

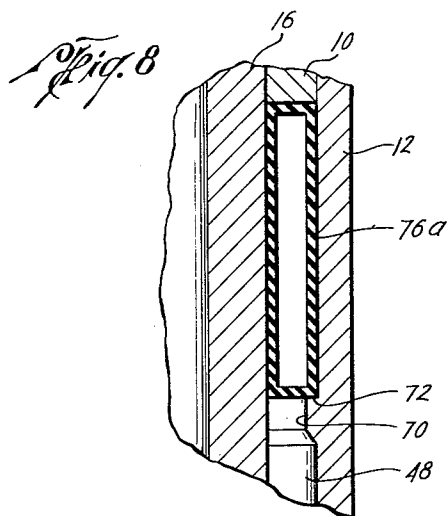
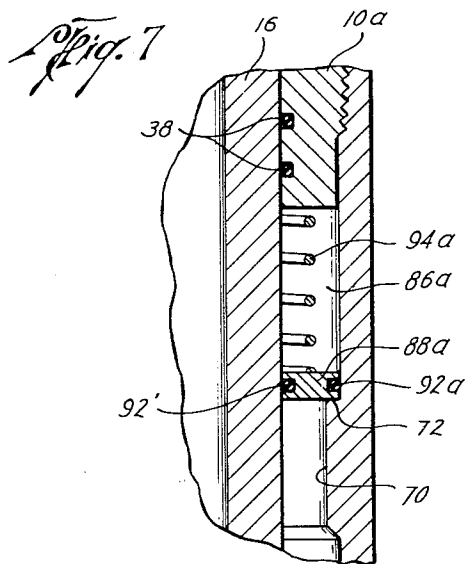
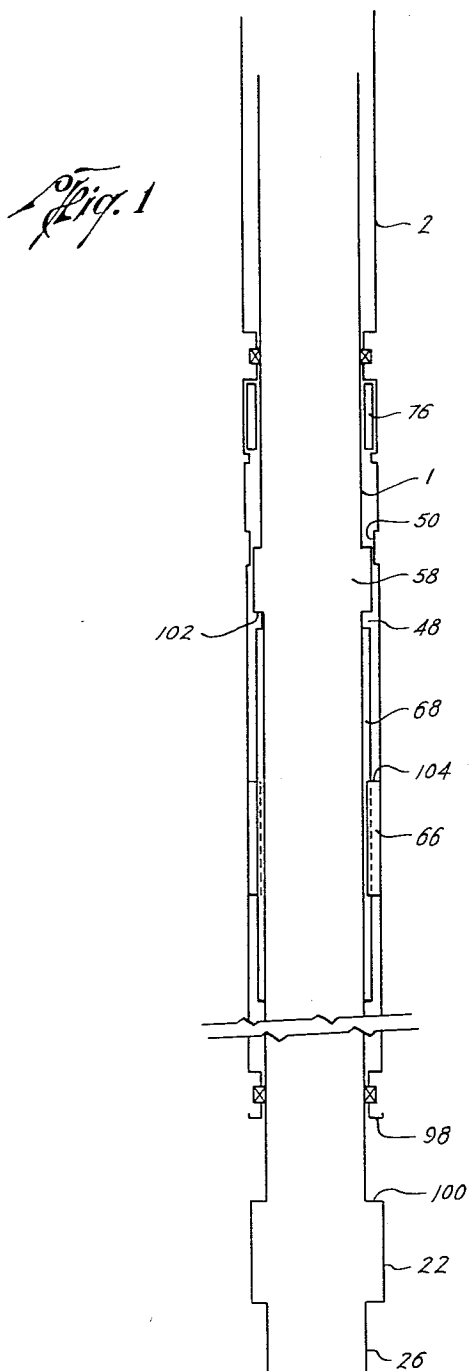
Oct. 18, 1955

L. W. STORM
HYDRAULIC WELL JAR

2,721,056

Filed Feb. 14, 1952

4 Sheets-Sheet 1



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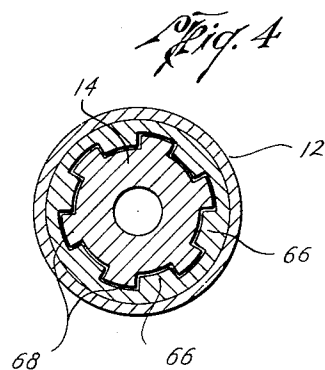
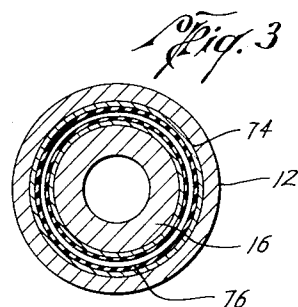
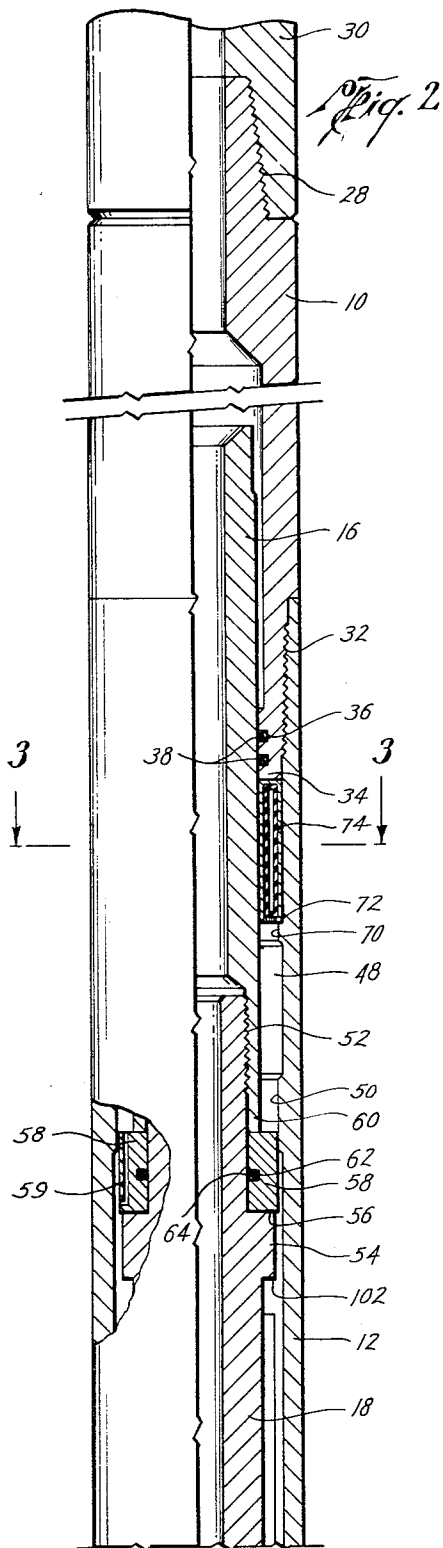
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4 Sheets-Sheet 2



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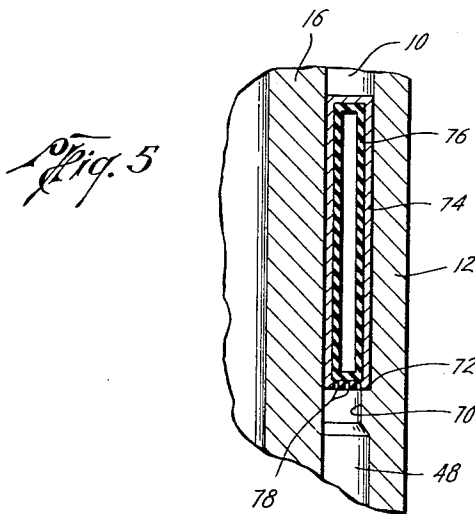
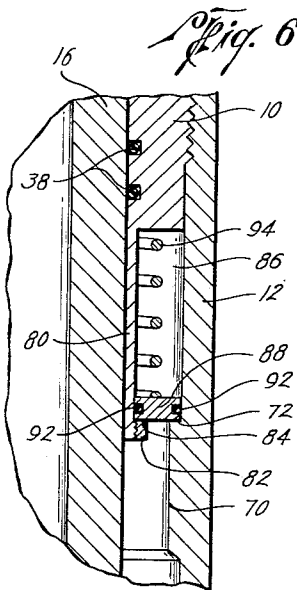
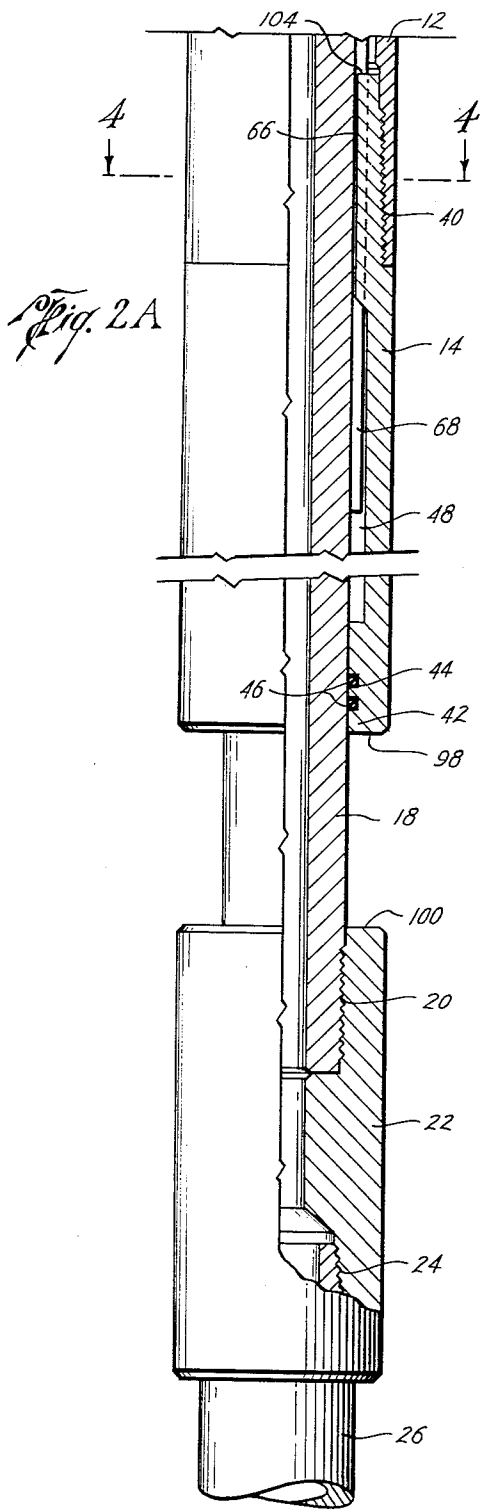
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4 Sheets-Sheet 3



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4 Sheets-Sheet 4

Fig. 9

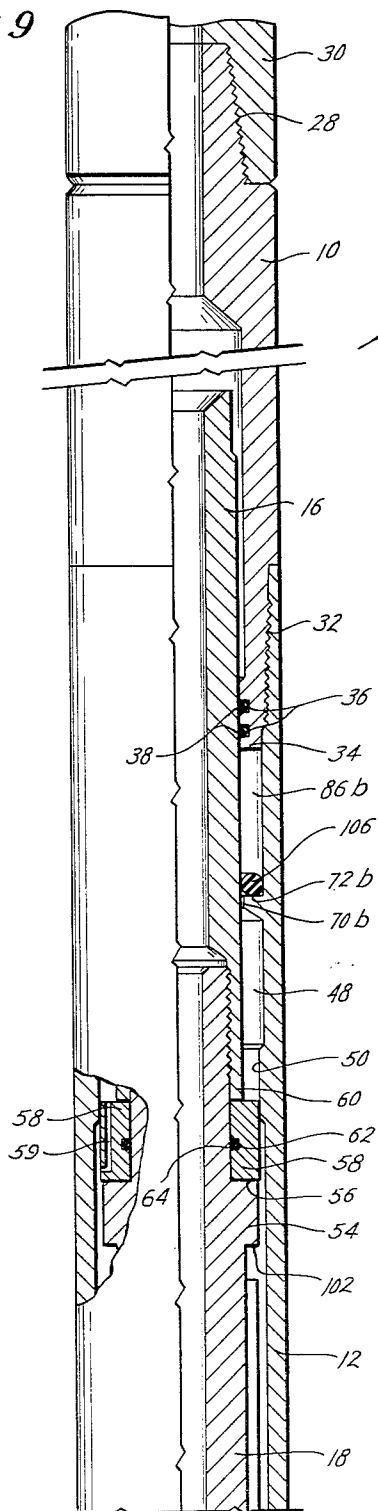
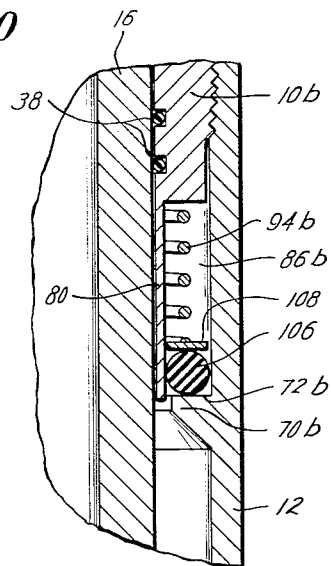


Fig. 10



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HYDRAULIC WELL JAR

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7 Claims. (Cl. 255—27)

This invention relates to a hydraulic well jar, and more particularly to a jarring tool for use in the removal of a stuck object in the bore of a well and in which a liquid is employed for controlling the action of the tool.

The invention finds particular application in jarring tools of the hydraulic type, having inner and outer concentrically arranged tubular parts movable longitudinally relative to each other and forming between them a closed fluid chamber. The outer part, or barrel, in jars of this type, is provided with a portion of restricted internal diameter within the fluid chamber, and the inner part, or mandrel, carries a piston which is movable into and out of the restriction, the annulus of the piston being slightly smaller than the internal diameter of the restriction to permit the flow of liquid past the piston as the piston moves in the restriction.

In the use of jars of this type, the outer part, or barrel, may be connected to an operating string, while the inner part, or mandrel, may be connected to an object stuck in the bore of a well, and upon upward or downward movement of the operating string, the parts are moved longitudinally relative to each other, the liquid in the chamber flowing past the piston during such movement. Upon movement of the piston into the restriction, however, the flow of liquid past the piston is restricted, so that further relative movement of the parts takes place very slowly, resulting in the development of tension or compression in the operating string, depending upon whether the same is being moved upwardly or downwardly. As soon as the piston moves out of the restriction, however, the relative movement of the parts is no longer restrained, and the parts move suddenly to the limit of their relative movement to produce a jarring action.

Jars of this type may be used to produce a jarring action either upwardly or downwardly, and in the event it is desired to operate such a jar to carry out a jarring action in one direction only, either upwardly or downwardly, the difficulty is encountered that the parts must be moved relative to each other in the opposite direction to bring them to position to initiate a jarring stroke, and such return movement of the parts can take place only very slowly as the piston makes its return movement in the restriction, thus greatly slowing the jarring operation.

In the use of such tools the fluid chamber is customarily filled completely with a suitable liquid, such as oil, and any loss of liquid due to leakage results in the entrance of air into the chamber, which may adversely affect the operation of the tool, in that it interferes with the hydraulic action of the same, and continued operation of the tool in such condition often results in the formation of an undesirable emulsion with the oil. The construction of such a tool having a fluid chamber which is adapted to be completely filled with liquid also presents a difficult problem in that the inner and outer parts must be so formed that no change in the volume of the fluid chamber will take place upon relative longitudinal

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movement of the parts. A slight variation in the volume of the fluid chamber, brought about upon relative longitudinal movement of the parts, may result in the production of a tool which does not operate properly or in which the packing between the moving parts is subjected to excessive pressures, causing leakage of the liquid, or permitting the entrance of air into the fluid chamber.

The present invention has for its principal object the provision of a jarring tool of the type referred to in which the above disadvantages are overcome, and in which means is provided for the relatively rapid movement of the piston in the restriction, upon relative longitudinal movement of the inner and outer parts in one direction, in order to permit a rapid movement of the parts to place the tool in condition for jarring operation upon relative movement of the parts in the other direction.

Another object of the invention is to provide a jarring tool of the hydraulic type, having inner and outer telescopically arranged tubular parts movable longitudinally relative to each other, and forming between them a closed liquid chamber, the outer parts having a portion of reduced internal diameter forming a restriction in the chamber, and the inner part carrying a piston whose annulus is slightly smaller than the restriction, there being compressible means within the chamber responsive to the pressure of the liquid therein, to permit the piston to have unrestrained movement in the restriction, upon relative longitudinal movement of the parts in one direction.

Another object of the invention is the provision of a jarring tool of the type referred to wherein a compressible fluid is utilized within the liquid chamber which is responsive to pressure developed in the liquid in the chamber to permit relatively unrestricted movement of the piston in the restriction, upon relative longitudinal movement of the parts in one direction, and means is provided for maintaining the compressible fluid out of contact with the liquid in the chamber to prevent intermingling of the fluid with the liquid.

A further object of the invention is to provide a jarring tool of the hydraulic type, constructed as described above, and embodying means responsive to the pressure of the liquid in the fluid chamber, upon relative longitudinal movement of the parts in one direction, to permit movement of the piston in the restriction in said one direction more easily than in the other direction, said means being effective to cause a flow of liquid through the restriction in the other direction, upon movement of the piston out of the restriction in said one direction.

Another object of the invention is the provision of a jarring tool constructed with inner and outer concentrically arranged tubular parts movable longitudinally relative to each other, and forming between them a closed fluid chamber, the outer part having a portion of reduced internal diameter forming a restriction within the chamber, and the inner part carrying a piston whose annulus is slightly smaller than said portion of reduced diameter, there being means in the chamber responsive to variations in the volume of the chamber at one side of the restriction, to allow the piston to have relatively unrestricted movement in one direction in the restriction.

A further object of the invention is the provision of a jarring tool of the type referred to, which is of simple design and rugged construction, capable of long withstanding the severe conditions of use to which such an object is customarily subjected.

The above and other objects and advantages of the invention will best be understood from the following detailed description, constituting a specification of the same.

when taken in conjunction with the annexed drawings, wherein—

Figure 1 is a schematic view illustrating the various parts of the invention and showing the general relationship between the parts;

Figure 2 is a fragmentary elevational view, partly in cross section, of the upper portion of a jar in accordance with the invention;

Figure 2A is a fragmentary elevational view, partly in cross section, of the lower portion of the same;

Figure 3 is a cross-sectional view taken along the line 3—3 of Figure 2, looking in the direction indicated by the arrows;

Figure 4 is a cross-sectional view taken along the line of 4—4 of Figure 2A, looking in the direction indicated by the arrows;

Figure 5 is a fragmentary vertical cross-sectional view on a somewhat enlarged scale, showing details of construction of a preferred form of the invention;

Figure 6 is a fragmentary elevational view, partly in cross section, illustrating a somewhat different form of the invention;

Figure 7 is a view similar to that of Figure 6, illustrating another form of the invention;

Figure 8 is a view similar to that of Figure 5, illustrating a further different form of the invention;

Figure 9 is a view similar to that of Figure 2, illustrating a further different form of the invention; and

Figure 10 is a view similar to that of Figure 6, illustrating a somewhat modified form of the invention.

Referring now to the drawings in greater detail, the jar comprises inner and outer telescopically arranged tubular parts indicated generally at 1 and 2, respectively, which parts are movable longitudinally relative to each other, and form between them a closed fluid chamber 48. The outer part is conveniently made up of an upper tubular coupling member 10, and intermediate barrel section 12 and a lower tubular member 14, and the inner part is made up of upper and lower tubular mandrel sections 16 and 18, respectively. The lower end of the lower mandrel section 18 is externally threaded, as indicated at 20, for the attachment thereto of a lower coupling member 22, which is provided with an internally threaded box portion, as indicated at 24, by which the inner part of the tool is attached to the upper end of a lower section 26 of the operating string, or other device below the jar.

At its upper end the upper coupling member 10 has an externally threaded end portion 28, by which this member may be attached to the lower end of a section 30 of an operating string, and at its lower end the upper coupling member has a reduced externally threaded portion 32, by which it is threadably attached to the upper end of the barrel 12. The lower end of the upper coupling member is also inwardly thickened, as indicated at 34, and is provided with inwardly opening, annular, internal grooves 36, within which sealing means, such as O-rings 38 are received, to form a fluid tight seal between the upper coupling member and the upper mandrel section 16.

The lower tubular member 14 has a reduced, externally threaded, upper end portion 40, by which this member is threadably attached to the lower end of the barrel 12, and the lower end of the member 14 is inwardly thickened, as indicated at 42, and is provided with inwardly opening, annular internal grooves 44, for the reception of sealing means, such as O-rings 46, which form a fluid tight seal between the member 14 and the lower mandrel section 18.

Between the inner and outer tubular parts, and extending from the sealing means 38 in the upper coupling member to the sealing means 46 in the lower tubular member 14 there is a closed fluid chamber 48, which is normally intended to be filled with a suitable liquid, such as oil. The barrel section 12 has an inwardly thickened portion

50, providing an annular restriction in the chamber 48, for a purpose later to be made apparent.

The upper and lower mandrel sections 16 and 18 are threadably connected together, as indicated at 52, and the lower mandrel section has an exteriorly thickened annular portion 54, forming an upwardly facing shoulder 56, upon which an annular member 58 is seated, the lower end 60 of the upper mandrel section being engageable with the member 58, to retain the same in position on the mandrel. The member 58 is conveniently formed with an internal annular groove 62, for the reception of suitable sealing means, such as an O-ring 64, forming a fluid tight seal between the member 58 and the mandrel. The member 58 forms a piston on the mandrel, which is adapted to move into and out of the restriction 50, upon relative longitudinal movement of the inner and outer parts.

With the parts assembled as shown, it will be apparent that upon relative longitudinal movement of the inner and outer parts, when the piston 58 enters the restriction 50 the flow of liquid in the chamber from one side to the other side of the restriction will be restricted, and the rate of relative longitudinal movement between the inner and outer parts will depend upon the amount of clearance between the restriction and the outer circumference of the piston. With the piston entering the restriction, the exertion of a downward force on the operating string will result in forcing the liquid in the chamber slowly from one side of the restriction to the other side thereof past the piston, thus building up a compressive force in the operating string while the piston moves slowly through the restriction. As soon as the piston moves out of the restriction, however, the liquid in the chamber may move freely past the piston, and the inner and outer parts may move rapidly relative to each other. The piston 58, may, if desired, have a restricted duct 59 leading from the upper to the lower side thereof, as seen in Figure 2, whereby liquid may flow from one side of the piston to the other as the piston moves in the restriction.

The lower end of the lower tubular member 14 has a contact face 98 on the outer part, which is engageable with the upper end face 100 of the lower coupling member 22 to produce a downward jarring action upon operation of the tool. The lower tubular member 14 is also provided with internal splines 66, which mesh with external splines 68 formed on the lower mandrel section 18, whereby relative rotation of the inner and outer parts is prevented. The exteriorly thickened annular portion 54 of the lower mandrel section 18 has a lower face 102, shown in Figure 2, which is engageable with the upper ends 104 of the splines 66 of the barrel 12 as seen in Figure 2A, to produce an upward jarring action in the operation of the tool.

As best seen in Figures 2, 3 and 5, the barrel 12 also has an inwardly thickened portion 70, providing an upwardly facing annular shoulder 72, and in the preferred form of the invention, as best seen in Figures 2 and 5, there is an annular casing 74, preferably formed of metal or other relatively rigid material, surrounding the upper mandrel section 16, within the barrel 12, and in engagement with the shoulder 72 therein. In order to securely maintain the casing against longitudinal movement in the barrel the lower end surface of the upper coupling member 10 may engage the upper surface of the casing to hold the same against the shoulder 72. The casing 74 is of hollow construction, and enclosed within the casing there is a hollow member 76, in the form of a closed container of flexible material, filled with compressible material, such as air. The casing 74 is also provided with openings 78, communicating with the interior of the casing and also with the chamber 48, whereby liquid in the chamber may enter the casing.

During the operation of the tool, the exertion of an upward pull on the operating string will result in moving the barrel longitudinally upwardly relative to the man-

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drel, so that when the piston 53 enters the restriction 50 the flow of liquid in the chamber from one side of the piston to the other side thereof will be restricted, resulting in a building up of tension in the operating string, until the piston moves out of the restriction, whereupon the flow of liquid past the piston will be unrestricted and the barrel will move suddenly upwardly relative to the mandrel, until the lower surface 102 of the piston engages the upper end 104 of the spline 66 of the barrel to cause an upward jarring action. After the occurrence of an upward jarring action of the tool, as just described, the operating string may be lowered, whereupon the barrel 12 will move downwardly relative to the mandrel and the piston 53 will move in the opposite direction through the restriction 50. As soon as the piston 58 enters the restriction the flow of liquid past the piston is retarded, resulting in a building up of the pressure within the fluid chamber above the restriction, which pressure causes liquid to pass through the openings 78 in the casing 74, thus compressing the container 76, so that the movement of the piston in the restriction is retarded only by the resistance due to the compression of the container 76, and the barrel may readily move downwardly over the mandrel to the limit of its downward movement relative thereto. Thus the parts may be quickly brought to position to initiate a further jarring operation of the tool. As soon as the piston moves out of the restriction on the return movement of the parts just described, the pressure built up in the flexible container 76 will immediately return the liquid through the opening 78 to the fluid chamber, thus immediately restoring the liquid in the chamber to a condition to effect another jarring action.

In the form of the invention illustrated in Figure 6, the upper coupling member 10 is formed with a downwardly extending sleeve-like portion 80, spaced radially inwardly of the barrel 12. At its lower end the sleeve-like portion 80 is externally threaded and has a nut 82 threaded thereon, providing an upwardly facing shoulder 84, opposite the shoulder 72 on the barrel. An annular space 86 is formed between the sleeve-like extension 80 and the barrel 12, which space provides an annular compartment or cylinder 86, closed at one end and opening at its other end into the fluid chamber 48, and in this cylinder an annular piston 88 is disposed for longitudinal movement. The piston 88 is provided with suitable packing, as indicated at 92, forming a fluid tight seal between the piston and the inner surface of the barrel 12. A coil spring, 94, or other equivalent resilient member is disposed in the space 86, bearing at one end against the upper coupling member 10, and at the other end against the piston 88, to urge the piston toward the shoulders 72 and 84. In this form of the invention, any increase in pressure in the chamber above the restriction, upon operation of the tool, will result in the liquid in the chamber 48 exerting a pressure against the piston 88, to move the same longitudinally in the space 86 against the action of the spring 94.

Upon movement of the barrel 12 to bring the piston 58 above the restriction, the liquid may move freely past the piston, and after the piston has moved out of the restriction the spring 94 will urge the piston toward the shoulders 72 and 84, returning liquid to the chamber.

The form of the invention illustrated in Figure 7 is similar to that shown in Figure 6, but in this case the upper coupling member 10a does not have the sleeve-like portion 80 thereon, and the shoulder 72 defines one end of the annular compartment 86a between the upper mandrel section 16 and the barrel 12. Within the compartment 86a an annular piston 88a is movably positioned, and suitable sealing means 92a is provided on the piston to form a fluid-tight seal between the piston and the mandrel section 16 and between the piston and the barrel 12. A coil spring 94a is also disposed in the compartment 86a which yieldably urges the piston toward the shoulder 72. This form of the invention is other-

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wise substantially the same as that illustrated in Figure 6, and operates in the same manner.

In Figure 8 there is illustrated a somewhat modified form of the invention similar to the form illustrated in Figure 5. In this case, however, the casing 74 is omitted and the flexible hollow container 76a is positioned within the compartment whose ends are defined by the lower end of the upper coupling member 10 and the shoulder 72 between the upper mandrel section 16 and the barrel 12. In other respects this form of the invention is similar to the form shown in Figure 5, and functions in the same manner.

A still further embodiment of the invention is illustrated in Figure 9, and in Figure 10 there is shown a somewhat modified form of the embodiment of Figure 9. As seen in Figure 9, the structure of the jar is substantially the same as that described in connection with Figure 7 except that the inwardly thickened portion 70b of the barrel 12 is of greater width than the portion 70 previously described, whereby a relatively wide upwardly facing annular shoulder 72b is provided defining the open end of an annular compartment 86b in communication with the fluid chamber 48. In this form of the invention an O-ring 106 takes the place of the piston 88a, which O-ring is preferably of flexible material such as rubber, or the like. The operation of this form of the invention is similar to that already described, the O-ring 106 moving upwardly in the compartment 86b against the pressure of the air therein during the movement of the piston 53 in the restriction 50, as the barrel 12 moves downwardly relative to the mandrel. Likewise, as soon as the piston 53 moves up out of the restriction the pressure of air in the compartment 86b returns the O-ring to a position in engagement with the shoulder 72b, thus returning the liquid from within the compartment to the fluid chamber 48.

The form of the invention illustrated in Figure 10 is like that shown in Figure 7, except that the portion 70 of the barrel is thickened as indicated at 70b to provide the relatively wide upwardly facing shoulder 72b with which the O-ring 106 is engageable at the limit of its outward movement in the compartment 86b. The O-ring 106 in this case is provided with a back-up ring 108, and there is a coil spring 94b within the compartment 86b which bears at one end upon the back-up ring and at the other end against the upper coupling member 10b. The spring 94b urges the O-ring toward the shoulder 72b.

This form of the invention is in other respects similar to the form illustrated in Figure 6, and functions in a similar manner.

It will be apparent that the compressible means described may be provided at either side of the restriction in the chamber, whereby the tool may be adapted for jarring either upwardly or downwardly as may be desired.

It will also be apparent that the invention, as described above provides a jarring tool having a closed chamber which may be maintained filled with liquid, in order to secure the maximum efficiency in the operation of the tool hydraulically, and wherein means is provided for compensating for variations in the volume of the chamber during the operation of the tool, so that injury or excessive wear of the packing elements is prevented, as well as leakage of the liquid from the chamber due to the development of excessive hydraulic pressures or the entrance of air into the chamber past the packing elements in the event of any increase in the volume of the chamber due to imperfection in the manufacture of the parts.

The invention has been disclosed in connection with certain specific embodiments of the same, but it will be understood that these are intended by way of illustration only, and that numerous changes can be made in the construction and arrangement of the various parts, with-

out departing from the spirit of the invention, or the scope of the appended claims.

Having thus clearly shown and described the invention, what is claimed as new and desired to secure by Letters Patent is—

1. A well tool comprising inner and outer concentrically arranged tubular parts movable longitudinally relative to each other, means for connecting one of said parts to an operating string, means for connecting the other of said parts to an object stuck in a well bore, said parts forming an annular liquid containing chamber between the parts, a piston on the inner part in the chamber, sealing means between the parts at each end of said chamber, said outer part having a portion of reduced internal diameter in the chamber forming a restriction between the ends of the chamber in which said piston is adapted to move upon relative longitudinal movement of said inner and outer parts, the external diameter of the piston being slightly smaller than the internal diameter of said restriction to permit the flow of liquid from one side of the piston to the other side thereof as the piston moves in said portion, pressure responsive means in said chamber on one side of said restriction, including a closed container of flexible material and compressible material filling said container, said means being responsive to variations in the pressure in said chamber on said one side of said restriction upon relative longitudinal movement of said parts to permit movement of the piston in one direction in said restriction against a reduced restraining force.

2. A well tool comprising inner and outer concentrically arranged tubular parts movable longitudinally relative to each other, means for connecting one of said parts to an operating string, means for connecting the other of said parts to an object stuck in a well bore, said parts forming annular liquid filled chamber between the parts, a piston on the inner part in the chamber, sealing means between the parts at each end of said chamber, said outer part having a portion of reduced internal diameter forming a restriction between the ends of the chamber in which said piston is adapted to move upon relative longitudinal movement of said inner and outer parts, the external diameter of the piston being slightly smaller than the internal diameter of said restriction to permit the flow of liquid from one side of the piston to the other side thereof as the piston moves in said restriction, means connected with the outer part and forming an annular compartment between said inner and outer parts, said compartment being closed at one end and opening at its other end into said chamber, a compressible fluid in said compartment and movable means in the compartment separating the fluid therein from said liquid positioned between the liquid in said chamber and said compressible fluid.

3. A well tool comprising inner and outer concentrically arranged tubular parts movable longitudinally relative to each other, means for connecting one of said parts to an operating string, means for connecting the other of said parts to an object stuck in a well bore, said parts forming between them a liquid containing chamber, a piston on the inner part in the chamber, sealing means at each end of said chamber between said inner and outer parts, said outer part having a portion of reduced internal diameter forming a restriction in the chamber in which the piston is adapted to move upon relative longitudinal movement of said inner and outer parts, the external diameter of the piston being slightly smaller than internal diameter of said restriction to permit the flow of liquid from one side of the piston to the other side thereof as the piston moves in said restriction, a compressible fluid in said chamber on one side of said restriction, movable means in said chamber separating said fluid from the liquid therein and movable in response to an increase of pressure in said chamber on said one side of said restriction to effect compression of said compressible fluid.

4. A well tool comprising inner and outer concentrically arranged tubular parts movable longitudinally relative to each other, means for connecting one of said parts to an operating string, means for connecting the other of said parts to an object stuck in a well bore, said parts forming between them a liquid containing chamber, a piston on the inner part in the chamber, sealing means at each end of said chamber between said inner and outer parts, said outer part having a portion of reduced internal diameter forming a restriction in the chamber in which the piston is adapted to move upon relative longitudinal movement of said inner and outer parts, the external diameter of the piston being slightly smaller than the internal diameter of said restriction to permit the flow of liquid from one side of the piston to the other side thereof as the piston moves in said restriction, a compressible fluid in said chamber on one side of said restriction, movable means in the chamber separating said fluid from the liquid therein, said means being movable in one direction upon an increase in pressure in said chamber on one side of said restriction to compress said fluid, and in another direction upon a decrease of pressure in said chamber on said one side of said restriction to permit said fluid to expand.

5. A well tool comprising inner and outer concentrically arranged tubular parts movable longitudinally relative to each other, means for connecting one of said parts to an operating string, means for connecting the other of said parts to an object stuck in a well bore, said parts forming between them a liquid containing chamber, a piston on the inner part in the chamber, said piston having a duct leading from the upper to the lower side thereof, sealing means at each end of said chamber between said parts, said outer part having a portion of reduced internal diameter forming a restriction between the ends of the chamber in which the piston is adapted to move upon relative longitudinal movement of said inner and outer parts, said piston being of a size to substantially close said restriction to cause a flow of liquid through said duct from one side of the piston to the other side thereof as the piston moves in said restriction, a compressible fluid in said chamber on one side of said restriction, means in said chamber separating said fluid from the liquid therein and movable in the chamber in response to changes in the pressure in said chamber on said one side of said restriction to effect corresponding changes in the pressure of said fluid.

6. A well tool comprising inner and outer concentrically arranged tubular parts movable longitudinally relative to each other, means for connecting one of said parts to an operating string, means for connecting the other of said parts to an object stuck in a well bore, said parts forming between them a liquid containing chamber, a piston on the inner part in the chamber, sealing means at each end of said chamber between said inner and outer parts, said outer part having a portion of reduced internal diameter forming a restriction between the ends of the chamber and in which the piston is adapted to move upon relative longitudinal movement of said inner and outer parts, the external diameter of the piston being slightly smaller than the internal diameter of said restriction to permit the flow of liquid from one side of the piston to the other side thereof as the piston moves in said restriction, pressure responsive means in the chamber on one side of said restriction and including a compressible fluid and movable means separating the fluid from the liquid in the chamber, said means being movable in response to variations in pressure in said chamber on said one side of said restriction to permit the piston to move against a smaller restraining force in one direction in said restriction than in the other direction therein.

7. A well tool comprising inner and outer concentrically arranged tubular parts movable longitudinally relative to each other, means for connecting one of said parts to an operating string, means for connecting the other of

said parts to an object stuck in a well bore, said parts forming between them a liquid containing chamber, a piston on the inner part in the chamber, sealing means at each end of said chamber between said inner and outer parts, said outer part having a portion of reduced internal diameter forming a restriction between ends of the chamber in which the piston is adapted to move upon relative longitudinal movement of said inner and outer parts, a compressible fluid in said chamber on one side of the restriction, movable means in said chamber separating said fluid from the liquid therein and movable in response to

an increase of pressure in said chamber on said one side of said restriction to effect compression of said compressible fluid.

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