May 17, 1966 M. P. LEBOURG 3,251,426

WELL JAR SYSTEMS

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Fig. 1

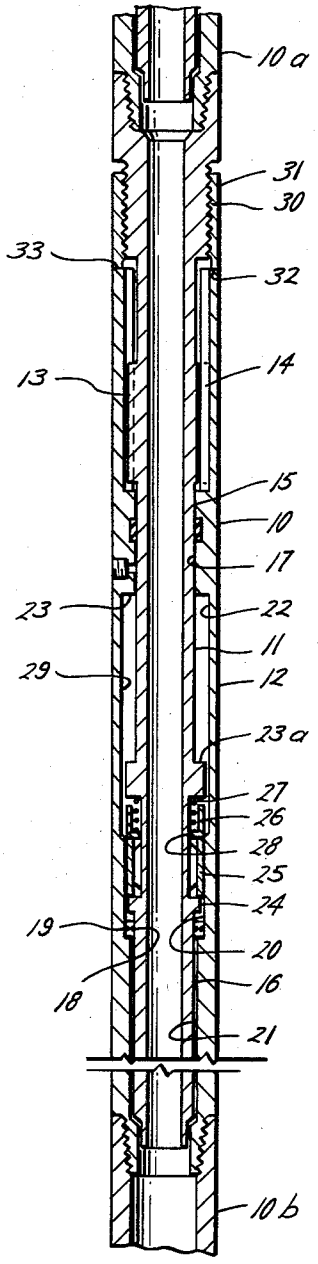


Fig. 2

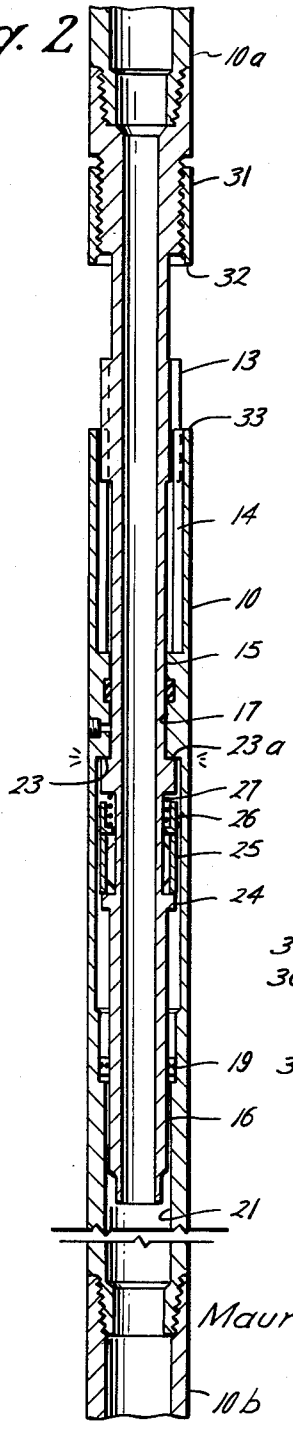


Fig. 3

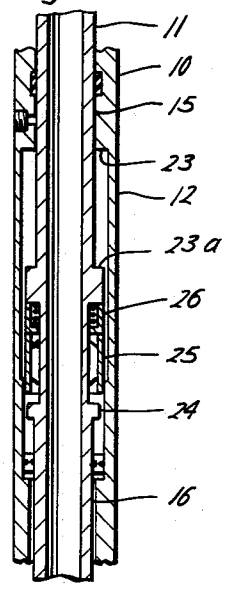
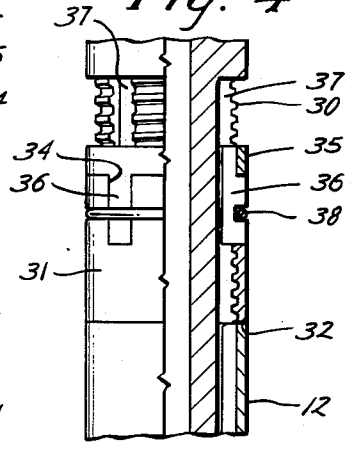


Fig. 4



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Fig. 5

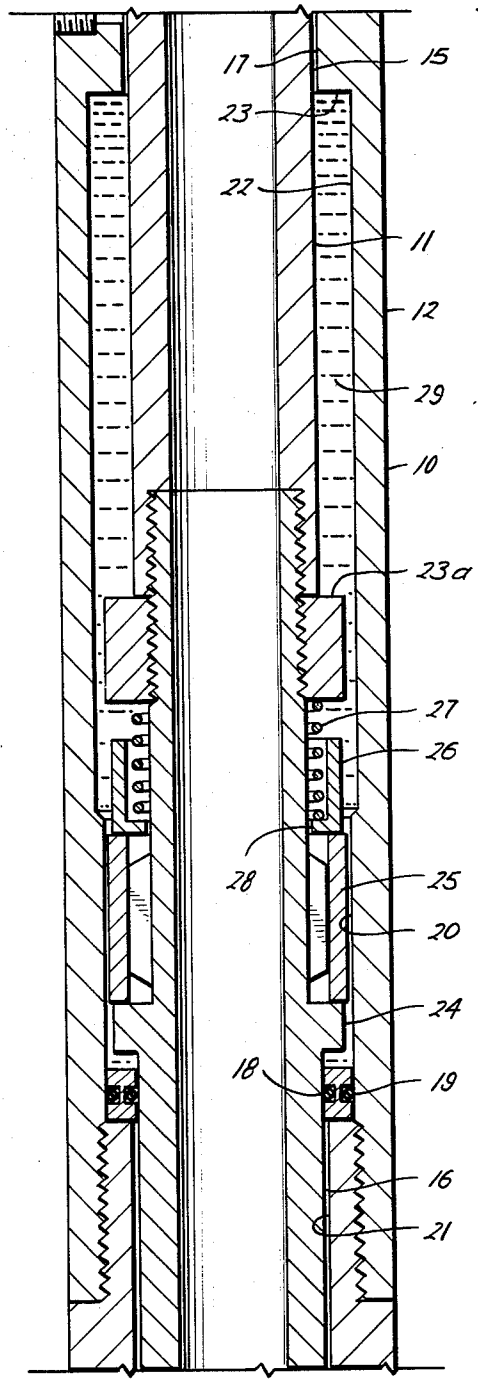
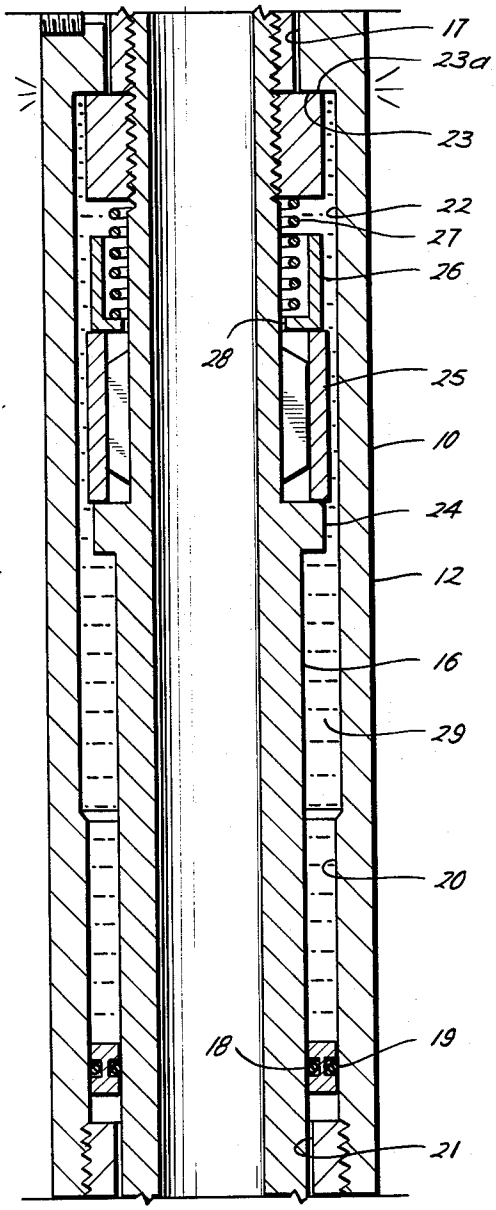


Fig. 6



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WELL JAR SYSTEMS

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9 Claims. (Cl. 175—297)

This invention relates to jars and, more particularly, to hydraulic well jars and methods for using jars in fishing operations in a well bore.

Jars are well-known implements in the oil field industry used in a string of drill pipe for the purpose of providing, when needed, an impact force to a portion of a drill pipe which has become stuck in the well bore. Hydraulic jars operate on the principle of a longitudinally-moving hammer (attached to the drill pipe) striking an anvil (attached to the part stuck in the well). To provide the longitudinal movement and resulting impact force, tension is applied to the drill pipe and the drill pipe is then locked in the drill stand. The initial relative longitudinal movement is retarded by a hydraulic mechanism to permit the tension to be applied and the drill pipe locked in the drilling stand. Following the retarded movement, the hammer is released to accelerate toward and into contact with the anvil. The jar is said to have "tripped" when the hammer is released.

The hydraulic mechanism provides a time delay by a piston moving in a compression bore to compress a hydraulic fluid in a chamber, the rate of movement of the piston being controlled by a fluid metering orifice bypassing the piston. The jar housing is provided with a release bore portion of larger diameter which provides a relatively large fluid bypass and release of the piston in the chamber. As will be appreciated, the compression of the hydraulic fluid produces tremendous forces within the jar and, thus, the tension which can be applied to a jar is limited by the structural limitations of the jar to withstand the hydraulic forces produced therein.

Accordingly, it is an object of the present invention to provide a new and improved drill string jarring system to provide improved jarring impact forces with applied tensions which exceed the mechanical capabilities of a single jar.

Another object of the present invention is to provide new and improved jars in which the delay time before tripping can be regulated.

The well jarring system in accordance with the present system includes the lowering of a well string into a well bore with tandem-connected well jars where each jar is adjusted to provide closely spaced but unequal delay times and applying a tensioning force to the well string to trip the jars in sequence providing sequential jarring impacts thereby increasing the total effectiveness of the jarring forces to the stuck well string.

Apparatus in accordance with the present invention includes a hydraulic well jar having an anvil, a hammer, and hydraulic fluid delay mechanism. In the hydraulic fluid delay mechanism, when tension is applied to the jar, a valved piston fitted relative to a compression bore provides a restricted annular space which regulates the bypass of fluid while the piston compresses fluid in a chamber with a larger bore. As soon as the piston exits from the compression bore into the larger bore, fluid freely bypasses the piston and the hammer is accelerated and comes into contact with the anvil to provide the jarring impact force. To reset the jar, the hammer is moved back to its original position where the valved piston is in the compression bore. During this movement, the valve in the piston provides a large fluid bypass for the hydraulic fluid permitting a quick resetting.

The present invention contemplates simple and effective means for adjusting the time delay of the jar by selective positioning of the valved piston in the compression bore.

The novel features of the present invention are set forth with particularity in the appended claims. The present invention, both as to its organization and manner of operation together with further objects and advantages thereof, may best be understood by way of illustration and example of certain embodiments when taken in conjunction with the accompanying drawing in which:

FIG. 1 discloses a well jar embodying concepts of the present invention showing the valved piston closed and the hammer in the process of being pulled upwardly toward the anvil;

FIG. 2 is a view in cross-section of a well jar embodying the concepts of the present invention similar to FIG. 1 but showing the hammer released and in an engagement with the anvil;

FIG. 3 is a view of the well jar of the present invention showing the hammer being moved downwardly and the valved piston in an open position;

FIG. 4 is a view in detail of means for adjusting the time delay of the well jar of the present invention;

FIG. 5 is an enlarged view of the hydraulic section of the apparatus as shown in FIG. 1; and

FIG. 6 is an enlarged view of the hydraulic section of the apparatus as shown in FIG. 2.

Referring to the accompanying drawing wherein similar reference characters designate similar parts throughout, the hydraulic well jar **10** includes a telescopically-mounted mandrel **11** and housing **12**. The mandrel **11** at its upper end has external splines **13** received within internal splines **14** on the housing permitting rotation of the drill string through the jar and at the same time also permitting longitudinal, nonrotative movement between the housing and mandrel.

The mandrel **11** has upper and lower sections **15**, **16** of identical diameter, the upper section **15** being received within an upper bore **17** in the housing while the lower section is received within the bore **18** of an annular piston **19** slidably mounted within a bore **20** in the housing. Sealing means are provided between the mandrel and housing and for the piston, the equal diameter sections **16**, **17** of the mandrel providing pressure balancing of the mandrel while the piston **19** compensates for volume changes in a fluid received in a hydraulic chamber **29** between the housing and mandrel. The mandrel **11** below the floating piston **19** is sized to a diameter somewhat less than the bore **21** of the housing to permit well bore fluid access to the floating piston.

The housing **12** has an enlarged bore **22** which forms a downwardly facing shoulder **23**, the shoulder being the jar anvil. The mandrel **11** is provided with an annular enlargement with an upwardly-facing shoulder **23***a* forming a hammer.

Valved piston means are provided on the mandrel below the hammer **23***a* in the form of an enlarged flange **24** on the mandrel on which a tubular metal sleeve **25** sets, the abutment of the sleeve with the flange forming a metal-to-metal fluid seal. The sleeve is normally urged toward the enlarged flange by an annular ring **26** slidably received on the mandrel **11** and a spring **27** extending between the ring **26** and lower portion of the mandrel hammer **23***a*. The annular ring **26** has a lower base portion slidably mounted on the mandrel with radial bypass ports **28**. The tubular sleeve **25** is slidably received within a compression bore **20** in the housing which adjoins the enlarged bore **22** of the fluid chamber **29**. Sleeve **25** is slidably mounted on an enlarged splined portion of the mandrel. The fit between the tubular

sleeve and compression bore is such that a restricted annular space is provided to meter fluid past the sleeve.

Operation of the apparatus described thus far is briefly as follows. The jar is coupled in a drill string and permits the usual well drilling or testing operations in a well bore. If the drill string becomes stuck, the operator determines the tension to be applied, pulls the tension on the drill string and locks the drill string at the desired tension in the drill stand. In the jar, the housing **12** is attached to the stuck portion while the mandrel **11** has tension applied thereto. The mandrel first moves slowly upward relative to the housing because the closed-valve piston means compresses the fluid contained in the fluid chamber. The rate of movement is controlled by the rate at which the compressed fluid bypasses the piston between the sleeve **25** and compression bore **20**. Slow movement of the piston means continues until the tubular sleeve **25** exits from the compression bore **20** and the jar is then tripped because fluid may be very rapidly bypassed between the housing **12** and sleeve **25** permitting a rapid relative movement between the mandrel and the housing which terminates with an impact of the hammer upon the anvil as shown in FIG. 2. If the pipe is still stuck, the operator repeats the operation. To reset the jar, the mandrel is moved downwardly (as shown in FIG. 3) and the tubular sleeve **25** will move upwardly so that fluid may bypass between the sleeve **25** and mandrel and permit a quick resetting of the valved piston means to its initial position in the compression bore.

From the preceding discussion, it will be appreciated that the length of time required for tripping the jar is the time required to move the valved piston means out of the compression bore. This time, for a given fluid viscosity and clearance between the tubular sleeve **25** and compression bore **20**, is dependent primarily upon the tension applied. For example, a tension of 40,000 pounds would trip the jar in a shorter time than a tension of 20,000 pounds.

The amount of tension applied to free a stuck member in a well bore is dependent upon many factors such as depth, type of tools in the well, etc. However, it will be appreciated that where less than the maximum tension is applied, the operator wastes valuable time waiting for the jar to trip. Thus, a jarring operation involving a large number of jarring actions, much time can be lost. By means of the present invention, the jar may be selectively adjusted to trip at any selected time. Thus, the operator with his knowledge of the operation can preset the jar to trip for predetermined tensions at predetermined times. To accomplish this, the upper end of the mandrel **11** has a threaded portion **30** which threadedly receives an adjustment sleeve **31**. The sleeve **31** has a lower end **32** which bears upon the upper end **33** of the housing. For the position shown, for example, in FIG. 1, it will be appreciated that a certain amount of time will be required for the valved piston means to exit from the compression bore for a given tension. To change this time, the adjustment sleeve **31** is rotated and thus moves the mandrel **11** and valved piston means upward relative to the housing thereby decreasing the time required for the sleeve **25** to exit from the compression bore by decreasing its length of travel to exit from the compression bore.

As shown in FIG. 4, the adjusting sleeve **31** has at its upper end one or more longitudinally-extending slots **34**. An annular ring member is slidably received over the threaded portion **30** and carries therewith one or more keying members **36** which fit into slots **34**. The threaded portion **30** of mandrel **11** also has one or more longitudinally-extending slots **37** which receive key members **36**. It will be appreciated that the key members **36** interconnect the sleeve **31** and mandrel **11** and prevent rotation therebetween. If the ring member **35** and connected keys **36** are slid upwardly, the keys **36** are displaced from the sleeve slots **34** permitting rotation of the sleeve relative to the mandrel and adjustment of the mandrel **11** relative to the housing **12**. Upon proper positioning of the sleeve, the ring member **35** and connected keys **36** are once again used to lock the sleeve **31** relative to the mandrel. To lock the slidable ring member **35** in a locking position, the sleeve **31** and keys **36** are circumferentially grooved to receive a snap ring **38**. Of course, the relationship of the slots and keys are such that a number of adjustments can be made.

It will now be appreciated that where jars are tandem connected in a drill string, the various jars can be set to trip at different times. As shown in FIG. 1, jar **10***a* can be tandem connected to jar **10**, and a fishing tool **10***b* can be connected to the lower jar **10**. The adjustment sleeve of one jar is set so that one jar trips in a shorter time than the other jar. Then, in operation, one jar trips first providing a first impact force followed by the tripping of another jar providing a second impact force. Of course, multiple arrangements of jars could be used, each with slightly different tripping times, as well as only two jars in tandem.

While particular embodiments of the present invention have been shown and described, it is apparent that changes and modifications may be made without departing from this invention in its broader aspects and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

What is claimed is:

1. A hydraulic well jar including telescopically-mounted mandrel and housing members movable between contracted and extended positions, said members respectively having an anvil and hammer, said anvil being spaced from said hammer when said members are in a contracted position and arranged for contact when said members are in an extended position, hydraulic means in said jar for retarding movement of said mandrel member relative to said housing member between a contracted and extended position for a given time, and selectively adjustable means connected to said mandrel member and engageable with said housing member when said members are in a contracted position for adjusting the operation of said hydraulic means to vary said given time.

2. The apparatus of claim **1** wherein said hydraulic means includes a fluid-filled chamber in said housing member with adjoining first and second bores, said first bore having a lesser diameter than said second bore, and a piston on said mandrel member received in said first bore, said piston having a slightly smaller diameter than said first bore to restrict the flow of fluid past said piston as it moves relative to said first bore until said piston exits from said first bore, and wherein said means for adjusting the operation of said hydraulic means includes an adjustment sleeve on said mandrel member and in contact with said housing member when said mandrel and housing members are in a contracted position, and means for selectively positioning said sleeve longitudinally relative to said mandrel member.

3. The apparatus of claim **2** wherein said means for selectively positioning said sleeve relative to said mandrel member includes a threaded connection between said sleeve and said mandrel member.

4. The apparatus of claim **3** and further including means for locking said sleeve in position relative to said mandrel member.

5. The apparatus of claim **4** wherein said means for locking includes a slot in said mandrel and sleeve and a key received in said slot.

6. A hydraulic well jar including telescopically-mounted mandrel and housing members arranged for movement between contracted and extended positions, said members respectively having an anvil and hammer spaced apart in said contracted position and in contact in said extended position, hydraulic means in said jar for retarding initial movement of said mandrel member rela-

tive to said housing member from said contracted position to said extended position and including a sleeve received in a compression bore and forming a restricted flow passage therebetween as long as said sleeve is in said compression bore, and means connected between said mandrel member and said housing member for changing the relative position of said sleeve in said compression bore when said members are in a contracted position.

7. A hydraulic well jar including telescopically-mounted mandrel and housing members, said members respectively having an anvil and hammer spaced from one another and adapted to be moved from a first spaced-apart position to a second contacting position, hydraulic means to retard initial relative movement of said hammer and anvil between said first and second positions including a compression bore in said housing and piston valve means in said compression bore where the position of said piston valve means in said compression bore determines the time that relative movement is retarded, and means on said mandrel and housing for changing the position of said piston valve means in said compression bore to change the time that relative movement is retarded.

8. A well tool having telescopically-mounted mandrel and housing members arranged for limited movement between contracted and extended positions, means for limiting the relative movement of said members to said contracted and extended positions, hydraulic means to retard relative movement of said members for a part of relative movement between said positions for a given time, and means for adjusting said hydraulic means and therefore varying said given time, said means for adjusting said hydraulic means including a sleeve adjustably arranged between said mandrel and housing members for limiting the relative movement of said members when said members are in a contracted position.

9. A hydraulic well jar including telescopically mounted mandrel and housing members movable between contracted and extended positions, said members having anvil and hammer means thereon, said anvil being spaced from said hammer when said members are in a contracted position and arranged for contact when said members are in an extended position, a sealed hydraulic chamber between said members and adapted to receive a hydraulic fluid, hydraulic means in said chamber coupled to one of said members and movable relative to the other of said members, said hydraulic means cooperating with said members when moved a first relative distance from said extended position toward said contracted position to compress fluid in said chamber and permit a limited bypass of fluid and cooperating with said members when moved beyond said first distance to permit a relatively free bypass of fluid, and means for adjusting the hydraulic means in said chamber to change the length of said first distance of travel.

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