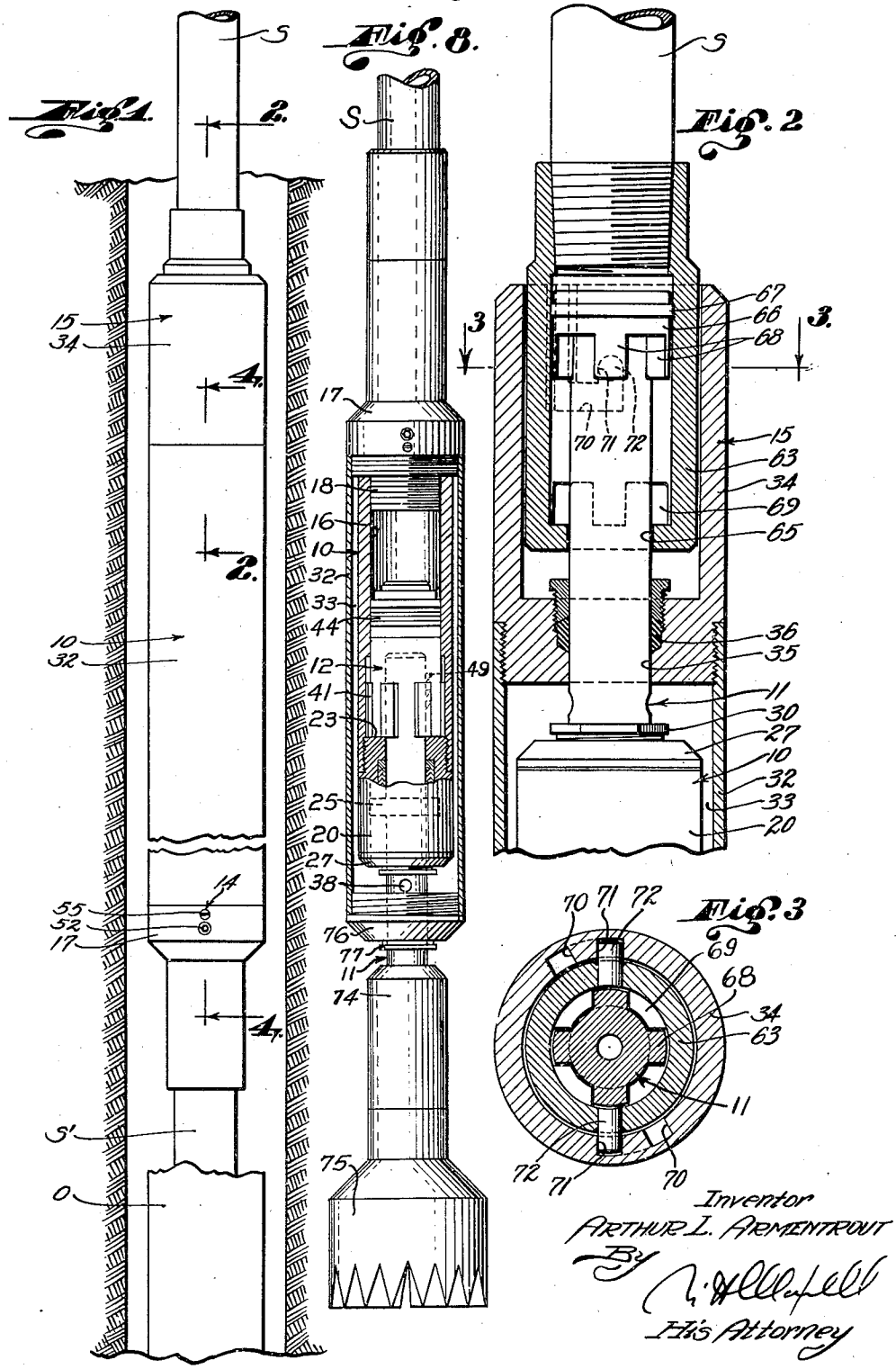
Nov. 27, 1945. A. L. ARMENTROUT 2,389,710

JARRING TOOL

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JARRING TOOL

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Fig. 4.

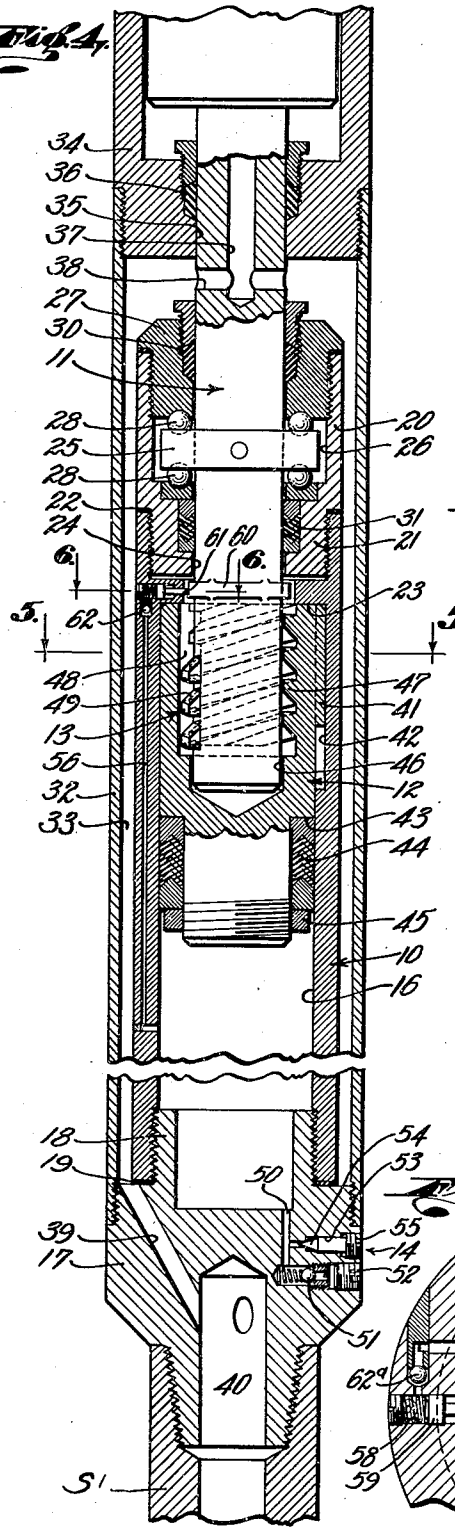


Fig. 5.

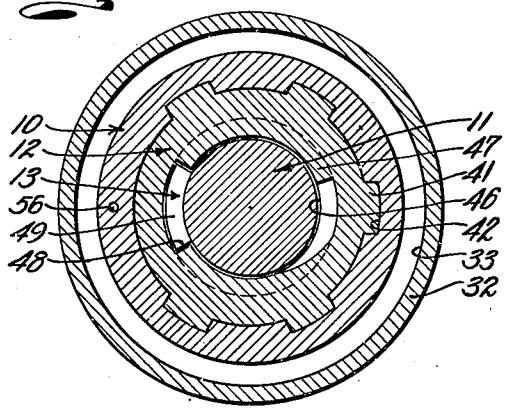


Fig. 7.

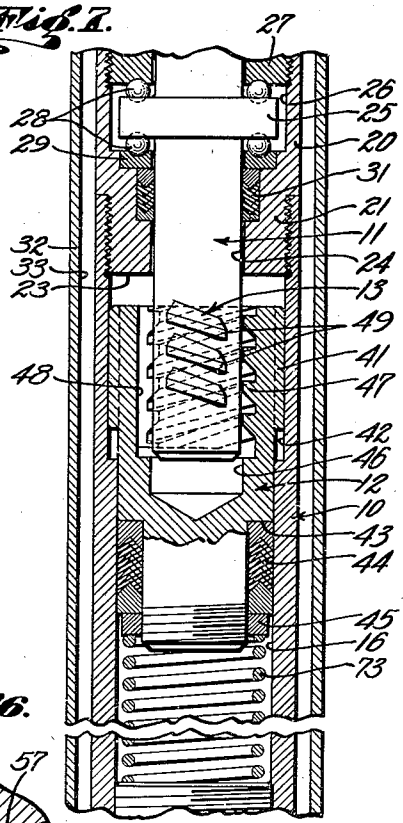
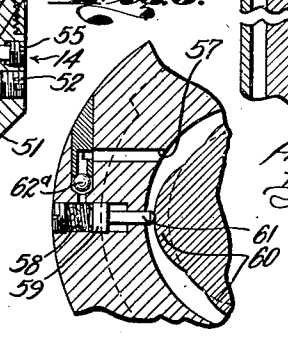


Fig. 6.



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2,389,710

JARRING TOOL

Arthur L. Armentrout, Long Beach, Calif.

Application August 12, 1941, Serial No. 406,465

7 Claims. (Cl. 255—27)

This invention relates to well tools and relates more particularly to jarring tools useful in removing objects that have become caught in wells. A general object of this invention is to provide practical and very effective jarring tools.

Many types of rotary jars have been developed to free or jar loose objects caught in wells but the majority of the jars in use have marked limitations and disadvantages. One general type of jar now in use embodies a hammer actuated by a spring which is either compressed by a pull on the fishing string or by a rotary cam mechanism. This spring actuated type of jar is ineffective for most jarring operations because the space limitation of a well tool prohibits the employment of a sufficiently strong spring. Another general type of jar now in use utilizes the stretch in the fishing string to obtain the jarring blow. This, of necessity, subjects the string to dangerous heavy tensile strains and subjects the hoisting cable to severe wear. Further, the sudden release of the last named type of jar momentarily interrupts or relieves the tension on the fish and it is impossible to obtain a jarring action while maintaining an uninterrupted or unrelieved pull on the fish. A third general type of jar has been proposed in which the hydraulic pressure or hydrostatic pressure of the well fluid is employed to actuate the jarring hammer. The hydraulic pressure is slow in its action and is unable to develop sufficient dynamic inertia to produce an efficient jarring blow.

An object of the present invention is to provide a jarring tool operable to produce a very heavy and effective jarring blow. The jar of the present invention is operable to produce a jarring blow of great magnitude, being operable to deliver a jarring action stronger than the action of the tools now known and used.

Another object of this invention is to provide a well jar operable to produce one or successive jarring blows of the required or desired magnitude without straining or endangering the operating string and without subjecting the cables or other equipment to excessive wear or strains.

Another object of this invention is to provide a jarring tool in which the hammer element is moved at a tremendous speed and with great force to develop dynamic inertia of the greatest magnitude and thus produce a most effective jarring blow. The hammer element of the present tool may be operated at a velocity and under a force far beyond the capabilities of previously introduced tools.

Another object of this invention is to provide a jarring tool of the character referred to operable to impart or produce jarring blows of great intensity while maintaining any selected pull or tension on the operating string. The magnitude of the blows struck by the hammer is not dependent upon the tension applied to the string and the operation of the jar does not necessitate releasing or relieving the tension maintained on the string so that the jarring action may be produced with any selected tension or pull maintained on the fish or object being jarred.

Another object of this invention is to provide a jarring tool that may be readily conditioned to provide jarring blows of any selected or required magnitude and, if desired, may be conditioned to utilize the high hydrostatic pressures in the well to increase the magnitude of the blows without a loss in the velocity of movement of the hammer element.

Another object of this invention is to provide a jarring tool that may be operated repeatedly and continuously for a long period without a reduction in the magnitude of the jarring blows.

A further object of this invention is to provide an effective jarring tool of the character above referred to that is easy to operate and that permits the ready control and operation of the fishing tools and other equipment connected in or attached to the operating string.

The various objects and features of my invention will be fully understood from the following detailed description of typical preferred forms and applications of my invention, throughout which description reference is made to the accompanying drawings, in which:

Fig. 1 is a side elevation of one form of tool of the invention connected in a well string above the object to be jarred. Fig. 2 is an enlarged fragmentary vertical detailed sectional view taken substantially as indicated by line 2—2 on Fig. 1 showing certain parts in elevation. Fig. 3 is a transverse detailed sectional view taken as indicated by line 3—3 on Fig. 2. Fig. 4 is an enlarged central longitudinal detailed sectional view of the principal parts of the jarring tool showing the hammer element in its jarring position. Fig. 5 is an enlarged transverse detailed sectional view taken as indicated by line 5—5 on Fig. 4. Fig. 6 is an enlarged fragmentary transverse detailed sectional view taken as indicated by line 6—6 on Fig. 4. Fig. 7 is a fragmentary longitudinal detailed sectional view of a tool of the type illustrated in Figs. 1 to 6, inclusive, with a slight modification. Fig. 8 is a side elevation of the lower portion of a well drilling string carrying

an impact bit illustrating the form of tool of Figs. 1 to 6, inclusive, connected in the string to operate the bit, with certain of the parts of the jarring tool appearing in longitudinal cross section.

Figs. 1 to 7, inclusive, of the drawings illustrates a form of tool actuated or operated by rotation and adapted to produce an upward jarring action. The tool of the invention illustrated in Figs. 1 to 7, inclusive, may be said to comprise, generally, a hollow or chambered body which I will term cylinder 10, a mandrel 11 connected with the cylinder 10 for relative rotation, a hammer element 12 in the cylinder 10, means 13, preferably interrupted thread means, operable upon relative rotation between the cylinder 10 and mandrel 11 for actuating the hammer element 12 in one direction, means 14 providing for the introduction of a gas under pressure into cylinder 10 to act on the element 12 for suddenly and forcibly moving the hammer element 12 in the other direction, and releasable means 15 for connecting the cylinder 10 and mandrel 11 against relative turning whereby rotation may be transmitted through the tool. When I use the term "cylinder" in referring to the body-like element 10 I use that term broadly and do not confine myself specifically to a part or element which is strictly a cylinder. The means 13, which is shown and described specifically as an interrupted thread means, is broadly a cam means designed to perform the desired function.

In the particular application of the jar illustrated in Figs. 1 to 6, inclusive, the cylinder 10 is the lower principal element of the tool and is connected with the object to be jarred or with the lower portion S' of the operating string, which in turn is connected with the object O to be jarred through the medium of a fishing tool, or the like, not shown. In this case the mandrel 11 is connected with the upper portion of the operating string S, that is, the main portion of the string which extends to the top of the well. The cylinder 10 is an elongate hollow body-like structure provided with a central longitudinally extending chamber or cylinder proper 16. A sub 17 has a pin 18 threaded in the lower end of the cylinder 10 and may serve to connect the cylinder 10 with the lower section 15 of the operating string. Sealing gaskets 19 are arranged between opposing surfaces of the cylinder 10 and the sub 17 to assure a fluid tight seal between the cylinder and sub. A head 20 has a pin 21 threaded in the upper end of the cylinder 10 and sealing gaskets 22 are arranged between opposing surfaces of the cylinder and head to provide a fluid tight connection. The upper portion of the cylinder 10 below the pin 21 has an inturned part providing a downwardly facing shoulder which I will term the "anvil" 23. The anvil 23 is annular and of substantial area.

The mandrel 11 is an elongate member considerably smaller in diameter than the cylinder 10 and arranged to extend downwardly through a central vertical opening 24 in the head 20 so that it projects into the cylinder 16. The mandrel 11 is freely rotatable relative to the cylinder 10 and is held against longitudinal movement with respect to the cylinder. An annular flange 25 is fixed on the mandrel 11 and is received in a socket 26 of the head 20 with considerable clearance. A plug 27 is threaded in the upper end of the socket 26 above the flange 25. Suitable anti-friction bearings 28 are engaged between the under side of the flange 25 and the lower end of the socket 26 and between the upper side of the flange 25 and the lower end of the plug 27. The lower bearing 28 may seat on a carrier or ring 29 set in the lower wall of the socket 26. A packing gland 30 is provided in the plug 27 to slidably seal about the mandrel 11 above the flange 25 and bearings 28. Packing 31 preferably of the chevron type is arranged in the sub 17 below the lowermost bearing 28 for sealing about the mandrel 11. The construction just described holds the cylinder 10 and the mandrel 11 against relative longitudinal movement while allowing free relative rotation.

It may be preferred to construct the tool so that the circulation fluid is diverted around or past the cylinder 10 so that the cylinder proper 16 may be of maximum capacity and need not be complicated by wash pipes, or the like. In the construction being described the tool includes a shell 32 for conducting the circulation fluid around the cylinder 10. The lower end of the shell 32 is threaded with the sub 17 and the shell extends upwardly around the cylinder 10 with clearance, leaving an annular fluid passage 33. The fluid handling shell 32 extends upwardly beyond the head 20 and plug 27 and a member 34 is threaded with the upper end of the shell to close the same above the body assembly. The mandrel 11 passes downwardly through a central opening 35 in the member 34 and a gland 36 in the member seals about the mandrel. The longitudinal fluid passage 37 of the mandrel 11 terminates in one or more lateral ports 38, which communicate with the interior of the shell 32 above the body assembly. One or more ports 39 are formed in the sub 17 and lead downwardly from the lower end of the passage 33 to a vertical opening 40, which in turn communicates with the lower portion of the operating string S'. It will be seen that circulation fluid from the mandrel passage 37 is free to flow down through the passage 33, the ports 39 and the opening 40 to the lower part of the operating string.

The hammer element 12 is shiftable vertically or longitudinally in the cylinder proper 16 and is controlled and actuated by the means 13 and the gas in the cylinder proper 16. The hammer element 12 is a cylindrical block-like member of selected length and weight. The length and weight of the hammer element 12 are factors controlling in part the intensity of the jarring blow obtained by the tool and may be varied as conditions may require. The hammer element 12 operates in the upper portion of the cylinder 16 and is considerably shorter than the cylinder. In the form of the invention being described the hammer element 12 is non-rotatable in the cylinder 16. Splines 41 are formed on the upper portion of the hammer element 12 and slidably operate in keyways or spline grooves 42 in the wall of the cylinder 16 to hold the hammer element against turning. The upper end of the element 12 is adapted to strike or hammer against the downwardly facing anvil 23 of the cylinder 10. The lower portion of the hammer element 12 is reduced in diameter to leave a downwardly facing annular shoulder 43. A chevron packing assembly 44 is arranged on the reduced lower part of the hammer element 12 and bears upwardly against the shoulder 43. A nut 45 is threaded on the lower part of the element 12 to actuate or compress the packing 44. The packing 44 is designed to seal off high pressures in the cylinder below the hammer element 12.

The means 13, which is broadly a cam means and in the preferred form of the invention is an interrupted thread structure, is operable upon relative rotation between the mandrel 11 and the cylinder 10 to move the hammer element 12 longitudinally a given distance and then release the hammer element for forcible actuation by the body of gas in the tool. The means 13 in the particular form illustrated includes a longitudinal socket 46 of substantial depth extending downwardly in the hammer element 12 to receive the lower portion of the mandrel 11. The means 13 further includes cooperating cams or threads on the wall of the socket 46 and the lower portion of the mandrel 11 for producing downward movement of the hammer element 12. A heavy steeply pitched thread 47 is provided on the wall of the socket 46. In the case of a right hand jarring tool the thread 47 is left hand and leads downwardly from the top of the hammer element 12. The thread 47 is interrupted, being provided with a vertical gap or channel 48 of substantial width.

The lower part of the mandrel 11 has a longitudinally extending row of thread parts 49 which cooperate with the thread 47. The width or circumferential extent of the thread parts 49 is slightly less than the width of the channel 48 so that the thread parts may travel longitudinally through the channel. The thread 47 preferably has a flat normal upper surface engaged by corresponding surfaces on the parts 49 and has a pitched lower surface cooperating with similar pitched upper surfaces on the parts 49. Upon turning of the mandrel 11 to the right the cooperation of the thread parts 49 with the thread 47 moves or forces the hammer element 12 downwardly. At the completion of approximately one revolution the thread parts 49 move into the channel 48 and allow the hammer element 12 to suddenly and forcibly move upwardly under the action of the means 14. It is preferred to construct the thread 47 and the parts 49 to move the hammer element 12 downwardly a maximum distance at each operation. The splines 41 engaged in the grooves 42 hold the hammer element 12 against turning during the action just described and guide the hammer element for straight longitudinal movement.

The means 14 provided for establishing a body of gas in the tool is an important element of the invention. The gas is operable to drive the hammer element 12 upwardly with great speed and great force upon the release of the means 13 as just described. The gas is operable to develop greater hammer speed and to impart greater force to the hammer element than the hammer actuating means of prior jarring tools and may be readily conditioned to produce blows of selected or required force within a wide range of action. The gas is confined in the portion of the cylinder proper 16 below the hammer element 12. In accordance with the invention the lower portion of the cylinder proper 16, that is, the portion of the cylinder below the hammer element 12 is pre-loaded or charged with air or other gas under superatmospheric pressure before running the tool into the well for use. The initial pressure in the cylinder proper 16, that is, the pressure in the lower part of the cylinder proper with the hammer element 12 in its uppermost position, is one of the important factors determining the intensity of the jarring blow obtained and this initial pressure may be varied within wide limitations. In practice, the initial air or gas pressure in the cylinder proper 16 may range from a few pounds per square inch to a thousand pounds per square inch or more.

While the invention contemplates sealing the cylinder proper 16 with a given or selected contained air or gas pressure it is preferred to provide means for introducing gas pressure and for relieving or unloading the pressure as conditions may require. Accordingly, the means 14 includes valved inlet and discharge means communicating with the lower end part of the cylinder proper 16. In the case illustrated, a port 50 leads downwardly in the sub 17 from the lower end of the cylinder proper 16 and then extends outwardly to the exterior of the sub. A check valve 51 of the spring loaded type is arranged in the lower portion of the port 50 and closes outwardly to prevent the escape or discharge of the contained air or gas pressure. The outer part of the port 50 is threaded to receive a pressure supply fitting and a removable plug 52 is threaded in this part of the port to seal the port against the high external hydrostatic pressures in the well and to prevent mud, and the like, from clogging the port. A second passage 53 in the wall of the sub 17 joins the port 50 and is equipped with a valve 54 for relieving the pressures in the cylinder 16. The valve 54 may be of the needle type provided with a threaded-in plug 55 for holding it closed and for sealing the outer portion of the passage 53. Upon removal of the plug 52 the discharge fitting of a suitable gas or air container or gas or air pressure developing means may be threaded in the port 50 to deliver the required air or gas pressure to the cylinder proper 16. The plug 52 is replaced upon removal of the fitting. The valve 54 may be easily opened to relieve the pressure in the cylinder proper 16 as required.

The means 14 is such that the initial superatmospheric pressure in the cylinder proper 16 may be amplified or increased by the hydrostatic pressure in the well. When it is desired to employ the hydrostatic pressure in the well to boost the initial air or gas chamber in the cylinder proper 16 the plug 52 is removed from the port 50 prior to running the tool in the well. The valve 51 remains closed to preserve the initial gas or air pressure in the cylinder 16. When the tool has been lowered through the well to a position where the hydrostatic pressures are in excess of the initial pressure in the cylinder proper 16 the valve 51 opens so that the pressure in the cylinder is increased by the external hydraulic pressure. It is to be understood that this utilization of the hydraulic pressure is not always essential and, in many cases, the plug 52 is left in the port 50 to keep the same closed.

The means 14 further includes a mechanism for transferring air or gas pressure that may have leaked upwardly past the packing 44 back into the cylinder proper 16 below the packing. A port 56 extends upwardly through the wall of the cylinder 10 to the anvil 23. The lower end of the port 56 is in communication with the cylinder proper 16. The upper end of the port 56 communicates with the interior of the cylinder assembly above the hammer element 12 as at 57 in Fig. 6. A compressor is arranged in the anvil 23 to be operated by rotation of the mandrel 11 relative to the cylinder 10 and the compressor takes air or gas from above the hammer 12 and forces it back into the cylinder proper 16 below the hammer element. The compressor comprises a radial cylinder 58 formed in the cylinder 10

and carrying a spring urged piston 59. One or more cams 60 on the mandrel 11 cooperate with a stem 61 on the piston 59 to produce reciprocation of the piston. A non-return check valve 62 is interposed between the cylinder 58 and the port 56 and a similar check valve 62a is provided between the inlet port 57 and the cylinder 58. When the tool is in operation the compressor just described is automatically operated to evacuate air or gas from above the hammer element 12 and discharge it into the cylinder proper 16 below the hammer element to compensate for any leakage of gas or air under pressure past the packing 44.

It will be observed that the hammer element 12 slidably seals with the wall of the cylinder proper 16, the packing 44 at all times maintaining a tight, effective seal. Accordingly, downward movement of the hammer element 12 by the action of the thread 47 and thread parts 49 produces a negative pressure or vacuum above the hammer element. This creation of the negative pressure accompanies the increase in the super-atmospheric pressure in the expansible fluid under the hammer element. When the means 13 releases to permit upward movement of the hammer element the vacuum action airs or supplements the action of the compressed gas under the piston in driving the hammer element upwardly with great force and at a high speed.

The means 15 is adapted to clutch or connect the cylinder 10 and the mandrel 11 for the transmission of rotation therebetween when it is desired to control the fishing tool or other object below the tool of the invention and is releasable or adapted to be conditioned to permit rotation of the mandrel 11 relative to the cylinder 10 for the actuation of the jarring tool. The means 15 includes the member 34 and a tubular inner member 63 fixed to the lower end of the main operating string S by threads, or the like. The outer member 34 receives the member 63 with suitable working clearance and the mandrel 11 extends upwardly through a central opening 65 in the lower wall of the inner member to project into the interior of the same. A head 66 on the upper end of the mandrel 11 carries packing 67 for slidably sealing with the interior of the member 63 and is provided with downwardly facing clutch parts 68. Upstanding clutch parts 69 are provided on the lower wall of the member 63 and are engageable with the clutch parts 68 when the string S is raised. When the lower portion S' of the string is engaged with the fish or object O an up-pull may be placed on the string S to engage the clutch parts 68 and 69. It is usually preferred to maintain an up-pull on the string and the fish during the jarring operation and this tension or up-pull holds the clutch parts 68 and 69 in engagement so that rotation may be transmitted from the string S to the mandrel 11 to operate the jar.

The means 15 further includes a pair of diametrically opposite J grooves 70 in the wall of the outer member 34. The long arms of the grooves 70 extend downwardly from the top of the member 34 and the lateral arms of the grooves have upwardly extending pockets 71. Pins 72 are fixed to the inner member 63 and are adapted to cooperate with the grooves 70. When the pins 72 are engaged in the pockets 71 they are adapted to transmit rotation between the mandrel 11 and the body 10 in both directions. By lowering the string S slightly and then turning to the left and then raising the string the pins 72 may be withdrawn from the grooves 70 to above the member 34. Slight continued upward movement engages the clutch parts 69 with the clutch parts 68. Thus, the string S is disconnected from the cylinder 10 and is clutched with the mandrel 11. To reengage the string S with the cylinder 10 for the transmission of rotation to the cylinder, the string is lowered slightly to bring the pins 72 against the upper end of the member 34. This downward movement of the string S disengages the clutch parts 69 from the clutch parts 68 and the string S may be turned to bring the pins 72 into registration with the upper ends of the grooves 70. The string S is then manipulated to reengage the pins 72 in the pockets 71. The means 15 provides for the free rotation of the string S and mandrel 11 relative to the cylinder 10 and for the transmission of rotation from the string S to the cylinder 10 at the will of the operator, and is located above the other parts of the tool where it does not complicate the construction.

In the use or operation of the tool illustrated in Figs. 1 to 6, inclusive, it may be assumed that the tool is to be employed in jarring a fish or object O caught in the well. Prior to lowering the tool into the well air or other expansible and contractible fluid is supplied to the lower portion of the cylinder proper 16 under suitable pressure. The pressure employed may vary greatly and depends upon such factors as the nature of the jarring operation, the capacity of the cylinder proper 16, the stroke of the hammer element 12, etc. The valved port 50 provides for the ready delivery of air or the like, under pressure, to the lower portion of the cylinder proper 16. The plug 52 is usually threaded in the port 50 when the required air pressure has been supplied to the cylinder proper 16. The jarring tool is run into the well on the string S and the string is coupled with the object O by a fishing tool, or the like, in accordance wtih the usual practice. When the lower portion of the string is being coupled with the object O the pins 72 of the means 15 may be engaged in the pockets 71 so that rotation may be transmitted to the fishing tool for its control. With the fishing tool engaged with the object O the means 15 is released, as described above, so that the string S and the mandrel 11 may be freely turned with respect to the cylinder 10. The required or selected up-pull or tension is then put on the string S and the string is rotated to operate the jarring tool.

During each rotation of the string S the thread parts 49 cooperate with the thread 47 to force the hammer element 12 downwardly and then suddenly disengage from the thread 47 to allow an upward movement of the hammer element 12. The downward movement of the hammer element 12 produced by the cams or threads of the means 13 compresses the air or gas under the hammer element 12 to greatly increase its pressure and creates a vacuum condition or negative pressure condition above the hammer element. The amount of increase in pressure of the air or gas under the hammer element 12 depends upon the length or volume of the cylinder proper 16 and the stroke of the hammer element. This relationship may, of course, be varied greatly. The downward movement of the hammer element 12 against the already highly compressed air or gas provides a great increase in the pressure so that a very high gas pressure may exist under the hammer element 12, while a substantial negative pressure or vacuum exists above the hammer

at the time the means 13 releases. When the thread parts 49 reach the channel 48 the hammer 12 is suddenly thrown up with a great force resulting from the instantaneous expansion of the highly compressed gas under the hammer aided by the negative pressure above the hammer. This forcible movement of the hammer element 12 at high speed causes the hammer element to strike the anvil 23 with great force. The impact generated depends upon several factors such as the weight of the hammer element 12, the diameter of the hammer element, the maximum pressure created under the hammer element, the length of the hammer element stroke, etc. The action just described, takes place with each rotation of the string S and mandrel 11 and a series of the heavy upward jarring blows is usually effective in loosening the fish or object O for recovery.

In the event that it is desired to utilize the hydrostatic pressure in the well to augment the action of the air or gas under pressure, the cylinder proper 16 may be charged with air or other gas under the selected initial pressure and the tool is run into the well with the plug 52 removed. When the tool reaches a level in the well where the external hydrostatic pressures are greater than the initial gas or air pressure in the chamber 16 the valve 51 opens so that the hydraulic pressure is superimposed on the gas pressure. In this way a very great initial gas pressure may be maintained in the cylinder proper 16 and yet employ a compressible and expansible pressure medium for acting on the hammer element 12. In other words, the air or gas trapped in the cylinder proper 16 under the initial pressure applied at the surface, and with its pressure increased by the hydraulic pressure applied in the well, expands instantaneously to drive the hammer element 12 upwardly with great speed and force and is not delayed in its action by the non-expansible well liquid. The jar operates in other respects as described above, the reduced pressure or vacuum above the hammer element 12 assisting in the actuation of the hammer element 12.

Fig. 7 of the drawings illustrates a slight modification of the type of tool illustrated in Figs. 1 to 6, inclusive. In this case a spring 73 is provided in the cylinder proper 16 and is arranged under compression between the lower end of the hammer element 12 and the upper end of the sub pin 18. The parts are proportioned and arranged so that the spring 73 is under compression when the hammer element 12 is in its uppermost position against the anvil 23. This compression is, of course, increased when the hammer element 12 is moved downwardly by the cooperation of the thread 47 and thread parts 49. The spring 73 assists in driving the hammer element 12 upwardly upon the release of the means 13 and, thus, aids the action of the air or gas under pressure in the lower portion of the cylinder proper 16 and the reduced pressure or vacuum above the hammer element 12. The various other parts of the tool may be the same, as described.

Fig. 8 of the drawings illustrates a tool of the type illustrated in Figs. 1 to 6, inclusive, employed to operate a percussion bit, or the like. In this case the tool is inverted so that the sub 17 is at its upper end and the mandrel 11 is connected with the object to be jarred. In the particular application illustrated the protruding lower portion of the mandrel 11 is connected with the stem 74 of a bit 75. The means 15 is eliminated and a plug member 76 closes the lower end of the shell 32. A packing gland 77 in the member 76 slidably seals about the mandrel 11. The port or ports 38 of the mandrel 11 communicate with the interior of the shell 32 above the member 76 so that the mandrel delivers the circulation fluid to the bit 75. The other parts may remain as described above.

In operating the equipment illustrated in Fig. 8 the string S is rotated in the well with or without the application of a down pressure on the jarring tool and bit 75. Rotation of the string S results in upward movement of the hammer element 12 by the thread 47 and thread parts 49 and the sudden rapid forceful driving of the hammer element 12 against the anvil 23, all as described above, except that in this case the hammer element 12 is suddenly and forcibly driven downwardly against the upwardly facing anvil. The tool may be inverted as shown in Fig. 8 of the drawings to operate as a down jar for loosening or freeing objects caught in wells and for performing other operations where a downward jarring action is required.

Having described typical preferred forms and applications of my invention, I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to myself any variations or modifications that may appear to those skilled in the art or fall within the scope of the following claims.

Having described my invention, I claim:

1. In a well tool, two sections connected for relative turning and adapted to be interposed in a well string, one section having a longitudinal cylinder, a hammer shiftable in the cylinder, means for introducing gas under pressure to the cylinder at one side of the hammer, means operable by relative turning of the sections for moving the hammer longitudinally against the gas under pressure to increase said pressure and produce a low pressure condition at the other side of the hammer and releasable following a given movement of the hammer to allow the hammer to move in the other direction under the action of the expanding gas and reduced pressure condition so that it strikes a jarring blow against a section, and means operable by relative rotation of the sections for pumping gas from the cylinder at said other side of the hammer to the cylinder at the first named side of the cylinder.

2. A well tool for use in a well string including a body having a cylinder, a mandrel entering the cylinder, means connecting the body and mandrel for relative turning, a hammer in the cylinder, the cylinder at one side of the hammer holding gas under pressure, cam means on the mandrel and hammer operable upon relative rotation between the body and mandrel to force the hammer against the gas pressure to increase the pressure thereof and then suddenly release the hammer to move in the other direction and jar against the body under the action of the expanding gas, and compressor means operable by relative rotation of the body and mandrel for transferring gas from the cylinder at the other side of the hammer to the cylinder at the first named side of the hammer.

3. A well tool for use in a well string including a body having a cylinder, a mandrel entering the cylinder, means connecting the body and mandrel for relative turning and holding them against relative longitudinal movement, a hammer in the cylinder, packing means between the hammer and the cylinder holding gas under pressure at one side of the hammer, and cam means

on the mandrel and hammer operable upon relative rotation between the body and mandrel to force the hammer against the gas pressure to increase the pressure thereof and then suddenly release the hammer to move in the other direction and jar against the body under the action of the expanding gas.

4. A well tool for use in a well string including a body having a cylinder, a mandrel entering the cylinder, means connecting the body and mandrel for relative turning and holding them against relative longitudinal movement, means for conducting circulation fluid around the cylinder between the mandrel and the end of the body most remote from the mandrel, a hammer in the cylinder, packing means between the hammer and the cylinder holding gas under pressure at one side of the hammer, and cam means on the mandrel and hammer operable upon relative rotation between the body and mandrel to force the hammer against the gas pressure to increase the pressure thereof and then suddenly release the hammer to move in the other direction and jar against the body under the action of the expanding gas.

5. A well tool for use in a well string including a body having a cylinder, a mandrel entering the cylinder, means connecting the body and mandrel for relative turning and holding them against relative longitudinal movement, releasable means for connecting the body and mandrel against relative turning, a hammer in the cylinder, packing means between the hammer and the cylinder holding gas under pressure at one side of the hammer, and cam means on the mandrel and hammer operable upon relative rotation between the body and mandrel to force the hammer against the gas pressure to increase the pressure thereof and then suddenly release the hammer to move in the other direction and jar against the body under the action of the expanding gas.

6. In a well tool, two sections connected for relative turning and adapted to be interposed in a well string, means holding the sections against relative rotation, one section having a longitudinal cylinder, a hammer shiftable in the cylinder, packing means between the cylinder and hammer, means for introducing gas under pressure to the cylinder at one side of the hammer, means operable by relative turning of the sections for moving the hammer longitudinally against the gas under pressure to increase said pressure and produce a low pressure condition at the other side of the hammer and releasable following a given movement of the hammer to allow the hammer to move in the other direction under the action of the expanding gas and reduced pressure condition so that it strikes a jarring blow against a section, said means comprising cooperable interrupted threads on the hammer and the other section.

7. A well tool for use in a well string including a body having a cylinder, a mandrel entering the cylinder, means connecting the body and mandrel for relative turning and holding them against relative longitudinal movement, a hammer in the cylinder, packing means between the hammer and the cylinder holding gas under pressure at one side of the hammer, the portion of the cylinder at the other side of the hammer being sealed so that movement of the hammer against the gas creates a negative pressure at said other side of the hammer, and cam means on the mandrel and hammer operable upon relative rotation between the body and mandrel to force the hammer against the gas pressure to increase the pressure thereof and then suddenly release the hammer to move in the other direction and jar against the body under the action of the expanding gas.

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