May 31, 1960 S. S. TANNEHILL 2,938,710

DRILL BIT

Filed March 14, 1955

FIG. 2.

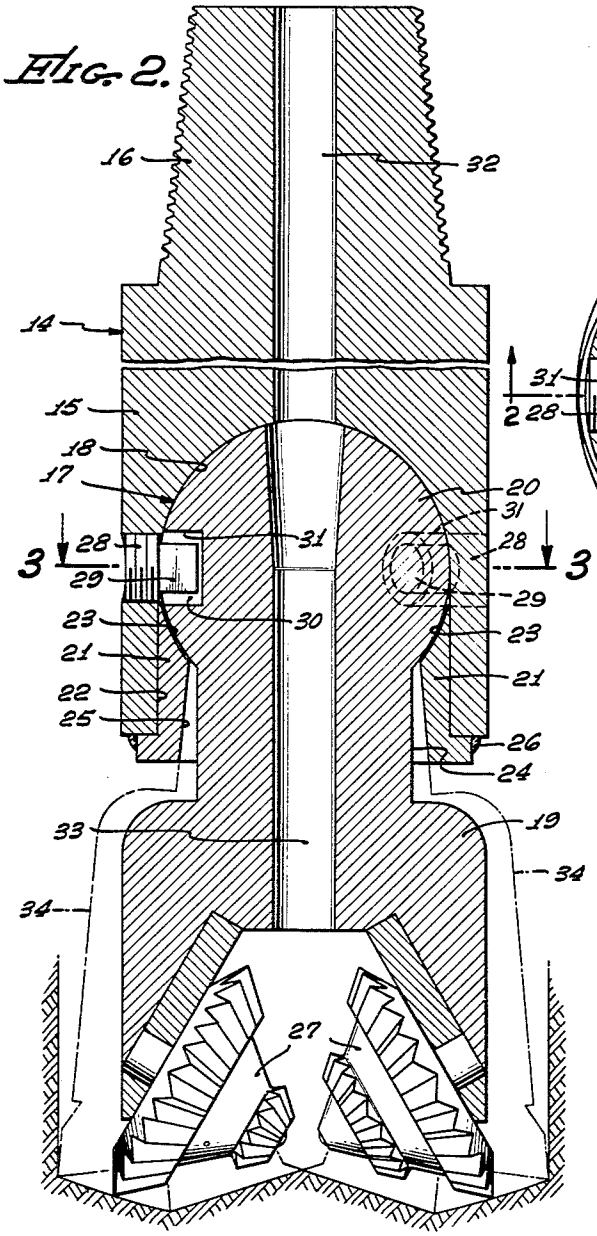
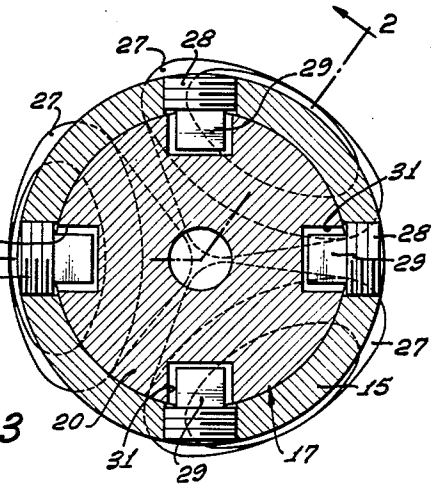


FIG. 3.



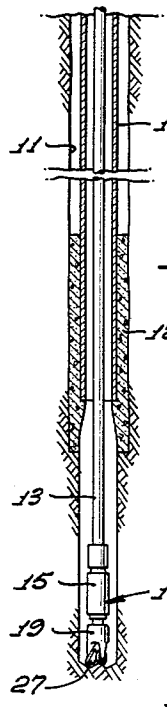
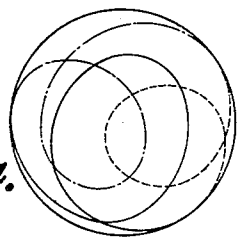


FIG. 1.

FIG. 4.



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DRILL BIT

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2 Claims. (Cl. 255—300)

This invention relates to the art of drilling wells and is particularly directed to improvements in apparatus for drilling deep oil and gas wells.

In present day oil well completion practice, casing may be set at any desired level. For example, ten thousand feet. The drill string may be inserted through the interior of the casing to drill out the cement plug at the bottom and to drill additional "open hole" below the bottom of the casing into the oil sands. Fifteen hundred feet, for example, of such open hole may be required. It is highly desirable to drill as large a hole as practicable below the casing but under present completion practice the maximum size hole which may be drilled below the casing is limited by the maximum size bit which may be passed through the casing. In some locations it is relatively much more difficult to drill the fifteen hundred feet of small diameter open hole than to drill the ten thousand feet of large diameter hole to receive the casing.

It is the principal object of my invention to provide apparatus which may be inserted through casing and which will drill a relatively large hole below the casing.

Another object is to provide a novel form of mounting for the bit which will permit the device to drill a larger hole than the nominal size of the bit.

A more particular object is to provide a ball and socket mounting for a cone roller bit which enables the bit body to move universally in every direction with respect to the axis of the drill string.

Other and more detailed objects and advantages will appear hereinafter.

In the drawings:

Figure 1 is a diagrammatic view showing a well casing and illustrating the operation of drilling below the lower end of the casing.

Figure 2 is a sectional elevation showing a preferred embodiment of my invention, and taken substantially on the lines 2—2 as shown in Figure 3.

Figure 3 is a transverse sectional view taken substantially on the lines 3—3 as shown in Figure 2.

Figure 4 is a diagrammatic plan view showing the path of travel of certain elements on the bit.

Referring to the drawings:

The casing generally designated **10** extends into the well bore **11** and the lower end is sealed with respect to the formation by the annular cement body **12**. A rotary drill string **13** of conventional form is inserted into the casing at the surface. This drill string carries the bit assembly **14** at its lower end. The bit assembly **14** includes a hollow shank **15** provided with an upwardly extending threaded pin **16**. The threaded pin is received within a cooperating threaded socket provided on the lower end of the drill string. The shank **15** is provided with a recess **17** having a substantially spherical surface **18**.

A bit body **19** is formed with a ball element **20** on its upper end and the outer surface of this ball element is received in surface contact with the recess **17** in the

shank **15**. A pair of semi-circular split bushings **21** extend into the cylindrical portion **22** of the socket **17** and serve to maintain the ball element **20** in contact with the socket **17**. A spherical surface **23** is formed on each of the bushings **21** for contact with the ball element **20**. The body **19** has a cylindrical shank portion **24** connecting the ball element with the enlarged lower end of the body. This cylindrical neck **24** extends through an upwardly converging taper bore **25** provided by the cooperating bushing **21**. From this description it will be understood that the bit body is free to swing universally in every direction about the center of the ball element **20** and the extent of this movement is limited by contact of the cylindrical neck **24** with the conical bore **25**. The bushing **21** may be held in place by any convenient means such as, for example, welding **26**.

The roller cone elements **27** of the bit assembly are conventional in form and are mounted in the usual manner to rotate with respect to the bit body **19**. While I have shown three roller cones **27** in the drawings, it will be understood that a greater or smaller number can be employed as desired. The roller cones are disposed so that the shape of the bottom of the hole which they produce is convex at the center of the bored hole. An upward facing conical protuberance is formed at the bottom of the hole.

Means are provided for transmitting torque from the shank **15** to the body **19** and as shown in the drawings, this means includes a plurality of drive pins **28** fixed in the shank **15**. Each of these drive pins **28** includes a drive portion **29** which is square in cross section and which projects into one of several drive pockets **30** formed in the ball element **20**. Each of these drive pockets **30** has parallel walls **31** adapted for contact with the driving portion **29** of the pins **28**. Since the dimensions of the pockets **30** are larger than the dimensions of the drive portions **29** of the pins, the ball element **20** has universal movement within the socket **17** but is caused to rotate as a unit with the shank **15**.

An axial passage **32** in the shank **15** is aligned with an axial passage **33** in the body **19** and these passages serve to carry drilling fluid to the roller cones **27** and to carry the cuttings upward within the hole outside of the bit assembly. In operation, the bit device **14** is attached to the lower end of the drill string **13** and is lowered through the interior of the casing **10**. Turning movement of the drill string causes the bit assembly to drill out the cement plug at the bottom of the casing and to continue on into the formation. The ball and socket mounting for the bit body allows the bit to swing laterally to the extent shown by the dot and dash lines **34** of Figure 2. Actual tests show that the hole produced by the bit is larger than the nominal diameter of the bit. The bit swings crosswise from side to side from about the center of the ball **20**, while the bit is rotated by the drill string. The shank **15** turns on the axis of the drill string but the bit body **19** is free to swing universally within the angular limits imposed by the taper bore **25** of the bushing **21**. The extent of lateral movement permitted by the surface **25** and the length of the assembly from the imaginary center of the ball **20** to the lower end of the bit are such that the outermost cutting edge of the bit cones cannot pass beyond the center of the hole. The lateral swinging action of the body **19** while the body and shank **15** are rotating is caused by the action of the bit cones **27**. Should one cone be loaded heavier than the others, the resulting off-center force on the bit causes it to swing laterally to spread the load on the other cones, but such swinging movement in turn loads another cone beyond its proportionate share with the result that lateral swinging continues to cause precessional orbital movement of the cones as shown in Figure 4.

One of the advantageous features of my invention is that a relatively large threaded connection **16** may be used as compared to the diameter of the lower portion of the bit body **19**. It is well known that the lowermost threaded connection on the drill string, that is, the threaded connection between the drill collar and the bit, is subjected to the most severe stresses in service. The relatively large size pin connection is therefore highly desirable. Another beneficial feature of my invention is that relatively large cone elements **27** may be employed compared to the lateral dimensions of the bit body. Furthermore the lateral swinging action of the bit body as it rotates under power produces a novel cutting action in that the roller cones **27** do not merely revolve in circles but on the other hand follow the general pattern shown in Figure 4. Each roller cone in turn cuts to the full outside diameter and then to a lesser diameter during the operation of the bit. In the diagrammatic illustration of Figure 4, the full lines indicate the path of one of the bit cones, the dash lines indicate the path of another and the dot and dash lines indicate the path of a third. The outer circle in Figure 4 represents the outside diameter of the drilled hole. The unusual path of travel of these bit cones is derived from the universal swivelling mount provided by the ball and socket joint, together with the mounting of the bit cones to produce a high center drill hole.

I have found that it is practicable to permit sufficient lateral movement of the bit body **19** to enable the cones to produce a drill hole diameter of substantially larger diameter than the hole which is drilled when the bit body **19** is in vertical position, that is, when the vertical center line of the bit body is in vertical alignment with the vertical center line of the shank **15**. This position is shown in solid lines in Fig. 2 of the drawing.

Having fully described my invention it is to be understood that I do not wish to be limited to the details herein set forth but my invention is of the full scope of the appended claims.

I claim:

1. A drill bit assembly of the class described, comprising in combination: a shank, said shank having a socket formed in the lower end thereof, a bit body, a ball element at the upper end of said bit body, said ball element fitting within the socket for limited universal swivelling movement therein, torque transmitting means extending from the shank into the body whereby said shank rotates said body, said means including drive pins fixed on the shank and extending into said ball element, the ball element having recesses therein of larger diameter than the drive pins to receive the drive pins and permit universal movement of the bit body in the shank, a bushing fixedly mounted on the lower end of the shank, said bushing including a partial spherical seat engaging the ball element, roller cone elements mounted on the lower end of the body and disposed to produce a drill hole having a central raised protuberance, and means on the shank engageable by the bit body acting to limit the extent of universal swivelling movement about the vertical center of the ball element to prevent the outer edges of the bit elements from moving past the central vertical axis of the shank.

2. A drill bit assembly of the class described, comprising in combination: a shank, said shank having a socket formed in the lower end thereof, a bit body, a ball element at the upper end of said bit body, said ball element fitting within the socket for limited universal swivelling movement therein, torque transmitting means extending from the shank into the body whereby said shank rotates said body, said means including drive pins fixed on the shank and extending into said ball element, the ball element having recesses therein of larger diameter than the drive pins to receive the drive pins and permit universal movement of the bit body in the shank, a bushing fixedly mounted on the lower end of the shank, said bushing including a partial spherical seat engaging the ball element, roller cone elements mounted on the lower end of the body and disposed to produce a drill hole having a central raised protuberance, and means on the shank engageable by the bit body acting to limit the extent of universal swivelling movement about the vertical center of the ball element to prevent the outer edges of the bit elements from moving past the central vertical axis of the shank, said last named means on the shank including an outwardly tapered bore in the bushing, said body extending through the outwardly tapered bore.

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