May 29, 1923. 1,457,193

E. M. SMITH ET AL

DEVICE FOR PERFORATING OIL WELL CASINGS

Filed Feb. 21, 1922 3 Sheets-Sheet 1

Fig. 4.

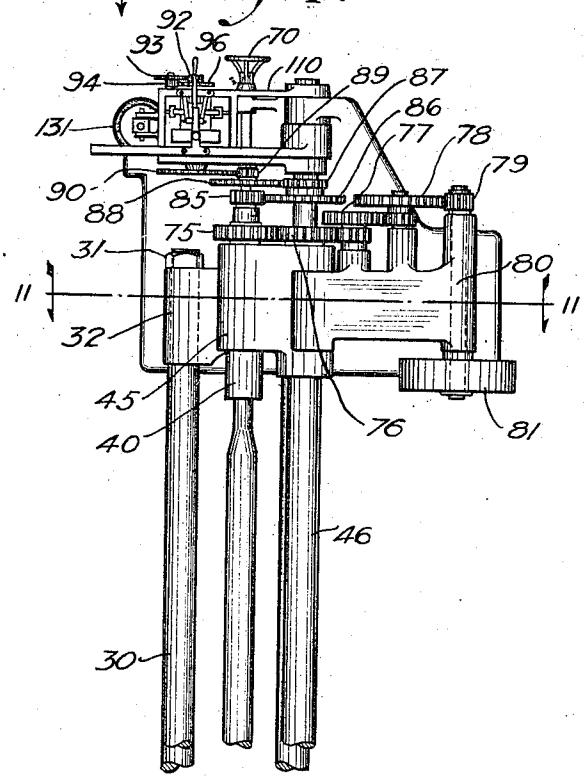
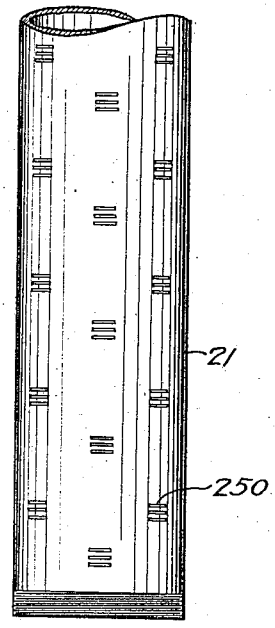


Fig. 1.



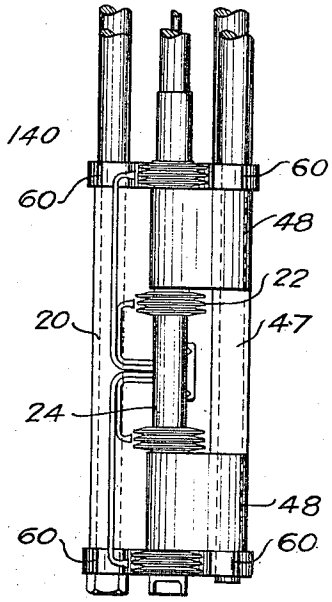


Fig. 2.

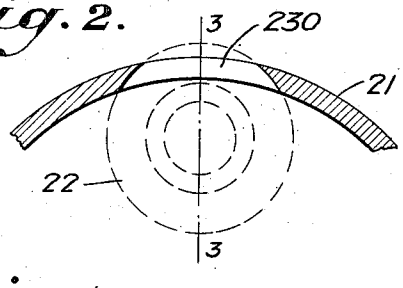
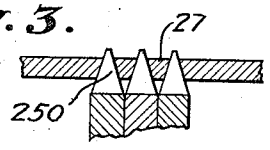


Fig. 3.



INVENTOR:
EDWARD M. SMITH,
RICHARD E. HEIDRICH,
BY
Graham + Harris
ATTORNEYS.

May 29, 1923. 1,457,193

E. M. SMITH ET AL

DEVICE FOR PERFORATING OIL WELL CASINGS

Filed Feb. 21, 1922 3 Sheets-Sheet 2

Fig. 5.

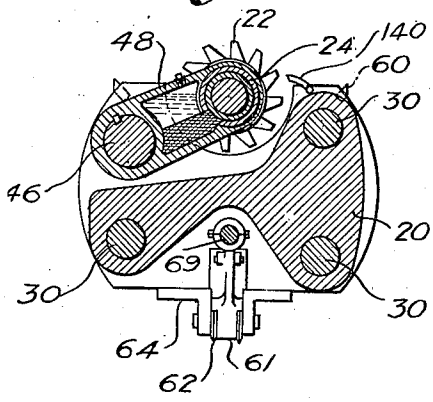


Fig. 6.

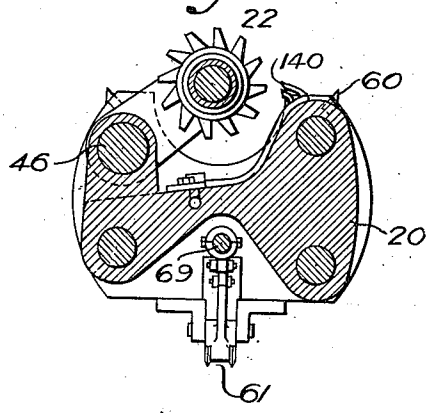


Fig. 7.

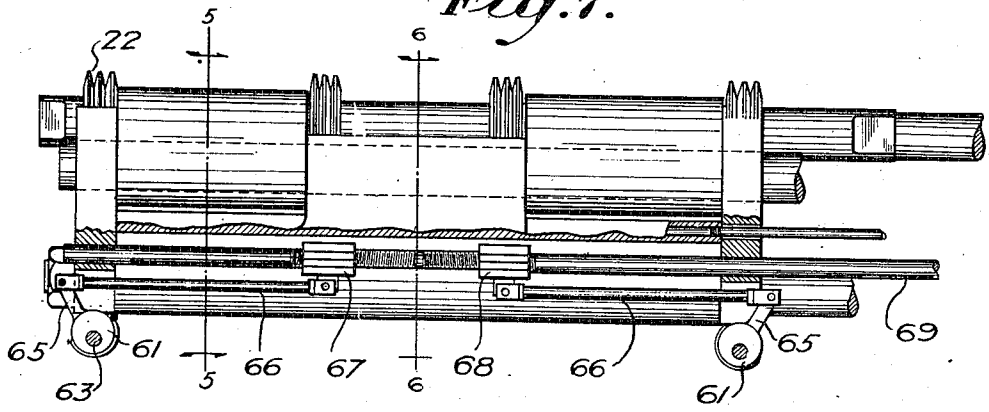


Fig. 8.

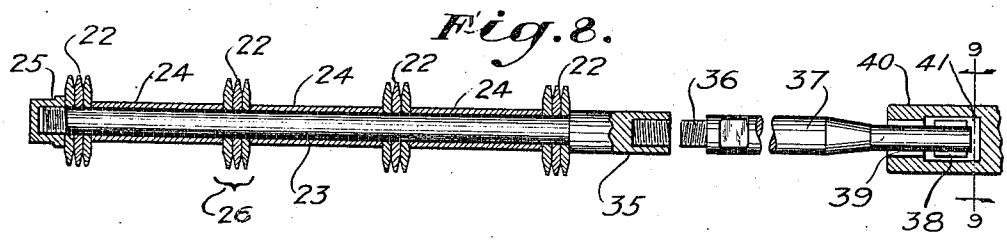
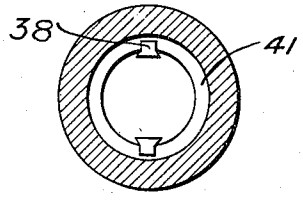


Fig. 9.



INVENTOR:
EDWARD M. SMITH,
RICHARD E. HEIDRICH,
BY
Graham & Davis
ATTORNEYS.

May 29, 1923. 1,457,193

E. M. SMITH ET AL

DEVICE FOR PERFORATING OIL WELL CASINGS

Filed Feb. 21 1922 3 Sheets-Sheet 3

Fig. 10.

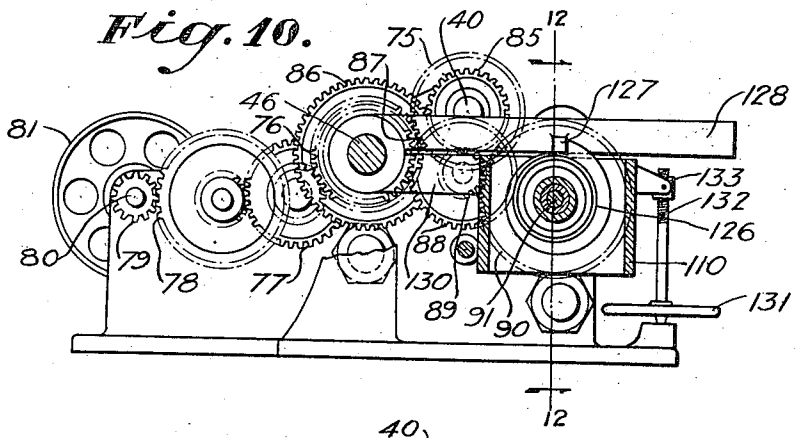


Fig. 11.

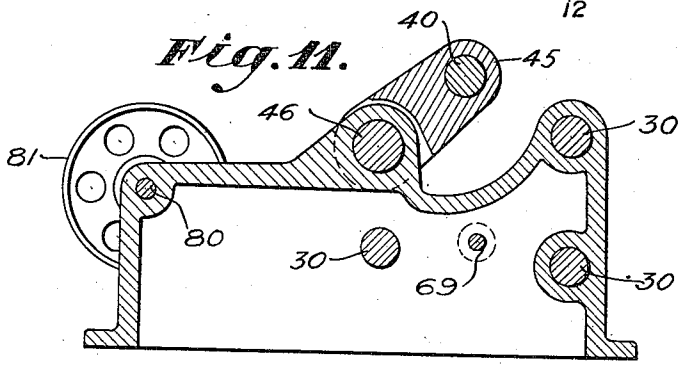
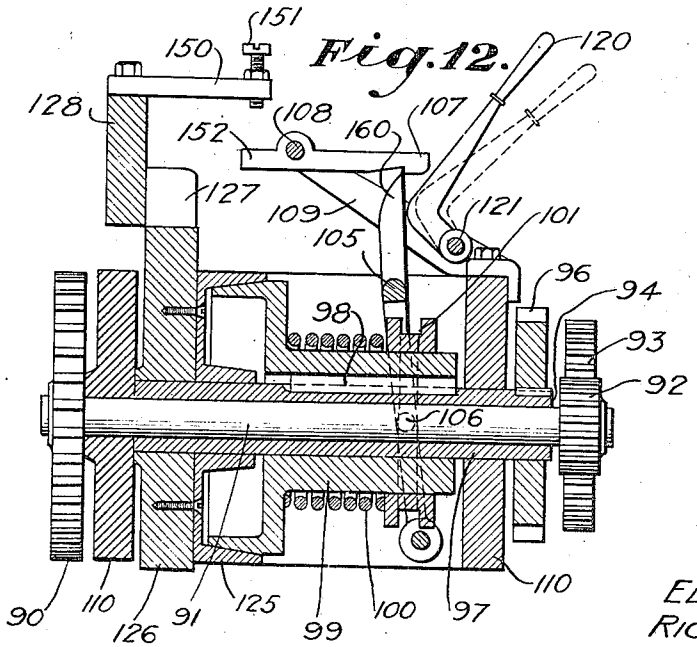


Fig. 12.



INVENTORS:
EDWARD M. SMITH,
RICHARD E. HEIDRICH,
BY Graham & Davis
ATTORNEYS.

Patented May 29, 1923. 1,457,193

UNITED STATES PATENT OFFICE.

EDWARD M. SMITH AND RICHARD E. HEIDRICH, OF LOS ANGELES, CALIFORNIA; SAID HEIDRICH ASSIGNOR TO SAID SMITH.

DEVICE FOR PERFORATING OIL-WELL CASINGS.

Application filed February 21, 1922. Serial No. 538,220.

To all whom it may concern:

Be it known that we, EDWARD M. SMITH and RICHARD E. HEIDRICH, both citizens of the United States, and both residing in the city of Los Angeles, county of Los Angeles, and State of California, have invented a new and useful Improvement Comprising the Devices for Perforating Oil-Well Casings, of which the following is a specification.

Our invention relates to the art of producing petroleum oil and particularly to the casing used in oil wells. It is common practice throughout the majority of oil fields of the country to place a casing inside the well which casing extends down into the oil sands and which is preferably formed of steel tubing. For the purpose of allowing the oil to enter the casing and at the same time excluding sand, gravel and particles of rock, it is common practice to provide a well strainer at the bottom of the casing or to perforate the casing with small holes through which the oil may enter.

An object of our invention is to provide a machine which may be used to perforate ordinary steel pipe so that it may be used as a well strainer.

Further objects and advantages will be made evident hereinafter.

Referring to the drawings which are for illustrative purposes only,

Fig. 1 is a view of the lower end of a section of pipe which has been perforated by the use of our invention.

Fig. 2 is a section on an enlarged scale showing a portion of the perforated pipe together with the action of the cutter thereon.

Fig. 3 is a partial section on a plane represented by the line 3—3 of Fig. 2 further showing the action of the cutters on the pipe.

Fig. 4 is a plan view of a preferred embodiment of our machine.

Fig. 5 is a section on a plane represented by the line 5—5 of Fig. 7 with the cutter in its retracted position and with the gripping dogs in their retracted positions as they appear previous to starting the cut.

Fig. 6 is a section on a plane represented by the line 6—6 of Fig. 7 with the cutters in their fully extended position and with the dogs expanded, the parts being in the position they assume at the end of the cut.

Fig. 7 is an enlarged view of the head, a portion thereof being cut away to better show the cam expanding mechanism.

Fig. 8 is a view partially in section showing the cutters in place on the cutting mandrel and the method of driving same.

Fig. 9 is a partial section on an enlarged scale on a plane represented by the line 9—9 of Fig. 8.

Fig. 10 is an end view of an enlarged scale of Fig. 4 viewed in the direction of the arrow of that figure, a portion of the tripping mechanism being omitted for the sake of clearness.

Fig. 11 is a section on a plane represented by the line 11—11 of Fig. 4.

Fig. 12 is a section on a plane represented by the line 12—12 of Fig. 10, this section being on a somewhat enlarged scale.

In the form of the invention illustrated, a head 20 is provided which is of sufficiently small size to slip readily inside the pipe 21 desired to be perforated. The utility of the head 20 is to carry the cutters 22 which are secured upon a mandrel 23 by means of sleeves 24 having a nut 25. The cutters are shown in dotted lines in Fig. 2 in the position they occupy at the end of the cut, the removed section of material being indicated at 230. We prefer to use cutters having edges formed of two cones so that keystone shaped bars 27, as shown in Fig. 3, will be left between the slots 250 produced by the cutters. We also prefer to use a multiplicity of cutters 22 in each set of cutters 26 and we prefer to put a multiplicity of sets 26 on the mandrel 23 so that a number of sets of slots can be cut simultaneously. In the drawing we have shown four sets of three cutters each, thus allowing twelve slots to be cut at one time. We also prefer to space the slots 250 approximately as shown in Fig. 1, the pipe being shifted upon the head, for this purpose.

Rigidly secured in the head 20 are three rods 30, these rods being secured by means of nuts 31 in a driving carriage 32. The rods 30 are of sufficient length to reach somewhat more than half way through the pipe so that, working from either end, slots 250 can be cut anywhere inside the pipe. The mandrel 23 is provided with a threaded head 35 in which a threaded pin 36 on a driving shaft 37 may be placed. The driving shaft 37 is provided with keys 38 which fit into keyed openings 39 in a stub shaft 40, this

stub shaft having a cavity 41 into which the keys 38 pass when the pin 36 is unscrewed, thus allowing the threaded end of the driving shaft 37 to drop down out of the way so that the mandrel 23 can be removed from the head 20. The stub shaft 40 is carried on an arm 45 which is keyed to a feed shaft 46, this feed shaft being carried in a bearing 47 in the head 20 and having also keyed thereon arms 48. These arms 48 are hollow as shown in Fig. 5 and filled with lubricant for the purpose of lubricating the sleeves 24 on the mandrel 23, the sleeves 24 turning in the arms 48.

Since the arms 48 and the arm 45 are all keyed to the shaft 46, it is evident that they turn about the axis of that shaft with the shaft and it is further evident that by turning this shaft, the cutters 22 can be fed from a disengaged position as shown in Fig. 5 into a position shown in Fig. 6 in which the slots 25 have been fully cut.

For the purpose of holding the head rigidly during the cutting operation we provide prongs 60 which are formed of hardened steel and which are secured in the head 20, and cams 61. The cams 61 are best shown in Fig. 5 and are provided with sharp edges 62. These cams turn on shafts 63 carried in brackets 64 and are actuated by means of arms 65 from two pull rods 66, one of which is attached to a left hand nut 67 and the other to a right hand nut 68. The nuts 67 and 68 are threaded on a shaft 69 which is turned by means of a hand wheel 70 outside the carriage 32. By turning this hand wheel, the nuts 67 and 68 can be forced towards each other, thus turning the cams 61 so that they engage the inside of the pipe which raises the whole carriage 32 and also causes the prongs 60 to engage the pipe. This holds the carriage 32 rigidly against chattering during the cutting action.

The stub shaft 40 is rotated by means of a gear 75 which is driven through gears 76, 77, 78 and 79 from a shaft 80 and a pulley 81, the pulley 81 being driven by any convenient source of power, not shown. The gear 76 turns loosely on the shaft 46 and the arm 45 can swing about that shaft without causing the gear 75 and 76 to get out of mesh. Secured to the stub shaft 40 is a gear 85 which drives a gear 86 which in turn is secured to a gear 87, this gear driving a gear 88 and a pinion 89. The pinion 89 drives a gear 90 which is shown in Fig. 12 and which in turn drives a shaft 91 which forms a part of the feeding mechanism. The shaft 91 carries a pinion 92 which drives a gear 93 which carries a pinion 94 driving a gear 96 on a sleeve 97, the sleeve 97 having a keyway 98 in which a cone clutch member 99 is free to slide, this clutch being forced to the right as shown in Fig. 12 by a compression spring 100 which acts against a grooved collar 101 which slides freely on the cone member 99. The spring 100 is compressed by means of a lever 105 having pins 106 engaging the groove in 101. The lever 105 has a sharp end 160 which is engaged by a latch 107, pivoted at 108 in a bracket 109 secured to a frame 110. The carriage 110 is pivoted on, but free to swing about the shaft 46 and carries an idler shaft on which the gears 88 and 89 turn and a second idler shaft upon which the gears 93 and 94 turn. A cam lever 120 pivoted at 121 on the bracket 109 is used to force the lever 105 to the left to compress the spring 100 and to force the end 160 into a position where it is engaged by the latch 107. The cone member 99 fits inside the member 125 which is secured on a spiral cam 126, this spiral cam turning freely on the sleeve 97 and being best shown in Fig. 10. This cam 126 engages a dog 127 carried on a lever 128 which is rigidly secured to the feed shaft 46. As the cam rotates, it forces the lever 128 upwardly, thus turning the shaft 46 and forcing the cutters 22 into the pipe.

For the purpose of adjusting the depth of cut, the frame 110 is provided, this frame being pivoted by means of arms 130 on the shaft 46 and may be moved up and down by means of a hand wheel 131 having a screw 132 fitting inside a nut 133 carried on the carriage 110. By turning the hand wheel 131, the center of the shaft 91 may be raised or lowered so that the final position of the arm 128 may be adjusted, thus adjusting the depth of cut. Lubricating pipes 140 are provided, these pipes extending back and being supplied with cutter lubricant from any convenient source, not shown.

The method of operation is as follows:

The latch 107 being tripped and the lever 120 being in its normal dotted position as viewed in Fig. 12, the clutch 99 is disengaged from the member 125 and the spiral cam 126 is in the position shown in Fig. 10 in which position the cutters 22 are in their retracted position as shown in Fig. 5. If desired, they can be further retracted by turning the hand wheel 131 which drops the carriage 110, the shaft 91, the cam 126 and the arm 128 thus turning the shaft 46 in a clockwise direction as seen in Figs. 5, 6 and 10 and thus further retracting the cutters 22. The hand wheel 70 is actuated to retract the cam 61 into the position shown in Fig. 5 and the head 20 is moved into the pipe to any desired distance. The hand wheel is then actuated to force the cams 61 into engagement with the pipe and thus solidly clamp the head 20 in place, and the driving means for the pulley 81 is started, thus rotating the cutters which are, however, not then in contact with the pipe. The hand wheel 131 can then be utilized if desired to adjust the desired depth of cut. The lever 120 is then raised latching the end 160 un-

der the latch 107 and causing the clutch 99 to grip the member 125 and to rotate the spiral cam 126 in a clockwise direction as viewed in Fig. 10. The gearing is so proportioned that this cam rotates slowly, raising the arm 128 and rotating the shaft 46 in a counter-clockwise direction; thus forcing the cutters 22 into the body of the pipe, these cutters moving from the position shown in Fig. 5 into the position shown in Figs. 2, 3 and 6. This causes the slots to be cut in the pipe as shown in Fig. 1 and continues until the cam has made a complete rotation at which time the arm 128 falls and a member 150 carrying a screw 151 strikes upon the end 152 of the latch 107, tripping same, thus allowing the member 105 to recede and release the clutch 99. In other words, as soon as the cutters have completed their cut, they are automatically returned to their initial position and the rotation of the cam 126 has stopped. Since the screw 151 is in contact with the end 152 of the latch 107 whenever the cam is in the starting position shown in Fig. 10, it is necessary to hold the lever 120 in the position shown in full lines in Fig. 12 until the arm 128 has been slightly lifted by the cam.

By the use of our invention a strainer pipe may be produced having perforations or slots which extend circumferentially through a limited arc around the pipe and which have bars of material 27 of keystone section therebetween. This form of pipe has certain advantages which need not be described in this application.

We claim as our invention:

1. In a device for cutting slots in pipe, the combination of: a head, small enough to go entirely inside the pipe which it is desired to slot; locking means carried by said head for locking said head inside said pipe; means by which said locking means may be actuated from a point outside said pipe with said head in place inside said pipe; a rotary cutter carried by said head; and means for positively driving said cutter from a point outside said pipe with said head in place inside the pipe.

2. In a device for cutting slots in pipe, the combination of: a head small enough to go entirely inside the pipe which it is desired to slot; an arm pivoted in said head and adapted to swing about an axis parallel with the axis of the pipe; a rotary cutter carried on the outer or free end of said arm; and means by which said cutter may be positively rotated from a point outside the pipe when the head is entirely inside the pipe.

3. In a device for cutting slots in pipe, the combination of: a head small enough to go entirely inside the pipe which it is desired to slot; an arm pivoted in said head and adapted to swing about an axis parallel with the axis of the pipe; means by which said arm may be so swung from a point outside said pipe when said head is inside said pipe; a rotary cutter carried on the outer or free end of said arm; and means by which said cutter may be positively rotated from a point outside the pipe when the head is entirely inside the pipe.

4. In a device for cutting slots in pipe, the combination of: a head small enough to go entirely inside the pipe to be slotted; a milling cutter having teeth on its periphery and so mounted as to rotate on an axis transverse to its cutting edge and so shaped as to cut an elongated slot in said pipe, said cutter being carried by said head; means for rotating said cutter; feed means for forcing said cutter outwardly against and into said pipe; and means by which said feed means may be actuated from a point outside said pipe with said head in place inside said pipe.

5. In a device for cutting slots in pipe, the combination of: a head small enough to go entirely inside the pipe which it is desired to slot; a milling cutter having teeth on its periphery, said cutter being so mounted as to rotate on an axis transverse to its cutting edge and so shaped as to cut an elongated slot; a member forming a portion of said head, said cutter being carried by said member; feeding means for forcing said member outwardly towards said pipe; and means by which said feeding means may be actuated from a point outside said pipe when said head is in place in said pipe.

6. In a device for cutting slots in pipe, the combination of: a head small enough to go entirely inside the pipe which it is desired to slot; a milling cutter having conoidal sides and having teeth upon its periphery and sides, said cutter being so mounted as to rotate on an axis transverse to its cutting edge and so shaped as to cut an elongated slot; a member forming a portion of said head, said cutter being carried by said member; feeding means for forcing said member outwardly towards said pipe; and means by which said feeding means may be actuated from a point outside said pipe when said head is in place in said pipe.

In testimony whereof, we have hereunto set our hands at Los Angeles, California, this 14th day of February, 1922.

EDWARD M. SMITH.
RICHARD E. HEIDRICH.