June 2, 1931. J. C. FORTUNE 1,807,837

WELL DRILLING APPARATUS

Filed June 16, 1928

Fig. 1.

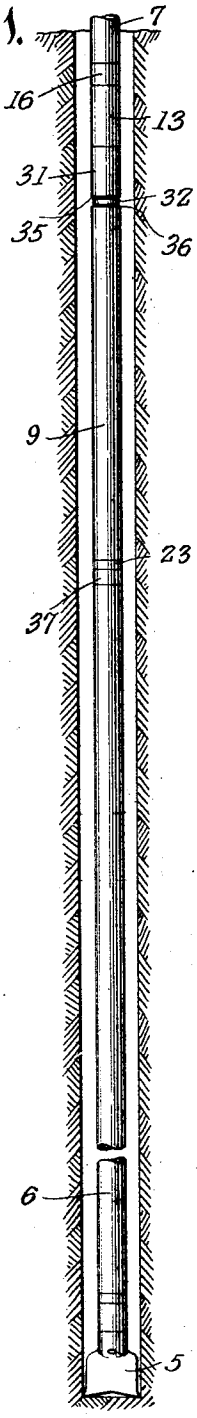


Fig. 2.

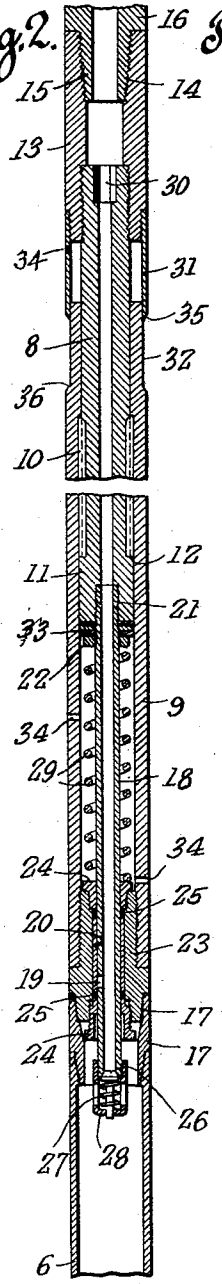
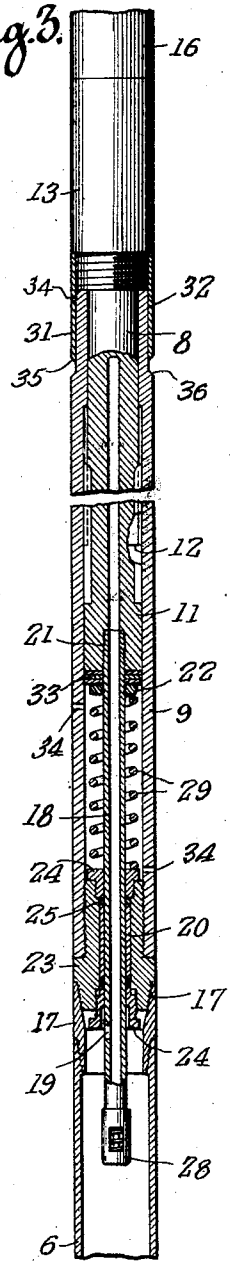


Fig. 3.



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WELL DRILLING APPARATUS

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This invention relates to the drilling of wells by the so-called "rotary" methods.

Special objects of the invention are to enable the drilling of the well with a predetermined desired weight on the bit; to control passage through the drill pipe in either direction; to control the buoyancy and hence reduce the dead weight of the pipe lowered into the hole as may be desired; to enable a rotary jar action when that effect is required to loosen a bit which has become stuck, and to provide mechanism for the above which will be simple, efficient and practical in all respects.

The foregoing and other desirable objects are attained in this invention by certain novel features of construction, combination and relations of parts as set forth in the following specification and broadly claimed.

In the drawings accompanying and forming part of the specification, a practical commerical embodiment of the invention is illustrated, but it will be understood that the structure may be modified and altered in its structural form without departure from the true spirit and broad scope of the invention.

Fig. 1 is a broken part sectional side view showing the invention as in use in an intermediate portion of a drill string; Fig. 2 is an enlarged broken longitudinal sectional view of the new apparatus showing the parts extended, as in entering the well and the valve controlled by such relatively moveable parts as closed; Fig. 3 is a similar view showing the parts shifted as with the bit working on bottom and the valve open to establish communication through the length of drill pipe.

In Fig. 1, the bit is shown at 5 attached to the end of a section of drill pipe 6 of sufficient length to provide the estimated proper weight on the bit. This section may consist of any number of lengths depending on the character of the formation, and the apparatus of the present invention is attached to the upper end of this section, where it forms a connection with the upper section 7 of drill pipe extending to the surface.

The structure of the apparatus will be clear from Figs. 2 and 3, where it is shown as consisting in the main of the two slidably related members 8 and 9 keyed together at 10, so as to turn one with the other. The inner member 8 is in the nature of a plunger having a head 11 at the lower end of the same, and the outer member 9 is in the nature of a barrel or sleeve sliding over the plunger and having an internal shoulder 12 engageable with the head to limit the downward sliding movement of the same. The plunger member is shown as screwed into a coupling sleeve 13 having a box 14 to receive the pin 15 of the tool joint 16 on the end of the upper or surface section of the pipe string. At the lower end, a tool joint or flush coupling 17 connects the apparatus with the section of pipe 6 which rests on the bit. With this construction therefore, the device may be connected in at any point in the length of a drill string, providing when so arranged, a vertical lost motion connection between the lower bit carrying section of pipe and the upper section of pipe extending to the surface. The keyed connection at 10 between the two telescopic members of the device enables the rotation of the upper pipe section to be transmitted to the lower pipe section, and hence the bit can be turned in all positions of the lost motion connection. By raising and lowering the upper section of the string, the device may be used as a jar to break the bit loose from the formation and the jarring may be employed independently of, or in conjunction with the rotary turning action.

Communication between the upper and lower sections of drill pipe is controlled in the present disclosure by the provision of a wash pipe 18 carried by the plunger 8 and provided with a port or ports 19 to operate as a valve in conjunction with the surrounding valve sleeve 20 mounted in the lower end of the barrel 9.

The wash pipe 18 is shown as having an adjustable connection with the plunger by screwing up into a seat 21 in the lower end of the plunger, where it is held in the desired relation by a lock nut 22. The range of adjustment permits the valve port 19 to be shifted relatively to the valve sleeve 20, and hence the valve opening and closing

movements to be timed relative to the telescopic movements of the plunger and barrel.

The valve sleeve 20 is shown as seating in a coupling sleeve 23 secured in the lower end of the barrel 9, and as being packed at opposite ends by glands 24 and packing rings 25.

The wash pipe is shown as closed at the lower end by a valve 26 normally held to its seat by a spring 27. This valve opens downwardly and hence will close automatically to pressure from below, but may be forced open by superior pressure from above, capable also of overcoming the valve closing force of spring 27.

The check valve 26 is shown as carried by a removable cage 28 screwed on the lower end of the wash pipe. This cage may be removed to leave the wash pipe open, or if the valve is not required and the wash pipe is to be kept closed, the same may be covered by a suitable cap screwed on the lower end of the pipe in place of the valve cage.

A spring 29 is shown located in the barrel between the lock nut 22 and upper gland nut 24 to hold the relatively telescopic parts in the extended relation in Fig. 2, which spring however may be left off and the weight of the bit and attached pipe be depended on to keep the sliding joint in the extended relation when the bit is off bottom.

The plunger member 8 is illustrated as having a key socket 30 in the upper end of the same by which it may be screwed up into the coupling collar 13. The gap in the sliding joint, between the lower end of collar 13 and upper end of the barrel 9 is shown as protected by a sleeve 31 secured to the lower end of the collar and slidingly engaging over the reduced upper end portion 32 of the barrel. This guard sleeve prevents grit from getting into the barrel and into the keyways from above, while suitable packing 33 between the head of the plunger and the inside of the barrel prevents grit from getting in under the keyways from below.

Circulation openings or vents 34 are shown provided in the upper and lower portions of the barrel and in the guard sleeve to prevent trapping a cushion of fluid therein, but if found desirable, one or more, or all these vents may be closed as by means of suitable plugs to use the fluid trapped in the barrel or sleeve as a cushion.

The two telescopically related members 8 and 9 of the sliding joint construction are keyed together in the present disclosure by means of a series of longitudinal keys on the plunger working in key grooves cut inside the barrel. This forms a strong and easily manufactured key connection.

In one use of the invention, a sufficient length of pipe is connected with the bit to give the weight which it is estimated will be best for drilling in the particular formation and the apparatus is then connected to the top of this section, other pipe sections being connected with the top of the apparatus sufficient to extend to the surface. The apparatus thereby becomes a driving unit and vertical lost motion connection between the two sections of pipe and in addition, a valve mechanism keeping the upper section of pipe dry, while the pipe is being lowered, but opening automatically when the bit reaches bottom to connect the two sections of the string and to leave the weight of the lower section on the bit for drilling purposes. The invention gives the driller notice when the bit reaches bottom by rush of air when the valve opens, as the circulation will be cut off while the pipe is being lowered, but will be established through opening of the valve when the bit rests on bottom. Circulation of drilling fluid may thus be kept up while drilling progresses and with the pipe held fast in the rotary, the lower section of the string will feed down with the bit until the closing of the valve and consequent rise in pressure of the circulation fluid indicates to the driller that the bit has advanced the extent of the lost motion connection, which for example, may be somewhere in the neighborhood of between 18 inches and three feet for usual drilling operations. In this way, the driller can tell whether the bit is off bottom or on bottom, knows that the desired drilling weight is on the bit, regardless of the depth of hole and is informed when the feeding movement of the bit is completed. The drilling can thus be advanced step by step as rapidly as practicable, at all times with the proper weight on the bit, no matter how deep the hole may go, and if it is desirable to change the weight on the bit, this can be done at any time by pulling out the string and adding or taking out as many lengths of pipe in the lower section as may be desired to increase or reduce the weight on the bit.

The invention may be used to clean out a well in which there is pressure by closing off the well at the top and introducing the valve structure, in a string of flush joint pipe, through a stuffing box. In this case when the bit encounters bottom, the valve will be opened and the cuttings may then pass up through the drill pipe under pressure from the well, or if additional pressure is required, this may be supplied by introducing suitable pressure into the casing surrounding the drill pipe, the circulation being then the reverse of that ordinarily employed in rotary drilling, the cuttings being flushed up through the drill pipe and the flow automatically cutting off when the drill pipe is pulled out, as soon as the bit is lifted off bottom.

As the valve is closed in going into the hole, the upper section of the string is empty and so can be "floated" into position with less strain on the hoist and derrick mechanism. The

construction operates as a check valve, but at the same time, may be positively opened and closed as occasions require, by simply lowering the string until the bit rests on bottom, or by hoisting the string enough to lift the bit off bottom. The apparatus may be used with flush joint pipe and operated through a stuffing box when the sleeve 31 is used over the lost motion joint, the tapered edge 35 of the sleeve and bevelled shoulder 36 on the barrel permitting these parts to pass through a stuffing box. The extent of the lost motion is sufficient to enable the apparatus being used as a powerful jar if such need arises at any time. By screwing the wash pipe 18 further into the head of the plunger, the valve port 19 will be uncovered later and be closed earlier in the reciprocating movements of the two members of the joint, and the reverse adjustment will have the reverse effects. By closing the lower end of the wash pipe with a check valve such as shown, forced circulation may be started, for instance, to overcome pressure in the well should the requirement arise. By the provision of a regular or suitable tool joint connection at opposite ends of the device, the same may be quickly coupled and uncoupled and used wherever required in the drill string. The various parts of the device are strong, can be readily assembled and are well capable of serving their purpose. The sliding form of valve shown is simple and substantial, and can be kept tight by the packing glands at opposite ends of the sleeve. This valve structure and other features of the invention however may be modified to meet special conditions or requirements and still be within the true scope of the invention.

What is claimed is:

1. In apparatus of the character disclosed, a slide coupling for connection at an intermediate point in a drill string and comprising relatively telescopic tubular members longitudinally keyed together to carry the rotation of the drill string independently of the sliding movements of the members relative to each other, drill string coupling elements at the ends of said telescopically related members, whereby the device may be connected for rotary driving operations at a selected point in the length of the drill string, valve means operative in the relative movements of the two members to control communication between the section of pipe below said drive coupling and the section of pipe above the same, and a check valve operable by superior pressure in the section above the drive coupling to open communication between the two sections of pipe.

2. In apparatus of the character disclosed, a combined drive coupling and valve comprising telescopically related tubular members adapted to be connected in an intermediate portion of a rotary drill string and having limited longitudinal movement relative to each other and keyed together, so that rotation of the upper member will transmit rotational drive to the lower member and the section of drill string below the same, and valve mechanism carried by said members adapted to be opened to establish communication between the upper and lower sections of drill string when the upper section is lowered with the lower section supported on the bottom of a well and to be closed when the lower section lowers away from the upper section as drilling progresses.

3. In well drilling apparatus, a rotary drill string, a bit carried thereby, a slide coupling interposed in said drill string and keyed to effect a rotary drive from the upper section to the lower pipe section, and valve means controlling communication between the upper and lower pipe sections and operable by the telescopic movements of said slide drive coupling to open communication between the upper and lower pipe sections when the upper section rests upon the lower section and to close communication between the pipe sections when the lower pipe section is suspended from the upper pipe section.

4. In combination with telescopically related members adapted to be interposed in a rotary drill string, said members having a sliding drive connection whereby rotation of the upper member will transmit rotation to the lower member, a wash pipe carried by the upper member and a co-operative valve member carried by the lower member, said wash pipe and valve member having cooperating elements of a valve to close communication between the upper and lower members when the lower member is suspended from the upper member and to open communication between said two members when the upper member is supported by the lower member.

5. In combination with telescopically related members adapted to be interposed in a rotary drill string, said members having a sliding drive connection, whereby rotation of the upper member will transmit rotation to the lower member, a wash pipe carried by the upper member, a co-operative valve member carried by the lower member and a downwardly opening check valve carried by said wash pipe.

6. In combination with telescopically related members adapted to be interposed in a rotary drill string, said members having a sliding drive connection, whereby rotation of the upper member will transmit rotation to the lower member, a wash pipe carried by the upper member, a co-operative valve member carried by the lower member and a check valve removably secured to the lower end of said wash pipe.

7. In apparatus of the character disclosed, a tubular plunger having a head at the lower

end of the same, a barrel slidingly engaged over said plunger and shouldered for engagement with the head on the plunger to limit the downward movement of the barrel over said plunger, a keying connection between the plunger and barrel, whereby the rotation of one will be imparted to the other, a downwardly extending wash pipe carried by the plunger and a cooperating valve body carried by the lower end of the barrel, said wash pipe and valve body having cooperating elements of a valve to open communication between the tubular plunger and surrounding barrel when the plunger is supported on the barrel and to close communication between said plunger and barrel when the barrel is suspended on the plunger.

8. In apparatus of the character disclosed, a tubular plunger having a head at the lower end of the same, a barrel slidingly engaged over said plunger and shouldered for engagement with the head on the plunger to limit the downward movement of the barrel over said plunger, a keying connection between the plunger and barrel, whereby the rotation of one will be imparted to the other, a downwardly extending wash pipe carried by the plunger, a cooperating valve body carried by the lower end of the barrel, said wash pipe having a port in the side of the same, the valve body having a valve sleeve surrounding the wash pipe and operable in the lowered position of the barrel to close said port, and in the lowered position of the plunger to open said port and a pressure operable check valve carried by the wash pipe.

9. In apparatus of the character disclosed, a tubular plunger having a head at the lower end of the same, a barrel slidingly engaged over said plunger and shouldered for engagement with the head on the plunger to limit the downward movement of the barrel over said plunger, a keying connection between the plunger and barrel, whereby the rotation of one will be imparted to the other, a downwardly extending wash pipe carried by the plunger, a cooperating valve body carried by the lower end of the barrel, said wash pipe having a port in the side of the same, the valve body having a valve sleeve surrounding the wash pipe and operable in the lowered position of the barrel to close said port and in the lowered position of the plunger to open said port and a pressure operable check valve controlling flow through the plunger and wash pipe.

10. In rotary drilling, the process which comprises interposing at a point in the drill string where the section of pipe on the bit substantially equals the desired weight on the bit for drilling in the particular formation, a longitudinally extensive limited lost motion drive coupling, drilling with said string while supporting the section above said coupling from the surface so as to leave the weight of only the section below the coupling on the bit and valving communication between the upper and lower sections of the string by the lost motion movements of said couplings.

11. In apparatus of the character disclosed, a slide coupling comprising telescopically related tubular members adapted to be connected in an intermediate portion of a rotary drill string and having limited longitudinal movement relative to each other and keyed together so that rotation of the upper member will transmit rotational drive to the lower member and the section of drill string below the same and an automatically closing check valve controlling communication between the sections of drill pipe above and below the slide coupling, said check valve being operable by superior pressure in the section above the slide coupling to open communication between said upper and lower sections of drill pipe.

12. In apparatus of the character disclosed, the combination of a tubular coupling member forming one element of a joint in a string of rotary drill pipe, a valve sleeve secured in the bore of said coupling member, a tubular valving member slidingly operating in said valve sleeve, said tubular valving member having a closed lower end below the lower end of the valve sleeve and having a port in the side of the same to be exposed below the lower end of the valve sleeve when said tubular valving member slides downwardly in the valve sleeve and a spring acting on the upper portion of the valving member above the valve sleeve.

13. In apparatus of the character disclosed, the combination of a tubular coupling member forming one element of a joint in a string of rotary drill pipe, a valve sleeve secured in the bore of said coupling member, a tubular valving member slidingly operating in said valve sleeve, said tubular valving member having a closed lower end below the lower end of the valve sleeve and having a port in the side of the same to be exposed below the lower end of the valve sleeve when said tubular valving member slides downwardly in the valve sleeve, said closed lower end of the tubular valving member having an automatically closing check valve which will open to pressure within the tubular valving member.

14. In apparatus of the character disclosed, the combination of a string of rotary drill pipe, a bit carried by said string, relatively telescopic drive coupling members interposed in an intermediate portion of said string of drill pipe, valve members carried by said members and maintained in valve-closed relation while the string is lowered into a hole to thereby enable the drill pipe being introduced into a well without the well flowing through the same, said valve means be-

ing automatically opened by the relative movement of the telescopic members when the bit operates on bottom to enable drilling cuttings to be recovered through the drill pipe by pressure in the well, said valve closing by the relative movement of the telescopic members when the drill pipe is lifted on completion of the drilling, whereby the drill pipe may be pulled out without the well flowing through the same and pressure operated valve means opening by pressure in the drill pipe superior to the well pressure, whereby passage may be forced into the well by pumping down the drill pipe from the surface at any time the same may be required.

In testimony whereof I affix my signature.

JAMES C. FORTUNE.