

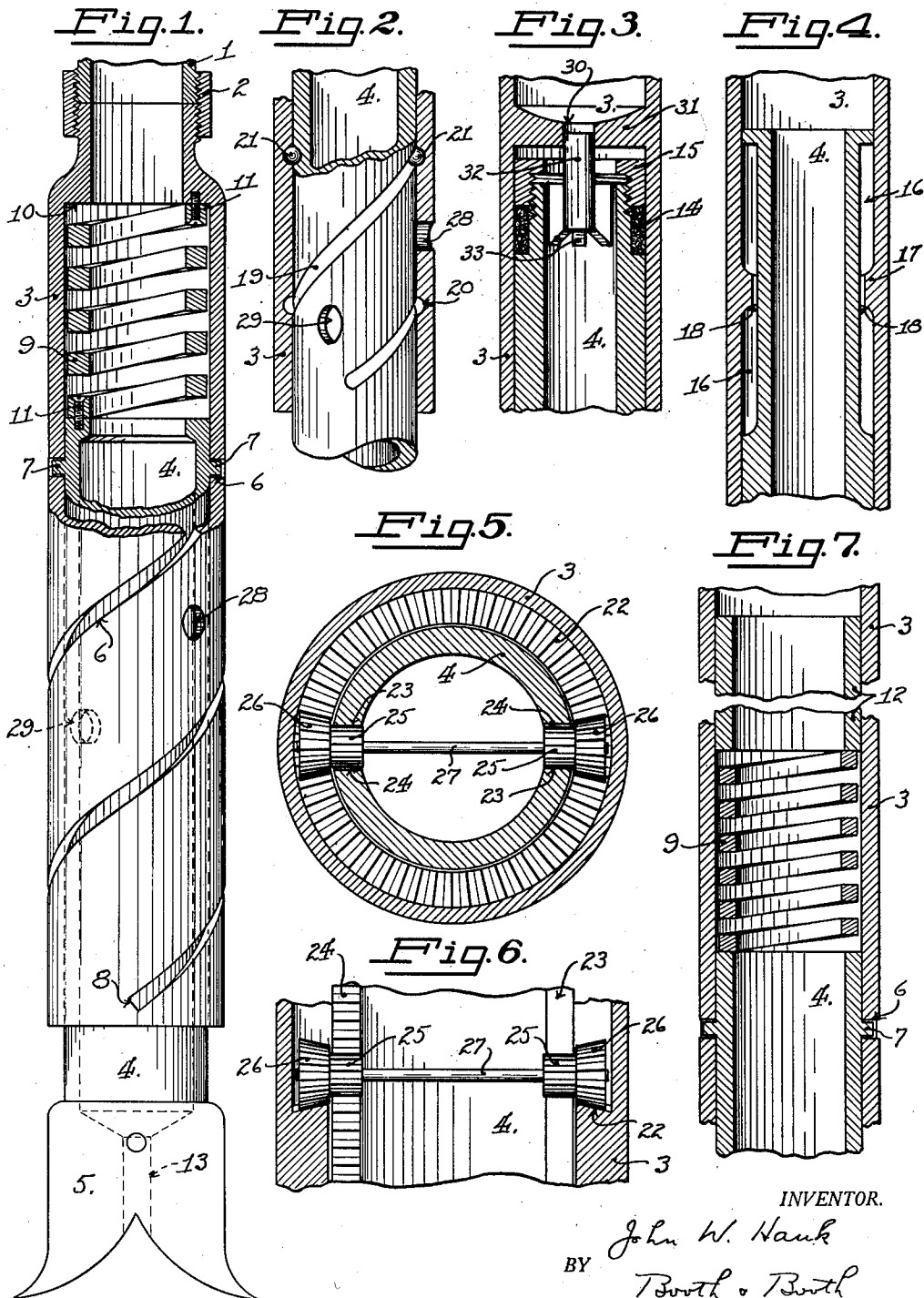
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J. W. HAUKE

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AUTOMATIC FEED DEVICE FOR ROTARY DRILL BITS

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INVENTOR.

BY John W. Hauke
Booth & Booth

ATTORNEYS.

UNITED STATES PATENT OFFICE

JOHN W. HAUKE, OF WHITTIER, CALIFORNIA, ASSIGNOR OF ONE-HALF TO LEROY G. GATES, OF BAKERSFIELD, CALIFORNIA

AUTOMATIC FEED DEVICE FOR ROTARY DRILL BITS

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My invention relates to the well drilling art, and more particularly to protective devices for rotary drill bits.

The principal object of the invention is to provide means for preventing breakage of the drill stem or drill bit. Such breakage is comparatively common, particularly in the lowermost sections of the drill stem, and is due to the twisting of the stem caused by the unequal resistance which the cutting faces of the bit encounters. Each time that the bit strikes an obstruction or hard spot, the resistance is increased, and the stem is twisted until such resistance is overcome, whereupon the stem untwists, causing the bit to rotate with increased speed. If a second obstruction is encountered during such increased speed, a sudden and violent shock ensues. In practice this occurs continually, so that the stem and bit are subject not only to repeated and violent torsional strains, but to excessive vibration as well. On account of the great length of the stem, the weight of the stem and bit, and the necessity for the greatest possible speed of operation, this strain and vibration causes frequent failure, especially in the lowermost joints of the stem, resulting in costly waste of time and labor.

By the use of a device embodying my invention, the torsional strain on the stem is rendered practically uniform, and the vibration is greatly reduced, thus minimizing breakage. A further advantage in my invention is that it may be applied to any existing drill bit or stem without changing the method of operation or interfering with the action of the bit or of the circulating fluid.

It should be understood that the form, arrangement, and construction of the several parts of my invention, as herein described and illustrated, may be varied, within the scope of the claims hereto appended, without departing from the spirit of the invention as set forth in said claims.

With this in view, several preferred embodiments of my invention will now be described fully with reference to the accompanying drawings, wherein:—

Fig. 1 is a part sectional elevation of one form of my device.

Fig. 2 is a vertical sectional detail illustrating a second form of differential connection between the relatively movable sleeves.

Fig. 3 is a vertical sectional detail illustrating one form of retarding device that may be used to dampen the relative movement of the sleeve.

Fig. 4 is a vertical sectional detail of a second form of retarding or dampening device.

Fig. 5 is a horizontal section illustrating a third form of differential connection between the sleeves.

Fig. 6 is a vertical sectional detail of the form shown in Fig. 5.

Fig. 7 is a vertical sectional detail illustrating a different arrangement of the spring shown in Fig. 1.

In the drawings, and referring for the moment to Fig. 1, the reference numeral 1 designates a portion of the usual drill stem, to which is connected, by a suitable coupling 2, a sleeve 3 of slightly increased diameter.

A second and smaller sleeve 4 is movably fitted within the sleeve 3, and its lower end is connected with the drill bit 5. A connection is employed between the sleeves 3 and 4, which will transmit the rotative driving force from the stem 1 to the bit 5, and which will permit the inner sleeve 4 with said bit 5 to rise independently of the outer sleeve 3 and said stem 1, thus permitting the bit to rise over an obstruction. In its simplest form, this connection is a helical sliding one, of any suitable construction, similar in effect to a screw thread. As one example of a simple type of such construction I have shown, in Fig. 1, helical slots 6 in the outer sleeve 3, and lugs 7 projecting from the inner sleeve 4 and slidable in said slots.

The effect of such an arrangement, assuming the proper direction of rotation of the stem 1, is to cause the inner sleeve 4 to rise whenever the resistance to the rotation of the bit 5 increases, and such rise, of course, immediately decreases the resistance, so that a practically uniform torque is maintained. Suitable means must be provided for preventing the inner sleeve 4 from dropping out, which can be done for example by closing

the lower ends of the slots 6, as shown at 8.

If the weight of the inner sleeve 4 and the bit 5 are not sufficient to give the bit the necessary effectiveness, a suitable resilient member may be interposed between the two sleeves in such a manner as to increase either the downward force or the rotative force, or both, on the bit. One form of such a resilient member is shown as a helical spring 9, interposed between the upper end of the inner sleeve 4 and a shoulder 10 in the outer sleeve 3. Such a spring increases the downward force on the bit, and, if its ends are respectively connected with the two sleeves, as shown at 11, it also directly increases the rotative force on said bit. It is to be understood, of course, that the connections 11 may be omitted, in which case the spring will directly increase only the downward force on the bit.

With the spring 9 positioned as in Fig. 1, the entire weight of the drill stem 1 may rest upon the bit. Such a weight may be too great for best results in certain formations, and it has the further disadvantage of increasing as the depth of the hole increases. Therefore, I may arrange the spring 9 as shown in Fig. 7, acting between the top of the inner sleeve 4 and a tubular weight 12 freely slidable within the outer sleeve 3, said outer sleeve being long enough in this case to accommodate said weight. In this arrangement the weight or downward force upon the bit is constant, and can be fixed at the desired value by properly proportioning the freely slidable tube 12.

The advantage in the use of a spring as shown in Figs. 1 and 7 is that the downward force on the bit can be increased to the best point, without adding to such force the effect of the inertia of the long drill stem. Obviously, the desired weight could be applied to the bit merely by adding a section of stem between the inner sleeve 4 and the bit, but such an arrangement would also add the effect of the inertia of such stem section to its weight whenever the bit started to rise. By interposing a spring between the weight and the bit, however, the effect of such inertia is overcome.

A second method of applying a controlled downward force on the bit is illustrated in Fig. 1. Rotary bits of this type are commonly used with a circulating mud fluid, which is forced down through the hollow drill stem and out through suitable discharge orifices in the bit, and which rises outside the stem, carrying with it the cuttings. The construction of my device is such that no interference is presented to the flow of such fluid, which passes freely through the inner sleeve 4. By making the discharge orifice in the bit, as indicated at 13, of smaller area than the area of the stem 1, the pressure of the mud fluid will effect a downward force on

the bit, which can be regulated by varying said pressure. The spring, arranged as shown in either Fig. 1 or Fig. 7, may or may not be used in connection with the fluid pressure, as desired.

In certain cases it may be desirable to dampen the action of the differential connection between the sleeves 3 and 4. This can be accomplished by friction as illustrated in Fig. 3, in which suitable packing 14 is secured in the upper end of the inner sleeve 4 by a ring 15, and has frictional contact with the inner surface of the outer sleeve 3. A second example of a dampening means is illustrated in Fig. 4, wherein the upper end portion of the inner sleeve 4 is formed with an annular recess 16 which is filled with a suitable fluid. The outer sleeve 3 has a ring 17, positioned to be normally about mid-way of the length of the recess 16. A suitably proportioned restrictive passage, as shown at 18, is provided in said ring 17, or between it and the surface of the sleeve 4, through which the fluid must pass upon vertical movement of the inner sleeve. Thus a dash-pot effect is produced, which retards or dampens the relative movement between the sleeves.

A second form of helical connection between the inner sleeve 4 and the outer sleeve 3 is shown in Fig. 2, in which said sleeves are formed with helical matched complementary grooves 19 and 20 respectively, forming channels in which ride a series of steel balls 21. The action, of course, is exactly similar to that of the slot and lug connection shown in Fig. 1.

A third form of differential connection between the sleeves 3 and 4 is shown in Figs. 5 and 6, in which the outer sleeve 3 is provided with an interior horizontal ring gear 22. The inner sleeve 4 is formed with diametrically opposite vertical slots 23, one face of each slot being provided with teeth forming a rack 24. A spur pinion 25 is mounted in each slot to mesh with the rack thereof, and is fixed to a bevel pinion 26 which meshes with the ring gear 22. Any suitable means may be provided for retaining the pinions in position, as for example a horizontal spindle 27 upon which the two pairs of pinions freely revolve. Thus relative rotation between the two sleeves causes relative vertical movement, which is the same effect produced by the helical connections shown in Figs. 1 and 2.

In said helical connections, the relation between the turning and lifting forces exerted on the bit can be varied by changing the pitch of the helical slots 6 or grooves 19 and 20. The same effect can be accomplished in the geared connection shown in Figs. 5 and 6 by changing the relative diameters of the pinions 25 and 26.

It will be apparent to those skilled in the art, and should be so understood, that either or both of the two forms of dampening de-

vices shown in Figs. 3 and 4 may or may not be used in connection with any one of the forms of differential connecting means shown in Figs. 1, 2, 5 and 6. Similarly either of the loading spring arrangements shown in Figs. 1 and 7 may or may not be used with any of said differential connecting means, and with either or both of the dampening devices. Also, the fluid pressure loading means indicated in Fig. 1 may be used with any of the other forms and devices described.

Other changes and variations will suggest themselves to those skilled in the art, and although I have shown and described certain forms of the invention and parts thereof, I do not wish to be understood as restricting myself thereto. For example, I have described the device as applied at the lower end of the drill stem in fairly close proximity to the drill bit. This is the preferred location, for the reason that it relieves the bit of the effect of the inertia of the stem, allowing it to respond instantly to sudden increases in resistance or torque reaction, but it will be apparent that the device may be used at any point in the length of the stem, or even at the surface. Moreover, such variations as placing the stem carried sleeve inside the bit carrying sleeve, instead of outside as shown and described, and the use of other well known forms of springs for loading the bit in place of the helical spring shown in the drawings, would be obvious to any skilled mechanic, and have consequently been omitted from the drawings to avoid confusion.

It is desirable that the operator at the surface have some indication of the relative positions of the differentially connected sleeves, so that he may know when the bit touches bottom and, more important still, when the weight of the drill stem has moved said sleeves to the limit of their relative travel, since under the latter condition the differential connection is inoperative. This indication can be given in a number of ways, but most conveniently by a change in the pressure of the circulating mud fluid. One example of a simple means for producing such pressure change is illustrated in Figs. 1 and 2, wherein 28 and 29 are ports in the outer and inner sleeves respectively, positioned to register when the bit-carrying sleeve reaches or approaches the upper limit of its movement in the stem carried sleeve. When said ports register, a free outlet is provided for the mud fluid, and the pressure thereof at the surface drops, thus giving the operator the desired indication. Obviously, the same means, although not shown, may be employed for varying the fluid pressure when the bit carrying sleeve is at the lower limit of its relative movement, or at any intermediate point.

A second means for indicating the relative positions of the sleeves is illustrated in Fig. 3, wherein 30 is a port in a head 31 in the

outer sleeve and 32 is a plug valve carried by the upper end of the inner sleeve by means of a spider 33. When the inner sleeve rises to its upper limit, as shown, the plug 32 closes the port 30, thereby cutting off the flow of mud fluid and increasing its pressure at the surface.

The pressure varying means shown in Figs. 1 and 3 may be combined in the same apparatus, as will be readily understood, the free discharge ports 28 and 29 being used, for example, to lower the fluid pressure when the bit is at its lower limit, and the valve arrangement 30—32 being used to increase said pressure when the bit is at its upper limit. Obviously, either or both such means may be used with any of the described forms of differential connection, and with any of the described loading and retarding means.

I claim:—

1. In a rotary well drilling apparatus, including a drill stem and a drill bit, a pair of relatively movable members, one carried by said stem and the other carrying said bit; gears carried by said members; and pinions meshing with said gears and connecting said members for relative movement in response to variations in the torque reaction of the bit.

2. In a rotary well drilling apparatus, including a drill stem and a drill bit, a pair of relatively movable members fitted one within the other, one being carried by said stem and the other carrying said bit; a substantially horizontal gear carried by one of said members; a toothed rack carried by the other member and angularly positioned with respect to the plane of said gear; and connected pinions engaging said gear and said rack and adapting said members for relative movement in response to variations in the torque reaction of the bit.

3. In a rotary well drilling apparatus including a drill stem and a drill bit; a pair of members secured respectively to said stem and said bit, said members fitting one within the other for relative vertical and rotative movement; a torque transmitting connection between said members, said connections causing relative vertical movement between said members in response to variations in the torque transmitted thereby; a weight movably associated with both said members; and cushioning means interposed between said weight and the bit carrying member.

4. In a rotary well drilling apparatus including a drill stem and a drill bit; a pair of members secured respectively to said stem and said bit, said members fitting one within the other for relative vertical and rotative movement; a torque transmitting connection between said members, said connection causing relative vertical movement between said members in response to variations in the torque transmitted thereby; means carried by

one of said members and adapted for frictional contact with the other member; and adjusting means for varying the amount of friction produced by said contact.

- 5 5. In a rotary well drilling apparatus including a drill stem and a drill bit; a pair of hollow members adapted to conduct fluid under pressure to said bit, said members being secured respectively to said stem and said
10 bit and fitting one within the other for relative vertical and rotative movement; and said members having cooperating ports positioned to be moved into and out of register upon said relative movement; and a torque
15 transmitting connection between said members, said connection causing relative vertical movement between said members in response to variations in the torque transmitted thereby.
- 20 In testimony whereof I have signed my name to this specification.

JOHN W. HAUK.

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