

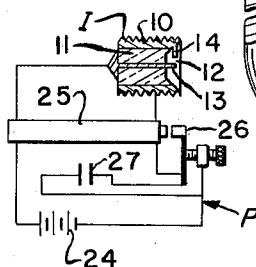
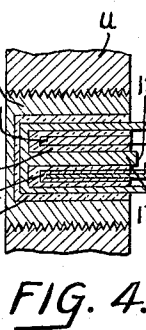
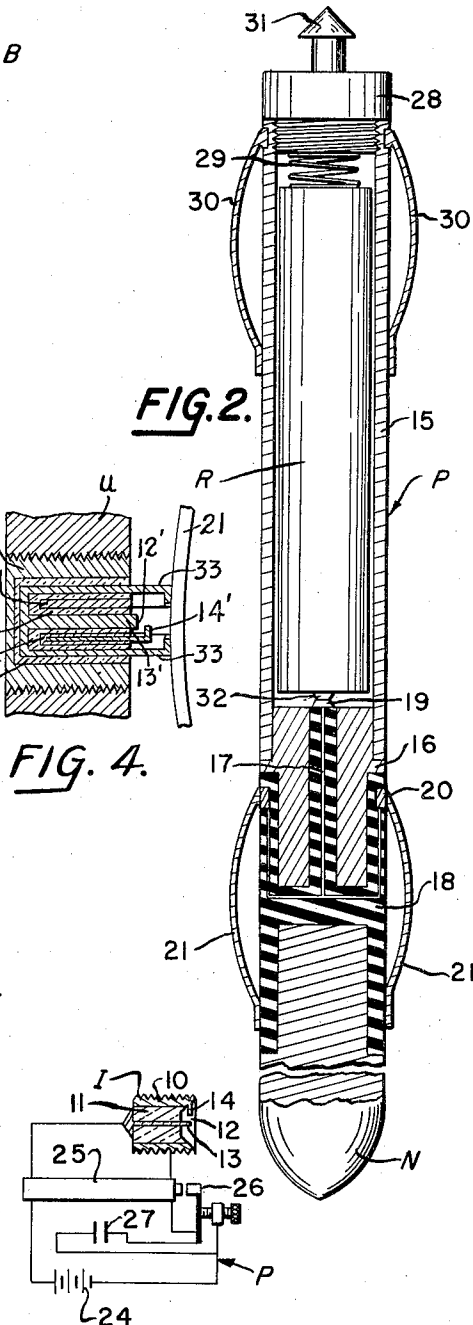
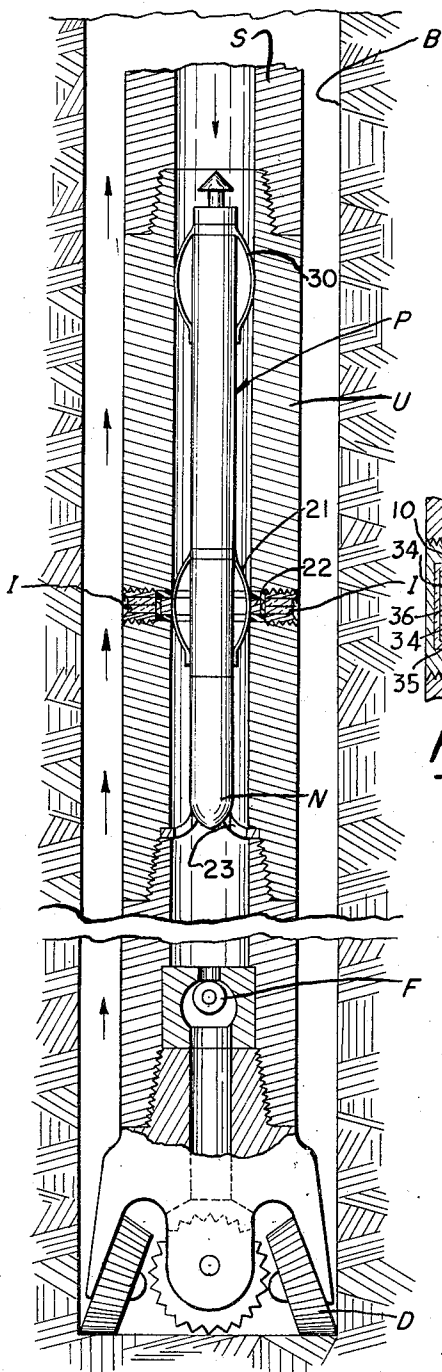
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J. G. JACKSON

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APPARATUS FOR AND METHOD OF EARTH BORE DRILLING

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INVENTOR.
John Gordon Jackson

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APPARATUS FOR AND METHOD OF EARTH-
BORE DRILLING

John Gordon Jackson, Denver, Colo., assignor to Well Completions, Incorporated, Denver, Colo., a corporation of Colorado

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This invention relates to the drilling of earth bores and more particularly to the drilling of such bores by rotary apparatus and with the use of a circulating gas which, as used in a broad sense, may be air, a combustible gas or a mixture of the two in the place of a circulating fluid or so-called "mud."

In the drilling of earth bores by rotary apparatus and circulating gas there is danger of explosions at the surface after the gas has been circulated down the bore and back during drilling operations or in the well bore during circulation. There is danger present, even though the circulating gas may be air instead of a combustible natural gas since the air may become mixed with natural gas coming into the bore from earth formations being drilled or already drilled. Also, in gas drilling, there are problems involved as to gas volumes and velocity which have not been solved to make this manner of drilling more efficient.

One of the objects of my invention is to produce means associated with a rotary drilling apparatus which will have less danger of gas explosions at the surface when gas is employed as the circulating fluid during drilling.

A more specific object is to provide means for associating with a drilling stem which will cause combustion of a circulating combustible gas during drilling and in the earth bore before the gas reaches the surface.

Another object is to produce by combustion of circulating gas during drilling a greater velocity of the gas upward to the earth's surface without increasing the volume of gas being injected or even under some conditions employing a less volume of injected gas.

A further object is to provide for the drying out of the earth's formations being drilled when the drilling is being accomplished with circulation of a gas, thus permitting better circulation of the gas with less mixture of water with drilling cuttings, and further an increase in a permanent manner the permeability of formations by the action of the heat resulting from the combustion.

Other objects of the invention will become apparent from the following description taken in connection with the accompanying drawings in which:

Figure 1 is a cross sectional view of the lower end of a rotary drilling structure having associated with the hollow drilling stem above the bit apparatus for causing combustion of the circulating gas and thereby carrying out my improved drilling method;

Figure 2 is a cross sectional view through the removable power unit for accomplishing the igniting of the circulating gas;

Figure 3 is a simple wiring diagram showing, by way of example, a manner for firing the spark plugs to ignite the gas; and

Figure 4 is a sectional view showing an igniter positioned for igniting of the circulating gas during its return path within the drill stem.

Referring to the drawings in detail and first to Figure 1, there is disclosed an earth bore B being drilled from the earth's surface by the usual rotary rig having a drill-

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ing stem or pipe S at the lower end of which is a drill bit D shown by way of example as a roller type of rock bit. The illustration is for drilling by the use of gas (air or a combustible natural gas or a mixture thereof) as the circulating fluid. In using gas as the circulating fluid it is pumped under pressure down the stem or pipe S where it passes through the usual float valve F to the drill bit D and then up the outside of the drill stem back to the earth's surface with considerable velocity. During its circulation it picks up the cuttings from the drill bit and carries them out, said cuttings being relatively small, and due to the gas velocity they will be picked up and carried along with the gas. Any tendency of a back pressure will be prevented by the float valve F. Said valve also prevents undesirable conditions from developing, as will become apparent.

The use of gas as a circulating medium is well known, either as air or a natural gas or a mixture thereof. Regardless of which is used, there exists the danger of explosions at the earth's surface when the oxygen and hydrocarbon content or other explosive mixture is conductive for such and there is the necessary igniting factor present. It is this danger that by reason of my invention I intend to eliminate and at the same time obtain many other beneficial results from the use of gas as a circulating fluid in the drilling of earth bores by a rotary drilling bit.

In accordance with my invention, I provide means for igniting the circulating combustible gas after it has circulated past the drilling bit. If air is used as the circulating fluid, it in itself will not be combustible, but during its circulating it may be mixed with natural combustible gases coming from the formations being drilled. In such event the mixture will be ignited in the bore and all danger of undesirable explosions will be eliminated. If combustible gas or a mixture thereof with air is the circulating fluid, then combustion will always occur with my invention in the bore and no danger of explosions at the surface will be present and in addition the other advantages occurring from the burning of the gas in the bore will be present, which is an important feature of my invention.

An example of the apparatus I can employ in carrying out my invention including my improved method of earth bore drilling by gas is shown in the drawings. In the drill stem above the drilling bit I insert a special sub U. The distance of this sub above the bit may vary in accordance with conditions. It may be 10 feet, 20 feet, 30 feet or even more. This sub U is hollow to permit circulation of the gas and suitably threaded at its upper and lower ends to fit into the stem as any section thereof.

Carried by the sub are a plurality of igniters or spark plugs L, preferably in a circular arrangement at one section of the sub. Each of these plugs, as best shown in Figure 3, is so constructed as to be screwed into the wall of the sub and has a body 10, an insulating part 11 therein and a spark gap 12 by spaced conductors 13 and 14 carried respectively by the insulating part and the body. The spark plugs are caused to be fired by a power unit P which is of the removable type. This unit has an outer case 15, the lower end of which is closed by a plug 16 carrying a conductor 17 embedded in insulating material 18 which can be of heat resistant rubber or other heat resistant insulating material. The conductors lead from a contact button 19 inside the case to a conductor ring 20 carried by the insulation 18 outside the plug 16. Bowed springs 21 are attached to the conductor ring so as to provide a conductor to the spark plugs L, all of which will have their conductor posts 13 arranged to be connected together by a ring 22 carried by any suitable insulating means with which the springs can engage regardless of the rotative position of the power unit. The power unit has a nose piece N which can engage a land-

ing plate 23 carried at the bottom of sub U as shown in Figure 1.

Within the casing is a replacement unit R which will include batteries 24, an induction coil 25 and a vibrator 26 to produce an intermittent surge of increased current to fire the spark plugs. Figure 3 shows a wiring circuit including these elements and a usual condenser 27 which are intended to illustrate only a simple and well known circuit arrangement whereby the plugs can be fired. The unit R is held in the case by a closure plug 28 and between it and the unit is a coiled spring 29 acting as a conductor from the unit R to bowed leaf spring 30 carried on the outside of the case which will contact the upper end of sub U and complete the circuit to the shells of the spark plugs and the conductors 14 carried thereby. The plug 28 can have a pickup spear 31 whereby the complete power unit P can be removed from its position in the sub U when desired by a retrieving line with an overshot attached to its lower end to connect onto the spear, as is known procedure. The lower end of the removable unit has a contact button 32 whereby the lower end of the unit will be placed in circuit with the spark plugs, said button 32 engaging button 19 when the unit is in place in the case 15.

From the foregoing description of apparatus embodying my invention and usable for carrying out my improved method of drilling, it will be seen that all danger of exploding mixtures is eliminated from any circulating gas which may contain such a mixture either as it is circulated from the earth's surface or as it may occur during circulation. I have shown one direction of circulation involved, but my invention also contemplates a reverse type of circulation whereby the circulating gas (air or a combustible mixture or a straight hydrocarbon natural gas) moves down the bore outside the drill stem to the bit and then up the bore inside the stem. In such case the firing of any combustible gas mixture will occur after the circulating gas has passed the drilling bit and the igniters will be shifted in a proper manner to take care of the change in direction of the circulating gas.

In Figure 4 there is illustrated one suitable manner of so shifting an igniter and referring to this figure, spark gap 12' is formed by conductors 13' and 14', the former being part of a member 33 engageable with spring 21 and the latter being a part of a ring 34 conductively connected with sub U. The ring 34 and member 33 are properly insulated by insulating means shown at 35 and 36.

When the gas mixture is fired, many beneficial results are obtained besides eliminating the danger of explosions at the surface. By firing the gas, heat is created and this will increase the volume of the circulating gas and consequently less pressure will be required as the greater volume increases the velocity and therefore less volume of gas needs to be supplied at the surface to obtain a predetermined upward rate of flow. The heated fired gas also tends to dry out moisture from the earth's formations and also permanently increases the permeability of the formations, due to increased heat involved.

I am aware that modifications in structure of the apparatus disclosed as embodying my invention is readily possible, and also that the specific steps described in the method can be varied without changing the fundamental principles involved. Therefore, I desire it to be understood that the scope of my invention is not to be limited except in accordance with the terms of the appended claims and equivalents thereof.

What is claimed is:

1. In earth bore drilling apparatus, a hollow drill stem, a drill bit at the lower end thereof, means for circulating a gas under pressure from and to the earth's surface past the drill bit to pick up cuttings and for other purposes, said path of circulation from and to the earth's surface including in one direction the interior of the stem and in the opposite direction the exterior of the stem, said gas being combustible or capable of becoming com-

bustible by a mixing with combustible gas coming from the earth's strata exposed to the bore being drilled, and means carried by the drill stem at a point above the drill bit for causing circulating gas which has passed the drill bit and is on its return path to the surface to be fired in the bore.

2. The earth bore drilling apparatus of claim 1 in which the means for firing comprises an igniter carried in a special sub interposed in the drill stem.

3. The earth bore drilling apparatus of claim 1 together with means for preventing any reverse circulation of the circulating gas by way of its downward path as a result of explosions during firing.

4. In earth bore drilling apparatus, a hollow drill stem, a drill bit at the lower end thereof, means for circulating a gas under pressure from the earth's surface down through the hollow drill stem past the drill bit and back to the surface exterior of the drill stem, said circulated gas being combustible or capable of becoming combustible by a mixing with a combustible gas from the formations being drilled after the circulated gas reaches the drill bit, and means carried by the drill stem above the drill bit for burning combustible gas in the bore after the circulating gas has passed the drill bit and comprising an igniter in the path of movement of the gas along the exterior of the stem.

5. The drilling apparatus of claim 4 together with valve means positioned in the stem above the bit for preventing return flow of circulating gas up the drill stem.

6. The drilling apparatus of claim 4 in which the igniter is carried in a wall of a hollow sub in the drill stem.

7. The drilling apparatus of claim 4 in which the last named means also comprises an electrical power unit for firing the operating igniter intermittently.

8. The drilling apparatus of claim 4 in which the last named means also comprises an electrical power unit provided with means cooperating with the igniter to cause it to operate and means for detachably mounting the unit on the stem for ready insertion in or removal from the drill stem without pulling the stem from the bore being drilled.

9. In earth bore drilling, a hollow drill stem, a drill bit at the lower end thereof, means for circulating a gas under pressure from the earth's surface down through the hollow drill stem past the drill bit and back to the surface exterior of the drill stem, said circulated gas being combustible or capable of becoming combustible by a mixing with a combustible gas from the formations being drilled after the circulated gas reaches the drill bit, means carried by the drill stem above the drill bit for burning in the bore combustible gas during its return path to the surface and after the circulating gas has passed the drill bit and comprising igniters in the path of movement of the gas along the exterior of the stem, and electrical power means for operating the igniter, and means in the drill stem for preventing return circulation of gas up the drill stem during combustion of gas mixtures.

10. A method of drilling an earth bore by a hollow drill stem with a rotatable bit on its lower end, said method comprising the circulating of a gas from the surface to the drill bit and return to the surface to thereby carry out earth cuttings and for other desired purposes, said circulation in one direction being by way of the interior of the hollow stem and the opposite direction by way of the exterior of the stem, and during the circulation of the gas below the surface firing in the bore any combustible mixture thereof and at a point in the circulating path which is after the gas has passed the drill bit and during its return to the surface.

11. The method of claim 10 in which the circulating of the gas is down the interior of the drill stem and then up the bore exterior of the drill stem and the firing takes place at the exterior of the stem and at a point relatively close to the drill bit but below the earth's surface.

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12. The method of claim 11 in which the firing is accomplished in an intermittent manner.

13. The earth bore drilling apparatus of claim 1 wherein the means carried by the drill stem includes an igniter, and means for operating the igniter for intermittent firing.

14. The earth bore drilling apparatus of claim 1 wherein the means carried by the drill includes an igniter, an electrical power unit for firing the igniter, and means for detachably mounting the unit on the stem so that the unit may be inserted and removed from the well bore and stem without pulling the stem.

15. The earth bore drilling apparatus of claim 2 wherein there is provided an electrical power unit for firing the igniter, and means for detachably mounting the unit

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in the sub so that the unit may be inserted and removed therefrom while the drill stem is in the bore.

16. Apparatus as defined in claim 15 wherein the last named means includes bowed leaf springs on the exterior of the unit engageable with the interior surface of the sub, said springs being electrically conductive for placing the igniter in circuit with the power of the unit.

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