesses 31, to enter recesses 31 in response to a small degree of relative rotational movement between stem 11 and cylinder 10 to lock the stem and cylinder against relative longitudinal movement.

Anchor means 17 is mounted on the upper end of uppermost stem section 32 and is composed of an enlarged generally cylindrical body 39 having an axial bore 40 therethrough which registers with axial bore 37. An annular channel 41 is cut circumferentially in the exterior of body 39 and has seated in the inner end thereof a

tubular sleeve 42, composed of rubber or other suitable resilient composition, which is radially expandible and contractible by fluid pressure applied to its inner face through ports 43 in the wall of body 39. A plurality of slip segments 44, having downwardly facing teeth 45, are mounted on the exterior surface of sleeve 42 and are adapted to be radially expanded and contracted in accordance with corresponding movement by sleeve 42. The upper end of body 39 carries an internally threaded box 46 for attachment of the stem structure to operating pipe 18. The lower end of stem 11 is fitted with an upwardly opening check valve (see Fig. 9 particularly) which comprises a tubular valve cage 47 which is screwed into the lower end of a collar 33 which is connected to the lower end of the lowermost stem section 32. The upper edge of cage 47 is provided with a tapered valve seat 48. An internal annular shoulder 49 is disposed in the bore of cage 47 intermediate its ends and a plurality of radial openings 50 in the wall of cage 47 provide fluid communication between the bore of the cage and the annular space between the cage and the inner wall of sub 26. A valve 51 having a downwardly tapering annular seat 52, fitted with an annular compressible seal ring 52*a* to tightly engage seat 48, is mounted above the latter on a stem 53 which extends downwardly through the bore of cage 47. A flange 54 is mounted on the lower end of stem 53 and has a diameter such as to extend radially over shoulder 29 and over the lower end of cage 47. A coil spring 55 surrounds stem 53 and is mounted within the bore of cage 47 in compression between shoulder 49 and flange 54 whereby to urge stem 53 downwardly to hold valve 51 on seat 48. The lower face of flange 54 is provided with a plurality of radial channels 56 to permit passage of fluid between the portions of bore 28 above and below shoulder 29 when flange 54 is in contact with shoulder 29. A number of radial openings 57 are provided in the wall of sub 26 to provide fluid communication between bore 28 and the exterior of the tool. Additional series of radial openings 58—58 are provided in the walls of cylinders 19 adjacent their lower ends.

The operation of the above described device is as follows: The tool will be connected to pipe string 18 by connecting the upper end of stem 11 thereto through the medium of box 18. Grapple means 12 will be connected to the lower end of shell 10 by means of pin 27, and the assembled string lowered into well bore 14 through casing 15. At this stage, which is illustrated particularly in Figs. 2 to 5, lugs 38 will be engaged in recesses 31 holding outer shell 10 in the elevated position relative to stem 11 and shoulder 29 will be thereby pulled upwardly against flange 54 whereby to urge valve stem 53 upwardly against the resistance of spring 55 and thereby raise valve 51 off of seat 48. Opening of the valve will permit fluid which may be, and usually is, present in the well and which must be displaced to allow the tool to move freely down the well, to flow through openings 57 and 50 into the bore of cage 47 and thence through the open valve into bore 37 of stem 11. Or well fluid may also be displaced upwardly through appropriate passages in the grapple means into bore 28 of sub 26, passing through channels 56, and thence through openings 50 into bore 37 of the stem. Grapple means 12 will then be engaged with the object, such as pipe 13, which is to be pulled, to thereby firmly anchor outer shell 10 firmly to the object. The attachment of a grapple means 12, such as the conventional pipe spear illustrated in Fig. 1, is entirely conventional and well known, and is accomplished ordinarily by limited rotation of the operating string which will cause slips 16 to be expanded into tight gripping engagement with pipe 13. The rotation of stem 11 necessary to effect this attachment of the grapple means to pipe 13 will be in the direction to also cause lugs 38 to rotate out of recesses 31, thereby releasing shell 10 and stem 11 for relative axial movement. The operating string will now be raised, pulling stem 11 upwardly relative to shell 10, since the latter will now be anchored to the stuck pipe. Lugs 38 will move upwardly in slots 30 until they strike the closed upper ends of the slots, whose length will ordinarily be made to approximately the full length of the "stroke" of the pulling tool, thereby fully extending the tool to the position at which pulling action is initiated. Figs. 6 and 7 illustrate the positions of the several parts of the tool at this stage of operations. It will be seen that seals 34 are now in the upper ends of piston chambers 25 and that the check valve in the lower end of stem 11, being also drawn upwardly out of contact with shoulder 29, is now closed by downward pressure of spring 55 against flange 54.

Hydraulic fluid, of any suitable character, such as ordinary drilling mud, will now be pumped down the interior of the operating pipe into the bore of stem 11. Since the latter is closed at its lower end by valve 51, pressure will be built up in the fluid, a portion of which will flow through ports 43 and will act against the inner face of sleeve 42 expanding the later outwardly under the pressure of the fluid. The resulting expansion of sleeve 42 will drive the slip segments 44 radially outwardly into tight gripping engagement with the wall of casing 15 (see Figs. 1 and 6), thereby firmly anchoring the upper end of stem 11 to the wall of the casing. At the same time, the fluid introduced into bore 37 of the stem will flow through ports 36 into the several piston chambers 25 and will exert hydraulic pressure therein between sealing rings 34 and the upper end closures formed by stuffing boxes 22, and will produce relative axial movement between these seals. Since stem 11 is now firmly anchored to casing 15, the pressure will act upwardly against the upper ends of the piston chambers, and as these are rigidly connected to shell 10, the latter will be forced in the upward direction relative to stem 11 and the upward force thus applied will be transmitted to grapple means 12 and its connected "fish" and pull the latter upwardly in the well bore. The upward movement of shell 10 will draw cylinders 19 up over seal rings 34, and at the completion of the stroke of the tool, the seal rings will be at the bottoms of the piston chambers (Figs. 2 to 5). Openings 58 permit escape of any fluid which may be trapped between the piston chambers below sealing rings 34.

As the cylinders approach the upper end of their strokes, shoulder 29 will again come in contact with flange 54 and upon slight additional upward movement of shell 10 will compress spring 55 and open the check valve. This will immediately relieve the fluid pressure in the tool, the fluid escaping from the lower end of bore 37 and flowing through the open valve into the bore of cage 47 and thence through openings 50 and 57, into well bore, either through bore 28 and the fluid passages in the grappling means, or directly through opening 57. The release of pressure will become immediately evident through a drop in pump pressure at the surface, thereby providing means for signalling completion of the pulling stroke. At the same time, the relief of pressure in the tool will also relieve the expansive pressure on resilient sleeve 42, thereby allowing slip segments 44, to retract from their gripping engagement with casing 15, and placing the tool and the attached fish in condition to be withdrawn from the well, if the fish has been sufficiently loosened. If not, the tool is in position to begin another pulling stroke. This may be accomplished, once the pressure has been relieved, as described, by again raising operating string 18 to pull stem 11 upwardly to its fully extended initial position, at which seal rings 34 will again be at the upper ends of the piston chambers and valve 51 will be closed. Fluid pressure will be reapplied to again expand slip segments 44 and anchor the stem in its newly elevated position, and simultaneously begin another pulling stroke of shell 10. This operation may

be repeated as often as necessary to effect withdrawal of the stuck pipe or other object to which the tool is connected.

It will be understood that the number and dimensions of the hydraulic cylinders which may be employed may be varied as desired, depending upon the pulling force and length of stroke desired. Various other alterations and changes may be made in the details of the illustrative embodiment within the scope of the appended claims without departing from the spirit of this invention.

What I claim and desire to secure by Letters Patent is:

1. A pulling tool of the class described, comprising, inner and outer tubular members telescopically connected for relative axial movement, longitudinally spaced annular seal means mounted on the respective members to seal between said members, means to introduce pressure fluid between said tubular members between said seal means to produce said relative axial movement, grapple means carried by said outer member connectible to an object to be pulled upwardly in a well bore, well wall-engaging anchor means mounted on said inner member above said outer member, and normally closed check valve means disposed in the bore of said inner member and including an operating member positioned to be engaged by said outer member upon pre-determined relative upward movement of said outer member to open said valve means.

2. A pulling tool of the class described, comprising, inner and outer tubular members telescopically connected for relative axial movement, longitudinally spaced annular seal means mounted on the respective members to seal between said members, means to introduce pressure fluid between said tubular members between said seal means to produce said relative axial movement, grapple means carried by said outer member connectible to an object to be pulled upwardly in a well bore, fluid pressure-actuated well wall-engaging anchor means mounted on said inner member above said outer member, and normally downwardly closing check valve means disposed in the bore of said inner member, and means carried by said outer member operably engageable with said valve means when the inner and outer members are in their fully inwardly telescoped positions to move said valve means to the open position.

3. A pulling tool of the class described, comprising, inner and outer tubular members, telescopically connected for relative axial movement, longitudinally spaced annular seal means mounted on the respective members to seal between said members, means to introduce pressure fluid between said tubular members between said seal means to produce said relative axial movement, grapple means carried by said outer member connectible to an object to be pulled upwardly in a well bore, fluid pressure-actuated well wall-engaging anchor means mounted on said inner member above said outer member, latch means between said members to releasably hold said members in relative contracted position, and normally closed check valve means disposed in the bore of said inner member.

4. A pulling tool of the class described, comprising, an inner tubular stem, an outer cylinder mounted to move longitudinally on said stem and having sealing means at its upper end surrounding the stem to seal off the cylinder, a seal member fixed on said stem to sealingly engage the inner wall of said cylinder, a port in said stem for transmitting pressure fluid from said stem into said cylinder between said sealed upper end and said seal member, an upwardly opening check valve means normally closing said stem below said seal member, shoulder means in said cylinder below the check valve means, said check valve means being positioned on said stem to be opened by engagement with said shoulder means by predetermined relative upward movement of said cylinder, grapple means on said cylinder for connecting it to an object to be pulled upwardly in a well bore, and fluid pressure-actuated anchor means mounted on said stem above said cylinder radially expandible into gripping engagement with the wall of said well bore.

5. A pulling tool of the class described, comprising, an inner tubular stem, an outer cylinder mounted to move longitudinally on said stem and having sealing means at its upper end surrounding the stem to seal off the cylinder, a seal member fixed on said stem to sealingly engage the inner wall of said cylinder, means normally closing the bore of said stem below the seal member, a port in said stem for transmitting pressure fluid from said stem into said cylinder between said sealed upper end and said seal member, grapple means on said cylinder for connecting it to an object to be pulled upwardly in a well bore, and fluid pressure-actuated anchor means mounted on said stem above said cylinder radially expandible into gripping engagement with the wall of said well bore, said anchor means comprising a resilient sleeve surrounding said stem, a port in said stem opposite said sleeve, and segmental slips mounted on the exterior of said sleeve.

6. A pulling tool of the class described, comprising, an inner tubular stem, an outer cylinder mounted to move longitudinally on said stem and having sealing means at its upper end surrounding the stem to seal off the cylinder, a seal member fixed on said stem to sealingly engage the inner wall of said cylinder, a port in said stem for transmitting pressure fluid from said stem into said cylinder between said sealed upper end and said seal member, grapple means on said cylinder for connecting it to an object to be pulled upwardly in a well bore, a resilient sleeve surrounding said stem above said cylinder, a pressure fluid transmitting port in said stem opposite said sleeve, segmental slips mounted on the exterior of said sleeve radially expandible into gripping engagement with the wall of said well bore by expansion of said sleeve, check valve means normally closing the bore of said stem below said seal member, and shoulder means in said cylinder below said check valve means, said check valve means being positioned on said stem to be opened by engagement with said shoulder means by pre-determined relative upward movement of said cylinder.

7. A pulling tool of the class described, comprising, inner and outer members telescopically connected for relative axial movement, longitudinally spaced annular seal means mounted on the respective members to seal between said members, means to introduce pressure fluid between said tubular members between said seal means to produce said relative axial movement, grapple means carried by said outer member connectible to an object to be pulled upwardly in a well bore, well wall-engaging anchor means mounted on said inner member, and normally closed check valve means disposed in the bore of said inner member and including an operating member positioned to be engaged by said outer member upon pre-determined relative upward movement of said outer member to open said valve means.

8. A pulling tool of the class described, comprising, inner and outer tubular members telescopically connected for relative axial movement, longitudinally spaced annular seal means mounted on the respective members to seal between said members, means to introduce pressure fluid between said tubular members between said seal means to produce said relative axial movement, grapple means carried by said outer member connectible to an object to be pulled upwardly in a well bore, fluid pressure-actuated well wall-engaging anchor means mounted on said inner member, and normally downwardly closing check valve means disposed in the bore of said inner member, and means carried by said outer member operably engageable with said valve means when the inner and outer members are in their fully inwardly telescoped positions to move said valve means to the open position.

9. A pulling tool for use in a well, comprising, inner

and outer tubular members telescopically connected for relative axial movement, said inner tubular member being normally closed at its inner end, longitudinally spaced annular seal means mounted on the respective members to seal between said members, means to introduce pressure fluid between said tubular members between said seal means to produce said relative axial movement, grapple means carried by said outer member connectible to an object to be pulled upwardly in the well bore, and well wall-engaging anchor means mounted on said inner member, said anchor-means comprising a plurality of segmental slips mounted about the exterior of the inner

member for radial movement relative thereto, and port means in said inner member opposite said anchor means for transmitting fluid pressure from the interior of said inner member against the slips.

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