June 7, 1955 H. G. LIVINGSTON ET AL 2,710,170

APPARATUS FOR DEFLECTING AND REAMING DRILL HOLES

Original Filed Jan. 17, 1951 2 Sheets-Sheet 1

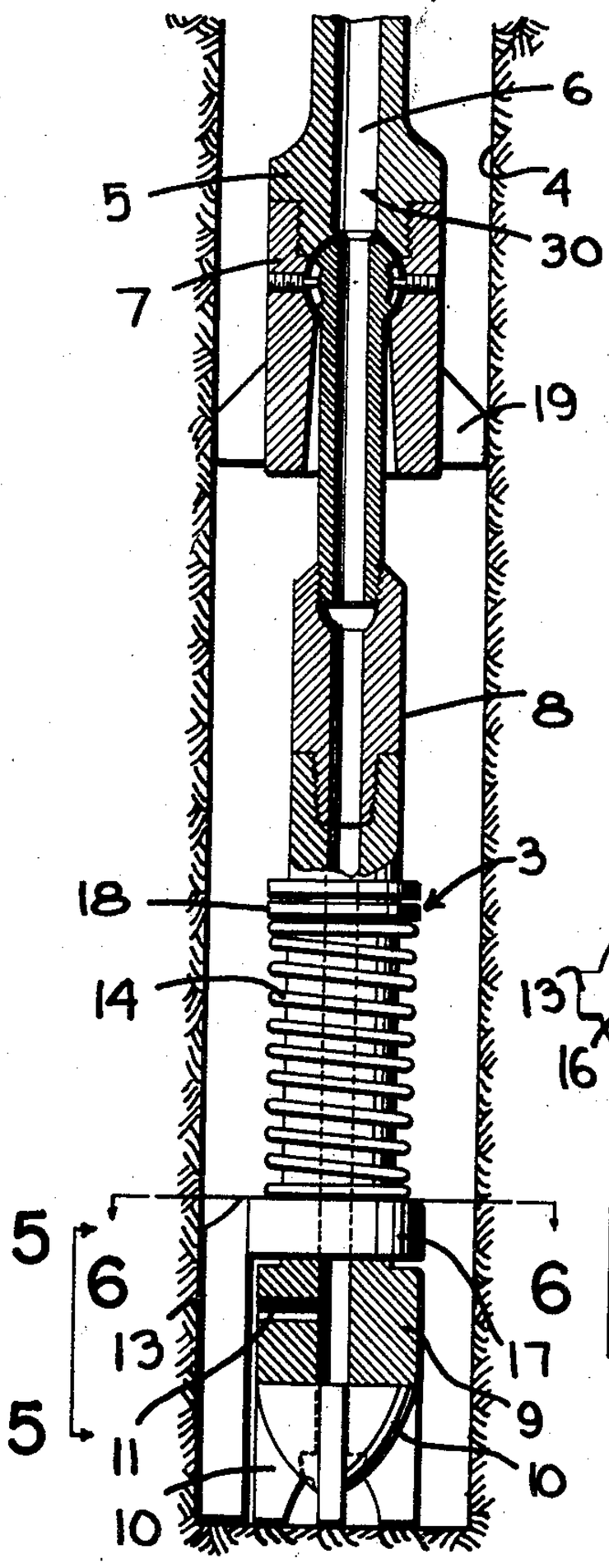

Fig. 1

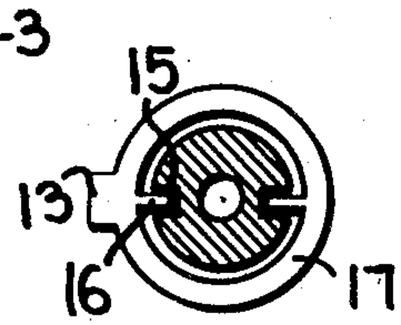

Fig. 6

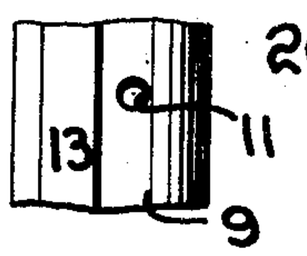

Fig. 5

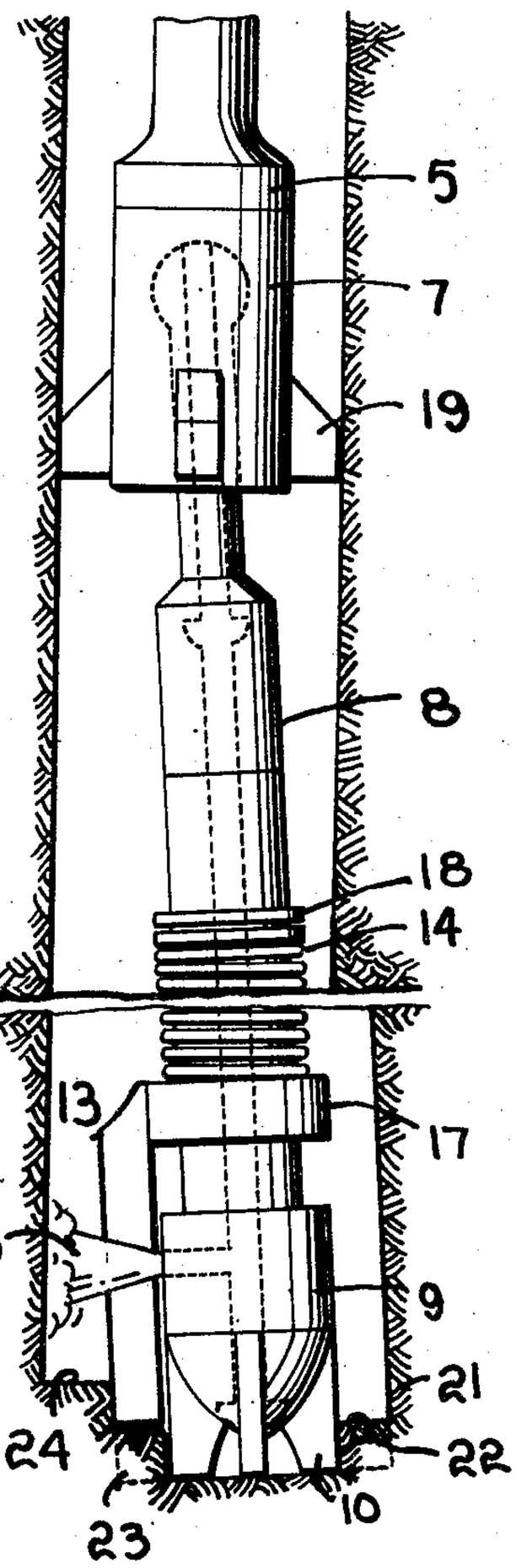

Fig. 2

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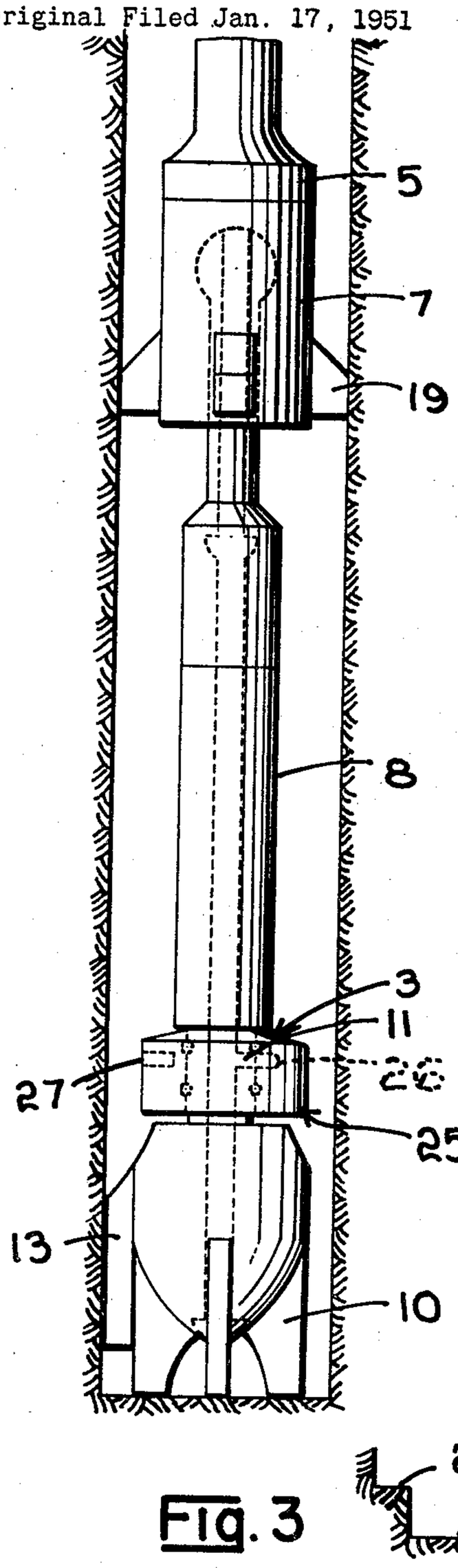

Fig. 3

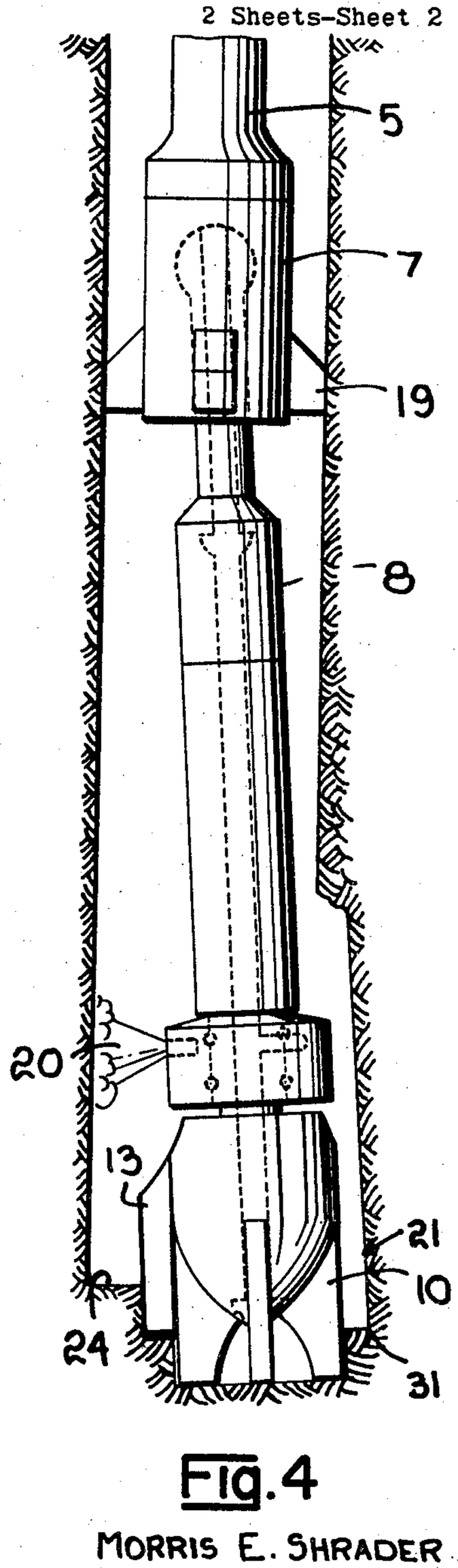

Fig. 4

Fig. 7

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APPARATUS FOR DEFLECTING AND REAMING DRILL HOLES

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Continuation of application Serial No. 206,374, January 17, 1951. This application April 1, 1955, Serial No. 498,557

6 Claims. (Cl. 255—1.6)

The invention relates to a device for deflecting and reaming wells.

Numerous devices have been proposed for the drilling of a well where it is desired to drill a portion of such well off vertical. These devices generally consist of a drill string which is provided with a knuckle joint at the lower end thereof; suitable deflecting means such as a whipstock may be used in conjunction with the knuckle joint whereby the lower end of the drill string is bent or deflected off its normal course.

One of the primary disadvantages with prior art constructions is that when the well string is moved over to the side of the well to drill the deflected portion thereof, a large shoulder is generally left at the point in the well where such deflected portion starts. This shoulder is formed by the juncture of the bottom of the straight portion of the well with the deflected portion being drilled. The surface area of such shoulder as compared to the horizontal sectional surface area of the deflected portion of the well bore at the same elevation as the shoulder is relatively large when the deflected portion of the well is formed by tools heretofore used.

It is not uncommon for the operator of the tools used in the prior art to make two, three, four or maybe five attempts before obtaining the correct amount of deflection or angle that is desired in the "rat hole," which is the term generally applied to the deflected portion of a well bore.

With the devices heretofore used if the first run of the tool is not successful, it is necessary to pull the whole string of pipe from the well, remove the knuckle joint and rat hole bit and place a bit thereon of standard size, whereupon the normal drilling operations can proceed until the well bore is drilled out the depth of the rat hole. The drill string is then removed from the well bore and the knuckle joint and rat hole bit placed thereon, whereupon the string is again lowered and a second rat hole, or deflected portion of the well drilled. This procedure continues until the rat hole is deflected from the well bore at the desired angle. It can therefore be appreciated that the tools heretofore used necessitate the reaming out of the whole well bore down to the level of the rat hole before a second deflection can be made.

One of the primary objects of the instant invention is to provide a construction for drilling a deflected portion of a rat hole which construction reams out the rat hole to substantially the same size as the well bore. This eliminates the necessity of withdrawing the string of pipe and reaming out the well bore before a second deflection is made, since a second, third, and any number of deflections can be made in the enlarged rat hole.

Still another object of the invention is to provide in a construction for drilling a deflected portion of a well bore, a reamer blade which is resiliently supported on the shank of a knuckle joint, adjacent a drill bit positioned on the lower end of such shank.

Still another object of the invention is to provide a

device for simultaneously drilling and reaming a deflected portion of a well bore to substantially the same size as the rest of the well bore.

A still further object of the invention is to provide an apparatus for deflecting a well bore which includes a drill string with a longitudinal fluid passage therethrough, a knuckle joint on the lower end thereof with a longitudinal fluid passage therethrough and a fluid escape port or orifice extending laterally therefrom and communicating with the fluid passage and a drill bit secured to the lower end of such shank with a reamer blade positioned adjacent the bit and substantially in the same vertical plane as the fluid escape port.

Still another object of the invention is to provide a device for simultaneously drilling and reaming a deflected portion of a well bore, such device including a shank secured to the lower end of a drill string movable relative thereto and provided with a lateral port to discharge fluid from the shank whereby the shank may be moved in a desired direction, and a bit secured to the lower end of such shank and a reamer blade secured adjacent the bit and facing in the same direction as the fluid escape port.

Still another object of the invention is to provide a device for simultaneously drilling and reaming a deflected portion of a well bore, such device including a shank secured to the lower end of a drill string movable relative thereto and provided with a lateral port to discharge fluid from the shank whereby the shank may be moved in a desired direction, and a bit secured to the lower end of such shank and a reamer blade secured adjacent the bit and facing in the same direction as the fluid escape port, resilient means supporting said reamer blade slidably but non-rotatable relative to the bit, whereby as weight is applied to the bit, the reamer blade will fall behind the bit as the deflected portion of the well bore is drilled.

A still further object of the invention is to provide a tool for deflecting and reaming a well, which tool is provided with a fluid port or orifice adjacent the lower end thereof to move the tool in a desired direction within the well bore, and a reamer blade secured adjacent the lower end of the device to ream the deflected portion of the bore to substantially the same size as the well bore.

Other and further objects and advantages of the invention will become more apparent from a consideration of the following description and drawings wherein:

Fig. 1 is a vertical elevational view partly in section illustrating a form of the invention in position in a well bore;

Fig. 2 shows the device in a well bore and the beginning of the drilling and reaming of the deflected portion;

Fig. 3 is a vertical elevation illustrating an alternate embodiment or modification of the invention;

Fig. 4 is a section elevation illustrating the modified form shown in Fig. 3 operating within the well bore;

Fig. 5 is a side elevation on the line **5—5** of Fig. 1 illustrating the relationship of the reamer blade and fluid escape port;

Fig. 6 is a sectional view on the line **6—6** of Fig. 1 illustrating a detail of construction of this modification of the invention;

Fig. 7 is a vertical sectional view illustrating the shape of the bottom of the deflected portion when using the tool illustrated in Figs. 3 and 4.

Referring to Fig. 1 of the drawings, the device is illustrated at **3** as being positioned within the well bore **4**. The drill string **5** extending upwardly to the surface of the earth is provided with the customary fluid passage **6** and has secured at the lower end of the drill string **5** a knuckle joint **7** which in turn is provided with a longitudinal fluid passage **6** through the shank **8** to supply fluid to the lower

end of the tool as will be more fully described hereinafter. The sub 9 on the lower end of the shank may be integral therewith or threadedly engaged to the shank 8 of the knuckle joint. A drill bit 10 is secured to the lower end of the shank 8 on the sub 9.

Extending laterally from the fluid passage 6 is the escape port or orifice 11 which is used to move the shank 8 of the knuckle joint as will be more fully described hereinafter.

A reamer blade 13 extends longitudinally adjacent the drill bit 10 and as more clearly illustrated in Fig. 5 faces in the same general direction and substantially in the same vertical plane as the escape port 11. The reamer blade is supported on the shank by the resilient means 14 illustrated as being in the form of a coil spring. Grooves 15 on the periphery of the shank 8 are adapted to engage with lugs 16 on the collar 17 of the blade 13 which permits sliding movement between the reamer blade 13 and shank 8 and connected drill bit 10. However, this construction prevents relative rotation between such reamer blade and the drill bit by reason of engagement of the lugs 16 in the grooves 15 in the sub. The coil spring 14 abuts the collar 17 of the reamer blade 13 and the stop 18 on the shank of the tool.

Stabilizer blades 19 are provided on the knuckle joint to centralize such joint in the well bore.

In the operation of the tool, the relationship of the escape port or orifice 11 and reamer blade 13 is determined with respect to any suitable reference medium such as the knife element 30, shown in Fig. 1, and the tool then lowered into the well and oriented by any suitable means so that the port or orifice faces in the proper direction. Where the knife element is not used, then the relationship to another reference medium may be established. As illustrated in Fig. 2, the shank 8 of the knuckle joint is swingable relative to the drill string 5. This movement is caused by raising the pump (not shown) pressure high enough to circulate mud fluid downwardly through the passage 6 faster than it can be discharged out the drill bit 10. This surge or back pressure of fluid will discharge a stream of fluid 20 out the escape port or orifice 11 which serves to "jet" the shank 8 towards the side of the well in which the deflected part is to be drilled.

With the pump pressure at a point to maintain the shank 8 deflected, the string of pipe is picked up at the surface and dropped to "spud" in the drill bit 10 on the proper side of the well bore. After the bit has been spudded in, drilling continues by rotating the drill string 5 whereupon the drill bit will be deflected as illustrated in Fig. 2 to drill the rat hole or deflected portion 21. Because of the resilient spring means 14 the reamer blade will fall behind the drill bit 10 as drilling progresses and the contour of the rat hole or deflected portion 21 will be as illustrated at 22. However, after the hole has been drilled to the desired depth, weight is removed from the drill string by supporting it in the hole at the surface and the drill string continued rotating whereupon the spring 14 will move the reamer blade 13 downwardly until the deflected portion 21 assumes the configuration illustrated by dotted lines 23 in Fig. 2.

Attention is directed to the shoulder 24 which is formed by the bottom of the undeflected well bore at the point where the well is deflected. By reason of the reamer blade in combination with the drill bit, the amount of this shoulder is substantially reduced and if it should be necessary to again deflect the well bore from the previously deflected portion 21, it is unnecessary to remove the drill string and reamer out of the hole. The deflected portion is, for all practical purposes, the same diameter as the well bore which allows the tool to be deflected again if necessary.

In the modification illustrated in Fig. 3 the reamer blade 13 is shown as being integral with the drill bit 10. In order to align the escape port or orifice 11 in the shank 8 of the modification illustrated in Figs. 3 and 4, and the

reamer blade 13, a collar 25 is provided which may be secured on the shank. This collar is provided with a groove 26 on the inner periphery thereof and a discharge port 27.

In making up the threaded connection between the drill bit 10 and shank 8 it is impossible, for all practical purposes, to align the discharge port 11 and the reamer blade 13 in the same vertical plane. This difficulty is overcome however, by providing the collar 25 with the groove 26 whereby the port 27 can be vertically aligned with the reamer blade 13 by rotation of the collar 25 to the proper position. The groove 26 supplies the fluid to be discharged from escape port 11 through discharge port or orifice 27. After the collar 25 has been positioned properly it is retained in position by any suitable means, such as set screws (not shown).

Attention is directed to Fig. 4 of the drawings wherein the invention is illustrated being spudded in to drill a deflected portion of a well bore. The blade 13 is fixed both longitudinally and rotatably relative to the drill bit 10, and it seems obvious therefore, that the bottom of the rat hole or deflected portion as illustrated at 28 will assume the configuration illustrated in Fig. 7.

The operation of this form of the invention is similar to that previously described for the invention as illustrated in Figs. 1 and 2, it being only necessary to increase the rate of discharge of fluid through the passage 6 of the drill string 5 in order to move the shank 8 of the knuckle joint to one side of the hole, whereupon the bit may be spudded in and drilling continued.

If it is desired to deflect the well bore after the drilling has proceeded in a once deflected portion, the drill string can be picked up, the tool deflected, so that the bit, when the string is lowered, will rest at 31.

Broadly, the invention contemplates a tool for simultaneously drilling and reaming a deflected portion of a well bore to the same size as the well.

This application is a continuation of our prior copending application Serial No. 206,374, filed January 17, 1951, now abandoned, for the same invention in "Apparatus for Deflecting and Reaming Drill Holes."

What is claimed is:

1. In a device for changing the direction of a well and simultaneously reaming it to substantially full size, a rotatable drill stem with a fluid passage extending longitudinally thereof, a knuckle joint at the lower end thereof, a shank depending therefrom with a fluid passage longitudinally therethrough and a fluid escape port at the lower end thereof, a drill bit on the lower end of said shank, a reamer blade slidably but non-rotatably mounted on said shank, said reamer blade extending longitudinally adjacent the lower end of said shank and facing in the same direction as the escape port.

2. In a device for changing the direction of a well and simultaneously reaming it to substantially full size, a rotatable drill stem with a fluid passage extending longitudinally thereof, a knuckle joint at the lower end thereof, a shank depending therefrom with a fluid passage longitudinally therethrough and a fluid escape port at the lower end thereof, a drill bit secured to the lower end of said shank, a reamer blade slidably but non-rotatably mounted on said shank, spring means abutting said blade and resiliently supporting it in position on said shank, said reamer blade extending longitudinally adjacent the lower end of said shank and facing in the same direction as the escape port.

3. A device for simultaneously drilling and reaming a well bore portion including a rotatable drill stem, a knuckle joint connected on the lower end thereof, stabilizer blades adjacent said joint to center it in the well, a shank depending from said joint, a drill bit secured to said shank, a reamer blade slidably but non-rotatably mounted on said shank, and means for urging said reamer downwardly alongside said bit and extending outwardly

relative thereto to ream the well as the bit and drill stem are rotated.

4. In a device for changing the direction of a well and simultaneously reaming it to substantially full size, a rotatable drill stem with a fluid passage extending longitudinally thereof, a knuckle joint at the lower end thereof, a shank depending therefrom with a fluid passage longitudinally therethrough communicating with the fluid passage in the drill stem, a drill bit secured to said shank, a reamer slidably but non-rotatably mounted on said shank and extending outwardly relative to said bit, and means for urging said reamer downwardly alongside said bit to ream the well to substantially full size.

5. In a device for drilling a well and simultaneously reaming it to substantially full size, a knuckle joint, a shank depending therefrom, a reamer means slidably but non-rotatably supported relative to said shank, and means for urging said reamer downwardly along said shank for reaming the well to substantially full size.

6. A device for reaming a deflected portion of a well bore at the time the deflected portion is drilled, comprising a shank, a drill bit secured thereto, a reamer blade extending longitudinally of said shank, spring means abutting said blade to resiliently support it relative to said bit, said spring means urging said blade downwardly alongside said drill bit as the deflected portion of the well bore is drilled so as to ream such deflected portion.

References Cited in the file of this patent

UNITED STATES PATENTS

1,514,156	Hancock	Nov. 24, 1924
1,634,001	Timbs	June 28, 1927
1,678,073	Phipps	July 24, 1928
2,016,042	Lewis	Oct. 1, 1935
2,061,317	Brack	Nov. 17, 1936
2,142,859	McMahan	Jan. 3, 1939
2,167,194	Anderson	July 25, 1939
2,241,486	Sharp	May 13, 1941
2,249,732	Green	July 22, 1941
2,266,383	Quintrell	Dec. 16, 1941
2,291,100	Oswald	July 28, 1942
2,345,766	Miller	Apr. 4, 1944
2,498,192	Wright	Feb. 21, 1950

FOREIGN PATENTS

226,077	Great Britain	of 1924