Oct. 17, 1961 B. P. NUTTER ET AL 3,004,616

JAR

Filed Sept. 27, 1956 2 Sheets-Sheet 1

FIG-1

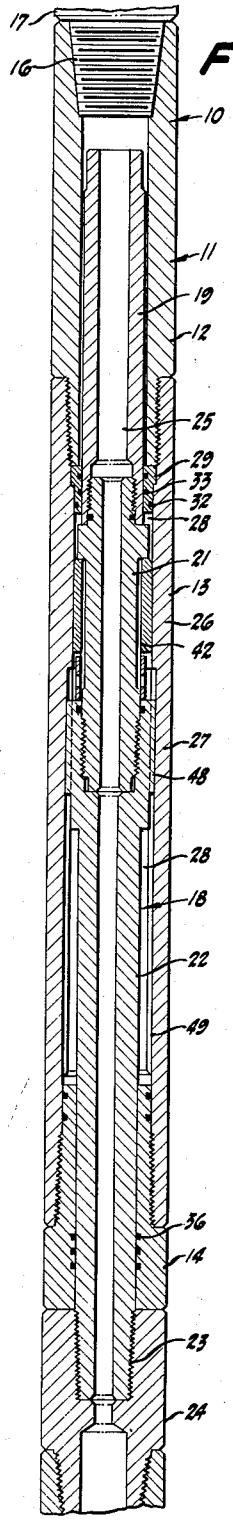


FIG-3

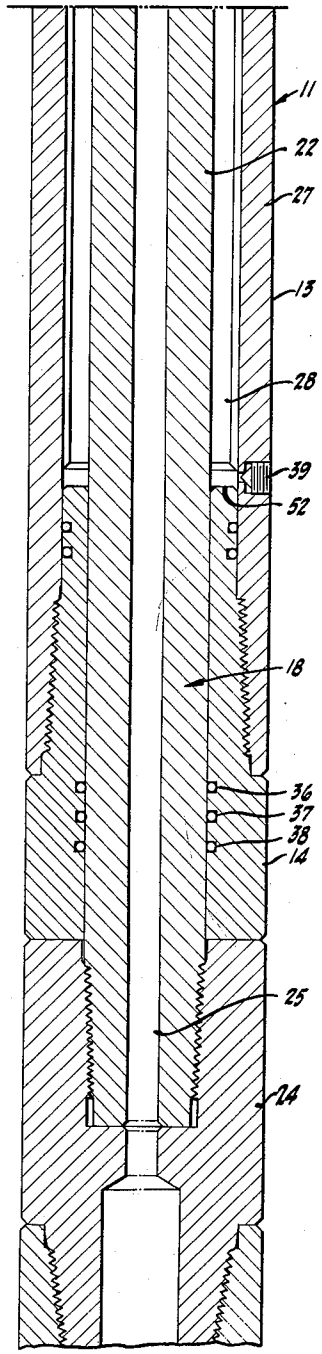
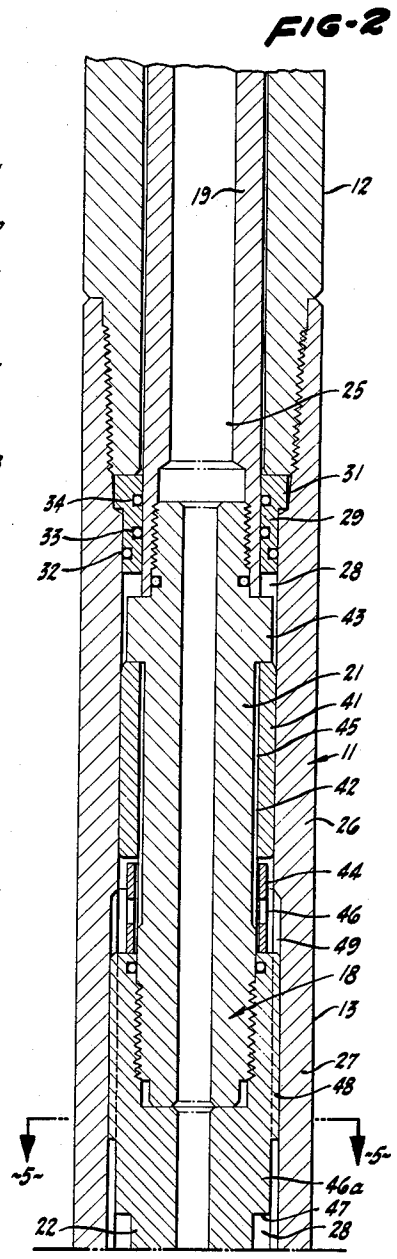


FIG-2



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JAR

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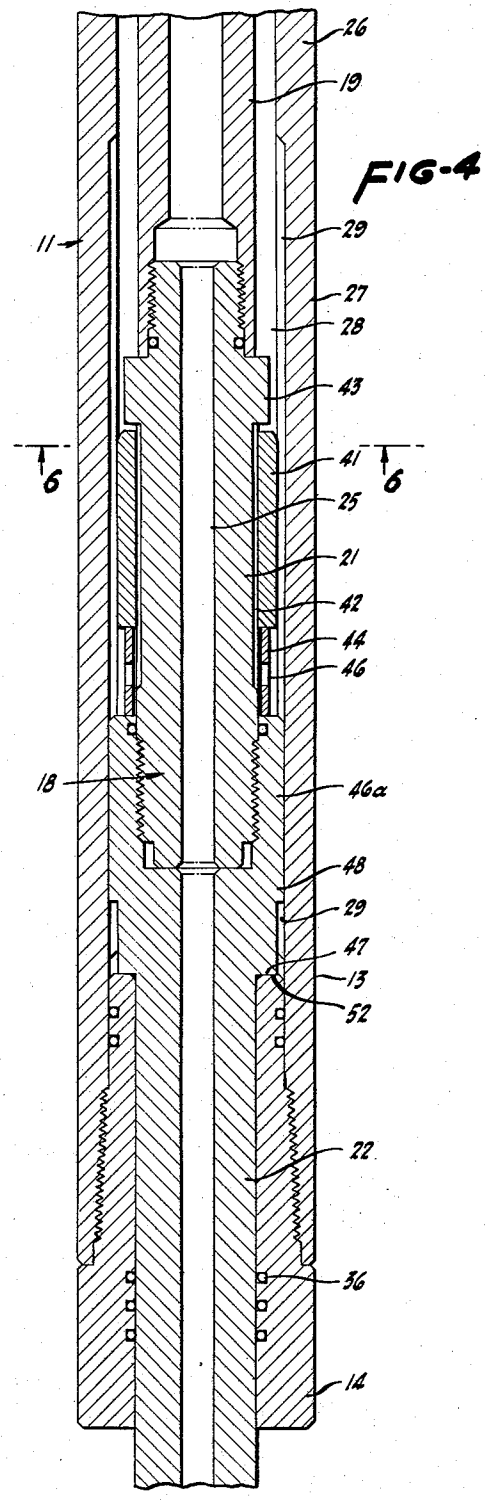


FIG-4

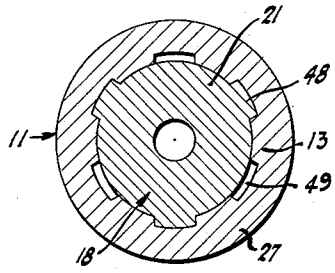


FIG-5

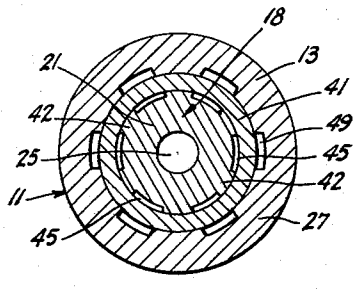


FIG-6

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JAR

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This invention relates to well jars and, more specifically, to well jars of the hydraulic type for use with oil well testing equipment.

In carrying on oil well testing procedures, various testing tools and one or more packers are connected to a pipe string and lowered into a well bore. The packers are set to seal off the well bore and standard testing procedures are followed, using the testing tools. At the end of the test, the packers are released and the pipe string is removed from the well. Sometimes, however, the packer or tools below it may become stuck in the well. To overcome this problem, a jar is often connected in the pipe string above the upper packer where it may be operated to free the stuck object so that the pipe string may be removed. If a jar is not placed in the pipe string, there is the danger that the pipe string may be broken in attempting to remove it by a manipulation of the pipe string alone. Thus, a pipe string may often be freed by repeated impacts of a jar, although stuck too tight to be freed by straight tensioning.

From the foregoing, it would appear that it would always be advisable to insert a jar in the pipe string in the eventuality that testing equipment becomes stuck in the well bore, but in practical usage this is not always done. The jar is but one of many tools to be connected at the end of the pipe string, and the total length of the tools is an important practical consideration to be weighed in determining what elements are to be used. Hence, the utilization of many existing jars is restricted because of their overall length.

Therefore, it is an object of this invention to provide a new and improved jar having a minimum overall length and, hence, a greater utility in well testing operations.

It is a further object of this invention to provide a new and improved hydraulic jar utilizing fixed packing retainers for the hydraulic fluid chambers and having rotation prevention splines arranged to require no extension of the overall length.

It is a further object of this invention to provide a new and improved hydraulic jar of economical and rugged construction adapted to be readily maintained.

In accordance with the present invention, a well jar is provided which includes a mandrel and an annular housing together defining a fluid chamber through which the mandrel extends. The housing has a grooved and an ungrooved bore portion of like diameter defining the outer wall of the chamber. A valve member carried by the mandrel moves from within the ungrooved position to within the grooved portion providing first for a restricted flow of fluid, then for a rapid flow as the jar is extended. An anvil is also carried by the mandrel and has longitudinally extending splines thereabout which are retained in the grooved portion to lock said mandrel and housing against relative rotation. An impact face on the mandrel strikes an impact face on the housing to terminate extension of the jar and to impart a jarring blow to an object connected by the jar to the lower end of a drill string.

Other objects and advantages will become apparent in the following detailed description.

In the accompanying drawings, forming a part of this application, and in which like numerals are used to designate like parts throughout the same,

FIG. 1 is a sectional elevational view of a jar embodying the invention;

FIGS. 2 and 3 are sectional elevational views of the upper and lower parts, respectively, of the jar of FIG. 1 on an enlarged scale, showing the jar in collapsed position;

FIG. 4 is a partial sectional elevational view similar to FIGS. 2 and 3, showing the jar in extended position;

FIG. 5 is a cross-sectional view of the jar taken on line 5—5 of FIG. 2; and

FIG. 6 is a cross sectional view of the jar taken on line 6—6 of FIG. 4.

In the drawings, there is shown for the purpose of illustrating a preferred embodiment of the invention, a jar which comprises an annular housing member 11 having an upper section 12, a middle section 13, and a hammer sub 14, each being threadedly connected to the adjacent section. The upper housing section 12 is provided with internal threads 16 adapted to receive the lower end of a pipe string 17.

A mandrel 18, having an upper wash mandrel section 19, an intermediate section 21, and a lower section 22, is internally and concentrically received within the housing member 11 for limited longitudinal movement as a unit with respect to the housing member. The bottom end of the mandrel 18 is provided with external threads 23 adapted to be connected to conventional testing equipment 24. A central bore 25 provides a fluid passage lengthwise through mandrel 18.

The housing section 13 has upper and lower portions 26 and 27 of unequal length but with equal internal diameters, these portions forming, with the mandrel 18, a hydraulic fluid chamber 28. The chamber 28 is sealed at the top by a packing member 29 fixed by means of an annular external flange 31 to the housing member 11 by the screw connection of housing sections 12 and 13. An O-ring 32 seals against fluid flow from the chamber 28 past the outer surface of packing member 29, and O-rings 33 and 34 prevent fluid flow between the mandrel 18 and the packing member 29. The lower end of chamber 28 is sealed by means of O-rings 36, 37 and 38 which prevent fluid flow between the hammer sub 14 of housing member 11 and mandrel 18. The mandrel 18 has the same external diameter at the upper sealing member 29 and at lower sealing rings 36, 37 and 38, and thus the chamber volume is maintained constant regardless of the relative longitudinal positions of the mandrel and the housing member. A plug 39 allows the chamber 28 to be filled with a suitable hydraulic fluid.

Surrounding the intermediate mandrel section 21 is an annular valve member 41 having an external diameter slightly less than the internal diameter of the relatively short upper portion 26 of the middle housing section 13 to allow a restricted flow of fluid between the valve member 41 and the portion 26. The valve member 41, as seen in FIGS. 2 and 6, has an internal diameter substantially greater than the outer diameter of the corresponding portion of mandrel section 21 and is centered for sliding movement along the mandrel section by circumferentially spaced longitudinal splines 42 formed on said mandrel section, such splines having cylindrical outer surfaces slidably fitted within valve member 41. An outwardly extending annular valve seat 43 is formed on the mandrel section 21 to limit the upward movement of valve member 41 and to shut off fluid flow through grooves 45 formed in circumferentially spaced relation between the splines 42 when the valve member 41 is forced against the valve seat 43. An annular valve stop 44 surrounds the mandrel section 21 below the valve member 41 and limits downward movement of the valve member to a travel sufficient to open the valve. The internal diameter of the valve stop member 44 corre-

sponds to the internal diameter of the valve member **41**, and lateral bores **46** formed through the valve stop member allow fluid communication from the chamber **28** to the grooves **45** between the valve member **41** and mandrel section **21** when the valve member rests against the valve stop member **44**.

The mandrel section **22** is radially enlarged at its upper end to form an anvil **46***a* having an annular downwardly facing impact face **47**. Longitudinal splines **48** are formed on the external surface of anvil **46***a*, extending short of the impact face **47**, and mating with grooves **49** formed longitudinally of the inner surface of the relatively long lower portion **27** of the section **13**. These splines and grooves prevent relative rotation between the mandrel **18** and housing member **11**, while permitting limited relative longitudinal movement therebetween. As will be seen in FIG. 5, the housing portion **27** has a greater number of grooves **49** than the anvil **46***a* has splines and thus there is relatively free fluid communication from one side of anvil **46***a* to the other in chamber **28** through the unoccupied grooves **49**.

The hammer sub **14** of housing member **11** has an upwardly directed impact face **52** adapted to contact the anvil impact face **47** when the jar **10** is pulled into its extended position.

The jar is assembled as in FIG. 1 with the chamber **28** being filled with hydraulic fluid, and is connected to the lower end of a pipe string **17** and to the upper end of a packer element **24** of a conventional tester. If at the end of a test the packer, or any of the other testing elements, is stuck in the well bore, the stuck object may be jarred loose in the following manner. A steady stress is applied to the upper end of the well string, thus urging the housing member **11** upwardly while the mandrel **18**, being connected to the stuck object, remains stationary. As the housing portion **26** moves upwardly with respect to valve member **41**, the valve member is urged against the valve seat **43** and the fluid in the lower portion of chamber **28** is subjected to pressure. Since the fluid is essentially non-compressible, no relative movement results between the housing member **11** and mandrel **18** except that provided by the transfer of fluid from the lower to the upper side of the valve member through the restricted passage between the valve member and housing portion **26**. A certain length of time is required for the valve member **41** to move out of the housing portion **26**, and during this time the upward pull on the pipe string imparts a stretch to the pipe string. At the instant the valve member **41** clears the housing portion **26**, a relatively free passage is provided for the compressed fluid in the lower section of chamber **28** around the valve member **41** and the stretched pipe contracts upwardly, causing the housing member **11** to suddenly rise with respect to the mandrel to the extended position shown in FIG. 4. The hammer sub impact face **52** strikes the anvil impact face **47**, thus imparting a violent blow to the mandrel **18** and the stuck object to which it is connected.

If this one blow is insufficient to dislodge the stuck object, the housing member **11** is again lowered. The valve member **41** moves downwardly against the valve stop member, thus providing a relatively unobstructed flow path to the fluid in the upper end of chamber **28** to the lower end of that chamber. With the jar **10** again in a collapsed position, another upward blow may be imparted to the stuck object as discussed previously. Successive blows may be generated until the stuck object becomes dislodged.

It will be noted that the overall length of the jar **10** is kept to a minimum by using a fixed packing member **29** instead of a floating packing retainer, the latter requiring an additional length of housing in which to float, and by the disposition of the mandrel splines **48** and housing member grooves **49** completely within the lower portion of the fluid chamber **28**. By this arrangement, the overall length of the jar **10** need be only enough to allow for the length of the fluid chamber **28** and the extendible length of the mandrel **18** with respect to the housing member **11**.

The provision that the mandrel splines **48** terminate short of the anvil impact face **47** insures that no impact will be delivered to the splines **48** upon the sudden extension of the jar, and thus eliminates the possibility that the relatively thin splines will be sheared from the anvil upon impact.

It is to be understood that the form of the invention, herewith shown and described, is to be taken as a preferred embodiment of the same, and that various changes in the shape, size and arrangement of parts may be resorted to, without departing from the spirit of the invention, or the scope of the attached claims.

We claim:

1. A well jar comprising an annular housing member and a cylindrical mandrel concentrically carried therein, said housing member and said mandrel being interfitted for limited longitudinal movement relative to each other between a contracted position and an extended position, said housing member and said mandrel providing opposite ends for said jar adapted for connection in a pipe string above an object which may become stuck in a well bore, annular seal means of like diameter spaced longitudinally apart for effecting a sliding seal between said housing member and mandrel to define an annular closed fluid-filled chamber therebetween with said mandrel extending completely through said closed chamber, said housing member having grooved and ungrooved portions of equal internal diameter forming the outer wall of said chamber, an enlarged portion of said mandrel intermediate the ends of said chamber having a valve seat thereon, a valve member carried by said mandrel and movable between a closed and an open position with respect to said seat by fluid pressure as said mandrel is extended and contracted, respectively, said valve member cooperating with the ungrooved portion of said outer chamber wall to restrict fluid flow past said enlarged portion in its closed position and to enhance fluid flow therepast in its open position, and an annular anvil carried by said mandrel slidably within said grooved portion of said outer chamber wall and closed to fluid flow therethrough, said grooved portion of said outer chamber wall providing unrestricted fluid flow around said anvil and around said enlarged portion when said jar is proximate to its extended position, said anvil and said housing member having confronting impact faces adapted to contact when said mandrel and housing member move to said extended position, said anvil having at least one spline engaged in said grooved portion of said outer chamber wall to prevent rotation between said mandrel and said housing member.

2. A well jar comprising an annular housing member and a mandrel concentrically carried therein, said housing member and said mandrel being interfitted for limited longitudinal movement relative to each other between a contracted position and an extended position, said housing member and said mandrel providing opposite ends for said jar adapted for connection in a pipe string above an object which may become stuck in a well bore, seal means of like diameter spaced longitudinally apart for effecting a sliding seal between said housing member and mandrel to define an annular closed fluid chamber therebetween with said mandrel extending completely through said closed chamber, said housing member having grooved and ungrooved portions of equal internal diameter forming the outer wall of the chamber, an enlarged portion of said mandrel intermediate the ends of said chamber providing a valve seat, a valve member movable between a closed and an open position with respect to said seat by fluid pressure as said mandrel is extended and contracted, said valve member cooperating with the ungrooved portion of said outer fluid chamber wall to restrict fluid flow past said enlarged portion in

its closed position and to enhance fluid flow therepast in its open position, said groove portion of said outer chamber wall providing unrestricted fluid flow around said enlarged portion and valve member when said jar is proximate to its extended position, and an anvil carried by said mandrel and disposed within said grooved portion, said anvil and said housing member having confronting impact faces adapted to contact when said mandrel and housing member move to said extended position, said anvil having at least one spline for engaging said grooved portion to prevent rotation between said mandrel and said housing member, each such anvil spline terminating short of said anvil impact face and being retained in said grooved portion.

3. A well jar comprising an annular housing member and a sectional tubular mandrel concentrically carried therein, said housing member and said mandrel being interfitted for limited longitudinal movement relative to each other between a contracted position and an extended position, said housing member and said mandrel providing opposite ends for said jar adapted for connection in a pipe string above an object which may become stuck in a well bore, seal means of like diameter spaced longitudinally apart for effecting a sliding seal between said housing member and mandrel to define an annular closed fluid-filled chamber therebetween with said mandrel extending completely through said closed chamber, said housing member having grooved and ungrooved portions of equal internal diameter forming the outer wall of said chamber, an enlarged portion of one section of said mandrel intermediate the ends of said chamber having a valve seat thereon, a valve member carried by said mandrel and movable between a closed and an open position with respect to said seat by fluid pressure as said mandrel is extended and contracted, respectively, said valve member cooperating with the ungrooved portion of said outer chamber wall to restrict fluid flow past said enlarged portion in its closed position and to enhance fluid flow therepast in its open position, and an annular anvil integrally carried by a second section of said mandrel slidably within said grooved portion of said outer chamber wall and closed to fluid flow therethrough, said grooved portion of said outer chamber wall providing unrestricted fluid flow around said anvil and around said enlarged portion when said jar is proximate to its extended position, said anvil and said housing member having confronting impact faces adapted to contact when said mandrel and housing member move to said extended position, said anvil having at least one spline engaged in said grooved portion of said outer chamber wall to prevent rotation between said mandrel and said housing member, said ungrooved portion of said housing member being substantially shorter than said grooved portion, said anvil threadedly receiving an end of said one mandrel section to connect said second section therewith, and said enlarged portion and said valve member being completely received within said ungrooved portion when said jar is fully contracted.

4. A well jar comprising an annular housing member and a mandrel concentrically carried therein, said housing member and said mandrel being interfitted for limited longitudinal movement relative to each other between a contracted position and an extended position, said housing member and said mandrel providing opposite ends for said jar adapted for connection in a pipe string above an object which may become stuck in a well bore, seal means spaced longitudinally apart for effecting a sliding seal between said housing member and mandrel to define an annular closed fluid chamber therebetween with said mandrel extending completely through said closed chamber, said seal means having a fixed longitudinal spacing and the same effective diameter, said housing member having grooved and ungrooved portions of equal internal diameter forming the outer wall of the chamber, an enlarged portion of said mandrel intermediate the ends of said chamber providing a valve seat of annular configuration carried by said mandrel, a valve member of annular configuration slidable a limited longitudinal distance along said mandrel between a closed and an open position with respect to said seat by fluid pressure as said mandrel is extended and contracted, said valve seat sealing with said valve member when said mandrel and housing member are being extended, said valve member cooperating with the ungrooved portion of said outer fluid chamber wall to restrict fluid flow past said enlarged portion in its closed position and to enhance fluid flow therepast in its open position, said grooved portion of said outer chamber wall providing unrestricted fluid flow around said enlarged portion and valve member when said jar is proximate to its extended position, and an anvil carried by said mandrel and disposed within said grooved portion, said anvil and said housing member having confronting impact faces adapted to contact when said mandrel and housing member move to said extended position, said anvil having at least one spline for engaging said grooved portion to prevent rotation between said mandrel and said housing member.

5. A well jar comprising an annular housing member and a mandrel concentrically carried therein, said housing member and said mandrel being interfitted for limited longitudinal movement relative to each other between a contracted position and an extended position, said housing member and said mandrel providing opposite ends for said jar adapted for connection in a pipe string above an object which may become stuck in a well bore, seal means spaced longitudinally apart for effecting a sliding seal between said housing member and mandrel to define an annular closed fluid chamber therebetween with said mandrel extending completely through said closed chamber, said seal means having a fixed longitudinal spacing and the same effective diameter, said housing member having grooved and ungrooved portions of equal internal diameter forming the outer wall of the chamber, an enlarged portion of said mandrel intermediate the end of said chamber providing a valve seat of annular configuration carried by said mandrel, a valve member of annular configuration slidable a limited longitudinal distance along said mandrel between a closed and an open position with respect to said seat by fluid pressure as said mandrel is extended and contracted, said valve seat sealing with said valve member when said mandrel and housing member are being extended, said valve member cooperating with the ungrooved portion of said outer fluid chamber wall to restrict fluid flow past said enlarged portion in its closed position and to enhance fluid flow therepast in its open position, said grooved portion of said outer chamber wall providing unrestricted fluid flow around said enlarged portion and said valve member when said jar is proximate to its extended position, and an anvil carried by said mandrel and disposed within said grooved portion, said anvil and said housing member having confronting impact faces adapted to contact when said mandrel and housing member move to said extended position, said anvil having at least one spline for engaging said grooved portion to prevent rotation between said mandrel and said housing member, an annular apertured stop member disposed around said mandrel intermediate said valve member and said anvil, said mandrel being relieved to provide a passage extending beneath said valve member and terminating interiorly of said stop member for the flow of fluid therethrough when said jar is being contracted.

6. A well jar comprising an annular housing member and a mandrel concentrically carried therein, said housing member and said mandrel being interfitted for limited longitudinal movement relative to each other between a contracted position and an extended position, means adapted to connect one end of the housing member to a pipe string, means adapted to connect the op-

posite end of the mandrel to an object which may become stuck in a well bore, seal means of like diameter spaced longitudinally apart for effecting a sliding seal between said housing member and mandrel to define an annular closed fluid chamber therebetween with said mandrel extending completely through said closed chamber, said housing member having adjacent grooved and ungrooved portions extending longitudinally of the chamber, an annular valve member surrounding said mandrel and adapted to be received in the ungrooved portion of said housing member when the well jar is in its contracted position, the outer diameter of said valve member being slightly smaller than the diameter of said ungrooved portion to permit restricted fluid flow between the valve member and said ungrooved portion, said valve member having an inner bore cooperating with the underlying portion of said mandrel to define a passage extending lengthwise beneath said valve member, a valve seat of annular configuration on an enlarged portion of said mandrel intermediate the ends of said chamber, said valve member being adapted to seat on said valve seat, an annular valve stop member surrounding said mandrel and adapted to allow said valve to move a limited distance from said valve member seat, passage means in said valve stop member allowing fluid communication from the passage provided between said mandrel and said valve member to the outer surface of said valve stop member, said valve member being adapted to be completely received in the grooved portion of said housing member when said jar is in extended position, an anvil having an impact face carried by said mandrel and disposed within said grooved housing portion, said anvil serving to position said valve stop member with respect to said mandrel, said housing member having an impact face defining the lower end of said chamber and adapted to contact the impact face of said anvil when said mandrel and housing member move to said extended position, and a plurality of splines formed longitudinally of said anvil and received in said grooved housing portion to prevent relative rotation between said mandrel and said housing member, said grooved portion affording a longitudinal passage for the passage of fluid around said anvil and said valve member.

7. A well jar comprising an annular housing member and a mandrel concentrically carried therein, said housing member and said mandrel being interfitted for limited longitudinal movement relative to each other between a contracted position and an extended position, said housing member and said mandrel providing opposite ends for said jar adapted for connection in a well string above an object which may become stuck in a well bore, seal means of like diameter spaced longitudinally apart for effecting a sliding seal between said housing member and mandrel to define an annular closed fluid-filled chamber therebetween with said mandrel extending completely through said closed chamber, said housing member having grooved and ungrooved portions of equal internal diameter forming the outer wall of said chamber, an enlarged portion of said mandrel intermediate the ends of said chamber having a valve seat thereon, a valve member carried by said mandrel and movable between a closed and an open position with respect to said seat by fluid pressure as said mandrel is extended and contracted, said valve member cooperating with the ungrooved portion of said outer chamber wall to restrict fluid flow past said enlarged portion in its closed position and to enhance fluid flow therepast in its open position, and an annular anvil carried by said mandrel slidably within said grooved portion of said outer chamber wall, said grooved portion of said outer chamber wall providing unrestricted fluid flow around said anvil and around said enlarged portion when said jar is proximate to its extended position, said anvil and said housing member having confronting impact faces adapted to contact when said mandrel and housing member move to said extended position, said mandrel carrying at least one spline engaged in said grooved portion of said outer chamber wall along a length of said wall which overlaps substantially with the length thereof traversed by said enlarged portion in movement of said mandrel from its contracted to its extended position, thereby to prevent rotation between said mandrel and said housing member.

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