Dec. 22, 1936. J. T. BARKELEW ET AL 2,065,262

ROTARY JAR

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Fig.1

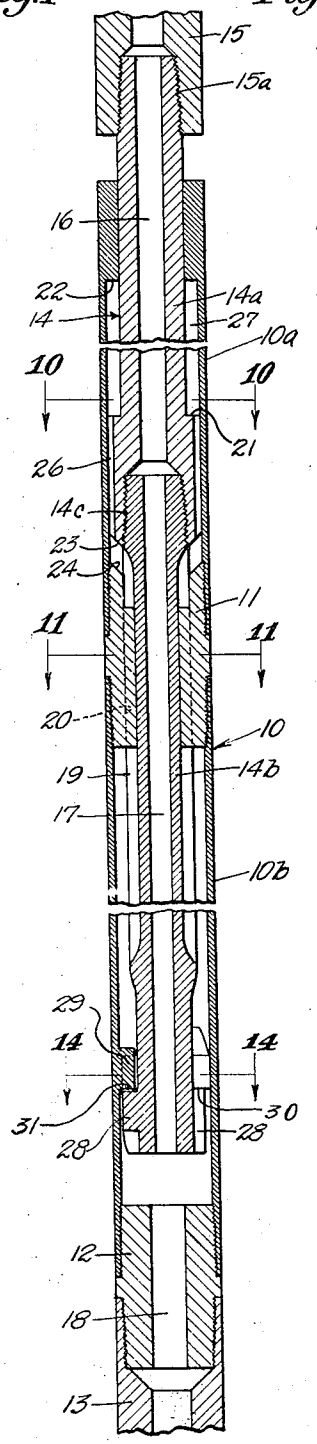


Fig.2

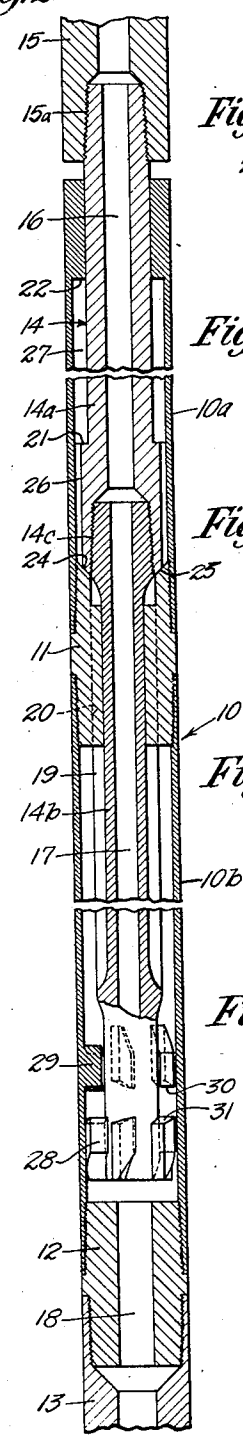


Fig.3

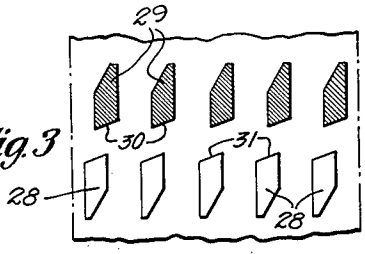


Fig.4

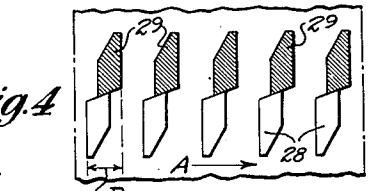


Fig.5

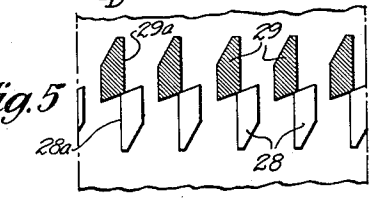


Fig.6

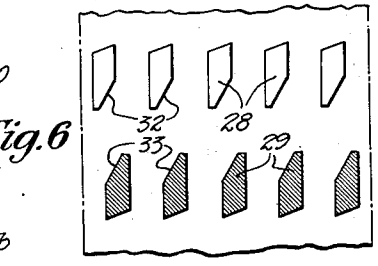
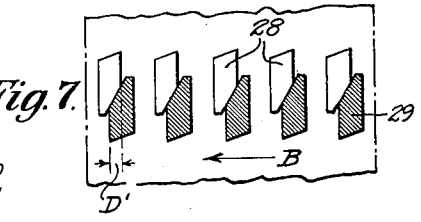


Fig.7



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ROTARY JAR

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Fig. 8

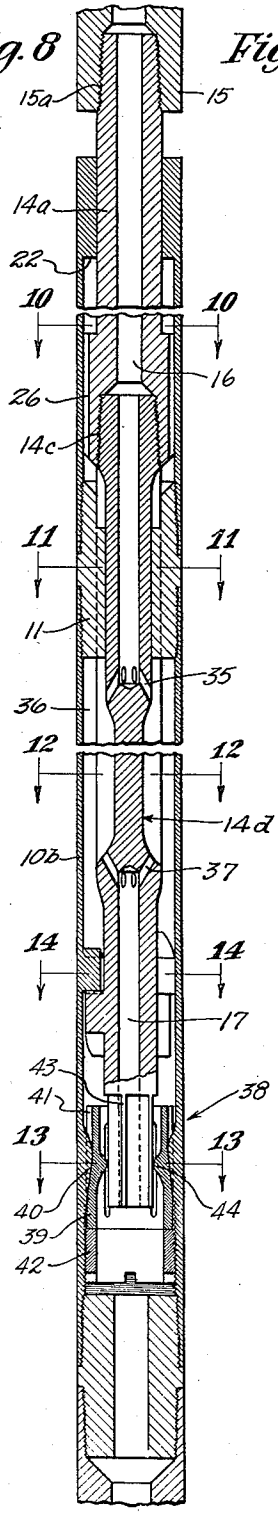


Fig. 9

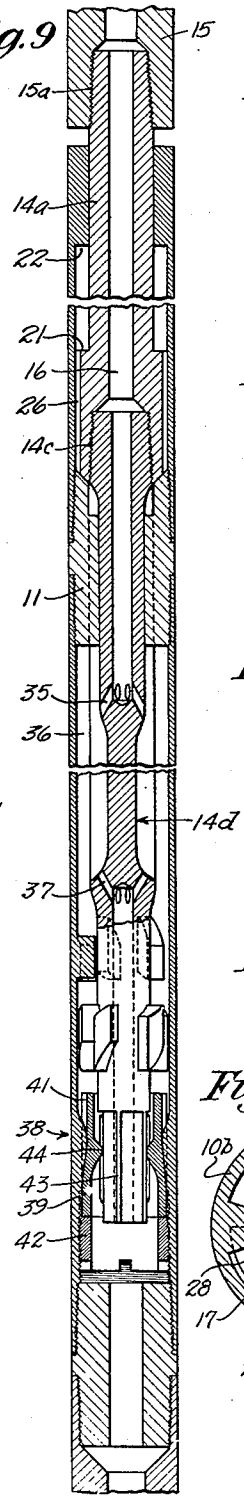


Fig. 10

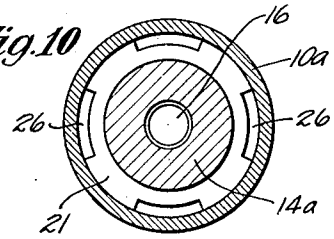


Fig. 11

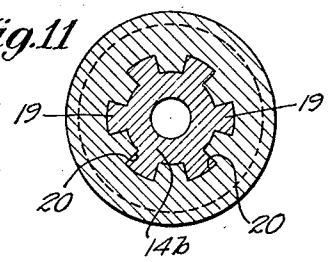


Fig. 12

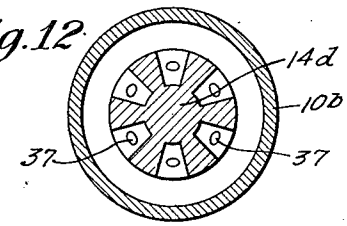


Fig. 13

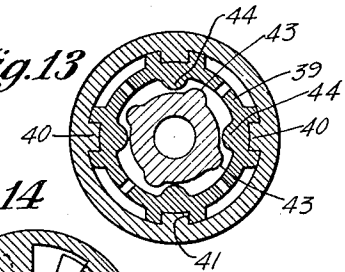
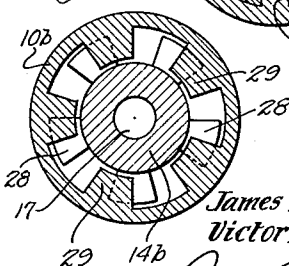


Fig. 14



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Patented Dec. 22, 1936 2,065,262

UNITED STATES PATENT OFFICE

2,065,262

ROTARY JAR

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Application January 14, 1935, Serial No. 1,627

4 Claims. (Cl. 255—27)

This invention deals with jars used in well drilling for loosening bits, pipe or other objects that have become lodged in the well, and which comprise a telescopic body and mandrel restrained against relative movement by releasable lock or detent until the drill pipe is subjected to a predetermined pull and stretch, after which the parts come into impacting engagement with the resultant blow or "jar" being transmitted to the lodged object. Generally speaking, jars may be classified as one of two types; that in which the release for jarring is accomplished by simultaneous stretching and rotation of the drill pipe, and the second, known as the straight-pull type, in which release and resetting is effected by straight up and down movement of the drill pipe.

The present jar is of the straight-pull type, although it involves rotational release of the locking element. While straight pull jars having this characteristic have been known, the invention differs primarily from such forms in that the rotational release is accomplished with the mandrel and body splined or otherwise held against substantial relative rotation, whereas previous types of jars involving rotational release have necessitated relative rotation between the body and mandrel. More specifically, the invention aims at the provision of a jar in which the body and mandrel are telescopic, though relatively non-rotatable, with inter-engaging lugs carried by the body and mandrel, the mandrel lugs being rotatively releasable from the body lugs by straight pull on the drill pipe. In order to retard the release to a point at which the pull and stretch exerted on the drill pipe will have been sufficient to deliver a jarring blow of sufficient magnitude, a yielding resistance is imposed against relative rotation of the lugs to the slip-off point. In a more limited aspect, the present application deals with the general structure outlined, in which one set of lugs is integral with the mandrel and in which the yielding resistance to lug release is provided through torsional strain of the mandrel.

In our copending application, Ser. No. 1,626, filed on even date herewith, and entitled Jar, this same general idea is embodied in jars in which the mandrel lugs are carried on a sleeve or other member rotatable with respect to both the body and the mandrel. Fundamentally, and in certain respects, the jar release mechanisms described herein and in the application referred to, are broadly similar as they involve the same general mode of operation. These features common to both, however are more broadly dealt with and claimed in the present application.

A description of certain forms of the invention will best serve to illustrate and further explain the above mentioned features as well as additional objects and details of the invention, without necessity for further preliminary remarks. Certain typical forms are treated in the following description, throughout which reference is had to the accompanying drawings, in which:

Fig. 1 is a sectional view showing one form of the invention with the parts set to take the pull prior to jarring;

Fig. 2 is a view similar to Fig. 1 showing the parts of the jar in drilling position;

Figs. 3 to 7, inclusive, are developed views showing the relative position of the mandrel and body lugs at progressive stages in the operation of the jar;

Figs. 8 and 9 are sectional views generally similar to Figs. 1 and 2, respectively, but showing a variational form of the invention;

Figs. 10 and 11 are sections on lines 10—10 and 11—11 of Figs. 1 and 8;

Figs. 12 and 13 are sections on lines 12—12 and 13—13 of Fig. 8; and

Fig. 14 is a section on line 14—14 of Figs. 1 and 8.

Taking up first the form of Figs. 1 and 2, the tubular body 10 is made up of sections 10*a* and 10*b* interconnected by a double pin coupling 11, the lower end of the body being attached through coupling 12 with a lower section 13 of the pipe string to which may be attached a drill bit, fishing tool or the like. The telescopically movable mandrel 14, attached at 15*a* to the upper section 15 of the drill pipe string, comprises upper and lower tubular sections 14*a* and 14*b* screw-threadedly connected at 14*c*. Circulation is maintained through the jar by way of mandrel bores 16, 17 and bore 18 of coupling 12.

Substantial relative rotation between the body and mandrel is prevented by splines 19 on the lower mandrel section 14*b* extending through spline ways 20 in the body coupling 11. Normally spaced striking shoulders 21 and 22 are formed on the mandrel and body, respectively, the striking shoulders being brought into impacting engagement upon release of the mandrel and body lugs, as will presently appear. In the drilling position of the parts, that is, under conditions where the weight of the upper section 15 of the drill string is transmitted through the jar to the lower section 13, the lower tapered end 23 of the upper mandrel section seats upon a

correspondingly tapered shoulder 24 formed on the upper end of coupling 11. Longitudinal grooves 26 extending through the enlarged portion of the mandrel permit escape of any fluid contained in space 27 which might otherwise inhibit free upward movement of the mandrel during its jarring travel.

In the position of Fig. 1 the mandrel is releasably held against upward movement relative to the body by two sets of interengaging lugs 28 and 29 integral with the mandrel and body respectively. Any suitable number of lugs may be provided in each set, consistent with maintaining a sufficiently large total area of contact to take the pull load on the mandrel while keeping the torsional strain on the mandrel within proper limits. As typical, we have shown five lugs in each set.

In the position of Fig. 1, the body and mandrel lugs are engaged along inclined faces 30 and 31, see Figs. 2 and 3, the angularity of which is greater than the coefficient of friction between the lugs, so that an upward pull on the drill pipe 16 twists the mandrel, and ultimately to the point at which the lugs will pass each other. In order to produce an effective jarring blow, it is necessary that the striking shoulders 21 and 22 impact with great force, and for the same reason that upward relative movement of the mandrel be restrained until a corresponding pull load is exerted on the drill pipe. As mentioned earlier, the mandrel itself affords a yielding resistance to disengagement of the lugs through its ability to take a torsional strain. The torsional resistance offered by the mandrel is dependent upon its length and cross sectional configuration, as well as the size, angles and arrangement of the mandrel and body lugs. All these factors are taken into consideration in design and construction, to meet particular requirements. In the form of Figs. 1 and 2, that portion of the mandrel below coupling 11, being the length subjected to torsional strain is hollow though reenforced against twisting by the longitudinal splines 19.

The developed view of Fig. 3 shows the relative positions of the body and mandrel lugs in the drilling position of the parts as represented by Fig. 2. In starting the jarring operation, the mandrel is pulled up to the point at which the angular faces 30 and 31 of the lugs come into engagement in the offset positions of Figs. 1 and 4. Since the mandrel lugs are caused to rotate in the direction indicated by arrow A, the angularity of the torsional strain on the mandrel in order for the lugs to pass, is represented by the distance D. As the pull on the mandrel is increased, the mandrel lugs are caused to rotate in the direction of arrow A to the point of release, the approach to which is illustrated in Fig. 5 wherein the lug edges 28*a*, 29*a* are nearing alignment. When the point of release is reached, the mandrel is suddenly freed for upward movement to cause shoulders 21 and 22 to come into striking engagement. The jar may then be reset by moving the mandrel down with the lugs, as they approach, in the relative positions of Fig. 6. Finally, the lugs come into engagement along inclined surfaces 32 and 33, the angularity of which is considerably greater and the frictional resistance offered by the lugs to movement past each other correspondingly less than during release with the lugs in engagement along surfaces 30 and 31.

In order for the mandrel lugs to pass the body lugs from the position of Fig. 7 to the starting position of Fig. 3, the mandrel is subjected to a torsional strain in the direction of arrow B, which is opposite the direction of rotation during release. Due to the relative offset of the lugs and the greater angularity of surfaces 30 and 31, the torsional strain on the mandrel during resetting and the resistance offered to passing of the lugs, are substantially less than during release. The comparative resistances due to mandrel strain are represented by the distances D and D', representing the angularity of the strain in the mandrel during release and resetting, respectively.

The variational form of the invention shown in Figs. 8 and 9, while being generally similar to the described embodiment, differs with respect to the mandrel construction and in the incorporation of a release control device for eliminating excessive localized stresses on the lugs. Other parts of the two forms are similar and have been given corresponding numerals. In Fig. 8 the central portion 14*d* of the mandrel in which the torsional strain is mainly taken, instead of being tubular, is made solid. The purpose is to give the mandrel greater torsional elasticity and thereby to enable the mandrel to be shortened in length. In this form the circulating fluid is discharged from the upper mandrel bore 16 through ports 35 into space 36 within the body, and is from there returned to the lower mandrel bore 17 through ports 37.

As will be seen from a comparison of Figs. 4 and 5, as the pull on the drill string and mandrel increases and mandrel lugs 28 rotate to the right, the surface area of engagement between the lugs along faces 30 and 31 progressively decreases as the lugs move from the intermediate position of full alinement toward the position of release. However, during this same interval, the pull load on the mandrel is increasing, the result being that as the lugs near the slip-off position, as for example in Fig. 5, they may be subjected to extremely great stresses at their contacting surfaces. In cases where such high localized stresses might prove objectionable, we may control the relative releasing movement of the lugs in such manner that at the point of greatest load, the lugs will be substantially alined with surfaces 30, 31 in full contact, or at least in contact along sufficient areas that excessive stresses will at no time exist. Then, after the maximum pull load has been taken, relative rotation of the lugs sufficient to permit them to pass will occur instantly, thus practically eliminating that interval toward the point of release during which small areas of the lugs otherwise would be in engagement under high stresses.

For this purpose, there is provided a device generally indicated at 38, operating in the nature of an escapement to retard the twisting of the mandrel until substantially the full load is taken, and to then suddenly release the mandrel for rotation of the lugs past each other. This device 38 comprises a sleeve 39 splined within the body by lugs 40 projecting into longitudinal ways 41 in the outer surface of the sleeve. A nut 42 threaded into the lower end of the body supports sleeve 39 from beneath. Longitudinally extending ribs 43 on the lower portion of the mandrel are provided for the purpose of coacting with internal lugs 44 on the sleeve as detents to initially restrain and then suddenly release the mandrel during its torsional movement, all in the general manner described above. Sleeve 39 is provided with elongated slots (Fig. 13) so that the sleeve

will be contracted by the cam action of lugs 40 as nut 42 is tightened. This makes possible adjusting jarring loads and compensation for wear.

In the jarring operation, starting with the lugs in the position of Fig. 4, the mandrel lugs are first rotated to a position approaching alinement with the body lugs. At this point the detent lugs 43 and 44 of the escapement 38 come into engagement, setting up resistance to further twisting of the mandrel (the resistance increasing comparatively rapidly during slight mandrel twist) as the detent lugs approach radial alinement, due to the resistance offered by sleeve 39 and the body to radial expansion necessary to permit the detents to pass. At the point at which the detent lugs 43 and 44 come into radial alinement, the pull load on the mandrel has reached its maximum and the mandrel lugs 28 may or may not have moved somewhat past positions of exact alinement with the body lugs, depending upon the relative arrangement of the lugs and escapement detents. The area of engagement along surfaces 30 and 31, however, will at this point be sufficiently great to take the load without excessive local stresses being imposed on them.

Further rotation of the mandrel detents 43 past the center or radially alined positions of the detents results in an instantaneous release of the resistance offered to torsional strain on the mandrel, with the result that the mandrel lugs 28 instantly rotate past the body lugs 29 to the point of release. After lugs 28 pass from under lugs 29 and move upward, the lower end of the mandrel passes above detents 44. Then, as the mandrel lugs are moved down past the body lugs to reset the jar, lugs 43 travel down between lugs 44, but without coming into engagement with them. Instead the former are rotated a short clockwise direction (in the aspect of Fig. 13) away from lugs 44, as the mandrel lugs 28 slip down past the body lugs 29.

We claim:

1. In a jar, a body and a relatively longitudinally movable mandrel, striking shoulders which are brought into engagement by relative longitudinal movement of the body and mandrel in one direction, a pair of interengaging members restraining the body and mandrel against relative movement in said direction, said members being releasable by relative rotation about the body axis to free the body and mandrel for relative movement in said direction, a connection between the body and mandrel holding them against substantial relative rotation during said relative releasing movement of the members, and a detent means imposing a predetermined resistance to releasing movement between said members.

2. In a jar, a body and a relatively longitudinally movable mandrel, striking shoulders which are brought into engagement by relative longitudinal movement of the body and mandrel in one direction, a pair of interengaging members restraining the body and mandrel against relative movement in said direction, said members being releasable by relative rotation about the body axis to free the body and mandrel for relative movement in said direction, a connection between the body and mandrel holding them against substantial relative rotation during said relative releasing movement of the members, and releasably engaged mandrel and body lugs resisting relative rotation between said members.

3. In a jar, a body and a relatively longitudinally movable mandrel, striking shoulders which are brought into engagement by relative longitudinal movement of the body and mandrel in one direction, a pair of interengaging members restraining the body and mandrel against relative movement in said direction, said members being releasable by relative rotation about the body axis to free the body and mandrel for relative movement in said direction, and a suddenly releasable escapement mechanism restraining relative rotational movement of said members.

4. In a jar, a body and a relatively longitudinally movable mandrel, striking shoulders which are brought into engagement by relative longitudinal movement of the body and mandrel in one direction, a pair of interengaging members restraining the body and mandrel against relative movement in said direction, said members being releasable by relative rotation about the body axis to free the body and mandrel for relative movement in said direction, and a pair of interengaging elements restraining relative rotational movement of said members but releasable to permit such movement when a predetermined pull is exerted to move the body and mandrel relatively in said direction.

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