April 12, 1932. H. HAYES 1,853,351

APPARATUS FOR AUTOMATIC WELL DRILLING

Filed March 4, 1931

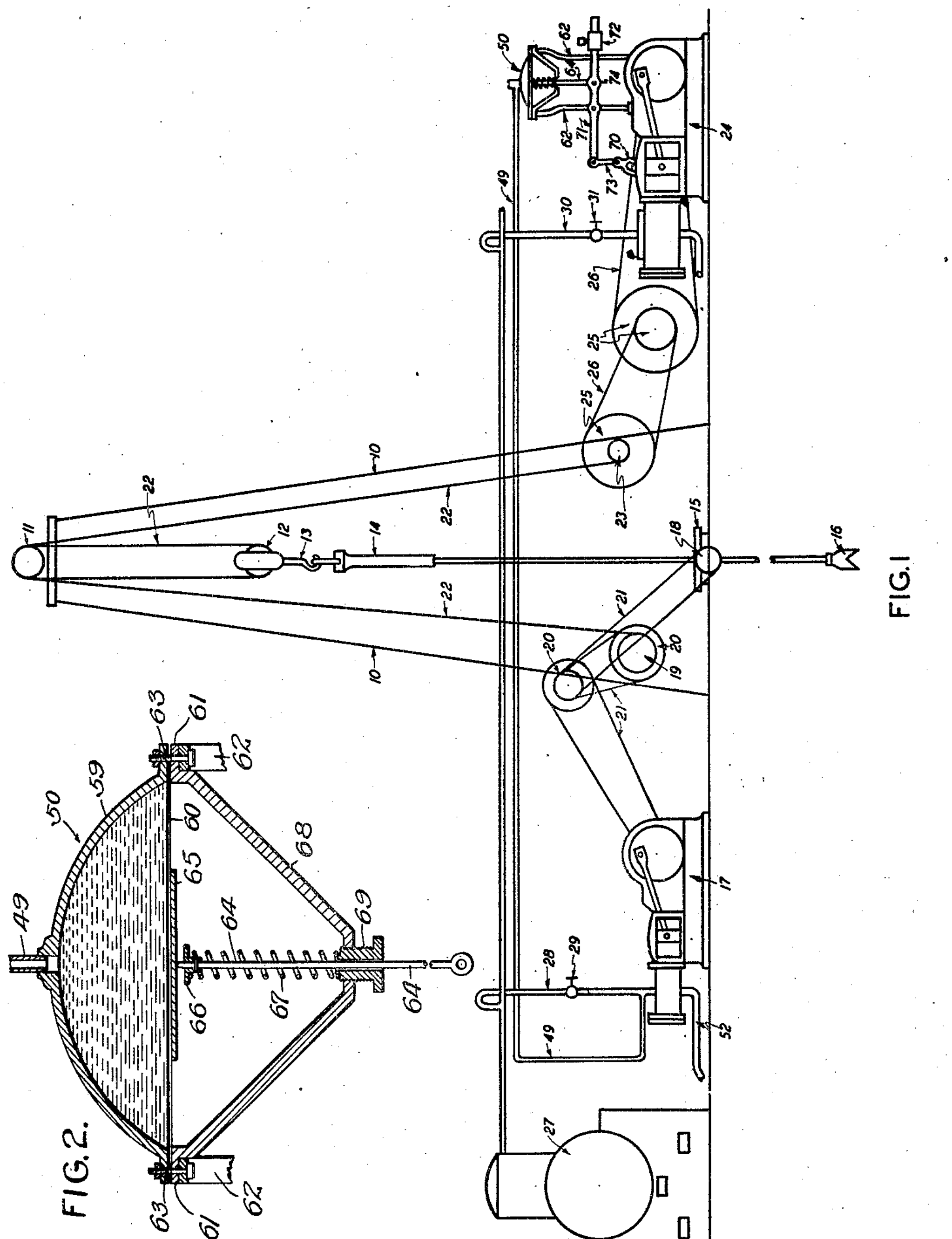

FIG. 1

FIG. 2.

HARRY HAYES
INVENTOR

Paul W. [signature]
ATTORNEY

Patented Apr. 12, 1932 **1,853,351**

UNITED STATES PATENT OFFICE

HARRY HAYES, OF ALHAMBRA, CALIFORNIA

APPARATUS FOR AUTOMATIC WELL DRILLING

Application filed March 4, 1931. Serial No. 520,072.

The object of my invention is to provide a means for automatically controlling the feed of a string of drill pipe in response to variations in the trosional stress on the upper end of the string.

My invention refers to the class of drilling apparatus in which a steam engine is used to actuate the rotary table and the hoisting drums, and comprises a steam-actuated secondary feeding engine and a drum operated thereby, together with means through which the variations in steam pressure in the cylinders of the drilling engine are caused to control the direction and the speed of rotation of the feeding engine.

The object and advantages of my invention may best be understood with reference to the attached drawings, showing an illustrative embodiment thereof, in which:

Fig. 1 is a diagram showing such parts of the drilling rig as are concerned in the practice of my invention;

Fig. 2 is a detail of the apparatus used to control the link motion of the secondary feeding mechanism indicated at 70 in Fig. 1.

Referring first to Fig. 1, 10 is the outline of a derrick, 11 the crown block, 12 the travelling block, 13 the swivel hook, 14 the drill stem, 15 the rotary table and 16 the bit. The drilling engine is indicated at 17; this may be any type of steam engine, though a twin engine is to be preferred. This engine drives the rotary table through a bevel gear 18 and also actuates the main winding drum 19 through sprockets and chains 20 and 21. The drilling line 22 is in part wound on the drum 19, then passed through the blocks 11 and 12 and the outer end wound on the calf wheel hoist drum 23. Up to this point the rig is entirely conventional and only the essential outlines are indicated.

The calf wheel drum is actuated by a secondary feeding engine 24 through a suitable combination of pulleys 25—25 and belts 26—26 or corresponding sprockets and chains. For the purpose of my invention the feeding engine 24 must be a steam engine with link motion and may be an ordinary drilling engine, though a twin engine is to be preferred as having no dead center—an important consideration in a device which is to be controlled automatically.

A boiler 27 supplies steam to the drilling engine through a pipe 28 controlled by a hand throttle 29 and to the feeding engine through a pipe 30 controlled by a hand throttle 31.

A pipe 49, which may be of small diameter, affords communication between pipe 28 and a diaphragm regulator 50 which is shown in more detail in Fig. 2. Pipe 49 must branch from pipe 28 at a point between the throttle 29 and the steam chest of the drilling engine, and the latter pipe must be of such diameter that the flow of steam to the engine will not be throttled therein. In other words, the end of pipe 49 must be in free communication with the interior of the steam chest, in order that the momentary pressure within the steam chest may be instantly transmitted to the regulator 50. This pipe will rapidly fill with condensed water in such parts as do not drain back to the steam chest, but for the purpose of my invention it is immaterial whether it contains water or steam, the requirement being solely for a confined fluid column capable of transmitting the varying pressure in the steam chest to the regulator.

Referring now to Figs. 1 and 2, the diaphragm regulator 50 consists of a domed cover or bowl 59, a flexible liquid-tight diaphragm 60, a ring 61 retaining the diaphragm against the rim of the bowl, straps 62 by means of which the assembly is supported in space relative to the apparatus which it operates, bolts 63, a thrust pin 64 bearing on a pad 65 in the center of the diaphragm, a collar 66 on the pin, a stiff open coil spring 67 bearing on the collar, a yoke 68 and a nut 69 passing through the yoke and adapted to adjust the pressure with which the spring urges the thrust pin toward the diaphragm.

When the bowl is filled with liquid under pressure through pipe 49 the diaphragm will be deflected outwardly and the pin thrust downwardly when the pressure of the liquid exceeds the resistance of the spring.

Referring to Fig. 1, a steam engine 24, which as said is preferably a twin engine, is supplied with steam through a pipe 30 controlled by a valve 31, which is wide open. This engine must be provided with a link motion for controlling the throw of the valves, the valve link being indicated at 70 in the figure. The straps 62—62 shown in Fig. 1 support the diaphragm regulator 50 in some convenient fixed relation to the engine. To one of these straps is pinned a lever 71 having at one end an adjustable weight 72 and being provided at the opposite end to the drag link 73 which is attached to valve link 70 in the usual manner. The lower end of the thrust pin 64 is pinned to lever 71 as at the point 74.

Connected in this manner an outward movement of diaphragm 60, due to increased pressure in bowl 59, causes a lifting of the valve link 70 while a decrease in pressure permits an inward movement of the diaphragm and a corresponding depression of the link. By pinning the lever 71 to the right instead of the left strap the direction of movement of the diaphragm will be reversed. In practice the relation is determined by the direction in which the engine is set as regards the rig.

In an actual arrangement of this apparatus the pins referred to should be as nearly frictionless as possible and may desirably be provided with small ball or roller bearings. The weight 72 should be adjusted to balance the weight of the valve link and the drag link. The spring 67 should be so adjusted that when the main drilling engine 17 is in normal operation under full load and the liquid in the regulating system under its normal operating pressure, the diaphragm 60 will be in its neutral or plane position. The thrust pin 64 should be of such length that when the diaphragm is in neutral position the lever 71 will be substantially horizontal.

The length of drag link 73 should be such that with the lever in this position the valve link will be so positioned as to admit a small quantity of steam to the engine in a winding-in direction. Finally, the lever should be so supported in relation to point 74 that an expansion of the diaphragm will so move the valve link as to increase the feed of steam in the said direction.

Arranged as described, the apparatus is operated and functions in the following manner. Assuming the apparatus to be at rest with the tools on the bottom of the hole, a sufficient length of the dead end of the line around calf wheel winding drum 23 and the remainder of the line on main winding drum 19, (the brakes on this drum being locked) throttle 31 is opened to admit steam to the feeding engine 24 and the free end of lever 71 is depressed by hand or by means of a temporary weight to admit a free flow of steam in a winding-in direction, the bit being thus lifted free of the bottom of the hole.

A small amount of steam is now admitted to drilling engine 17 and the tools allowed to run free until the regulating system including pipe 49 and the bowl 59 of regulator 50 fills with condensed water. This has to be done only in starting new apparatus as, once filled, the system will stay full.

The temporary weight is now removed and, as the pressure in the drilling engine steam chest is below normal operating pressure while the tools are idling, the pressure in the regulating system is also below normal and therefore the energy in spring 67 will lift the diaphragm past its neutral position, thus shifting link 70 until engine 24 reverses its direction and runs in an unwinding direction. The line is thus paid out until the bit engages the bottom of the hole.

Valve 29 is now opened to admit an operating supply of steam to drilling engine 17 and the pressure in the steam chest immediately rises. This rise in pressure being transmitted to bowl 59 the diaphragm is distended and link 70 is thus again shifted to reverse feeding engine 24 to a winding-in direction which tends to again lift the fit free of the bottom.

At this point the operation of the apparatus becomes automatic up to the point where all the line on drum 23 is paid out or until the lengthening of the drill pipe is required. As the bit drills itself free the steam chest pressure in the drilling engine decreases, the regulator pressure falls and the valve link is shifted into or toward an unwinding setting of the valves in the feeding engine.

The line is thus paid out and the pressure of the bit on the bottom of the hole and its resistance to rotation are increased. The steam pressure in the steam chest of the drilling engine rises, increasing the pressure in the regulator, the valve link is shifted into a winding-in position, and the tools are retrieved. By a proper balancing of these two effects the tools may be maintained in such degree of contact with the bottom as will maintain, without exceeding, that desired maximum torsional stress on the drill string at which the greatest amount of hole is made without overstressing the drill pipe.

It will be seen that with the apparatus functioning in this manner the greater part of the weight of the drill string is in effect suspended from the reel 23, which thus tends to unwind and pay out line, and that this tendency must be resisted in some manner. In the description previously given it is assumed that the transmission arrangements (as the pulleys and belts 25 and 26) is reversible and that the load on the winding drum is thus transmitted back to the engine and tends to reverse it, this tendency increasing as the length and weight of the drill string increases.

In the above description this tendency is resisted by such setting of the valve link as will admit a small amount of steam to the engine in a winding-in direction at such times as the drilling engine is operating at normal drilling pressure, this quantity of steam being such as will maintain the feeding engine stationary against the load tending to reverse it. This steam would condense and fill the engine cylinders with water, and in operating in this manner the cylinders should be provided with bleeders which should be left slightly open at all times. The amount of steam required to hold the engine stationary will vary with the load on drum 23 and the feed may be controlled by small adjustments of the length of the drag link, which for this purpose should be so constructed as to have its length varied without interrupting operation, as by a nut with opposed threads, a hand operated cam, a pair of adjusting screws adapted to move one of the pin bearings or any of the well known means for varying the length of a linkage rod.

If the transmission between engine 24 and drum 23 be so constructed as to be irreversible—as by the interposition of a worm at some point—the dead load will be carried by the transmission, there will be no tendency of the load to reverse the engine and the paying out of line for feeding will require the admission of steam to the engine in an unwinding direction. In this case the valve link is set on center so as to admit no steam to the feeding engine while the drilling engine is carrying its normal drilling load. In such case the engine may remain stationary long enough to become cold, as when drilling in very hard formation and, to prevent sluggishness in starting, not only the cylinders but also the steam chest should be continuously bled to avoid accumulation of water.

While I have shown and described the well known diaphragm pressure regulator as a preferred means for actuating the valve link of the feeding engine it will be understood that any alternative distensible means, such as a piston operating in a cylinder, may be used for this purpose.

I claim as my invention:

1. In a mechanism for drilling wells by the rotary method, said mechanism including a string of drill pipe, a rotary table, a main winding drum, a cable adapted to raise and lower said pipe and having one end wound on said drum, and a steam actuated drilling engine adapted to rotate said table; pipe feeding means comprising: a secondary winding drum having wound thereon the end of said cable opposite first said end; a steam actuated feeding engine operatively connected to said secondary drum, said feeding engine having a valve-controlling link; a diaphragm regulator having its fluid chamber fixed in position relative to said feeding engine; linkage between the diaphragm of said regulator and the link of said engine whereby the position of said link is altered in response to changes in position of said diaphragm, and a fluid conducting channel connecting the steam chest of said drilling engine with the fluid chamber of said regulator whereby a change in the pressure within said steam chest is caused to alter the position of said diaphragm relative to said regulator and the position of said link relative to said feeding engine.

2. In a mechanism for drilling wells by the rotary method, said mechanism including a string of drill pipe, a rotary table, a main winding drum, a cable adapted to raise and lower said pipe and having one end wound on said drum, and a steam actuated drilling engine adapted to rotate said table; pipe feeding means comprising: a secondary winding drum having wound thereon the end of said cable opposite first said end; a steam actuated feeding engine operatively connected to said secondary drum, said feeding engine having a valve-controlling link, and distensible means actuated by and responsive to variations in steam chest pressure in first said engine adapted to vary the position of said link relative to second said engine.

In witness that I claim the foregoing I have hereunto subscribed my name this 26th day of February, 1931.

HARRY HAYES.