June 7, 1955 E. W. BAGNELL 2,710,171

HYDRAULIC WELL JAR

Filed June 24, 1952 2 Sheets-Sheet 1

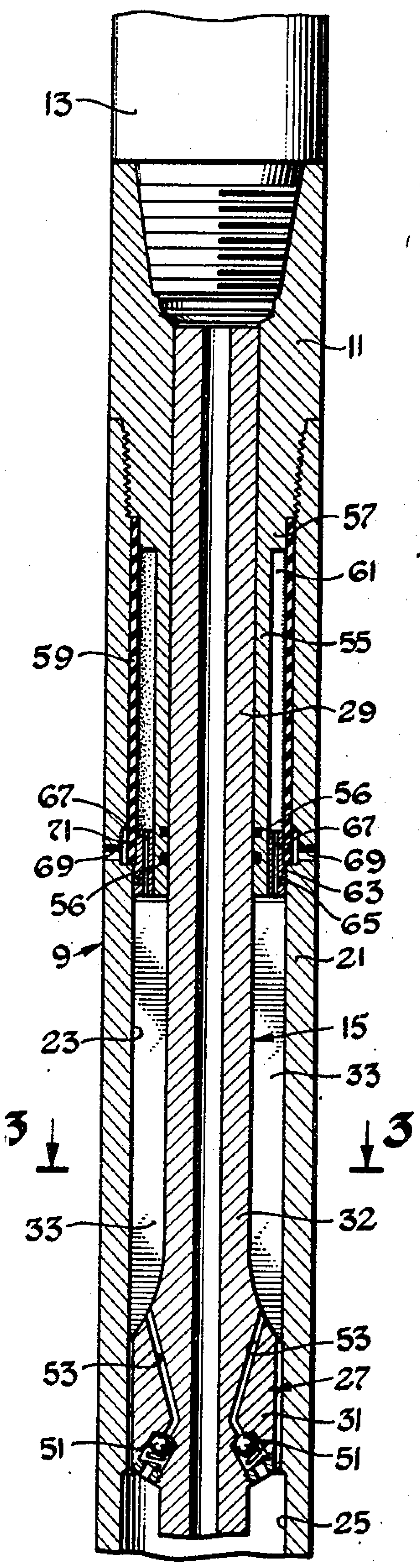

FIG. 1a.

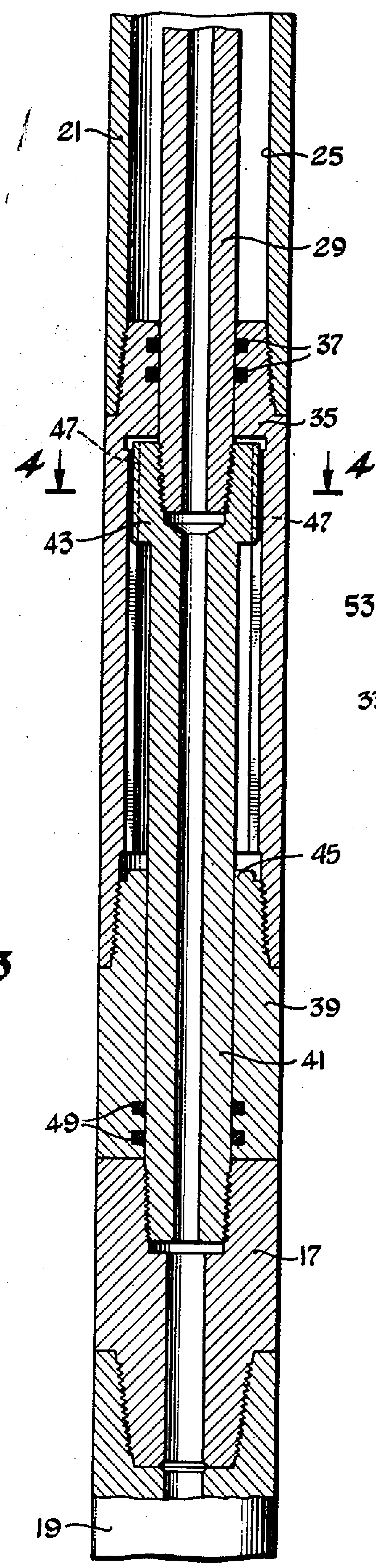

FIG. 1b.

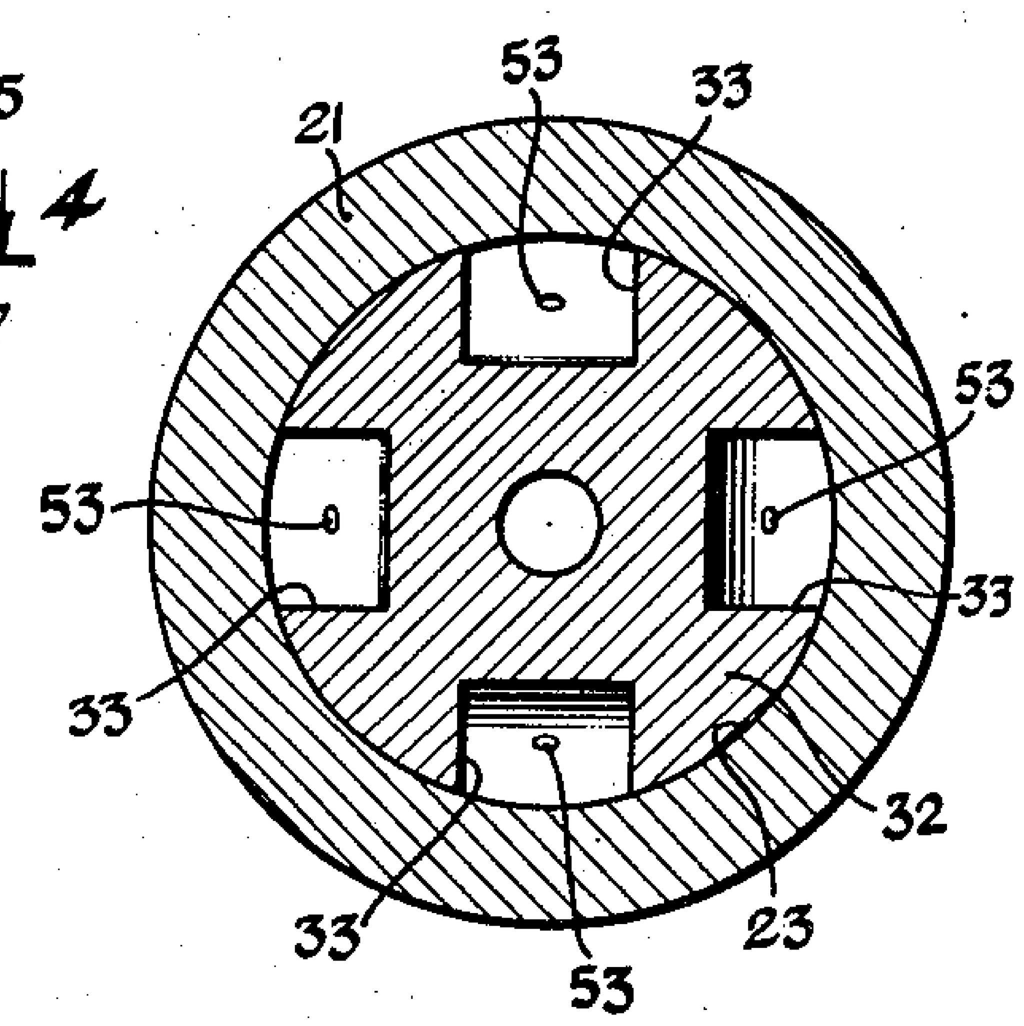

FIG. 3.

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HYDRAULIC WELL JAR

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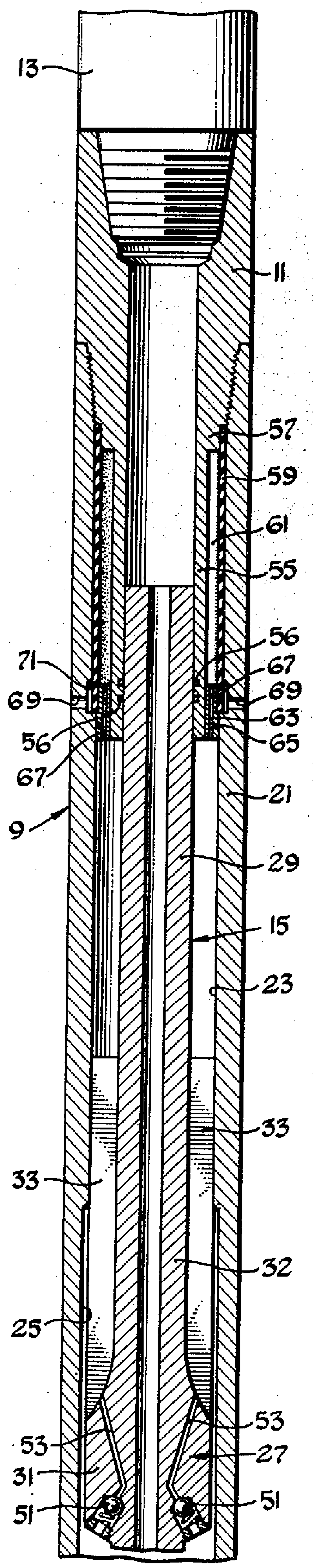

FIG. 2a.

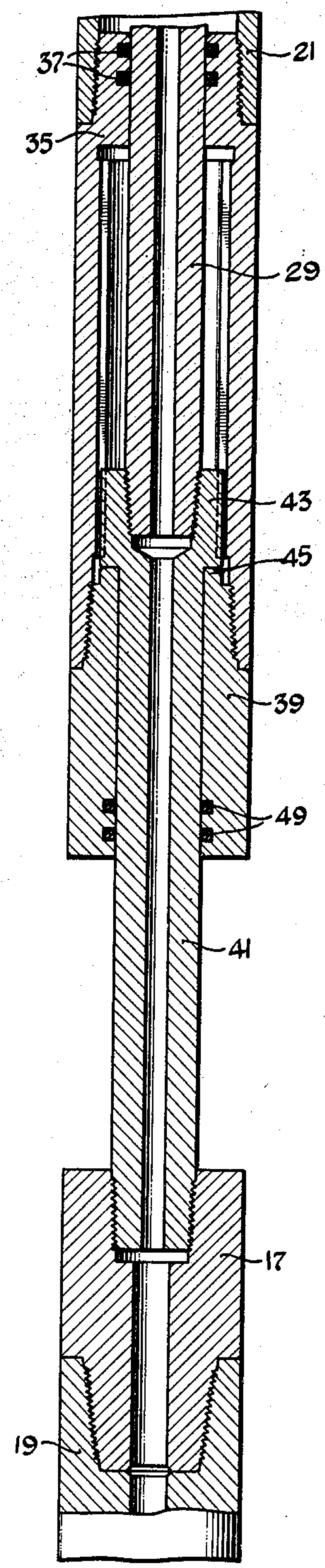

FIG. 2b.

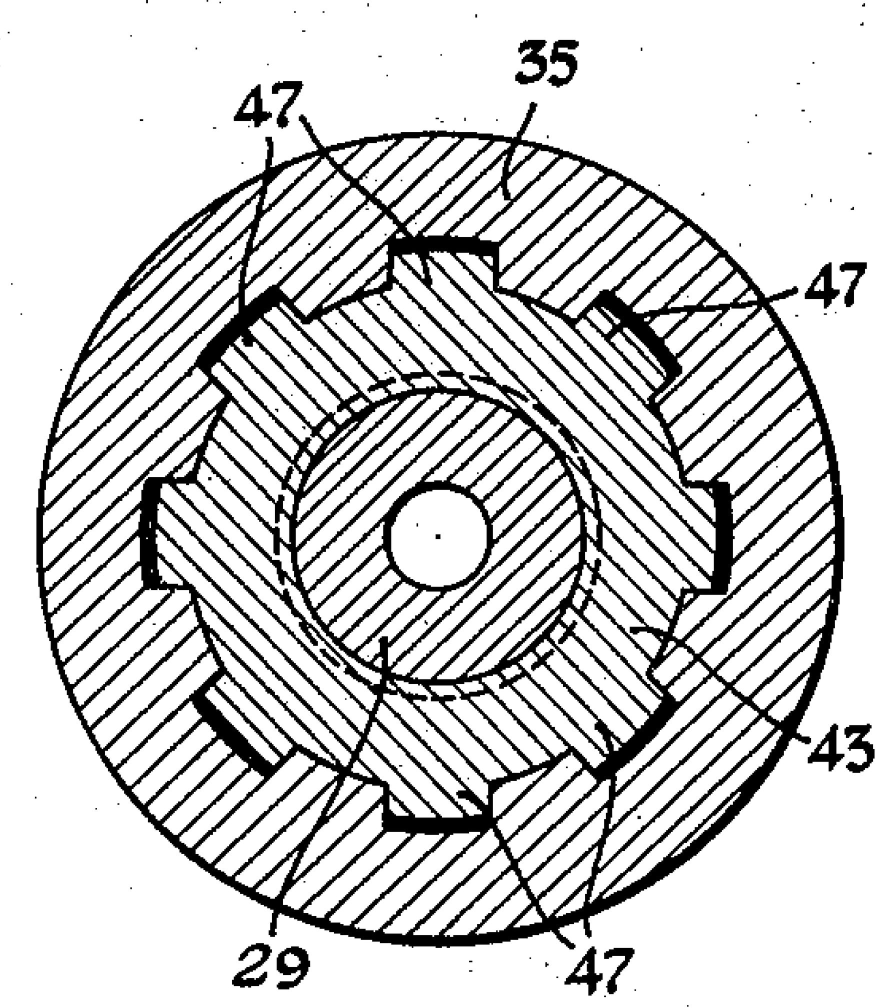

FIG. 4.

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HYDRAULIC WELL JAR

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Application June 24, 1952, Serial No. 295,201

4 Claims. (Cl. 255—27)

This invention relates to an oil well tool and particularly to a hydraulic well jar of the type adapted to be connected at its lower end to a stuck member to be jarred and at its upper end to a drill string, by which the hydraulic well jar can be operated to subject the stuck member to a succession of jarring blows.

In certain types of conventional hydraulic jars, for example that shown in the patent to W. B. Wigle, No. 1,637,505, granted August 2, 1927, a valve member tightly fits within a small bore and is adapted to be forced from the small bore into a larger bore, and during its movement in the small bore to force trapped hydraulic fluid from within the large bore past the valve member into the small bore. This resistance to movement of the valve member is utilized to stretch the drill string so that upon full entry of the valve member into the large bore, the resistance movement is suddenly released to allow the valve member to strike an anvil. The valve member, therefore, also functions as the hammer and is normally referred to as a hammer, although it performs both functions of a valve member and a hammer.

There are several disadvantages to this construction. The hammer is submerged in hydraulic fluid and it has been discovered that there is a cushioning effect unavoidably created between the hammer and anvil due to the rush of hydraulic fluid past the opposing faces of the hammer and anvil as the two members move together to effect a jarring blow. Furthermore, the hammer becomes deformed during use and, therefore, no longer properly fits within the small bore, and consequently the jarring action tends to become erratic and unpredictable.

A main object of the present invention is to provide a hydraulic well jar overcoming the above disadvantageous operating characteristics by including a separate valve member disposed within a hydraulically filled chamber and a separate hammer connected to the valve member but disposed in a vacant or dry chamber, i. e., one not filled with hydraulic fluid, so that the hammer can strike the anvil without the creation of a cushioning effect, and the valve can properly operate without being battered or deformed by striking the anvil.

A further object of the present invention is to provide a hydraulic jar having a novel diaphragm construction for preventing the creation of voids in the hydraulic fluid chamber.

Various other objects of the present invention will be apparent from the following description taken in connection with the accompanying drawings, wherein:

Figs. 1*a* and 1*b* are successive longitudinal mid-sectional views of a hydraulic well jar embodying the concepts of the present invention, showing the tool at the beginning of a cycle of operation with the hammer spaced from the anvil and the valve member disposed within the small bore.

Figs. 2*a* and 2*b* are views similar to Figs. 1*a* and 1*b* but show the parts in the positions they assume at the instant of impact between the hammer and anvil.

Fig. 3 is a cross-sectional view of the tool taken along line 3—3 of Fig. 1.

Fig. 4 is a cross-sectional view of the tool taken along line 4—4 of Fig. 1.

Referring to the accompanying drawings wherein similar reference characters designate similar parts throughout, there is disclosed a hydraulic well jar comprising two main parts, an outer composite tubular mandrel **9** connected at its upper end by a sub **11** to the lower end of a drill string **13**, and an inner composite tubular mandrel **15** telescopically received within the outer mandrel and connected at its lower end by a sub **17** to the upper end of a stuck member **19**.

Outer composite tubular mandrel **9** includes a tubular valve housing **21** filled with hydraulic fluid such as oil, and having formed therein a small bore **23** and a somewhat larger bore **25** disposed beneath the small bore and in direct communication therewith. Valve member **27** constitutes an enlargement on a tubular valve section **29** of inner composite tubular mandrel **15**. The small bore **23** is of such size as to form a tight fit with the valve member **27**, and large bore **25** is of such size as to freely accommodate said valve member.

Valve member **27** includes a bottom portion **31** having an unbroken exterior so as to form a plug within a small bore **23**, and an upper portion **32** having longitudinally extending by-pass grooves **33** formed therein. Upper portion **32** is arranged so that it is never entirely withdrawn from the small bore and, therefore, forms a pilot for ready passage for the plug portion **31** into the small bore (into which it tightly fits). Upper grooved portion **32** functions to allow fluid to freely pass from the large bore into the small bore once the plug portion **31** has been forced out of said small bore.

Threadedly connected to the lower end of valve housing **21** is a sub **35**, which forms a part of the outer composite tubular mandrel **9** and slidably receives the lower reduced end of inner tubular valve section **29**. There are high pressure O ring seals **37** provided on the interior of sub **35** in sealing engagement with tubular valve section **29** to prevent the escape of hydraulic fluid from within the valve housing **21**.

Sub **35** is connected at its lower end to an anvil sub **39**, within which is slidably disposed a tubular hammer section **41** having formed on its upper end an enlarged hammer head **43**. Hammer head **43** is threadedly connected to the lower end of tubular valve section **29** and is adapted to violently strike an anvil **45** formed on the upper end of anvil sub **39**. Hammer head **43** and sub **35** are nonrotatably connected by a spline formation at **47**, see Fig. 4.

Sub **35** forms a vacant housing within which the hammer head operates and this housing is sealed off from the hydraulic fluid by O rings **37**, previously mentioned, and from well fluid by O rings **49** provided on the interior of anvil sub **39** in sealing engagement with tubular hammer section **41**.

At the beginning of a jarring stroke (see Figs. 1*a* and 1*b*), valve member **27** is disposed within small bore **23** and is maintained in somewhat the same absolute position during operation of the hydraulic jar because of its connection to the stuck member **19**. Upon upward movement of the drill string **13**, outer tubular mandrel **9** is pulled upwardly forcing the hydraulic fluid trapped in housing **21**, between sub **35** and valve member **27**, upwardly between the exterior of said valve member and the walls of small bore **23** into the upper end of said small bore. This naturally creates a heavy resistance to upward movement of the drill string so that there results a relatively slow upward movement of outer mandrel **9** and a stretching of the drill string until the upper edge of the large bore **25** passes the upper edge of the plug portion **31** to uncover the by-pass grooves **33**, at which time the valve housing is released, whereupon outer mandrel **9** suddenly jumps upwardly (the stretched drill string contracting) to bring hammer head **43** and anvil **45** into violent engagement to cause a jarring blow to be dealt to stuck member **19**. Since there is no hydraulic fluid in the chamber in which hammer head **43** operates, there is no cushioning effect created between the hammer and anvil, to therefore allow a more violent engagement between the hammer and anvil than heretofore realized in prior hydraulic jars of the type set forth above. It is pointed out that, as shown in Figs. 2*a* and 2*b*, valve member **27** at the end of the stroke of the housing **21** is still spaced from the upper end of sub **35** so that no cushioning effect is created in the valve chamber. It is further pointed out that since the valve member does not strike the anvil, it is not deformed or battered and will continue to properly fit within the small bore and insure proper operation of the well jar.

After the jarring stroke, the drill string **13** is lowered and the valve housing **21** readily moves down relative to valve member **27** with the fluid by-passing through grooves **33**. Suitable spring-loaded ball valves **51** are provided in valve member **27** to allow hydraulic fluid to by-pass the valve member through by-pass ducts **53** formed in said valve member, upon entrance of the plug portion **31** of said valve member into small bore **23**, to readily allow full retraction of the valve member within said small bore. The upper end of lower sub **17** engages the lower end of anvil sub **39** to limit downward movement of housing **21** relative to valve member **27**.

Housing **21** is connected at its upper end to the lower end of top sub **11**, said top sub having a reduced depending tubular portion **55** slidably received about the upper end of tubular valve section **29**, and having its exterior spaced from the interior of valve housing **21** as is apparent from the drawings. O ring seals **56** are provided on the interior of tubular portion **55** in sealing engagement with tubular valve section **29**.

Adjacent the upper end of tubular portion **55**, sub **11** is formed with an annular step **57** which receives thereon the upper end of a sleeve type flexible diaphragm **59**, the interior of which is spaced from the exterior of tubular portion **55** to provide a reserve oil space **61**. The upper end of diaphragm **59** is secured to step **57** and the lower end of said diaphragm is secured to the exterior of a ring **63**, which is connected to the lower end of tubular portion **55**. Ring **63** carries on its exterior an O ring seal **65** in sealing engagement with the interior of valve housing **21**, and has oil passages **67** extending axially therethrough to provide communication between the oil reserve space **61** and the interior of valve housing **21**.

Valve housing **21** is ported at **69** and annularly relieved at **71** so as to subject the exterior of diaphragm **59** to the well pressure. The diaphragm will flex under the influence of the well pressure to an extent to prevent the creation of any voids in the hydraulic fluid chamber defined by the housing **21**, particularly upon the unavoidable escape of hydraulic fluid therefrom such as past O rings **56**.

By the present invention a hydraulic well jar has been provided in which the anvil and hammer are permitted to more violently come into impact because the hammer operates in a vacant instead of a hydraulic fluid-filled chamber. Furthermore, the valve member is separate from but connected to the hammer and so does not come into violent engagement with any abutment, and therefore its proper fit within the small bore of the tool is assured, and therefore proper operation of the tool is attained.

While I have shown the preferred form of my invention, it is to be understood that various changes may be made in its construction by those skilled in the art without departing from the spirit of the invention as defined in the appended claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. A hydraulic well jar, comprising a tubular body adapted to be connected at its upper end to a supporting string of pipe and reciprocably receiving a mandrel which is adapted to be connected at its lower end to a member to be jarred, said body having an upper enlarged bore portion forming a fluid-filled chamber and a lower enlarged bore portion forming a vacant chamber, the bore between said chambers being restricted and the walls thereof sealingly engaging the mandrel, the fluid-filled chamber having a portion of slightly smaller diameter than the remainder of said chamber, an enlargement on said mandrel forming a valve adapted to slidably engage said smaller diameter portion, said valve being adapted to retard movement of said mandrel relative to said body when in said smaller portion and then suddenly release the tubular body from the mandrel in response to an upward pull on the body when it leaves said smaller portion, one end wall of said vacant chamber constituting a hammer adapted to strike an anvil within said chamber and fixed to said mandrel upon release of the tubular body, and a resilient sleeve-shaped diaphragm fastened at both its ends to the wall of the fluid-filled chamber and having its exterior in communication with the fluid in the well bore exterior of the tubular body, whereby the space occupied by any fluid leaking from the chamber will be taken up by inward flexing of the diaphragm under influence of the well fluid.

2. A hydraulic well jar, comprising a tubular body adapted to be connected at its upper end to a supporting string of pipe and reciprocably receiving a mandrel which is adapted to be connected at its lower end to a member to be jarred, said body having an upper enlarged bore portion forming a fluid-filled chamber and a lower enlarged bore portion forming a vacant chamber, the bore between said chambers being restricted and the walls thereof sealingly engaging the mandrel, the fluid-filled chamber having a portion of slightly smaller diameter than the remainder of said chamber, an enlargement on said mandrel forming a valve adapted to slidably engage said smaller diameter portion, said valve being adapted to retard movement of said mandrel relative to said body when in said smaller portion and then suddenly release the tubular body from the mandrel in response to an upward pull on the body when it leaves said smaller portion, one end wall of said vacant chamber constituting a hammer adapted to strike an anvil within said chamber and fixed to said mandrel upon release of the tubular body, a resilient sleeve-shaped diaphragm fastened at both its ends to the wall of the fluid-filled chamber and having its exterior in communication with the fluid in the well bore exterior of the tubular body, whereby the space occupied by any fluid leaking from the chamber will be taken up by inward flexing of the diaphragm under influence of the well fluid, and means for preventing rotation between the tubular body and the mandrel.

3. A hydraulic well jar, comprising a tubular body adapted to be connected at its upper end to a supporting string of pipe and reciprocably receiving a mandrel which is adapted to be connected at its lower end to a member to be jarred, said body having a fluid-filled chamber connected to a vacant chamber by a bore through which the mandrel extends, means for preventing fluid flow between the mandrel and the walls of the bore, a sudden release hydraulic valve in the fluid-filled chamber carried by the mandrel and cooperable with small and large bores in the fluid-filled chamber to retard and then suddenly release the tubular body from the mandrel in response to an upward pull on the body, one end wall of said vacant chamber constituting a hammer adapted to strike an anvil within said chamber and fixed to said mandrel upon release of the body, and a resilient sleeve-shaped diaphragm fastened at both its ends to the wall

of the fluid-filled chamber and having its exterior in communication with the fluid in the well bore exterior of the tubular body, whereby the space occupied by any fluid leaking from the chamber will be taken up by inward flexing of the diaphragm under the influence of the well fluid.

4. A hydraulic well jar, comprising a tubular body adapted to be connected at its upper end to a supporting string of pipe and reciprocably receiving a mandrel which is adapted to be connected at its lower end to a member to be jarred, said body having a fluid-filled chamber connected to a vacant chamber by a bore through which the mandrel extends, means for preventing fluid flow between the mandrel and the walls of the bore, a sudden release hydraulic valve in the fluid-filled chamber carried by the mandrel and cooperable with small and large bores in the fluid-filled chamber to retard and then suddenly release the tubular body from the mandrel in response to an upward pull on the body, one end wall of said vacant chamber constituting a hammer adapted to strike an anvil within said chamber and fixed to said mandrel upon release of the body, a resilient sleeve-shaped diaphragm fastened at both its ends to the wall of the fluid-filled chamber and having its exterior in communication with the fluid in the well bore exterior of the tubular body, whereby the space occupied by any fluid leaking from the chamber will be taken up by inward flexing of the diaphragm under the influence of the well fluid, and means for preventing rotation between the tubular body and the mandrel.

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