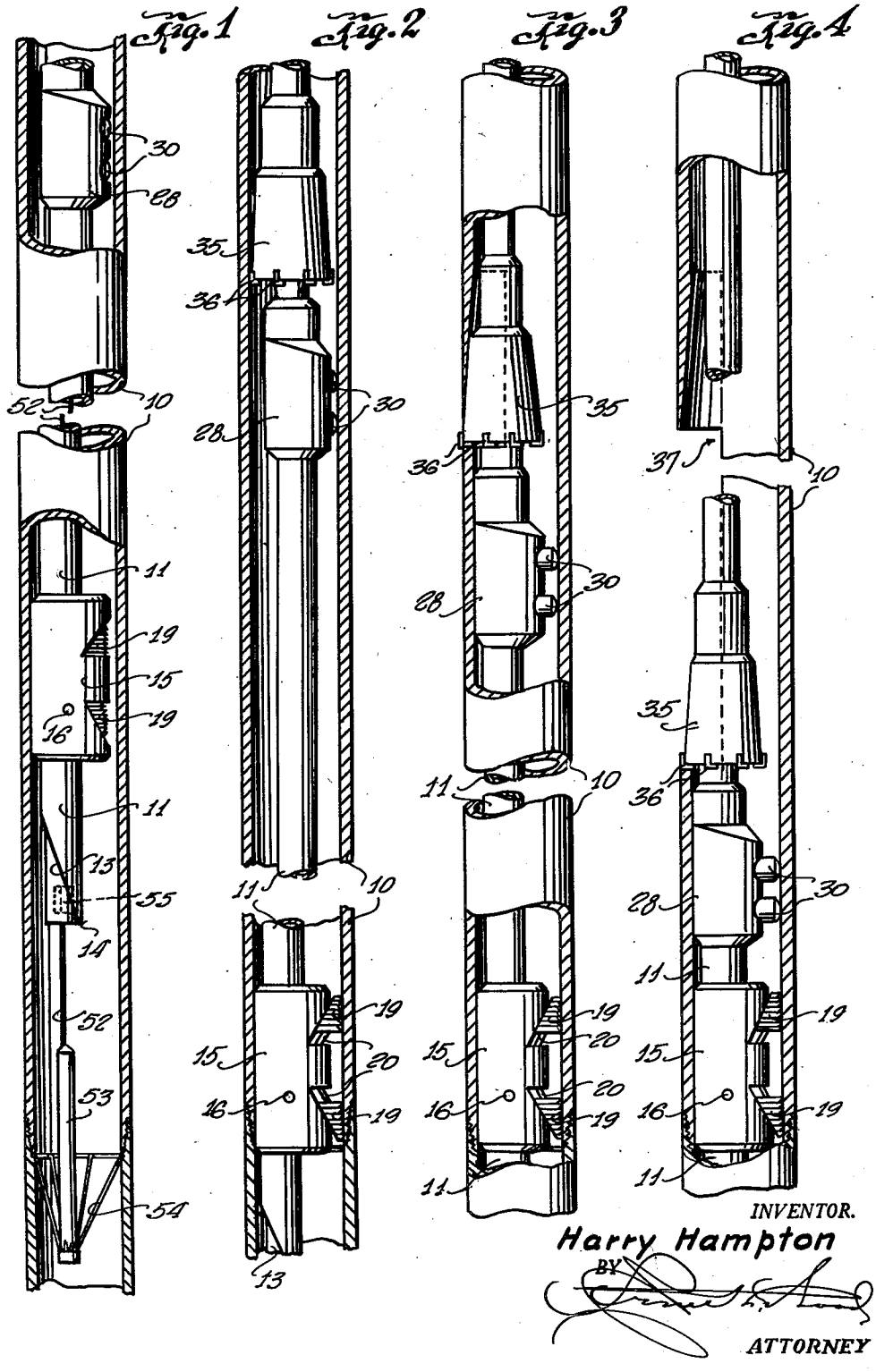
March 31, 1953 H. HAMPTON 2,633,331

APPARATUS FOR PREPARING WELL CASINGS FOR SIDETRACK DRILLING

Filed Sept. 7, 1948 4 Sheets-Sheet 1



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APPARATUS FOR PREPARING WELL CASINGS FOR SIDETRACK DRILLING

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Fig. 5

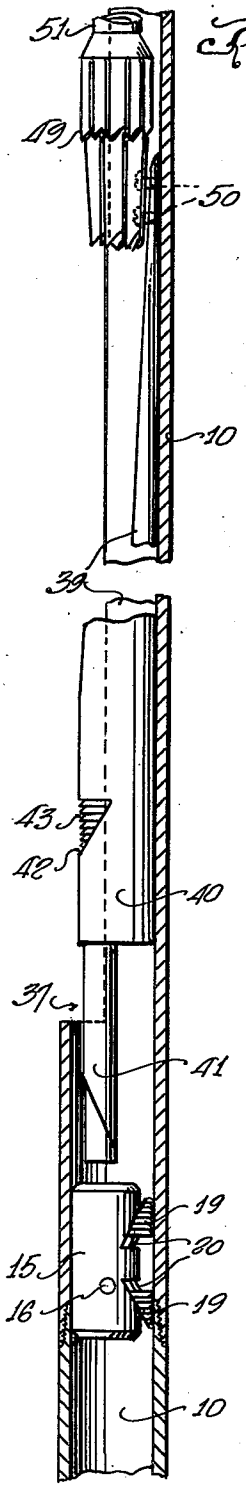


Fig. 6

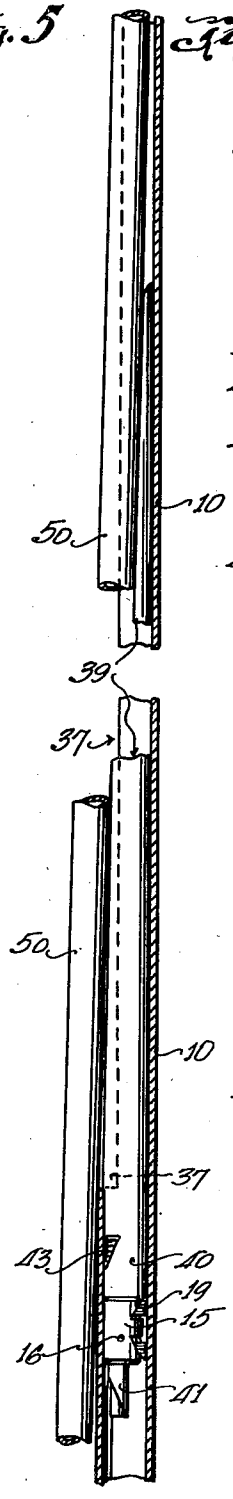


Fig. 7

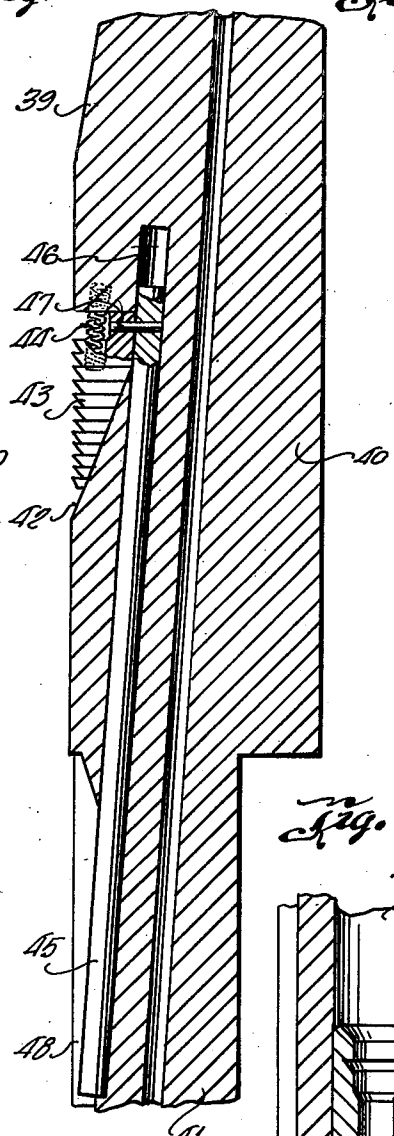
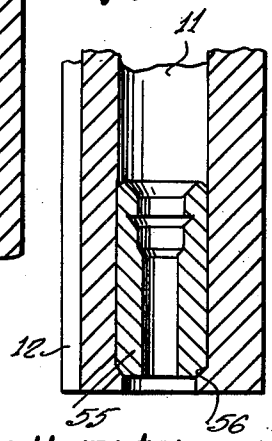


Fig. 8



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APPARATUS FOR PREPARING WELL CASINGS FOR SIDETRACK DRILLING

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Fig. 9

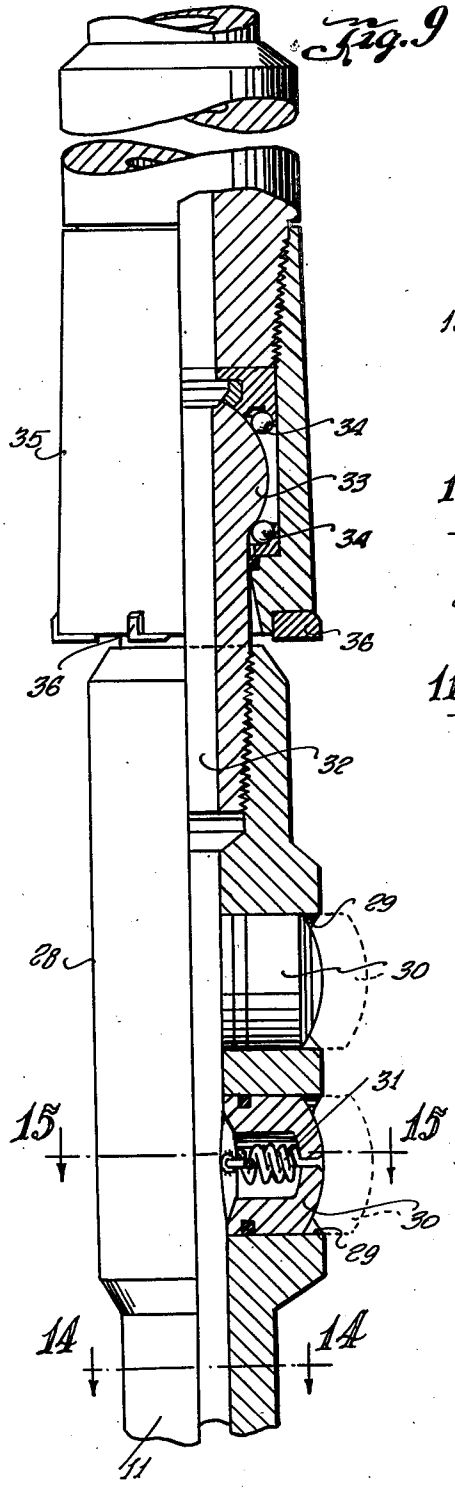


Fig. 10

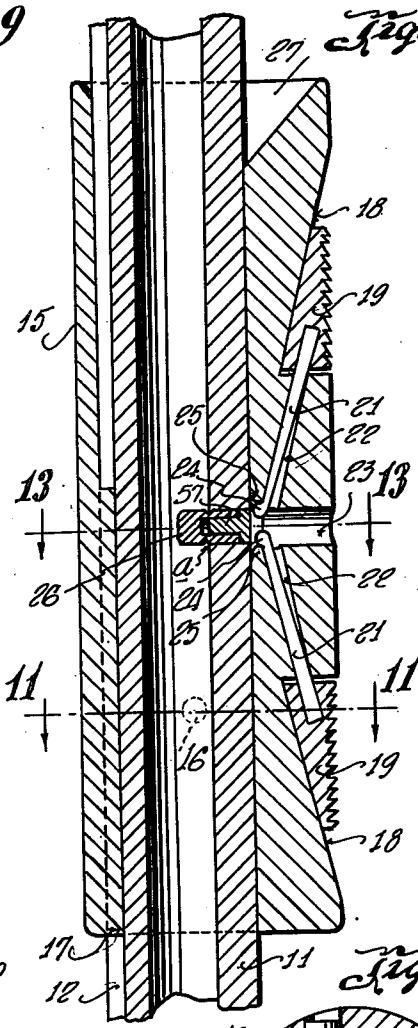
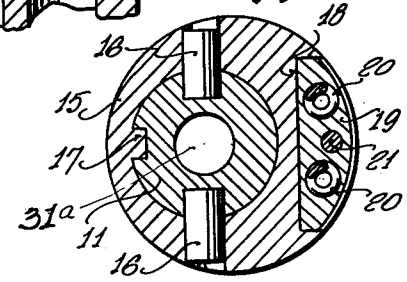


Fig. 11



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APPARATUS FOR PREPARING WELL CASINGS FOR SIDETRACK DRILLING

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Fig. 12

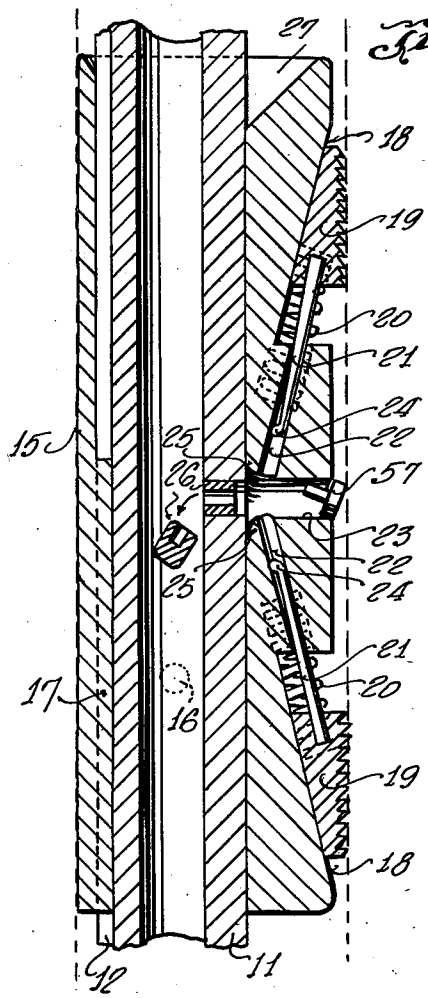


Fig. 13

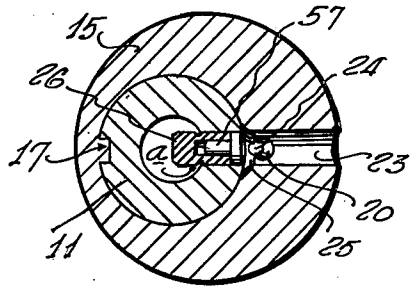


Fig. 14

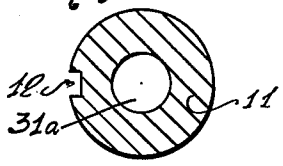
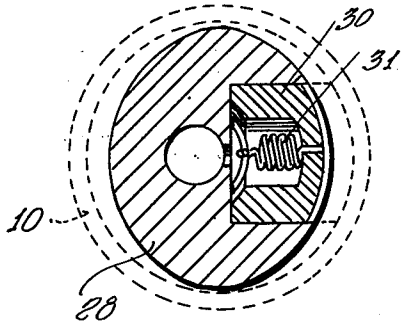


Fig. 15



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Patented Mar. 31, 1953 2,633,331

UNITED STATES PATENT OFFICE

2,633,331

APPARATUS FOR PREPARING A WELL CASING FOR SIDETRACK DRILLING

Harry Hampton, Burkburnett, Tex.

Application September 7, 1948, Serial No. 48,014

4 Claims. (Cl. 255—1.6)

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This invention relates to well drilling tools and equipment and it has particular reference to new and useful improvements in whipstocks as well as to related equipment for installing and adapting the whipstock in a well.

The principal object of the invention is to provide sidetracking equipment, together with a method of installation and use which will simplify a sidetracking job, a procedure which at its best, involves considerable guesswork. The invention seeks not only to eliminate many of the time consuming steps necessary in carrying out a conventional sidetracking operation and thus effect a material saving in costs but also to obviate the element of conjecture through the provision of means for accurately determining beforehand the exact location in the casing where sidetracking is to begin.

Another object of the invention is to provide sidetracking equipment for wells, consisting of an assembly made up of an aligning bar, a slip anchor shearably mounted on the aligning bar, a milling tool on the upper end of the aligning bar and a hydraulic feed unit effective to shift the bar in the casing of a well to urge the milling tool into operative cutting engagement with the casing to provide a window through which any suitable bit may be passed for the continuation of the well drilling operation past an obstruction in the well. Moreover, the invention includes a whipstock adapted to be lowered by and sheared from the drilling tool or bit to direct the latter angularly through the window made in the casing, said whipstock having means thereon cooperating with means on the anchor for orienting the whipstock with the casing window, as well as means by which the whipstock is positively secured against rotation and longitudinal displacement in the casing.

Another object of the invention is to provide a process of sidetracking in drilling which consists in determining the position of a joint of casing in a string through which drilling is to be sidetracked; establishing an anchor at a predetermined point below the proposed sidetracking area; in milling out the casing at the sidetracking area, using the anchor as a guide; in maintaining lateral pressure on the milling tool during its operation in cutting the casing; in withdrawing the cutting tool from the casing and finally in setting a whipstock in the casing, orienting the same with the milled out area by the anchor.

With the foregoing objects in view, the invention has further reference to certain features of accomplishment which will become apparent as

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the description proceeds, taken in connection with the accompanying drawings wherein:

Figure 1 is an elevational view showing the aligning bar, anchor and hydraulic feed unit of the invention suspended in a well casing, the latter being fragmentary and partly in longitudinal section.

Figure 2 is a view similar to Figure 1 in which the anchor is shown as being set preparatory to the step of milling the casing.

Figure 3 is a view similar to Figures 1 and 2 but in which the milling operation is shown as under way.

Figure 4 is a view showing the milling operation completed preparatory to setting the whipstock.

Figure 5 is a view of the milled casing showing the whipstock immediately prior to setting and its attachment by shear pins to a drilling tool.

Figure 6 is a view of the milled casing showing the whipstock installed and its effect in sidetracking the drill pipe.

Figure 7 is a fragmentary sectional view of the whipstock showing its anchoring slip.

Figure 8 is a fragmentary sectional view showing the lower end of the aligning bar and choke.

Figure 9 is a view partly in section and partly in elevation, showing the milling tool and hydraulic feed unit on a slightly enlarged scale.

Figure 10 is a fragmentary sectional view of the aligning bar showing the anchor thereon in longitudinal section on a slightly enlarged scale.

Figure 11 is a view in transverse section, taken on line 11—11 of Figure 10.

Figure 12 is a view similar to Figure 10 showing the anchor with slips extended and illustrating the shear plug by which the position of the proposed sidetracking area is located.

Figure 13 is a transverse sectional view taken on line 13—13 of Figure 10.

Figure 14 is a transverse sectional view taken on line 14—14 of Figure 9, and

Figure 15 is a transverse sectional view taken on line 15—15 of Figure 9.

Continuing with a more detailed description of the drawing, reference is primarily made to Figures 1 to 4 in which numeral 10 denotes a well casing at the approximate level in a well where drilling must be sidetracked to avoid obstructions of any nature; to straighten crooked holes, or for other reasons.

In Figure 1 is shown the position of the invention initially as preparations are made to cut a window in the casing 10. The elements of the invention consist of an aligning bar or tube 11 which has a longitudinal groove 12 extending the

full length thereof. Also, the aligning bar 11 is formed at its lower end with a substantially V-shaped cut-away portion 13 which defines a point 14 at the extremity of the bar on one side. By so forming the end of the bar, it will readily find its position in an anchor 15 when it is found necessary to withdraw the bar after the anchor is set.

The anchor 15 consists of a tubular body which surrounds the aligning bar 11 at a point spaced above its lower end and is attached thereto by means of shear pins 16 (Fig. 11). The purpose of these pins will be explained presently. Also, by virtue of a tongue 17 formed longitudinally on one side of the bore of the anchor body 15, which is received by the groove 12 of the aligning bar 11, the bar is held against rotation once the anchor has been set in the casing 10.

The anchor 15 has formed thereon on one side a pair of inclined recesses 18 in which are slidably retained slips 19. These slips are normally urged to extended position, as shown in Figure 12 by coiled springs 20 and to each slip is attached one end of a latch arm 21, these arms extending through angular passages 22 communicate with a lateral passage 23 in the wall of the anchor body 15. The inner ends of the latch arms 20 are each provided with a hook 24 which engages under a lip 25 formed at the inner end of the lateral opening 23, as exemplified in Figure 10.

The opening 23 in the anchor 15 is in register with an opening in the wall of the aligning bar 11 (Fig. 10) when the shear pins 16 are intact. A plug 26 is installed in the opening in the aligning bar and is annularly grooved at *a* to provide a weakened portion intermediate its ends so that it may be readily broken off in the manner to be presently described and for the purpose to be explained. The upper end of the anchor body 15 is interiorly beveled at 27 (Figs. 10 and 12) to receive the pointed guide 14 of the aligning bar 11 to facilitate engagement of the bar with the anchor and to effect alignment of the latter's tongue 17 with the groove 12 of the bar 11.

On the upper end of the aligning bar 11 is formed a hydraulic feed unit consisting of a body 28, integral with the aligning bar 11, which is preferably of elliptical cross-section, as exemplified in Figure 15. The body 28 has longitudinally spaced openings 29 therein (Fig. 9) in which operate plungers 30, the latter being normally retracted by coil springs 31 but are extended by internally applied fluid pressure in a manner to be presently explained. The plungers 30 are slidably disposed in openings 29 which communicate with the bore 31*a* extending longitudinally through the aligning bar 11 and the body 28. The plungers 30 are biased toward retracted position by the springs 31. The opposite ends of each spring 31 are connected to a plunger 30 and to a pin or rod 31*b*, extending across the associated opening 29 and secured to the body 28 by welding or other conventional means.

Threaded into the upper end of the body 28 of the hydraulic feed unit is a shank 32 on which is formed a ball 33, the latter being retained in a socket defined by ball bearings 34, mounted in races spaced apart in the body 35 of a milling tool, the latter having cutter blades 36 spaced about its lower end. It is evident that the ball 33, suspended as it is by the socket formed by the balls 34, permits the elements of the assembly below the milling tool 35 to be misaligned or disposed at an angle in relation to the longitudinal axis of the casing 10 but such misalignment does not occur until the milling tool 35 is put into operation to cut a window 37 in the wall of the casing 10 (Figs. 4, 5 and 6).

The foregoing description explains the construction and relationship of the parts making up the equipment for installing the whipstock, which latter is indicated generally by reference numeral 39 in Figures 5 and 6. Specifically, the whipstock consists of the gradually tapered and hardened upper portion which is identified at 39 and the lower or base portion 40. Extending below the base portion 40 is an aligning element 41 like the lower end of the aligning bar 11 and which facilitates engagement of the whipstock with the anchor 15 which has been set in the casing.

In one side of the lower portion 40 of the whipstock there is made an inclined recess 42 which slidably retains a slip 43. The slip is normally urged toward engaged position with the casing wall by a coil spring 44 but is restrained by a rod 45 (Fig. 7) which is slidable in an angular bore 46 extending upwardly in the whipstock and is connected to the slip 43 by means of a shear pin 47. The lower end of the rod 45 is adapted to be brought up against the upper end of the tongue 17 in the bore of the anchor (Fig. 10) when the whipstock is lowered and guided into the anchor by the member 41 formed on the whipstock. When the rod is moved upwardly in its bore 46 the pin 47 is sheared off, releasing the slip 43 to the action of spring 44 which urges the slip against the casing wall, thereby holding the same against upward displacement therein. The anchor 15 prohibits downward displacement of the whipstock while the longitudinal groove 48 in its lower end, engaging the tongue 17 in the bore of the anchor, prohibits rotative displacement of the whipstock, hence there is always the assurance that a drilling tool 49 (Fig. 5) by which the whipstock is lowered, will be in alignment with the window 37 which is milled in the wall of the casing 10 when the shear pins 50 connecting the whipstock to the drill are sheared off by downward weight imposed on the drill pipe 51.

In operation, the assembly shown in Figures 1 to 4, that is, the aligning bar 11, anchor 15, hydraulic feed unit 28 and milling tool 35, is lowered into the well casing to the approximate depth where sidetracking is to be started. With the assembly so positioned, circulation is effected to clean out the hole. Following this operation, it is necessary to determine the location of the particular joint of casing in which a window is to be milled in order to insure against cutting through a coupling and severing the casing string. This is accomplished by running a wire measuring line 52 (Fig. 1) downwardly through the drill pipe or tubing, thence through the milling tool 35, and the aligning bar 11 to the stop plug 26 in the anchor 15. When the plug 26 is encountered by the sinker bar or weight 53 carried by the line 52, the depth of the anchor is made known. When this information is recorded, the sinker bar 53 is used to break off the severable end of the plug 26 (Fig. 12), whereupon the measuring line is continued downwardly through the bottom of the aligning bar 11 (Fig. 1) and, by virtue of the device 54 carried by the sinker bar, whose radial spring fingers pass freely through the assembly and expand upon emergence therefrom, the upper and lower collars of the casing joint are located, after which the measuring line is withdrawn. The sinker bar 53 may be pulled out with the line if desired leav-

ing the device 54 in the casing. Or the spring fingers of the device may be sufficiently flexible so that they may be bent by a relatively strong pull on the line 52 to a downwardly and outwardly extending position so that the device 54 may be withdrawn along with the sinker bar 53. The sinker bar is removed prior to the milling operation while the device 54 may be removed or left in the casing as desired.

After the casing joint couplings have been located as described, the assembly is lowered to a point where the anchor 15 will be disposed at or immediately above the lowest collar. A choke 55 (Fig. 8) is then dropped into the drill pipe and this choke, after passing through the assembly, will come to rest on the annular shoulder 56 formed in the bore of the aligning rod 11 at its lower extremity. After setting the choke 55, pressure in the drill pipe is built up as well as within the assembly above the choke 55 so that the fluid pressure within the anchor 15 will exert sufficient force against a core 57 (Figs. 10, 12 and 13) in the remaining portion of the plug 26, that this core will be outwardly displaced to impinge the hooked ends of the latch arms 21, releasing them from the retaining lips 25, to the action of springs 20 which latter will act to thrust the slips 19 outwardly into engagement with the walls of the casing and thus permanently set the anchor therein.

After setting the anchor as described, pressure in the assembly is relieved and security of the anchor is determined by raising and lowering the drill pipe, after which, the weight of the drill pipe is set down to shear the pins 16 (Fig. 11) which action will permit free sliding movement of the aligning bar 11 through the anchor 15 but rotation of the aligning bar is precluded by the tongue 17 of the anchor lying in the groove 12 of the bar.

Pressure in the assembly is renewed and circulation again started to displace the plungers 30 of the hydraulic feed unit 28 outwardly against the wall of the casing. The milling tool 35 is thereby caused to be moved against the opposite wall of the casing, as shown in Figure 2, after which the milling tool is started rotating to cut the window 37 in the casing. The self-aligning socket 33 will compensate for misalignment of the aligning bar by the hydraulic feed unit 28, and which misalignment occurs only while starting the cut. The milling tool continues to operate until the window 37 is completed when the hydraulic feed unit comes to rest on the anchor 15. Figure 4 shows the unit 28 approaching this position.

The milling assembly consisting of the aligning bar, milling tool and hydraulic feed unit, is now withdrawn. This assembly can be withdrawn at any time before completion of the window 37 in case another joint of drill pipe is required to be added or to change milling tools. Replacement of the assembly is made readily possible by the self-locating or aligning member 14 formed on the aligning bar 11. Thus, the assembly is returned to the exact cutting position it was in when withdrawn.

To install the whipstock 39, the upper extremity thereof is secured by shear pins 50 to a formation cutter, rock bit, shale bit or other type cutter 49 and is lowered with this bit by the drill stem 51 and the keyway 48 in the lower portion 41 of the whipstock will receive the tongue 17 in the anchor 15, which will orient the tapered side of the whipstock in relation to

the window which has been milled in the casing wall. When the whipstock is within approximately six inches above final set position, the lower end of the plunger 45 in the whipstock engages the upper end of the tongue 17 in the anchor 15 and the weight of the anchor combined with that imposed thereon, will shear off the pin 47, as previously explained, releasing the slip 43 to the action of springs 44 which will firmly set the whipstock in proper position to direct the bit 49 outwardly through the window 37 when the pins 50, connecting the whipstock and bit, have been sheared by the full weight of the drill stem.

Manifestly, the construction as shown and described is capable of some modification and such modification as may be construed to fall within the scope and meaning of the appended claims is also considered to be within the spirit and intent of the invention.

What is claimed is:

1. Apparatus for preparing a well casing for sidetrack drilling, including an aligning bar adapted to be suspended in a casing string, an anchor carried by said aligning bar, a milling tool having a longitudinal bore on the upper end of said aligning bar, a swivel forming connection between said milling tool and aligning bar, said bar having a longitudinal bore means on said aligning bar below said milling tool responsive to fluid pressure within said bore for displacing said aligning bar in said casing to urge said milling tool against the wall of the latter, means responsive to fluid pressure within said bore for setting said anchor immovably in said casing, means extending between and connecting said anchor and aligning bar and shearable by weight imposed downwardly on the latter to release said aligning bar for sliding movement through said anchor, a choke removably disposed in said aligning bar for establishing fluid pressure in said bores above said choke to actuate said first pressure responsive means and that of said anchor, and means for rotating said milling tool to cut a window in said casing.

2. Apparatus for preparing a well casing for sidetrack drilling comprising, an aligning bar having a longitudinal bore provided with a longitudinal internal groove; a tubular body disposed about said aligning bar and having a tongue engaging the groove of said bar; shearable pins holding said body in a predetermined position on said aligning bar, spring loaded slips carried by said body; means for holding said slips in retracted position, said body and said aligning bar having registering transverse lateral apertures when said body is in said predetermined position; a shearable plug in said lateral aperture of said aligning bar extending into said longitudinal bore; a core in said lateral aperture of said aligning bar exposed to fluid pressure from within said longitudinal bore when said plug is sheared off and movable by said pressure into said lateral aperture of said body for releasing said holding means and releasing said slips from retracted positions; a hydraulic unit on the upper end of said aligning bar and having a longitudinal bore communicating with said bore in said aligning bar, said unit having a lateral opening communicating with said longitudinal bore; a plunger slidably disposed in said aperture; means biasing said plunger to retracted position within said lateral opening, said plunger being exposed to fluid pressure from within said longitudinal bore and being movable thereby into

outwardly extending position to contact the inner wall of said well casing; a milling tool having a longitudinal bore disposed above said unit; means pivotally and rotatably connecting said milling tool to said hydraulic unit, said means having a longitudinal bore, the bores of said milling tool, said hydraulic unit and said connecting means communicating with one another, said shearable plug being shearable by a weight allowed to descend through said longitudinal bores; means positionable in said longitudinal bore of said aligning bar below said tubular body to restrict said bore and increase the fluid pressure within said tubular bores to move said core and said plunger outwardly after said plug is sheared off, said core actuating said holding means to release said slips and anchor said tubular body in said casing, said plunger moving said unit relative to said well casing to bias said milling tool into engagement with the wall of said casing; and means for rotating said milling tool to cut a window in said casing, said pins being shearable by a downward force applied to said milling tool to allow said aligning bar to move downwardly with respect to said anchored tubular body as said tool cuts said window.

3. Apparatus for preparing a well casing for sidetrack drilling including an aligning bar having a longitudinal bore, a choke removably disposed in said aligning bar, an anchor releasably attached to said bar, casing engaging slips on said anchor; means for holding said slips in retractable position with respect to said casing, means mounted on said bar extending laterally into said bore and shearable from said aligning bar by a weight descending through said bore, pressure responsive means exposed to fluid pressure within said bore when said last mentioned means is sheared for actuating said holding means to release said slips into casing engaging position, a hydraulic feed unit on said bar above said anchor, said unit having a longitudinal bore communicating with the bore of said aligning bar, pressure responsive plungers in said unit outwardly extendable by fluid pressure within the internal bore of said unit, spring means holding said plungers normally retracted, a milling tool having a longitudinal bore pivotally and rotatably connected to and above said hydraulic feed unit, said choke establishing fluid pressure

in said bores above said choke to displace the pressure responsive means to actuate said holding means and to actuate the plungers of said hydraulic feed unit to urge said milling tool against said casing, means for vertically actuating said aligning bar to release the same slidably with respect to said anchor and means for rotating said milling tool to cut a window in said casing.

4. Apparatus for cutting a window in a casing string comprising an aligning bar having a longitudinal bore; a choke in said bore for establishing fluid pressure within said bore above said choke; an anchor on said aligning bar; shear pins holding said anchor on said bar; slips on said anchor; means on said anchor for holding said slips in retracted position, means on said aligning bar engageable with said last mentioned means and responsive to fluid pressure within said bore for releasing said slip holding means; a milling tool having a longitudinal bore disposed above and rotatable in relation to said aligning bar and from which the latter is suspended, said bar having a transverse aperture communicating with said bore; means in said aperture also responsive to fluid pressure in said bore and extendable to contact said casing for urging said milling tool against said casing, biasing means for said last mentioned means normally holding said last mentioned means in non-extended position; means for actuating said aligning bar to shear the pins holding said anchor on said bar to release the latter for sliding displacement in said anchor; and means for rotating said milling tool to cut a window in said casing.

HARRY HAMPTON.

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