

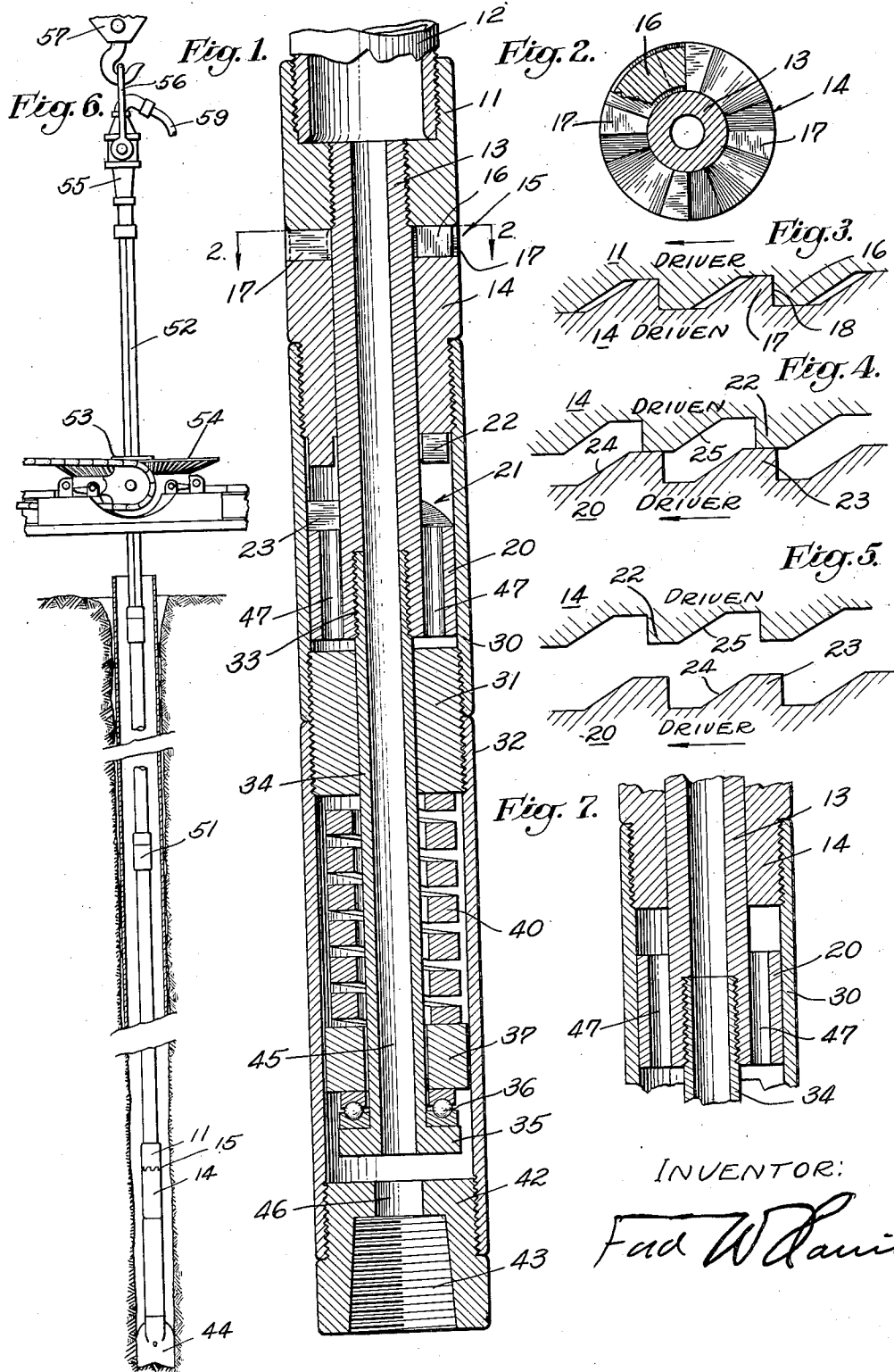
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ROTARY JAR

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UNITED STATES PATENT OFFICE

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ROTARY JAR

Application filed January 18, 1932. Serial No. 587,280.

This application is a continuation-in-part of my application entitled Rotary jar, Serial No. 453,812, filed in the U. S. Patent Office May 19, 1930.

My invention relates to the art of drilling oil wells by the rotary system. In this art a bit secured to the lower end of a string of drill pipe is rotated in the bore of the well by said pipe which is driven by a rotary table above the surface of the ground.

During the drilling operation the bit occasionally becomes jammed in the hole due to caving formations or other causes so that it cannot be turned or withdrawn by an upward pull on the drill pipe.

It is an object of my invention to provide means for freeing a jammed bit.

It is a further object of my invention to provide means for striking an upward blow on the structure supporting the bit, if the bit becomes wedged or jammed in the hole, so that it is driven upwardly out of its wedged position. This striking operation is quite effective in freeing the bit and is commonly called "jarring" and any device designed to permit jarring is commonly called a "jar". Such jars are quite commonly used in the "standard" or percussive system of drilling in which the bit is reciprocated in the hole by means of a cable, but my invention is intended to be used solely in the "rotary" system and hence is called a rotary jar.

It is a further object of my invention to provide a rotary jar through which the bit is positively driven as long as a portion of the weight of the drill stem is transmitted to the bit but which acts to automatically jar the bit as soon as the bit becomes jammed if the drill pipe is pulled upwardly in the hole.

It is a further object of my invention to provide a jar which strikes a rapid succession of blows which tend not only to raise the bit but also to turn it in the hole.

It is a further object of my invention to provide a jar which automatically discon-

tinues jarring and resumes its positive driving function whenever the bit is freed so that it can turn.

Further objects and advantages will be made evident hereinafter.

In the drawing, which is for illustrative purposes only:

Fig. 1 is a vertical cross-section through one form of my invention.

Fig. 2 is a horizontal cross-section on a plane represented by the line 2—2 of Fig. 1.

Fig. 3 is a development of the positive driving elements in the position they assume when the bit is being positively driven.

Fig. 4 is a development of the jarring elements in the position they assume when the bit is being jarred.

Fig. 5 is a development of the jarring elements in the position they assume when the bit is being positively driven.

Fig. 6 shows the rotary jar as used in drilling a well.

Fig. 7 shows an alternate form of construction.

In the form of the invention shown I provide a driving member and a driven member, each made up of a plurality of separate parts. The driving member is secured to the drill pipe and driven thereby, and the driven member is secured to and drives the bit.

The driving member is provided at its upper end with a pipe socket 11 threaded to receive the lower end of a drill pipe 12. Secured in the socket 11 is a spindle 13. The spindle 13 may be threaded in the socket 11, as shown, or may otherwise be rigidly secured thereto, no movement between these parts being necessary in the operation of the device and the threads therebetween being for convenience in manufacturing and assembly.

The spindle 13 passes through and slides freely in an intermediate collar 14. Between the socket 11 and the collar 14 I provide positive driving means 15 consisting of down-

wardly projecting teeth 16 on the socket and upwardly projecting teeth 17 on the collar. The form of the teeth is shown projected in Fig. 3. It will be noted that both the teeth 16 and the teeth 17 have straight faces meeting when in full driving position, as shown in Fig. 3 on a plane 18 which is perpendicular to the line of motion, as shown by the arrow 19. The teeth 16 being driven from right to left drive the teeth 17 in the same direction.

The spindle 13 extends below the collar 14 and terminates in a head 20. Between the upper end of the head 20 and the lower end of the collar 14 I provide jarring means 21 consisting of upper teeth 22 projecting downwardly from the collar 14 and lower teeth 23 projecting upwardly from the head 20. The form of the teeth 22 and 23 is shown projected in Fig. 4 in the position they assume when jarring. It will be noted that the teeth 22 and 23 have the same general form as the teeth 16 and 17. The method of operation of the jarring teeth 22 and 23 is different from the positive driving teeth. This will be understood if it is remembered that the lower teeth 23 are the driving teeth. The only way the teeth 23 can drive the teeth 22 is by the teeth coming into an engaged position similar to that shown in Fig. 3 so that any movement of the lower tooth towards the left causes the sloping face 24 of the lower tooth to engage the sloping back 25 of the upper tooth. When in this position the lower teeth will drive the upper ones but will slip whenever the driving torque exceeds a certain value determined by the vertical pressure between the members 14 and 20, the angle of the sloping face 24, and the coefficient of friction of the tooth surfaces.

If the collar 14 is positively locked against movement, which occurs when the bit solidly jams, the teeth 22 are held solidly against movement and the teeth 23 slide thereon. If the teeth are considered as initially in a position similar to the teeth shown in Fig. 3, it will be seen that a continued movement of the teeth 23 to the left will bring them into the position shown in Fig. 4 and that as soon as the vertical backs of the teeth pass each other the teeth 23, if under upward pressure, will snap back into a position similar to that shown in Fig. 3. This snapping back produces a blow of the teeth 23 on the teeth 22, and a continued rotation of the head 20, the collar 14 being held stationary, produces a series of sharp upward blows by the teeth on the head 20 against the teeth on the collar 14.

It will be noted, however, that while the teeth 23 slide over the teeth 22 and periodically strike an upward blow thereon they also exert considerable driving force, tending to force the teeth 22 to the left as shown by the arrow 26. The jarring action between the

teeth 22 and 23 is partly upward and partly torsional.

Threaded on the collar 14 is an upper shell 30 which extends down and encloses the head 20 which is free to slide vertically therein. A coupling collar 31 is threaded in the upper shell 30 and in a lower shell 32. The parts 30, 31, and 32 may be made integral if desired, but are shown in three pieces threaded together for convenience in manufacture and assembly.

Threaded at 33 in the head 20 is a spindle extension 34 which extends through the coupling collar 31, being free to slide vertically therein. The spindle extension has an enlarged end 35 for retaining a ball bearing 36 placed between said enlarged end and a follower 37. The follower 37 slides freely vertically in the lower shell 32, and the spindle extension 34 can both turn and slide freely in the follower 37.

Surrounding the spindle extension 34 inside the lower shell 32 is a compression spring 40. This spring is assembled, as shown, under considerable initial compression pressing upwardly on the coupling collar 31 and downwardly on the follower 37. The final effect of the spring 40 is to force the socket 11 towards the collar 14 and hold the teeth 16 and 17 of the positive driving means in engagement, as shown in Fig. 3.

When the teeth 16 and 17 of the positive driving means are so engaged the teeth 22 and 23 of the jarring means 21 are entirely out of engagement, as shown in Fig. 5, the separation of the teeth 22 and 23 of the jarring means 21 when in this position being sufficient to allow the teeth 16 and 17 of the positive driving means 15 to entirely separate before any engagement of the teeth 22 and 23 of the jarring means 21 occurs.

Threaded in the lower end of the lower shell 32 is a tool joint coupling 42 threaded at 43 for the reception of a drilling bit shown at 44 in Fig. 6.

Extending entirely through the spindle 13 and the spindle extension 34 is a port 45 through which rotary mud from the drill pipe 11 may pass, the tool joint coupling 43 having a port 46 for the same purpose.

To prevent the head 20 acting as a piston sliding in the upper shell 30 ports 47 are drilled therein. These ports should be as large as possible consistent with proper mechanical strength in the head 20.

The spring 40 is of sufficient size and is under sufficient initial compression to hold the socket 11 and coupling 14 solidly together when the device is suspended from the drill pipe 12 and the bit and any intermediate members are attached. In some cases a heavy drill stem is threaded in the tool joint coupling 42 and the bit 44 is threaded to the bottom of the drill stem. The spring 40 should be under sufficient initial compression

sion to hold the positive driving means 15 in engaged position against the weight of such a drill stem and bit. In practice I prefer to give the spring 40 an initial compression when used in connection with four inch drills of at least one thousand pounds more than the combined weight of the bit and drill stem with which it is to be used so that the positive driving means 15 cannot be pulled out of engagement unless the bit is so jammed that it can resist an upward pull of at least one thousand pounds.

The jar is used in the manner shown in Fig. 6. The bit 44 is screwed in place in the tool joint coupling 42 and the drill pipe 12 is screwed in place in the pipe socket 11. The jar may be used with a drill string which may be several thousand feet in length, this string being made up of separate joints of drill pipe from 20 to 30 feet long and usually from 3 inches to 6 inches internal diameter, these joints being joined by standard tool joints 51.

A square drill stem or kelly 52 is usually secured to the upper end of the drill string and passes through the usual kelly bushings 53 carried in the rotary table 54. The kelly has a central fluid opening through which the rotary mud may be circulated. The rotary table is provided with power means by which it may be rotated, thus rotating the drill string through the kelly.

In accordance with the usual practice the upper end of the kelly 52 is secured in a rotary swivel 55 having bails 56 by means of which it is supported from a travelling block 57 suspended on a cable not shown. The cable passes upwardly to the crown block of the derrick and downwardly to suitable hoisting drums, all of these parts being well known and commonly used and therefore not illustrated. Any of the well known devices for indicating the tension in the cables and therefore the load imposed on the block 57 may also be used. Rotary mud under pressure is supplied from pumps, not shown, to the swivel 55 through a flexible hose 59.

The method of operation of the invention is as follows:

The bit assembled with the other parts is lowered into the well, as shown in Fig. 6, and the drilling operation is carried on in the usual manner; that is, the rotary table turns the drill string and rotates the bit. The spring 40 holds the positive driving means 15 in driving position.

Under normal drilling conditions the jar has no functions to perform other than to provide a positive drive for the bit through the positive driving means 15. The jarring action comes into effect only when the bit jams. When this occurs the operator by use of the hoisting mechanism of the derrick pulls upwardly on the block 57 through the cables. This may release the bit, in which

event, the jar is not needed. If the bit is stuck so that it cannot be pulled upwardly by the drill string the driven portion of the device which is attached to the bit remains stationary and the driving member moves upwardly therein. This compresses the spring 40 and puts an upward tension on the bit. As the driving member moves upwardly, the positive driving means 15 is disengaged and the driving member is free to rotate inside the driven member.

If the upward pull on the drill pipe is made sufficiently great after the positive driving means 15 is disengaged the jarring means 21 is pulled into action. This causes a series of sharp upward blows to be delivered to the driven member of the device and causes a certain amount of torque to be applied to the driven member. This torque is dependent on the pressure between the inclined backs 24 and 25 of the teeth of the jarring means, which is equal to the pull on the drill pipe less any excess pressure of the spring 40.

The drill pipe, however, being of steel possesses considerable elasticity and suffers considerable elongation under stress. In wells several thousand feet deep it is possible to elongate the drill pipe several feet without reaching the elastic limit of the material.

In practice, the operator pulls upwardly on the upper end of the drill pipe until he exerts a considerable pressure on the surfaces 24 and 25. If he now rotates the table 54 and the bit does not turn, the surfaces 24 and 25 slip on each other and the teeth 22 and 23 slip into the position shown in Fig. 4. This of course slightly elongates the drill pipe which acts as a tension spring. The teeth 22 and 23 do not stop in the position shown in Fig. 4, however, but the teeth 23 pass to the left, and as soon as the teeth 23 reach the proper position they are pulled quickly upward by the spring action of the drill string so that the upper surface of the teeth 23 strike a percussive blow on the teeth 22. This percussive blow is upward and tends to raise the bit. In practice, if the table 54 is rotated slowly the teeth 23 deliver a succession of hammer blows. During the time these blows are being delivered the bit is also subjected to the upward force of the spring 40. As soon as the bit starts up the spring 40 and the elasticity of the drill pipe act and tend to pull it free. As soon as the bit is free the spring 40 pushes the driven member to its extreme upper position on the driving member, the teeth of the jarring means 21 are entirely disengaged and the teeth of the positive driving means 15 engage and positively drive the bit and normal drilling is resumed. It should be noted that the teeth 22 and 23 are not only driven violently together, but between each blow the surfaces 24 and 25 engage, thus producing an inter-

mittent or jerking torque on the bit which also assists in releasing it.

The operator can regulate the force of the jarring action by regulating the tension on the drill string. He usually starts with a small tension, gradually increasing it until the bit frees itself. During the jarring action the circulation of mud is not interrupted and as soon as the bit is free the positive driving means 15 comes into action so that any rejaming of the bit is prevented. The hammer blows of the jars are transmitted through the drill pipe so that an operator with his hand on the upper end of the drill pipe can feel or hear the vibrations and thus know what is going on.

By the use of my invention a jammed bit can be quickly released and normal drilling immediately and automatically resumed.

It should be noted that the spindle 13 is not depended upon to drive the pipe during normal drilling operations.

It should also be noted that the jarring means 21 has a triple function. In the first place it jars the bit to loosen it, in the second place it applies a frictional torque to the bit due to the slipping of the surfaces 24 and 25, and thirdly, it transmits the upward pull of the drill pipe to the bit. The degree to which it performs each of these functions can be widely varied and one or more of these functions can be entirely omitted without departing from the spirit of my invention. For example, the teeth of the jarring means may be omitted and the lower surface of the coupling 14 and the upper surface of the head 20 may be made smooth, as shown in Fig. 7 so that the jarring action is eliminated. The device then tends to frictionally drive the bit, when the upper surface of the head 20 is pulled solidly against the lower surface of the coupling 14 due to surface friction between the surfaces, and the upward pull of the drill pipe is transmitted to the bit through these surfaces.

The amount of frictional drive can also be greatly reduced or entirely eliminated by friction reducing means placed between the head 20 and the coupling 14 without destroying the utility of my device, since it will still be possible to exert upward pressure on the bit.

If now the drill pipe is slowly rotated and rotary mud vigorously pumped downwardly through the drill pipe the jetting action of this mud tends to wash the bit free. This operation can be safely continued for a long time, since the drill pipe is rotating and the mud circulation is maintained and there is little danger of sticking the pipe. At the same time the upward pressure is maintained on the bit and as soon as it is freed the spring 40 snaps the positive driving means 15 into action and the bit rotates with the pipe. The drill pipe, having been previously elongated

under tension, shortens as soon as the bit is free and the bit rotates some distance above the point where it stuck. It is, therefore, evident that while the jarring means is of value since it tends to assist in freeing the bit, and some sort of frictional drive between the driving and driven members when upward tension is exerted on the device is desirable, since this friction also tends to free the bit, neither jarring nor frictional drive is absolutely essential to the utility of my invention.

This application is a continuation-in-part of my application Ser. No. 453,812, filed May 9, 1930 in which claims 1 to 5 presented herewith were finally allowed on November 4, 1931.

I claim as my invention:

1. A rotary jar comprising: a driven member adapted to be attached to a bit; a driving member adapted to be attached to the drilling string; positive driving means by which said driving member drives said driven member; means for normally holding said driving member in positive engagement with said driven member, said driving member being disengaged from said driven member whenever there is an upward pull on the drilling string; and means by which said driving member intermittently strikes an upward blow on said driven member when the drilling string is rotated with the driving means in said disengaged position.
2. A rotary jar comprising: a driven member adapted to be attached to a bit; a driving member adapted to be attached to the drilling string; positive driving means by which said driving member drives said driven member; a spring so disposed as to force said driving means together, said driving member being disengaged from said driven member whenever there is an upward pull on the drilling string; and means by which said driving member intermittently strikes an upward blow on said driven member when the drilling string rotates with the driving means in said disengaged position.
3. A rotary jar comprising: a driven member adapted to be attached to a bit; a driving member adapted to be attached to the drilling string; positive driving means by which said driving member drives said driven member; a spring so disposed as to force said driving means together, said driving member being disengaged from said driven member whenever there is an upward pull on the drilling string; and means by which said driving member can frictionally drive and percussively strike said driven member when said driving member is pulled upwardly with relation to said driven member.
4. A rotary jar comprising: a driven member adapted to be attached to a bit and having engageable projections formed thereon; a driving member adapted to be attached to

a drilling string, movable longitudinally with relation to said driven member and having engaging projections formed thereon in such a position that they engage said engageable projections when said driving member is in an extreme driving position with relation to the driven member and are disengaged therefrom when said driving member is in its extreme disengaged position; a spring acting between said driven and driving members and tending to force said projections into engagement; and means for striking percussive blows on the driven member when said driving member is moved away from its extreme driving position.

5. A rotary jar comprising: a driven member adapted to be attached to a bit and having engageable projections formed thereon; a driving member adapted to be attached to a drilling string, movable longitudinally with relation to said driven member and having engaging projections formed thereon in such a position that they engage said engageable projections when said driving member is in an extreme driving position with relation to the driven member and are disengaged therefrom when said driving member is in its extreme disengaged position; a spring acting between said driven and driving members and tending to force said projections into engagement; and means by which said driving member strikes percussive blows on said driven member when said driving member is in its extreme disengaged position.

6. A driving device for use in rotary drilling comprising: a driving member secured to the lower end of a drill pipe; a driven member associated therewith and adapted to drive a drilling bit; driving means between said driving member and said driven member; and a spring tending to hold said driving means in engaged position and having sufficient strength to allow considerable upward pressure to be exerted on the bit by an upward pull on the drill pipe without allowing said driving means to be disengaged until this pressure is exceeded, said driving member being free to rotate with relation to the driven member when said driving means is disengaged.

7. A driving device for use in rotary drilling comprising: a driving member secured to the lower end of a drill pipe; a driven member associated therewith and adapted to drive a drilling bit; mutually engageable means secured to said driven and driving members and adapted to cause said driving member to drive said driven member when said means is in the engaged position and to become disengaged and allow said driving member to rotate with relation to said driven member when said means is moved out of said engaged position, said means being so placed as to tend to be pulled out of said engaged position whenever upward tension is exerted

on the bit by pulling on the drill pipe; and a spring so placed as to tend to force said means into said engaged position, said spring having sufficient strength to prevent the weight of the driven member and parts carried thereby from moving said means out of the disengaged position.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 14 day of January, 1933.

FORD W. HARRIS.