Dec. 29, 1942. W. N. SUTLIFF 2,306,670

WELL CASING PERFORATING DEVICE

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Fig. 1.

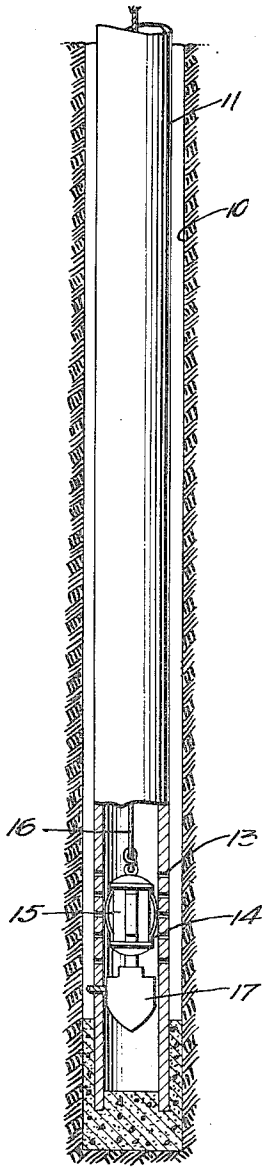
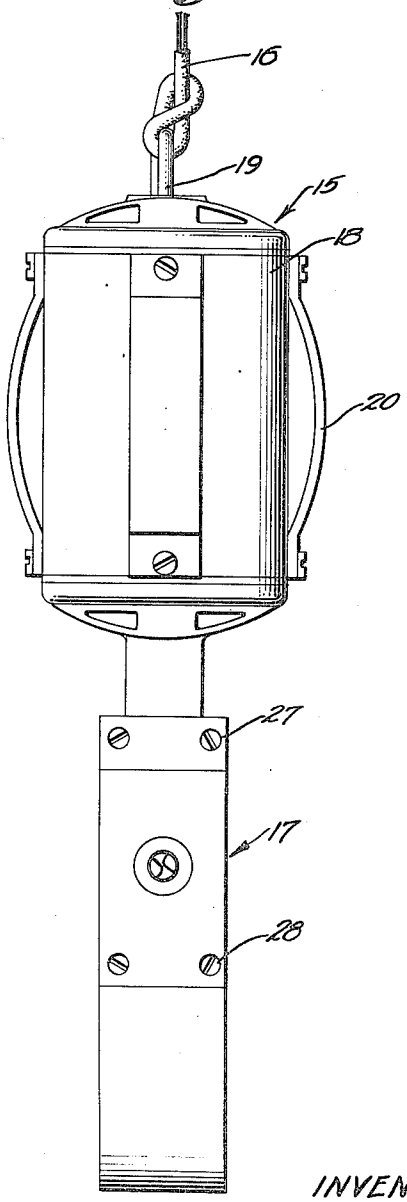


Fig. 2.



INVENTOR
WAYNE N. SUTLIFF
BY James M. Abbett
ATTORNEY

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Fig. 3.

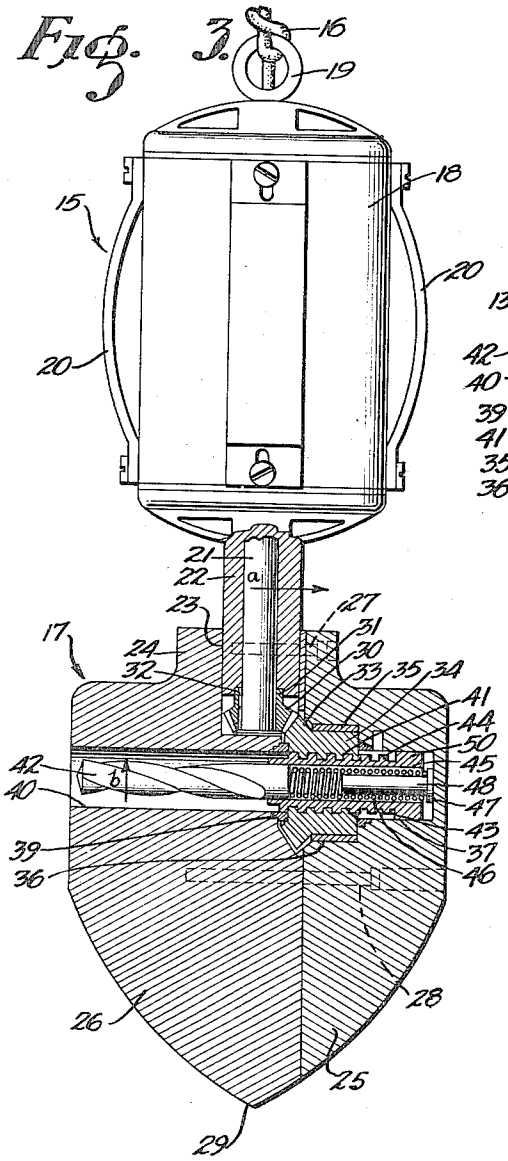


Fig. 4.

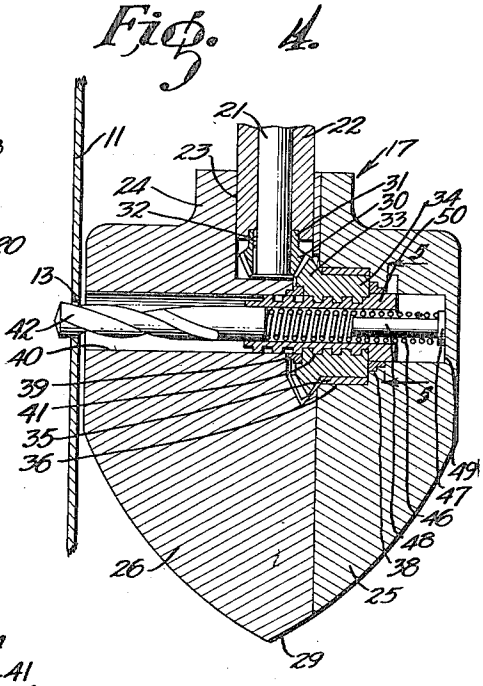
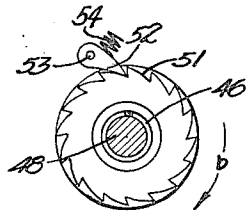


Fig. 5.



INVENTOR
WAYNE N. SUTLIFF
BY
James M. Abbott
ATTORNEY

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WELL CASING PERFORATING DEVICE

Wayne N. Sutliff, Whittier, Calif.

Application August 19, 1939, Serial No. 291,043

4 Claims. (Cl. 77—32)

This invention relates to oil well tools and particularly pertains to a well casing perforating device.

In preparing oil wells for production it is common practice to provide a perforated section of well casing or well screen in the producing area of the well. In some instances a previously prepared well screen is lowered into the well and set. In other instances a selected length of well casing is perforated after it has been permanently positioned within the well. This perforating operation is performed by various mechanical devices as well as guns and the like, in all of which instances it is difficult to form a perforation the walls of which are smooth and the diameter of which perforations are uniform. When irregular and non-uniform perforations are formed there is a tendency for undue abrasion of the walls of the perforations and also a tendency for the perforation to clog, thus restricting the fluid yield from the formation into the casing. It is the principal object of the present invention, therefore, to provide a casing perforator which may be easily lowered into a well and may be accurately controlled from the top of the well to produce a perforation through the well casing, the said perforation being properly positioned and being formed of a predetermined diameter and with a smooth wall surface, thus making it possible to rapidly and efficiently prepare a well casing for production operations.

The present invention contemplates the provision of a motor driven perforator supplied with a drill by which the casing is perforated as the electric current for the motor is controlled from the top of the well.

The invention is illustrated by way of example in the accompanying drawings, in which:

Figure 1 is a fragmentary view in section and elevation showing the mode of operating the present invention.

Fig. 2 is an enlarged view in elevation showing the perforating device.

Fig. 3 is an enlarged view in vertical section and elevation showing the details of construction of the perforating device.

Fig. 4 is a fragmentary view in section showing the drill portion of the device with the drilling element in its projected position.

Fig. 5 is a view in transverse section as seen on the line 5—5 of Fig. 4 disclosing a ratchet lock for the feed sleeve of the drill.

Referring more particularly to the drawings, 10 indicates a well bore within which a casing 11 is set. It is desired to form perforations 13 through this casing and in the present instance a perforating device 14 is provided. This perforating device includes a motor 15 adapted to be lowered into the well and suspended on a cable 16 and which motor drives operating mechanism in a perforator body 17 suspended from the motor. The motor is provided with the usual motor case 18 and carries a supporting element 19 at its upper end to which the cable 16 is suitably secured and from which the cable leads into the motor structure. It is understood that this cable has sufficient strength to support the weight of the structure suspended from it and embodied within it are the electric feed lines for the motor. Mounted upon the outside of the motor case 18 are spring arms 20 which bow outwardly and are intended to frictionally engage the walls of the casing 11 so that the motor will be held centrally within the casing and will steady the structure during a perforating operation. The rotor shaft 21 of the motor 15 extends downwardly through a bearing 22 which is formed as a portion of the end of the motor case 18. This bearing projects into the bore 23 of a boss 24 formed as a part of the perforator body 17. The perforator body 17 is made in two parts 25 and 26 which separate on a vertical plane offset from the longitudinal center of the shaft 21. The parts are secured together by cap screws 27 which pass through parts of the boss 24 and cap screws 28 which pass through the lower portion of the body structure 17. It is preferable that the lower end of the perforator body 17 is formed with a substantially pointed nose 29 so that the structure will readily find its way when lowered through the casing. The cap screws 27 and 28 clamp the perforator body around the bearing element 22 of the motor so that the structure will be held as a unit. Mounted at the lower end of the shaft 21 and within the bore 23 is a bevel gear pinion 30 which is secured onto the shaft. A hub 31 is interposed between the pinion and the bearing 22. The pinion is preferably keyed to the shaft 21 as indicated at 32. In mesh with the pinion 30 is a bevel gear 33. This gear is provided with a hub portion 34 extending at right angles to the axis of the shaft 21 and the hub is mounted in a bushing 35. The bushing 35 is disposed within a counterbore 36 of a bore 37 which is formed in the portion 25 of the perforator body 17. A thrust bearing 38 is disposed at the shoulder of the counterbore 36 and within the body portion 25 while a thrust bearing 39 is disposed in the body portion 26 and around a drill bore 40 formed in the body portion 26 of the perforator structure 17. The bore 37 and the bore 40 are in longitudinal align-

ment, and while their central axes are in the same vertical plane with the axis of the motor shaft 21 these axes are disposed at right angles to each other. Thus, by this arrangement the motor shaft stands vertically within the casing 11 and with its axis substantially coincident with the central axis of the casing and the longitudinal axis of the bore 40 extends at right angles thereto and substantially horizontal.

A central threaded bore 41 is formed through the bevel gear 33. The thread in this bore is preferably a square thread with a pitch which will permit it to feed and retract a drill bit 42 quickly. A feed sleeve 43 is formed with a corresponding male thread 44 which meshes with the female thread 41. Thus, when the bevel gear 33 is rotated and the feed sleeve 43 is held against rotation the bushing will be fed through the bore of the bevel gear 33 in an advancing or retracting motion. Mounted in the forward end of the feed sleeve 43 is the drill bit 42. The drill bit is positioned within a central bore 45 of the feed sleeve 43 and is fixed with relation to the sleeve so that the feed sleeve 43 and the drill bit may reciprocate together. Disposed within the bore 45 of the feed sleeve 43 is a helical spring 46 which rests against the end of the drill bit 42 or some other abutment within the feed sleeve 43 and also rests against a shoulder on the head 47 of a pin 48. The head of this pin is flat and bears against the end face 49 of the bore 45. The feed sleeve 43 is formed with a head 50 which in outside diameter substantially agrees with the diameter of the bore 37 within which it slides. Formed around the circumference of this head portion is a series of teeth 51 which may be engaged by a pawl 52 which is pivoted on a pin 53 and rides over the teeth 51 until the drill 42 has reached the length of its stroke. It is then desirable to retract the drill from the perforation and the motor 15 is then driven in a reverse direction. When the reverse direction of the motor is initiated the pawl 52 will engage the teeth 51 and temporarily and positively hold the sleeve 43 against rotation. This will cause the sleeve to be retracted by the driving movement and will insure that the drill 42 will be positively withdrawn from the perforation it has made. A spring 54 acts to urge the pawl toward its engaging position.

In operation of the present invention the perforating tool is assembled as shown in the drawings and may be lowered thereafter to a desired position within the well casing 11 while suspended upon the cable 16. When the cable has been paid out a distance required to place the perforating tool at a desired level within the well casing the electric current in the cable 16 may be turned on to drive the motor 15. As here shown, the motor will drive in the direction of the arrow *a* in Fig. 3 of the drawings. This will cause the bevel gear pinion 30 to rotate in the same direction and the bevel gear 33 to rotate in the direction of arrow *b* in Fig. 5 of the drawings. At the same time the expansive action of the spring 46 will tend to hold the feed sleeve 43 against rotation, with the result that the quick acting threads 41 and 44 will force the feed sleeve 43 longitudinally through the gear 33 and will advance the drill bit 42 in the bore 40. When the point of the drill bit encounters the wall of the casing 11 there will be resistance to further advance of the drill bit so that the drill 42, the feed sleeve 43 and the gear 33 will tend to rotate together. This will produce a drilling action. When the drill bit has cut away material in its path of penetration the spring 46 will continue to exert an expansive action to hold the sleeve 43, at which time the gear 33 will continue to advance the sleeve until there is sufficient resistance to the penetration of the point of the drill bit 42 to overcome the friction existing between the head 47 of pin 48 and the face 49. When that condition again arises the gear 33 will continue to drive the drill bit 42 forwardly and to rotate it. It will also be recognized that a compound action will possibly take place as equilibrium in the driving action of the gear 33, the feed sleeve 43, the drill bit 42 and the head 47 of the pin 48 is established. Such equilibrium will tend to simultaneously advance the drill bit while rotating it. This equilibrium is established by selecting a spring 46 of a required strength and establishing a coefficient of friction between the end face of the head 47 on pin 48 and the end face of the bore 37 against which the pin bears. It will be recognized that when there is a tendency to over-feed the drill bit the sleeve 43 will be yieldably held against rotation. When the drill bit is advanced and until it has reached the limit of its penetration the pawl 52 will ride up onto the head 50 of the feed sleeve 43 and over the teeth 51. At this time it is then necessary to reverse the direction of flow of current through the motor 15 so that the motor 15 will operate in a reverse direction and retract the drill bit 42 from the perforation 13 which it has formed. When this reverse motion begins the pawl 52 will fall into engagement with one of the teeth 51 and positively hold the sleeve against rotation as the sleeve and drill bit are retracted. When the sleeve reaches the end of its retracting stroke the pawl 52 will be out of engagement with the ratchet teeth 51. This will insure that at the end of the retracting stroke of the sleeve it may rotate freely as driven with the gear 33 and without possibility of binding. The tool may then be moved to a new position on the casing and another perforation 13 formed in the same manner.

It is to be understood that while the drill is here shown as being actuated by bevel gears which transmit a driving action from the motor to a drill moving at right angles to the axis of the motor that the drill bit may be disposed in other positions so that perforations will be formed at angles to the horizontal.

It will thus be seen that the perforating device here disclosed is simple in its construction, may be readily lowered to an operating depth, and will automatically operate to feed a drill through the wall of a casing to a desired depth of penetration, after which it may be positively retracted as controlled from the top of the well.

While I have shown the preferred form of my invention as now known to me, it will be understood that various changes may be made in combination, construction and arrangement of parts by those skilled in the art, without departing from the spirit of my invention as claimed.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. In a well perforating tool comprising a motor adapted to be lowered into a well, a perforator body suspended from the motor, a drill feed including a gear mounted in said body, a gear driven from the motor and in mesh with the gear in the body, a sleeve threaded through the gear in the body, a perforating element carried by the sleeve and adapted to be driven outwardly

from the body to perforate a casing wall, and yieldable means tending to hold the sleeve against rotation whereby the driving action of the gear will act to rotate the sleeve and perforating member simultaneously.

2. The combination as set forth in claim 1 and means engaging the sleeve at the outer end of its stroke to positively hold the same when the direction of the motor is reversed and to cause the sleeve and the perforating element to be retracted with relation to the well casing.

3. In a perforating tool comprising an electric motor, a perforating body supported from the motor, suspending means for the perforating tool including means for conducting an electric current to the motor, a drive shaft for the motor extending into the perforator body, a drill feed including a gear on the drive shaft, a second gear in mesh therewith and rotatably supported within the perforator body, said gear being formed with a central threaded bore therethrough disposed at an angle to the longitudinal axis of the motor shaft, a sleeve extending through said bore and having a male thread thereon meshing with the thread of the bore, whereby when rotation of the sleeve is retarded the gear will act to advance and retract the sleeve through the bore, a drill bit carried at the end of the sleeve and adapted to move simultaneously therewith, and yieldable means placing the sleeve under tension and tending to hold it against rotation whereby the rotation of the gear will transmit linear motion to the drill bit while rotating the same.

4. The combination as set forth in claim 3 and locking means acting at the outer limit of the stroke of the sleeve to positively hold the sleeve against rotation when the driving direction of the motor is changed whereby the sleeve and its drill bit will be positively retracted from the perforation which it has formed.

WAYNE N. SUTLIFF.