

Jan. 5, 1937.

E. E. LORING ET AL

2,066,409

PERFORATOR

Filed June 22, 1935

3 Sheets-Sheet 1

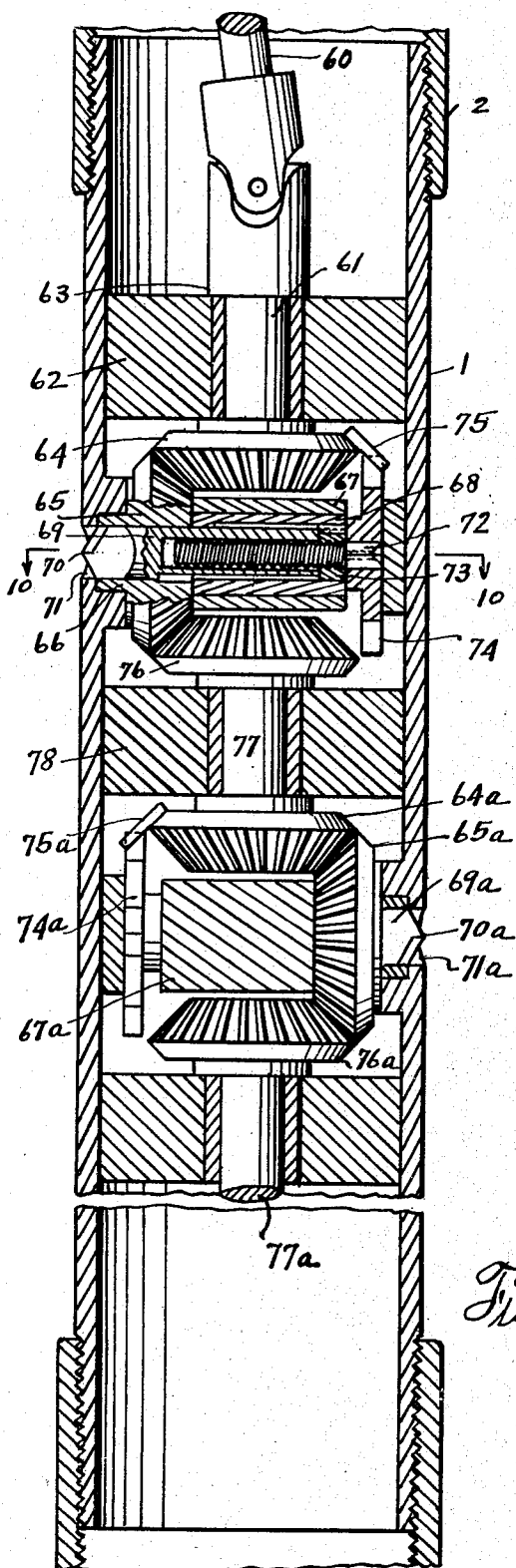


Fig. 2.

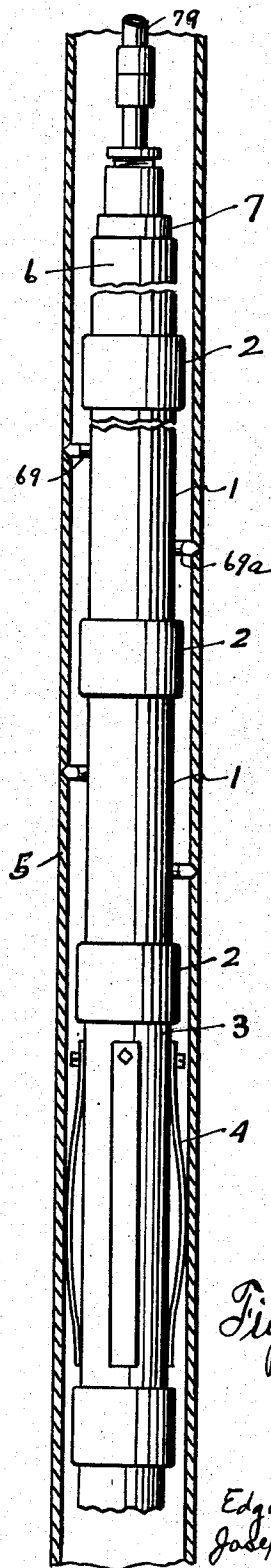


Fig. 1.

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3 Sheets-Sheet 2

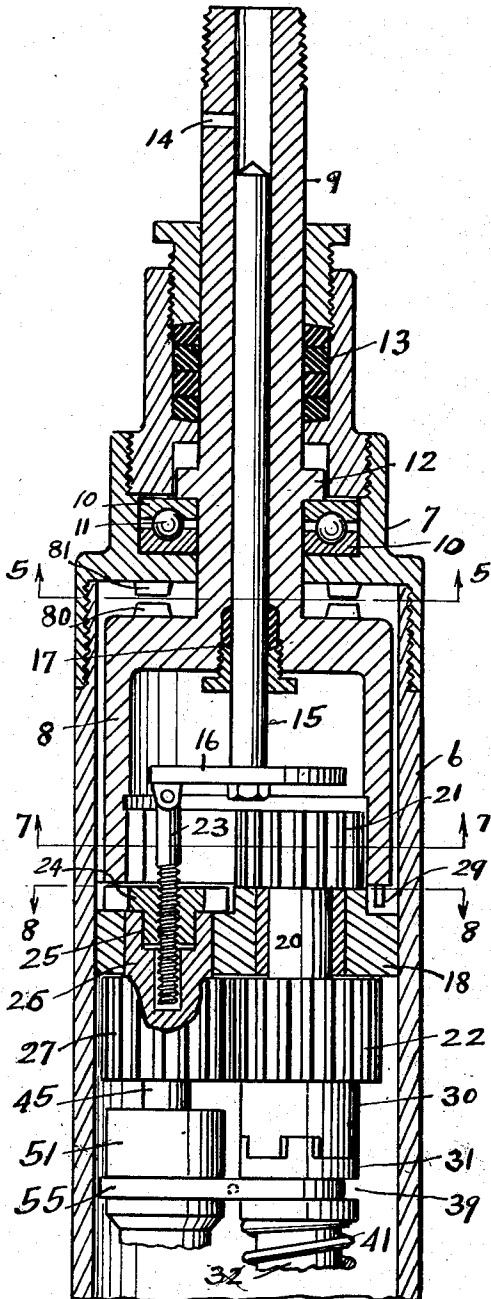


Fig. 4.

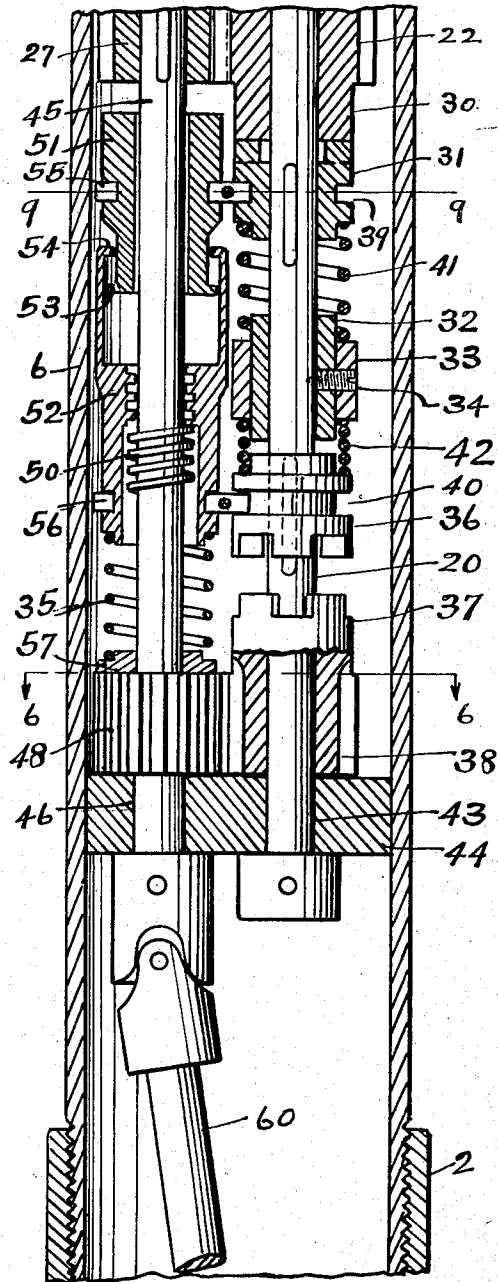


Fig. 3.

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3 Sheets-Sheet 3

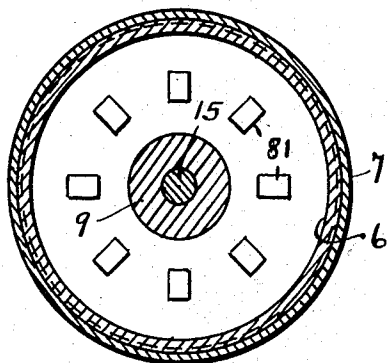


Fig. 5.

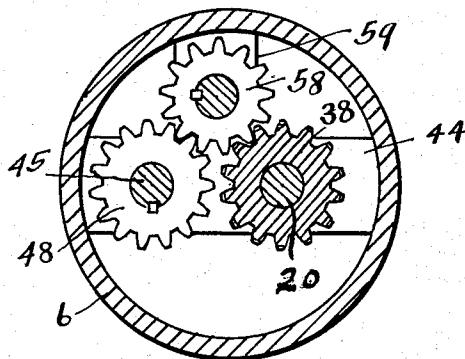


Fig. 6.

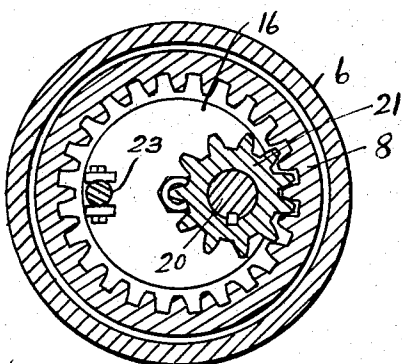


Fig. 7.

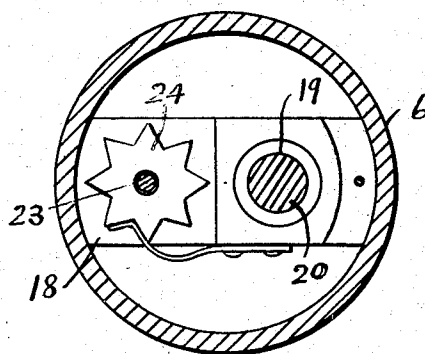


Fig. 8.

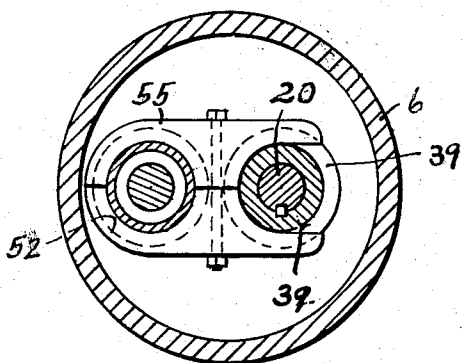


Fig. 9.

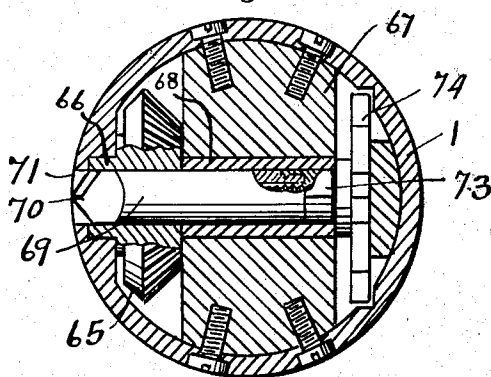


Fig. 10.

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UNITED STATES PATENT OFFICE

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PERFORATOR

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Application June 22, 1935, Serial No. 27,832

3 Claims. (Cl. 77—7)

This invention relates to a perforator.

An object of the invention is to provide a perforator of the character described specially adapted to be lowered into a well and provided for the purpose of perforating pipe set in the well.

Another object of the invention is to provide apparatus of the character described shaped to be lowered into a well and equipped with a plurality of radial drills with means for rotating the drills and simultaneously moving them outwardly whereby perforations will be drilled through the surrounding pipe, or casing, in the well.

A further feature resides in a reversing mechanism incorporated into the apparatus whereby upon completion of the perforating operation, the movement of the drills will be reversed and they will be withdrawn inwardly clear of the pipe.

A still further object is to provide a pipe perforator of the character so constructed that it may be bodily moved by means of the operating string into different positions in the pipe while the operating mechanism thereof remains inactive.

With the above and other objects in view, the invention has particular relation to certain novel features of construction, operation, and arrangement of parts, an example of which is given in this specification and illustrated in the accompanying drawings wherein:—

Fig. 1 shows a side elevation of the perforator as located in a well.

Fig. 2 shows an enlarged vertical sectional view of the lower unit of the operative mechanism.

Fig. 3 shows a vertical sectional view of an intermediate section thereof.

Fig. 4 shows a vertical sectional view of the upper end section thereof.

Fig. 5 shows a cross-sectional view taken on the line 5—5 of Fig. 4.

Fig. 6 shows a cross-sectional view taken on the line 6—6 of Fig. 3.

Fig. 7 shows a cross-sectional view taken on the line 7—7 of Fig. 4.

Fig. 8 shows a cross-sectional view taken on the line 8—8 of Fig. 4.

Fig. 9 shows a cross-sectional view taken on the line 9—9 of Fig. 3, and

Fig. 10 shows a cross-sectional view taken on the line 10—10 of Fig. 2.

Referring now more particularly to the drawings wherein like numerals of reference designate similar parts in each of the figures, the numerals 1 designate adjacent sections of the shell which are tubular in form and which may be connected by couplings, as 2. Any number of sections may

be employed, depending on the number of units composing the complete structure.

Beneath, and connected to the lower section of the shell, there is a similar tubular section 3 connected to said lower section by a similar coupling 2. Said lower section carries the outwardly curved, flexible wiper springs 4 which frictionally engage the inside of the pipe 5 to be perforated, and which prevent the shell 1 from turning.

A conventional releasing spear may be carried by the lower end of the complete apparatus, if desired, for a purpose to be hereinafter stated. This type of releasing spear is of conventional construction and well known to those familiar with the art of pulling stuck pipe from wells.

Attached to the upper end of the shell 1, by means of a suitable coupling, as 2, there is the transmission housing 6 whose upper end has the cap 7 screwed thereto.

Within the upper end of the transmission housing 6, there is the internal gear 8 which is of an inverted cup-shape, and a tubular shaft 9 extends upwardly from said gear 8 through a central bearing in the cap 7. Annular thrust plates 10 are housed within the cap 7 around the shaft 9, and between said plates are the anti-friction bearings 11. An annular rib 12 on the shaft 9 is supported on the upper thrust plate 10 whereby the gear 8 is rotatably supported in the transmission housing.

The shaft 9 is surrounded by a suitable stuffing box 13 which is connected to the upper end of the cap 7 and shaft 9 has a limited vertical movement relative to the cap 7, as indicated in Fig. 4.

The shaft 9 has an outlet port 14 and fitted upwardly into the shaft 9 there is a rod 15 whose upper end is normally beneath the port 14 and whose lower end carries the disk 16 which is fixed thereon and which is located within the gear 8. A suitable stuffing box 17 is carried by the gear 8 and surrounds the rod 15 to form a fluid tight joint therewith.

Secured within the housing 7, beneath the gear 8, there is a supporting bar 18 having the vertical bearing 19 in which the shaft 20 rotates. Fixed to the upper end of the shaft 20 there is a spur gear 21 whose lower end rides on the bar 18, and loosely mounted on said shaft 20 underneath said bar, there is the larger spur gear 22. The spur gear 21 is located within and in mesh with the internal gear 8.

Fastened to and depending from the disk 16 there is the adjusting screw 23 which is eccentric with respect to the disk 7, and whose lower end is threaded through a star wheel 24 located on the

supporting bar 18. The lower end of the star wheel 24 is reduced and seated in the bearing 25 in the upper end of the stub shaft 26. This shaft extends up through a suitable bearing in the supporting bar 18 and the spur gear 27 is located beneath said bar and is in mesh with the spur gear 22, and may be formed integrally with the shaft 26.

Depending from the margin of the gear 8 there is a pin 29 arranged to intermittently engage, and impart intermittent, partial rotations to, the star wheel 24 as the gear 8 rotates.

The lower end of the gear 22 is formed with a clutch member 30 adapted to engage a similar clutch member 31 splined on the shaft 20. Fastened on the shaft 20 there is a sleeve 32, and around this sleeve there is a collar 33, said collar and sleeve being secured in place by a suitable set-screw 34. Splined on the shaft 20 beneath the sleeve 32 there is a clutch member 36 adapted to be engaged with and released from the clutch member 37 which is formed on the upper end of the spur gear 38. The clutches 31, and 36 are formed with corresponding, external grooves 39, 40, respectively, and the upper and lower coil springs 41, 42, are interposed between the collar 33 and the upper and lower clutch members 31, 36. The gear 38 is mounted to rotate on the shaft 20 and the lower end of said shaft is mounted to rotate in a vertical bearing 43 of the transverse bearing member 44 which is secured in the transmission housing.

The spur gear 27 is suitably attached to the upper end of the shaft 45 and the lower end of the shaft extends through a vertical bearing 46 in the bearing member 44. Fastened to the lower end of the shaft 45 and riding on the bearing member 44 there is a spur gear 48. The shaft 45 has the coarse threads 50 thereon. As shown, these are righthand threads.

On the shaft 45 is the upper slidable sleeve 51 and the lower nut 52 which is coarsely threaded internally, the pitch of the internal threads corresponding to the pitch of the threads 50. The lower end of the sleeve 51 has the outwardly turned annular flange 53 and the nut 52 is upwardly extended and telescoped over the lower end of the sleeve 51 and has the internal annular flange 54 engageable with the flange 53. The lower end of the nut 52 is also extended downwardly forming a housing for the threads 50. Upper and lower clamps 55 and 56 are clamped tightly about the sleeve 51, and the nut 52 respectively, and the clamp 56 holds said nut 52 against turning and these clamps are formed into yokes which fit into the respective grooves 39 and 40, as illustrated in the Figs. 3 and 9. There is a thrust plate 57 mounted on the shaft 45 which rides on the gear 48 and mounted on this thrust plate and surrounding the shaft 45 there is a coil spring 58 whose upper bears against the lower end of the extension of the nut 52. The gears 38, 48, are in mesh with a reversing gear 59, as shown in Fig. 6, and this reversing gear is rotatably supported on the bearing member 59 which is secured to the housing 6.

There is a transmission shaft 60 whose upper end has a universal connection with the lower end of the shaft 45 and whose lower end has a universal connection with the upper end of the shaft 61. The shaft 61 rotates in a central, vertical bearing in the transverse bar 62 which is secured in the upper section of the shell. The lower end of the shaft 61 is reduced, forming an external annular shoulder 63 which rides on the bar 62.

and attached to the lower end of said shaft 61, there is a beveled gear wheel 64 which is in mesh with and drives a corresponding beveled gear 65. The gear 65 has an outwardly extended tubular shaft 66 which works in a radial bearing in the shell 1, said shell being inwardly thickened to provide material for said shaft bearing, as more accurately shown in Figs. 2 and 10. The inner end of the gear 65 has a flat bearing face which works against the facing side of the cross bar 67 whose ends are anchored to the shell 1. The bar 67 has a transverse bearing sleeve 68 secured therein and a drill 69 is located in said sleeve 68 and extends axially through the beveled gear wheel 65, and its outer end is formed with a suitable bit 70. The shell has an opening 71 aligned with the drill and through which the drill works. The drill has a splined connection with the gear 75, as shown in Fig. 2, so as to rotate therewith, and its inner end has a deep socket to receive the externally threaded shaft 72. Within, and secured against rotation relative to, the sleeve 68, there is a nut 73 through which the shaft 72 is threaded, and fixed on the outer end of the shaft 72 there is a star wheel 74. The beveled gear 64 has an arm 75 thereon, and as said gear wheel rotates, the arm 75 imparts partial rotation intermittently to the star wheel 74 and to the shaft 72, and thus gradually forces the nut 73 against the inner end of the drill 69 forcing the drill outwardly against the pipe to be perforated, said drill being meanwhile rotated with the beveled gear 65.

In mesh with the gear wheel 65 there is a similar beveled gear wheel 76 which is fixed on the upper end of the vertical shaft 77 which rotates in a central vertical bearing in the transverse bar 78. This bar is fixed in the shell 1 and beneath it, and fixed on the lower end of the shaft 77 is a beveled gear wheel 74a similar to the gear wheel 74. The beveled gear wheel 74a is in mesh with and drives a beveled gear wheel 65a similar to the gear wheel 65, and mounted axially in the gear 75a is the drill 69a which is supported and operated in a manner similar to the gear 69, but it works out radially in a direction in the opposite of that of the drill 69. The mechanism for feeding and rotating the drill 69a is the same as that of the drill 69. The drill feeding and driving mechanism may be duplicated as desired, and that beneath may be driven from the beveled gear wheel 74a, in mesh with the gear wheel 65a, and the shaft 77a to which the gear 74a is fixed, the drill feeding and driving mechanism being the same as that illustrated in Fig. 2.

The apparatus is driven by means of a suitable operating string 79 which is tubular and whose lower end is connected to the upper end of the shaft 9. In operation the apparatus may be assembled, as shown in Fig. 1, and let down into the pipe 5 to be perforated. With the drills 69, 69a, withdrawn or in inactive position, the clutches 31, 36, will be in upper position with the spring 42 under compression, and the clutch member 31 will be held in said engaged position by reason of the fact that the threads of the nut 52 are above and supported by the threads 50. The rod 15 will also be in its lower position clear of the outlet port 14.

Upon rotation of the operating string to the right, the gear 8 will be correspondingly rotated imparting rotation to the gears 21, 22, and the gear 27, and through it to the shafts 45, 60, and 61, as well as to the gearing operatively connected

with said last-mentioned shaft in an obvious manner. The gear 65 and the drill 69 splined thereto will accordingly be rotated and intermittent rotations will be imparted to the star wheel 74 thus gradually feeding the drill to the work, as above explained. Meanwhile the gears 58 and 38 will rotate idly, being driven from the gear 48. The shaft 45, however, is driven to the left, or in an anti-clockwise direction, causing the threads 50 to mesh with the internal threads of the nut 52 and move said nut downwardly. This movement is so timed that when the drill has completed the perforation in the pipe 5, the flange 54 will have moved downwardly and engaged the flange 53, and the clutch 36 will be ready to engage with the clutch 37, and the threads of the nut 52 will be ready to disengage the threads 50 and upon further rotation of the shaft 45, said threads will completely disengage and the spring 42 will suddenly move the clutch 36 into engagement with the clutch 37 overcoming the pressure of the spring 35 which is somewhat weaker than the spring 42, and the sleeve 51 will suddenly move downwardly, at the same time disengaging the clutch 31 from the clutch 30. The threads 50 will then be above the threads of the nut 52 and upon engagement of the clutch 36 with the clutch 37, the direction of rotation of the shaft 45 will be reversed, in turn, reversing the direction of the rotation of the shaft 60 of the drill-feeding and -driving mechanism to the end that the drills 69, 69a, will be withdrawn into their original position. Upon reversal of the direction of rotation of the shaft 45, the thread 50 will again engage the threads of the nut 52 and will move the said nut upwardly. The upward pressure of the spring 35 will hold the nut in position for such reengagement of the threads upon the reversal of the direction of the shaft 45, and as the nut 52 moves upwardly, the clutch 36 will be gradually withdrawn from engagement with the clutch 37, placing the spring 42 under compression, and when the threads of the nut 52 shall have disengaged the threads 50, the spring 41 will suddenly elevate the clutch 31 and cause it to engage the clutch 30, and the direction of rotation of the shaft 45 will again be reversed and the drills will thereupon begin their outward movement.

While the apparatus is being operated to effect the perforation of the pipe 5, water will be forced under pressure down through the operating string 79 and out through the port 14; the star wheel 24, however, will be intermittently rotated by the pin 29, gradually forcing the screw 23 upwardly and correspondingly elevating the rod 15 until it closes the port 14, and slows up or stalls the pump generating the pressure, and thus indicating to the operator that the perforating operation has been completed; thereafter, upon the shifting of the clutches, as hereinabove explained, and reversal of the operation, the screw 23 will be run back downwardly through the star wheel 24 causing the corresponding downward movement of the rod 15 until it clears the port 14, thus relieving the pressure and causing the pump to speed up indicating to the operator that the drills have been withdrawn.

It is desirable to shift the entire apparatus

about its vertical axis so that pipe may be perforated on all sides. In order to accomplish this, an upward pull may be exerted on the operating string so as to carry the teeth 80 at the upper end of the gear 8 into mesh with the teeth 81 carried by the lower side of the cap 7. Upon this upward pull of the operating string, the wipers 4 will hold the shell 1 against upward movement, and, if it is found desirable, a releasing spear may be connected to the lower end of the tubular section 3 to assist said wiper springs.

The entire apparatus may then be turned as a unit so as to adjust the drills about the pipe to be perforated; and the apparatus may be adjusted up and down in an obvious manner so that the pipe may be perforated throughout any portion of its length as may be desired.

The drawings and description disclose what is now considered to be a preferred form of the invention by way of illustration only while the broad principle of the invention will be defined by the appended claims.

What we claim is:

1. A pipe perforator shaped to be lowered into a pipe in a well and including radially directed drills, means for rotating and feeding the drills outwardly to effect perforation of the pipe, means for driving the rotating and feeding means and an automatically reversible transmission mechanism operatively connecting the driving means with the rotating and feeding means to effect retraction of the drills, said driving means including a tubular operating string having an outlet port through which the fluid under pressure may be directed into the well, and means arranged to co-act with said parts for automatically varying the pressure at the limit of the outward and inward movement of the drills to effect an indicating reaction at the source of pressure.

2. A pipe perforator shaped to be lowered into a pipe in a well and comprising a shell, radially movable drills radially mounted in the shell, mechanism within the shell for rotating and feeding the drills to the work, an operating string rotatable independently of the shell for driving said mechanism, said string having a limited lengthwise movement relative to the shell, and means effective, upon such movement, to clutch said string with the shell whereby the string and shell may be rotated as a unit.

3. A pipe perforator shaped to be lowered into a pipe in a well and including radially directed drills, means for rotating and feeding the drills outwardly to effect perforation of the pipe, means for driving the rotating and feeding means, said driving means including a tubular operating string having an outlet port through which fluid, under pressure, may be directed into the well, an automatically reversible transmission mechanism operatively connecting the operating string with the rotating and feeding means to effect retraction of the drills, and means arranged to co-act with said port to cause variation in the pressure of the liquid when the drills reach the limit of their outward and inward movement, to effect indicating reaction at the source of the pressure.

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