May 31, 1938. E. F. RAYMOND 2,118,982

JAR

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Fig. 1.

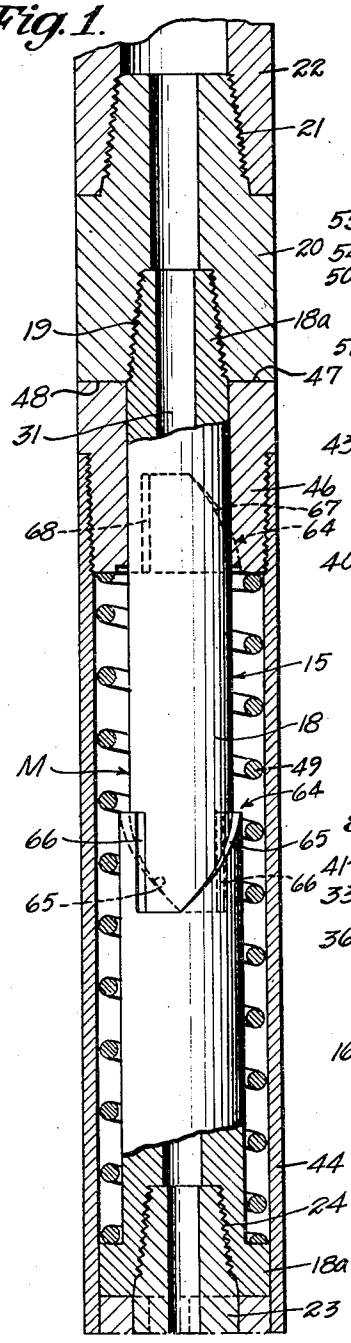

Fig. 2.

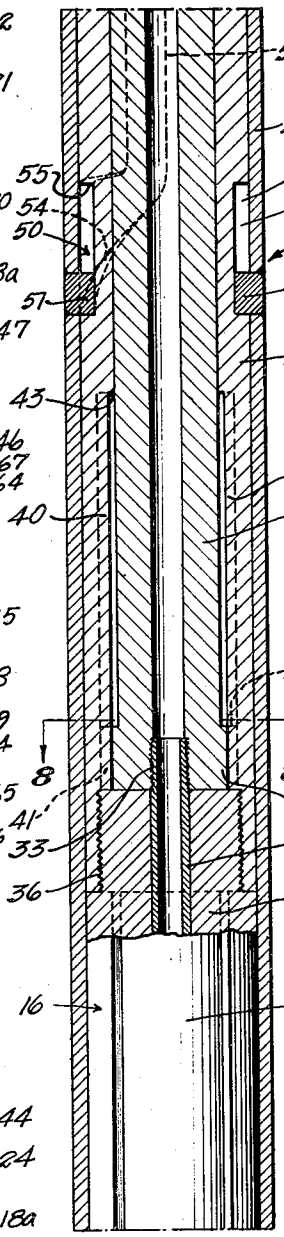

Fig. 3.

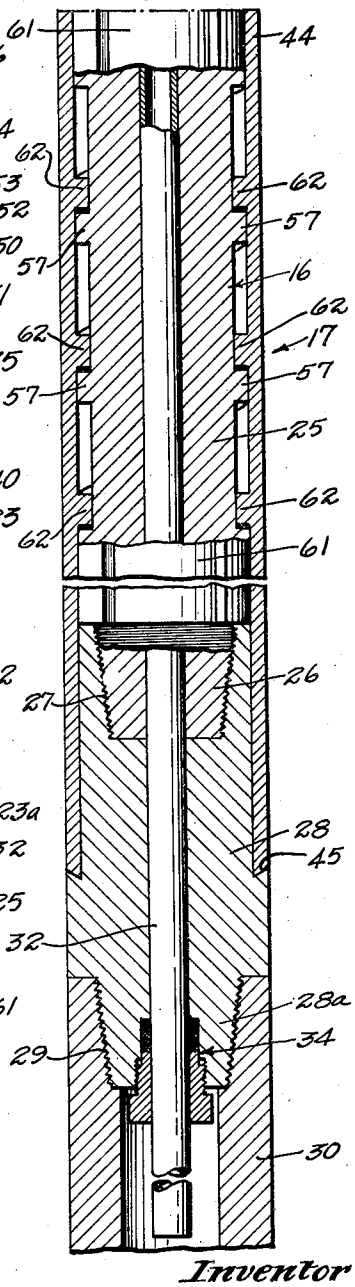

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Fig.4.

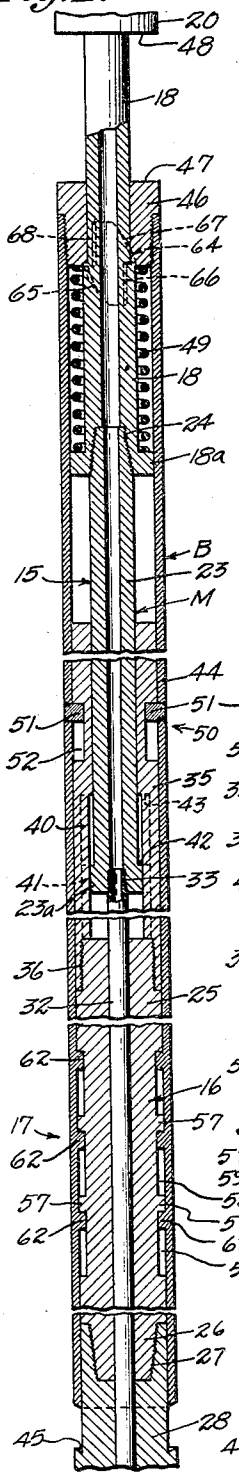


Fig.5.

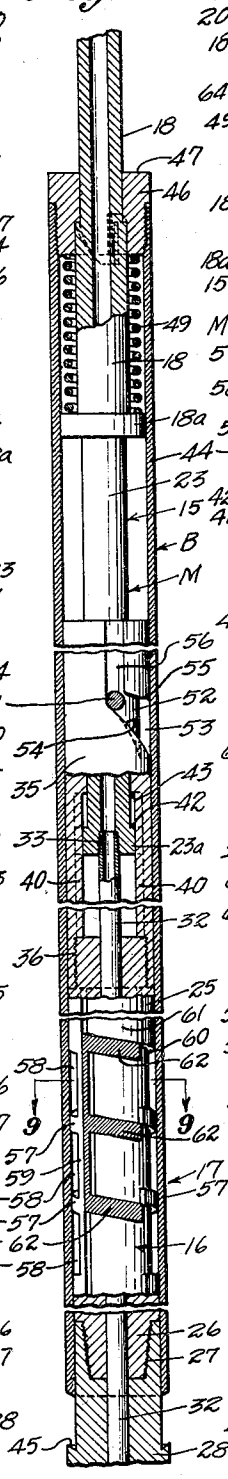


Fig.6.

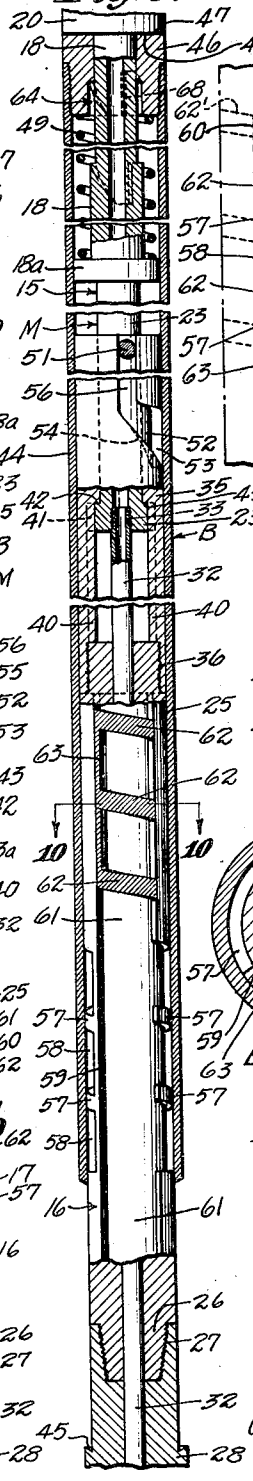


Fig.7

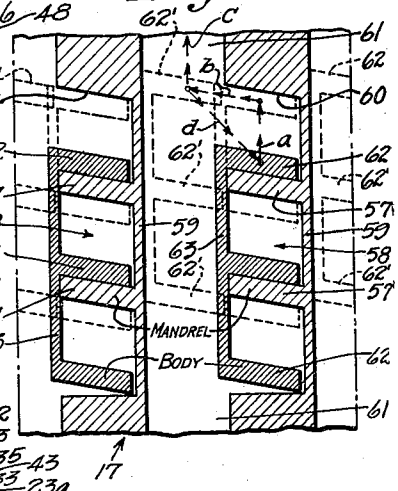


Fig.8

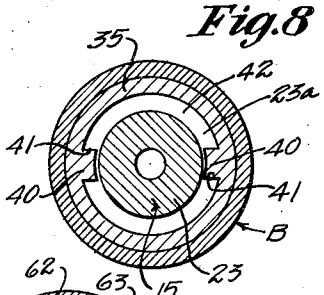


Fig.9.

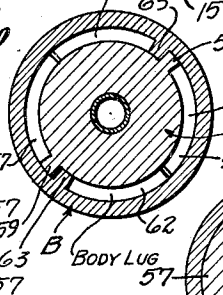
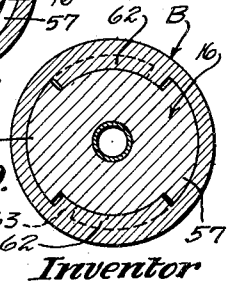


Fig.10.



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Patented May 31, 1938

2,118,982

UNITED STATES PATENT OFFICE

2,118,982

JAR

Edward F. Raymond, Huntington Park, Calif., assignor to John Grant, Los Angeles, Calif.

Application April 4, 1936, Serial No. 72,753

17 Claims. (Cl. 255—27)

This invention deals generally with rotary jars for use in conjunction with oil well tools, and has for its primary object to provide an improved multiple jarring tool that operates to deliver a plurality of upwardly directed blows acting to dislodge the fish.

In the operation of the usual type of jar, an upward pull and stretch is taken on the drill string until a sufficient tension is exerted to cause the jar parts to release and deliver a single blow. If a second blow is required, it is necessary to reset the jar by lowering the drill string until the jar detent parts come into reengagement after which the first described operation is repeated. Thus in any single operation, the ordinary jar is capable of delivering only a single blow.

The present tool differs characteristically in that it is capable of delivering in a single jarring operation and after the jar is put under tension by stretching the drill pipe, two rapidly succeeding blows. Operating in this manner, the jarring efficiency is superior to that of the usual single blow jar, in that no opportunity is given the fish to sink back into the sand after the first blow. The second blow follows immediately afterward, and is communicated to the fish at an instant when it is in a condition of greatest partial dislodgment resulting from the first blow. In addition to the advantage of having a multiple jarring action, my improved jar retains the practical advantages, from the standpoint of simplicity in operation, of the straight pull type jar, that is, one which is capable of release and resetting by straight up and down movement of the drill string.

The invention has various additional features and objects both with reference to structural details and characteristics of operation, but all these will be understood to best advantage without necessity for further preliminary discussion, from the following description of the invention in one of its typical and preferred forms. Reference is had throughout the description to the accompanying drawings, in which:

Figs. 1, 2 and 3 are vertical sectional views in downward progression in the order named, showing the jar parts in drilling position;

Fig. 4 is a reduced scale longitudinal section showing the jar parts positioned preparatory to releasing of the detent mechanism;

Fig. 5 is a view similar to Fig. 4, showing the parts of the detent mechanism at the point of release;

Fig. 6 is a similar view illustrating the jar parts in released position;

Fig. 7 is a developed view showing the relative positions of the body and mandrel lugs at different positions during relative movement between the body and mandrel;

Fig. 8 is a cross section on line 8—8 of Fig. 2; and

Figs. 9 and 10 are enlarged cross sectional views taken on lines 9—9 and 10—10 of Figs. 5 and 6, respectively.

The typical form of jar shown in the drawings may be described generally as comprising a mandrel, indicated at M, that includes upper and lower relatively vertically movable sections 15 and 16, and a telescopic sleeve or body B that is movable vertically with relation to the mandrel. The mandrel and body are releasably held against telescopic movement by a detent mechanism generally indicated at 17, and which, as I later explain, holds the jar parts against relative movement in a jarring direction until a predetermined pull and stretch is taken on the drill string, and which then releases to cause the striking shoulders of the tool to come into jarring impact.

The upper mandrel section 15 comprises a tube 18 having a top pin end 18a threaded at 19 into the box end of a coupling 20, which in turn is threadedly attached at 21 to the drill string 22. Mandrel section 15 also includes a reduced diameter portion 23 threaded at 24 into the lower end of tube 18. The lower mandrel section 16 comprises a tubular portion 25 of enlarged diameter and slidably engaging the wall of body B, and having a lower pin end 26 threaded at 27 into the box end of a coupling 28. The coupling pin end 28a is connected at 29 with a sub or drill pipe section 30 which in turn is attached to a drill bit, fishing tool or other work in conjunction with which the jar is to be used. Circulating fluid is discharged from the bore of the drill string 22, downwardly through the mandrel bore 31 into a wash pipe 32 that is threaded at 33 into the lower end of mandrel section 23 and extends through a suitable packing gland 34 within the bore of coupling 28. The wash pipe thus moves with the upper mandrel section 15 in its vertical travel relative to the lower mandrel section 16.

A sleeve 35, connected at 36 with the upper end of the lower mandrel section, is capable of telescopic longitudinal movement with relation to mandrel section 23, these parts however being keyed against rotation in all positions of the jar, by a pair of splines 40, see Fig. 8, integral with the sleeve 35 and received within vertically longitudinally extending ways 41 in the lower enlarged diameter end 23a of the upper mandrel section.

This mandrel enlargement presents an upwardly facing shoulder **42** which, together with the interior sleeve shoulder **43** at the upper ends of splines **40**, provide a pair of striking shoulders that come into engagement in the released position of the jar parts as shown in Fig. 6.

Body portion B of the jar comprises a sleeve **44** telescopically fitted to the mandrel and seating, in the drilling position of the parts illustrated in Figs. 1 to 3, downwardly against an annular shoulder **45** formed on coupling **28** connecting the mandrel with the work. Bushing **46**, threaded into the upper end of the body sleeve **44**, has a sliding engagement with mandrel portion **18** and provides an upwardly facing shoulder **47** engaged by the downwardly facing shoulder **48** of coupling **20** in the drilling position of Fig. 1, the two shoulders also forming a second pair of surfaces that are caused to impact, upon release of the detent mechanism from the position of Fig. 5, to deliver a jarring blow. Upward movement of the upper mandrel section **15** relative to the body sleeve, is resisted by a coil spring **49** of great compressive strength, confined between the lower end of bushing **46** and the mandrel flange **18***a*.

During releasing movement of the jar parts, the body **44** is caused to rotate relative to the mandrel within predetermined limits and in a predetermined relation to relative longitudinal movement of the upper mandrel section. The sleeve rotating means, generally indicated at **50**, comprises a pair of diametrically opposed pins **51** carried by the body and projecting within opposed slots **52** formed in the surface of the mandrel sleeve **35**. As best illustrated in Fig. 5, each of the slots **52** is shaped to provide a surface **53** extending vertically between cam surface **54** and a shoulder **55**, the angularity of the latter being less than the slip angle. The upper portions of the slots are formed as ways **56** to receive the pins during their upwardmost travel relative to the mandrel.

The detent mechanism, indicated at **16**, comprises two sets of angularly extending and circularly spaced lugs formed integrally with the body and mandrel, respectively, and movable from engaged or vertically overlapping positions, to offset positions of release, by relative rotation of the body and mandrel. Two diametrically opposed pairs of vertically spaced lugs **57** are formed on the mandrel, one end of each of the spaces **58** above and below the lugs being closed by diametrically opposed, vertically extending mandrel ribs **59**. As shown in Fig. 5, shoulders **60** on the top portion of mandrel section **25** form, in effect, a third mandrel lug. Opposite sides of the cylindrical surface of mandrel portion **25** are recessed at **61** to provide vertically extending ways within which the body lugs may travel upwardly when released from the mandrel lugs.

For purposes of facilitating the description of the construction and arrangement of the body lugs, they have been illustrated in section at **62** in Fig. 5, as they would appear if sheared from the body at the inner surface of sleeve **44**. The two diametrically opposed sets of lugs **62** are integral with the body sleeve **44** and are bridged across at one end by vertically extending ribs **63**. Preferably, the angularity of the mandrel and body lugs **57** is slightly less than the slip angle, so that some force, independent of upward pull exerted by way of the drill string, is required to rotate the lugs to the point of release.

This independent lug rotating force is provided by a pair of cams, generally indicated at **64**, formed on the body bushing **46** and the upper mandrel portion **18**. As best illustrated in Fig. 1, the surface of mandrel section **18** intermediate its ends is machined to form a pair of diametrically opposed cam shoulders **65** and straight vertical shoulders **66**. The bushing **46** is similarly shaped to provide two pairs of complementary cam shoulders **67** and vertical shoulders **68**. It may be observed at this point that by raising the mandrel relative to the body, cam shoulders **65** and **67** are brought into engagement to rotate the body about the mandrel.

During normal drilling operations, the parts assume the relative positions shown in Figs. 1 to 3, with the effective weight of the drill string being transmitted through the jar to the work by engagement of the lower end of upper mandrel section **15** with the upper end of lower section **16**, and, as at all times, with the mandrel sections held against relative rotation by splines **40**. As shown in Fig. 3, the lower end of the body sleeve seats on the under cut shoulders **45** to take part of the down load and to seal the interior of the body against the entry of well fluid. In performing a jarring operation, the drill string is progressively elevated and the jar parts moved through a series of positions as illustrated in Figs. 4 to 6. During initial upward movement of the drill string, the body **44**, being supported on spring **49**, travels with the upper mandrel section **15** until further upward sleeve movement is arrested by engagement of sleeve lugs **62** with the vertically stationary mandrel lugs **57**. Continued upward travel of the drill string and upper mandrel section results in the compression of spring **49**, as illustrated in Fig. 4 wherein the cam surfaces **65** and **67** are shown just coming into engagement. As the mandrel moves on up, the body sleeve is cammed around by the coaction of cams **65** and **67**, to withdraw pins **51** from the lower portions of slots **52**, and to rotate the body lugs **62** toward the point of release from mandrel lugs **57**, all as illustrated in Fig. 5. A slight upward movement of the mandrel beyond this point causes pins **51** to move into the lower ends of grooves **56**, and the body lugs **62** to slip off the ends of mandrel lugs **57**, whereupon the body is thrust upwardly by spring **49**, with the body lugs travelling within the vertical ways **61** in mandrel section **25**.

The release of the body and mandrel shoulders also frees the upper mandrel section **15** for upward movement relative to the lower mandrel section **16**, to cause striking shoulder **42** to impact against shoulder **43**. Simultaneously, the body is freed for upward movement on the mandrel to bring striking shoulders **47** and **48** into engagement. When released by the detent mechanism, the upper mandrel section **15** travels upwardly to bring striking shoulders **42** and **43** into engagement, by virtue of the stretch taken in the drill pipe **29** during the course of exerting the pull required to release the jar. This same pull force acts to compress spring **49**, but after the detent is released, the spring acts independently to impact shoulder **47** against **48**, excepting as its upward thrust is aided by the upward movement of the mandrel. The longitudinal dimensions of the jar parts may be proportioned so that either shoulders **42** and **43**, or shoulders **47** and **48**, will strike first. In the drawings I have shown the proportions and relative positions of the mandrel and body parts to be such that shoulders **42** and **43** will strike first, to deliver an initial upward

jarring blow to the work attached to the lower mandrel section. This first delivered blow then is immediately followed by a second blow produced by the upward impact of shoulder **47** against the coupling shoulder **48**, and transmitted through the mandrel to the work.

The jar is reset by lowering the drill string straight down to the point at which the parts of the detent mechanism come into reengagement. During initial downward movement of the drill string, the body sleeve, supported on the upper mandrel section by spring **42**, travels straight down relative to the lower mandrel section to the point at which pins **51** come into engagement with cam shoulders **54**. During continued downward movement, shoulders **54** cam the pins around to the lowermost ends of slots **52** and to a limiting position of engagement with surface **53**, during which time the body lugs **62** are rotated between and into vertical alinement with the mandrel lugs **57**. To perform a second jarring operation, the drill string is first elevated to raise the body lugs into engagement with the mandrel lugs, beyond which point the above described operations are repeated.

The relative movement between the body and mandrel lugs during the complete sequence of operations is diagrammatically illustrated in the developed view of Fig. 7, wherein the solid lines show the positions of the parts after the body lugs have been cammed into alinement with the mandrel lugs and after the body has been lowered to its bottom position. In carrying out a subsequent jarring operation, the drill string, together with the body and upper mandrel section, are raised to elevate body lugs **62**, in the path indicated by the arrows *a*, into engagement with the under surface of mandrel lugs **57** and shoulders **60**. Then, as the cams **66** and **67** rotate the body to back pins **51** out of slots **52**, the body lugs move in the path indicated by arrows *b* to the position of dotted lines **62'**, in which the lugs are freed for upward movement in the direction of arrows *c* within the mandrel ways **61**. In the resetting operation, as the body is lowered to cam pins **51** into the slots **52**, the body lugs rotate in an angular path indicated by the arrows *d* to positions of reengagement with the body lugs, the vertical spacing of the latter being sufficient to permit the body lugs to rotate and at the same time move relatively downward to the point at which further relative rotation between the lugs is arrested by the engagement of lugs **57** with ribs **63**.

I claim:

1. In a rotary jar, the combination comprising, a pair of relatively longitudinally movable members, one being connected to the drill string and the other to the work, releasable means holding said members against relative longitudinal movement, said means being releasable by straight upward movement of the drill string and means automatically operable upon release of said holding means and by virtue of the same straight upward movement of the drill string, for imparting to the work a succession of upwardly directed blows.

2. In a rotary jar, the combination comprising a pair of relatively longitudinally movable members, one being connected to the drill string and the other to the work, releasable means holding said members against relative longitudinal movement, said means being releasable by movement of the drill string, means for imparting to the work an upwardly directed blow upon release of said holding means, and means automatically operable upon release of said holding means, for imparting to the work a second upwardly directed blow, both of said blow imparting means being operable by straight upward movement of the drill string.

3. In a rotary jar, the combination comprising, a pair of relatively longitudinally movable members, one being connected to the drill string and the other to the work, releasable means holding said members against relative longitudinal movement, said means being releasable by straight upward movement of the drill string, means for imparting to the work an upwardly directed blow upon release of said holding means, and spring actuated means automatically operable upon release of said holding means, for imparting to the work a second upwardly directed blow.

4. In a rotary jar, the combination comprising, a pair of relatively longitudinally movable members, one being connected to the drill string and the other to the work, releasable means holding said members against relative longitudinal movement, said means being releasable by straight upward movement of the drill string, means for imparting to the work an upwardly directed blow upon release of said holding means, and means automatically operable upon release of said holding means, for imparting to the work a second upwardly directed blow said last mentioned means including a member movable vertically relative to both of the first mentioned members.

5. In a rotary jar, the combination comprising, a pair of relatively longitudinally movable members, one being connected to the drill string and the other to the work, releasable means holding said members against relative longitudinal movement, said means including a cooperating pair of relatively rotatable detent elements releasable by movement of the drill string, means for imparting to the work an upwardly directed blow upon release of said holding means, and means automatically operable upon release of said holding means, for imparting to the work a second upwardly directed blow, both of said blow imparting means being operable by straight upward movement of the drill string.

6. In a rotary jar, the combination comprising, a pair of relatively longitudinally movable members, one being connected to the drill string and the other to the work, releasable means holding said members against relative longitudinal movement, said means being releasable by stretching the drill string, means for imparting to the work, upon release of said holding means, an upwardly directed blow developed by the contractive force of the drill string, and means automatically operable upon release of said holding means, operating independently of said contractive force of the drill string for imparting to said work another upwardly directed blow, both of said blow imparting means being operable by straight upward movement of the drill string.

7. In a rotary jar, the combination comprising, a pair of relatively longitudinally movable members, one being connected to the drill string and the other to the work, releasable means holding said members against relative longitudinal movement, said means being releasable by stretching the drill string, means for imparting to the work, upon release of said holding means, an upwardly directed blow developed by the contractive force of the drill string, and means operating independently of said contractive force of the drill string for imparting to said work another up-

wardly directed blow in closely timed relation with the first mentioned blow, the last mentioned means comprising a striking member movable vertically relative to both of said relatively longitudinally movable members.

8. In a rotary jar, the combination comprising a pair of relatively longitudinally movable members, one being connected to the drill string and the other to the work, releasable means holding said members against relative longitudinal movement, said means being releasable by stretching the drill string, means for imparting to the work, upon release of said holding means, an upwardly directed blow developed by the contractive force of the drill string, and means operating independently of said contractive force of the drill string for imparting to said work another upwardly directed blow in closely timed relation with the first mentioned blow, the last mentioned means comprising a striking member movable vertically relative to one of said relatively longitudinally movable members, and a spring for actuating said striking member.

9. In a rotary jar, the combination comprising, a pair of relatively longitudinally movable members, one being connected to the drill string and the other to the work, releasable means holding said members against relative longitudinal movement, said means being releasable by stretching the drill string, means for imparting to the work, upon release of said holding means, an upwardly directed blow developed by the contractive force of the drill string, and means operating independently of said contractive force of the drill string for imparting to said work another upwardly directed blow in closely timed relation with the first mentioned blow, the last mentioned means comprising a striking member movable vertically relative to one of said relatively longitudinally movable members, a spring for actuating said striking member, and means for controlling the operation of said striking member by said holding means.

10. In a rotary jar, the combination comprising, a mandrel having upper and lower relatively longitudinally movable sections connected to the drill string and work respectively, a body surrounding said mandrel sections and movable longitudinally relative thereto, a pair of striking shoulders formed on said mandrel sections, a second pair of striking shoulders formed on said body and the upper mandrel section, and means for bringing said pairs of shoulders successively into impacting engagement.

11. In a rotary jar, the combination comprising, a mandrel having upper and lower relatively longitudinally movable sections connected to the drill string and work respectively, a body surrounding said mandrel sections and movable longitudinally relative thereto, a pair of striking shoulders formed on said mandrel sections, a second pair of striking shoulders formed on said body and the upper mandrel section, means for bringing one pair of shoulders into impacting engagement, and spring actuated means for bringing the other pair of said shoulders into impacting engagement.

12. In a rotary jar, the combination comprising, a mandrel having upper and lower relatively longitudinally movable sections connected to the drill string and work respectively, a body surrounding said mandrel sections and movable longitudinally relative thereto, a pair of striking shoulders formed on said mandrel sections, a second pair of striking shoulders formed on said body and the upper mandrel section, releasable means holding said body and lower mandrel section against relative longitudinal movement until a predetermined stretch is taken on the drill string, and means for bringing said pairs of shoulders successively into impacting engagement upon release of said holding means.

13. In a rotary jar, the combination comprising, a mandrel having upper and lower relatively longitudinally movable sections connected to the drill string and work respectively, a body surrounding said mandrel sections and movable longitudinally relative thereto, a pair of striking shoulders formed on said mandrel sections, a second pair of striking shoulders formed on said body and the upper mandrel section, releasable means holding said body and lower mandrel section against relative longitudinal movement until a predetermined stretch is taken on the drill string, and means for bringing said pairs of shoulders successively into engagement upon release of said holding means.

14. In a rotary jar, the combination comprising, a mandrel having upper and lower relatively longitudinally movable sections connected to the drill string and work respectively, a body surrounding said mandrel sections and movable longitudinally relative thereto, a pair of striking shoulders formed on said mandrel sections, a second pair of striking shoulders formed on said body and the upper mandrel section, releasable means holding said body and lower mandrel section against relative longitudinal movement until a predetermined stretch is taken on the drill string, said pairs of shoulders being adapted to be moved successively into striking engagement upon release of said holding means, and a spring resisting upward movement of the upper mandrel section relative to the body.

15. In a rotary jar, the combination comprising, a mandrel having upper and lower relatively longitudinally movable sections connected to the drill string and work respectively, a body surrounding said mandrel sections and movable longitudinally relative thereto, a pair of striking shoulders formed on said mandrel sections, a second pair of striking shoulders formed on said body and the upper mandrel section, releasable means holding said body and lower mandrel section against relative longitudinal movement until a predetermined stretch is taken on the drill string, said pairs of shoulders being adapted to be moved successively into striking engagement upon release of said holding means, and means actuated by upward movement of the upper mandrel section relative to the body for releasing said holding means.

16. In a rotary jar, the combination comprising, a mandrel having upper and lower relatively longitudinally movable sections connected to the drill string and work respectively, a body surrounding said mandrel sections and movable longitudinally relative thereto, a pair of striking shoulders formed on said mandrel sections, a second pair of striking shoulders formed on said body and the upper mandrel section, releasable means holding said body and lower mandrel section against relative longitudinal movement until a predetermined stretch is taken on the drill string, said pairs of shoulders being adapted to be moved successively into striking engagement upon release of said holding means, a spring resisting upward movement of the upper mandrel section relative to the body, and means actuated by upward movement of the upper mandrel sec-

tion relative to the body for releasing said holding means.

17. In a rotary jar, the combination comprising, a mandrel having upper and lower relatively longitudinally movable sections connected to the drill string and work respectively, a body surrounding said mandrel sections and movable longitudinally relative thereto, a pair of striking shoulders formed on said mandrel sections, a second pair of striking shoulders formed on said body and the upper mandrel section, releasable means holding said body and lower mandrel section against relative longitudinal movement until a predetermined stretch is taken on the drill string, and a spring resisting upward movement of the upper mandrel section relative to the body, said striking shoulders on the mandrel sections being brought into engagement by contractive movement of the drill string upon release of said holding means, and said pair of shoulders on the body and upper mandrel section being brought into engagement by the action of said spring.

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