May 6, 1952 J. MOON 2,595,401

DRILL HEAD

Filed Dec. 10, 1945 2 SHEETS—SHEET 1

Fig. 2.

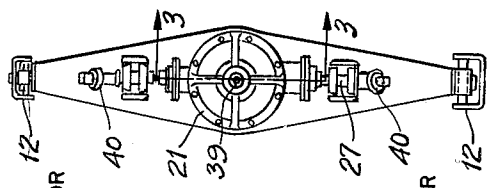
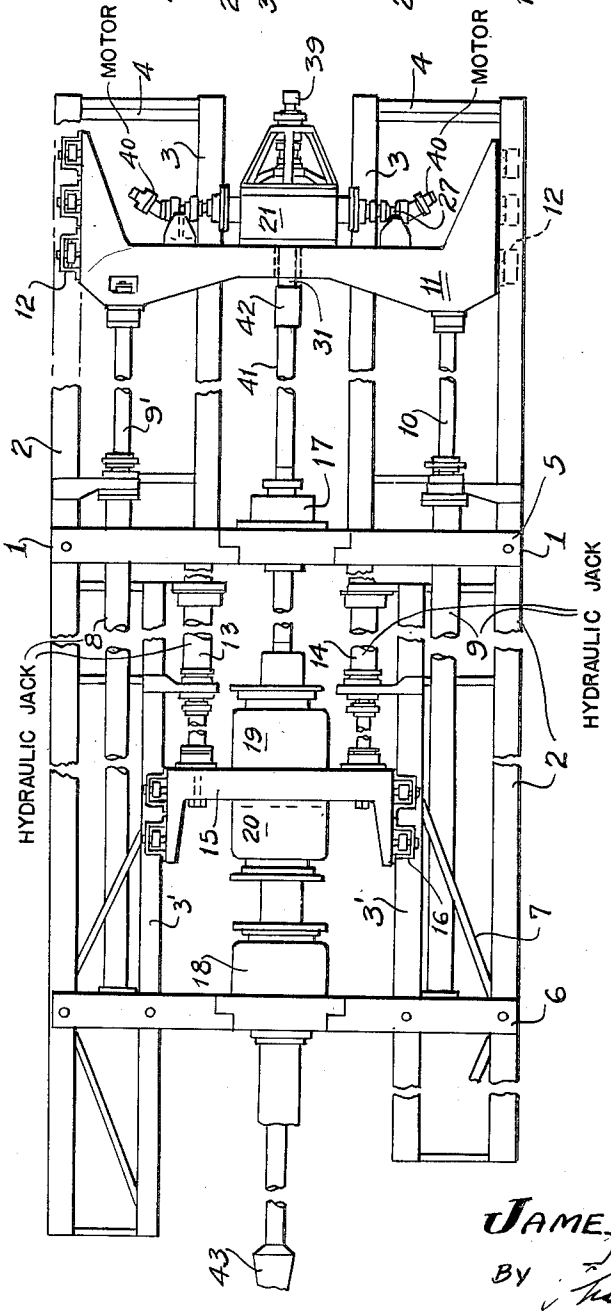


Fig. 1.



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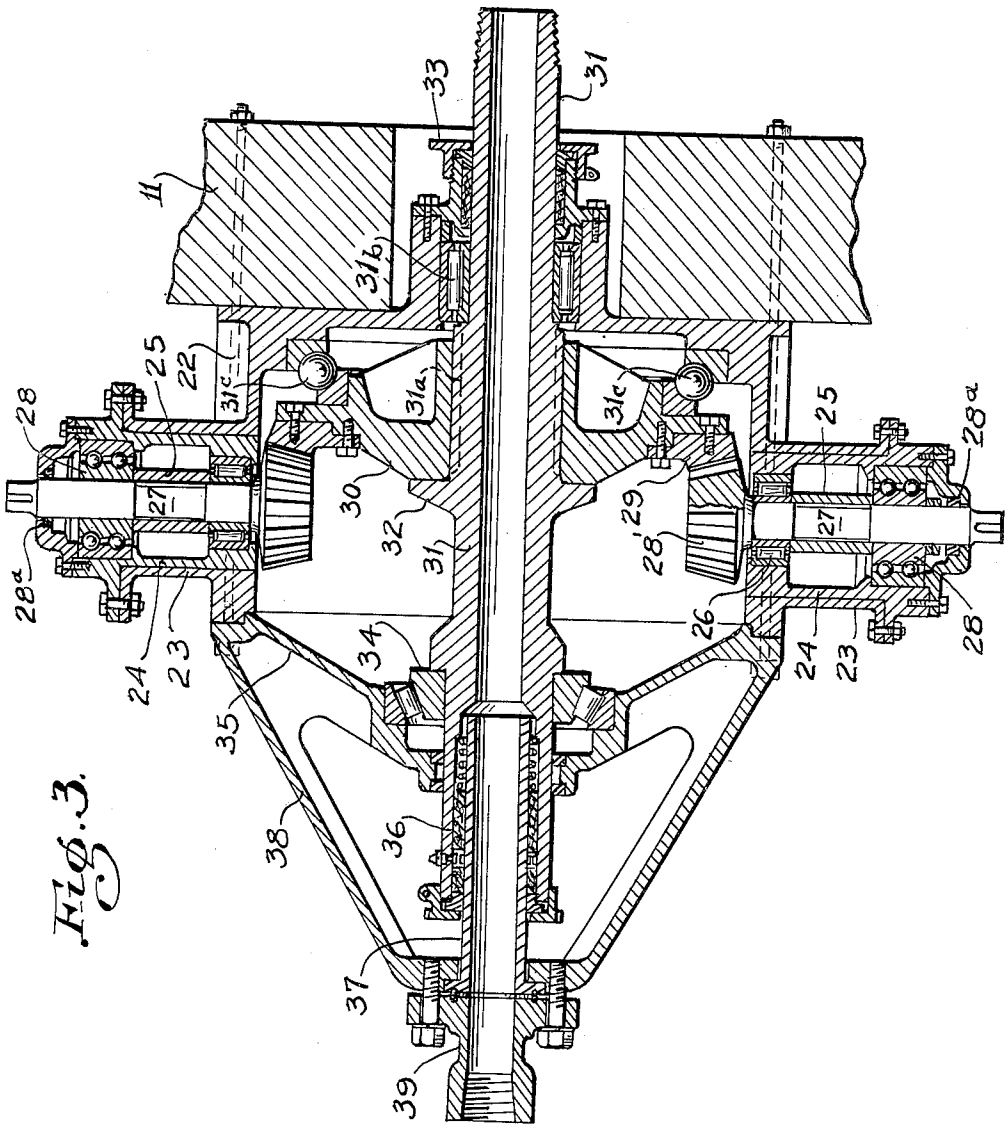


Fig. 3.

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UNITED STATES PATENT OFFICE

2,595,401

DRILL HEAD

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5 Claims. (Cl. 255—23)

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This invention relates to a combined drill head and motor assembly.

In conventional rotary assemblies for rotary drilling of bore holes for oil or gas wells, the drill pipe is rotated by and passed vertically through the rotary drill table. The drill pipe and casing is handled by the conventional drilling rig. A conventional swivel is employed for passage of mud fluid into the drill pipe.

It is an object of my invention to design a power operated drill head and swivel structure which may be mounted upon a power operated hoist and which will move together with the drill pipe as the drill pipe advances during drilling and will also function to rotate the drill pipe.

My drill head is particularly adapted for use with hydraulically operated jacks which are so mounted as to advance the drill pipe or casing into or withdraw drill pipe or casing from the bore hole.

It is a further object of my invention to design such a drill head wherein the motive power for rotation of the drill pipe may be mounted with the drill head and advance therewith, and to reduce the size of the power unit by employing a plurality of such power units.

It is an additional object of my invention to provide means for transmitting the power to the drill head through a plurality of shafts, each separately connected to a source of motive power mounted in association with said drill head.

It is a further object of my invention to so mount the drill stem in association with the drill head that the loads imposed longitudinally of the drill stem are not transmitted to the gear system by which the rotary power is transmitted from the shafts to the drill stem.

These and other objects of my invention will be better understood by reference to the accompanying drawings which illustrate a preferred embodiment of my invention, and in which:

Fig. 1 shows an assembly view showing the mounting of my drill head on a well bore drilling machine;

Fig. 2 is an end view of Fig. 1; and

Fig. 3 is a sectional view of my drill head taken along the line 3—3 of Fig. 2.

In Fig. 1 the drilling machine 1 includes braces 2 which also act as the longitudinal braces of the machine and the longitudinal braces 3. Transverse end braces 4 and transverse braces 5 and 6, and angular braces 7 are also provided at suitable places to impart rigidity to the structure.

Mounted on transverse brace 6 is a pair of hydraulic jacks 8 and 9. The cylinders are mounted on 6 and pass through the transverse brace 5. The jack piston rods 9' and 10 are connected to the yoke 11 which is mounted on rollers 12 adapted to roll on braces 2 which act as tracks.

Mounted on cross brace 5 and connected to brace 3' is a pair of hydraulic jacks 13 and 14. The jack piston rods are connected to yoke 15 which moves on rollers 16 guided on the braces 3' which act as tracks therefor.

Slips 17 are mounted on brace 5 and slips 18 on brace 6. Mounted on yoke 15 are the compound slips 19 and 20. Bolted to yoke 11 is the combination drill head and swivel assembly 21.

The drill head box 22 (see Fig. 3) carries the cylindrical journal boxes 23 in which are positioned the sleeves 24 carrying bearings 26 and 28. The bevel gear 28' is mounted on hollow shaft 27 in bearing 26. Shaft 27 is keyed in the tube 25 and mounted in bearing 28 and packed off at 28a. The shaft 31 is driven by a gear formed of a ring gear 29 mounted on a disc 30 which rotates on ball bearings 31c. The hollow shaft 31 is driven by 30 through the splines 31a in bearings 31b and is packed off at 33. The housing is bolted to 11 so that the drive shaft 31 is in axial alignment with the slips 17 and the drill pipe 41. The shaft 31 carries a load disc 32 abutting against 30. There is no rotational connection between 32 and 30 except through shaft 31 via splines 31a. The shaft 31 operates against a thrust bearing 34 mounted in the housing cover 35. Telescoping into shaft 31 and suitably packed by packing 36 is a stationary tube 37 carried on the spider 38 formed integrally with the cover 35. A flange connection 39 holds the tube 37 in the spider and in the packing.

Mounted on the yoke 11 (see Fig. 1) is a pair of power units 40 connected to the shafts 27. These power units may be a pair of electric motors, such as synchronous motors connected to a common supply of alternating current, or a pair of hydraulic motors connected in parallel to a common supply of fluid such as oil under pressure. Such hydraulic motors are well known and one example thereof is the type described in Patents No. 2,320,727 and No. 2,313,407. These motors have the characteristic such that for a given setting of the motor the speed is dependent on the volume of the applied fluid and so long as this volume is maintained constant for any motor setting, the speed of the motor remains constant.

Fig. 1 shows two such Vickers hydraulic motors mounted on the yoke 11 and connected, one each, to the shafts 27.

The use of such means of motive power with a plurality of gears 28' to drive the single gear 29, preferably spaced around said drive gear 29 and in mesh therewith, and each driven by a separate power shaft 27, has a number of advantages. It permits of the application of a large amount of power to the gear 29 while employing relatively small gears such as 28', and thus the size of the gear box may be kept small. This is highly desirable for a drill head which is to be mounted on the yoke 11. By placing a number of gears 28' and the associated power unit at various positions around the periphery of the gear 27, the size of each power unit can be minimized. Two such gears and power units are shown in Fig. 3. A larger number may be used. By using a multiplicity of small gears instead of a single gear, I am able to balance wear load on the gears 28' and the gears 29 so as to get uniform tooth wear. By using a multiplicity of gears we are able to apply a total drive load to gear 28' equal to the sum of the loads applied via each pinion gear. The total tooth pressure is held to the pressure applied by the pinions and will thus be materially less than the tooth pressure required to transmit the same load through one pinion gear.

Since, however, each gear 28' is operated from a separate power unit, I have found it desirable that the speed of all of the gears 28' be the same. Where all the gears 28' are the same size, this means that the shafts 27 should rotate at the same R. P. M.

Where these shafts are operated from different power units there is a danger that these speeds cannot be kept at the desired equal R. P. M. I have provided a simple means for obtaining this synchronized speed. Thus, by employing hydraulic motors such as described above and assuring, by proper manifolding, that the fluid pressure applied to each motor is the same and that the volume of fluid at such pressure is the same to each motor, I can be sure that the motors will rotate all shafts 27 at the same speed. This is accomplished by a balanced manifolding of the fluid inlets and outlets from the hydraulic motors and by adjusting the setting of the hydraulic motors. As an alternative I may employ, when space considerations permit, A. C. synchronous motors in parallel driven from the same source of A. C., so that each motor will turn at the same speed determined by the current characteristics in the feed line. In these manners, also, I may rotate all shafts 27 at the same speed.

The connection between shaft 31 and 30 forms a floating mounting of drive shaft 31. As shown in Fig. 3, any upward thrust of the spindle 31, occasioned as will be described below, will be transmitted to the thrust bearing 34 and will not be transmitted to the ring gear 29. This is caused by the spline connection 31*a* and the absence of any connection between 31 and 30 whereby any thrust toward bearing 34 is transferred to the disc 30. This is important since it assures that the alignment of the gears 28' and 29 will be unaltered notwithstanding the sudden and large variations in load which occur during drilling, as will be described below. Any upward thrust on the gear 29 will cause a jamming of the teeth of 29 into the teeth of 28 and thus cause an acceleration of wear and an excessive loading of gear 28.

Any reverse load on spindle 31 causes a pressure of the load disc 32 against the disc 30 which is transmitted to the bearings 31*c*. Additionally, any thrust load occurring during rotation of 29 by 28' is also taken up by 31*c*. In this manner

the relationship of the gears 29 and 28' remains unaltered notwithstanding any sudden and large variation of load on the spindle 31.

In operation, the yoke 11, being at its extreme position with piston rods 9' and 10 in full retard position and its extreme position near 5, the slips 17 are set to grip pipe 41 and the connection at 42 is broken. The rods 9' and 10 are extended to separate 11 from 5 and a section of pipe is introduced and connected to the drill pipe in slips 17 and to connection 42. Slips 17 are opened and again the pipe is advanced through the open slips 17 by attaching the piston rods 9' and 10. In this manner pipe is advanced until the drill 43 is in drilling position in the bore hole. Slips 17 are opened and 39 is connected to a hose for mud fluid. The power is connected to 40 and drilling is commenced. The gears 28' rotate 29 and this rotates the spindle 31 via the splines 31*a*. The tube 37 is stationary while 31 rotates. As drilling is continued the mud is circulated down 39 and through the swivel connection 37 through 31 and down the drill pipe, and returns up the bore hole outside the drill pipe.

In advancing the drill pipe by retracting the jack piston rods 9' and 10, during rotation of the pipe by means of 31 or with the rotation interrupted, the resistance to the advance of the drill pipe down the hole causes a thrust up the drill pipe and spindle 31 which is taken up by the thrust bearing 34 with the results described above.

When it is desired to withdraw the drill pipe from the bore, for example, when the drill is to be changed, the reverse procedure is followed. With the slips 17 open the piston rods 9' and 10 are extended. The slips 17 are set to grip pipe 41 and the joint 42 is broken and the pipe uncoupled above the slips 17. The loosened joint is removed. The rods 9' and 10 are retracted and the pipe in the slips 17 is joined to the spindle 31 by the joint 42. The slips 17 are freed and another joint of pipe 41 is withdrawn by extending the rods 9' and 10. In this manner the pipe may be withdrawn from the bore.

In thus operating, the resistance of the pipe, due to its weight and drag, causes a pull on the spindle 31 which is taken up in the bearings 31 with the results described above.

Provision is made in the drilling machine for introducing casing. With the drill pipe entirely withdrawn from the well, casing is run through the slips 19, 20, and 18, and with slips 19 set and 20 and 18 open, the casing is introduced into the well by jacks 13 and 14. In similar manner the casing may be withdrawn by opening slips 19 and 18 and setting slip 20.

While I have described a particular embodiment of my invention for the purpose of illustration, it should be understood that various modifications and adaptations thereof may be made within the spirit of the invention as set forth in the appended claims.

I claim:

1. A bore hole drilling head, comprising a hollow drill pipe drive shaft, means for connecting said drive shaft to drill pipe, a drive gear, a spline connection between said shaft and said drive gear, said shaft being driven by said gear through said spline connection, pinion gear in meshing engagement with said drive gear, a power shaft for said pinion gear, means for transferring the axial load on said drive shaft to said gear in one axial direction only, said means including a load disc on said drive shaft abutting the side of

said drive gear between said gear and said thrust bearing, the shaft being mounted for relatively free movement in said gear in the opposite axial direction, and a thrust bearing for said gear mounted against the opposite side of said drive gear.

2. A bore hole drilling head, comprising a hollow drill pipe drive shaft, means for rigidly connecting said drive shaft to said drill pipe, a drive gear, a spline connection between said shaft and said drive gear, said shaft being driven by said gear through said spline connection, a plurality of pinion gears peripherally spaced around said drive gear and each in meshing relation with said drive gear, a drive shaft for each pinion gear, a thrust bearing for said drill pipe drive shaft, means for transferring the axial load on said drive shaft to said gear in one axial direction only, said means including a load disc on said shaft abutting the side of said drive gear between said gear and said thrust bearing, the shaft being mounted for relatively free movement in said gear in the opposite axial direction, and a thrust bearing for said gear mounted against the opposite side of said drive gear.

3. A drill head adapted for rotating and advancing and lowering of drill pipe into and from bore holes for wells drilled in the earth, which comprises a housing, a hollow drive shaft in said housing, means for rigidly connecting said drive shaft to said drill pipe, a drill pipe advancing and withdrawing means, means for mounting said housing on said advancing and withdrawing means with said hollow drive shaft in axial alignment with the drill pipe, a drive gear in said housing, a spline connection between said drive shaft and said drive gear, a pinion gear in said housing in mesh with said drive gear, means for transferring the axial load on said drive shaft to said gear in one axial direction only, said means including a thrust bearing for said shaft mounted on said housing, a load disc on said hollow shaft abutting said drive gear and mounted on said shaft between said drive gears and said thrust bearing, the shaft being mounted for relatively free movement in said gear in the opposite axial direction, and a thrust bearing in said housing mounted on the opposite side of said gear.

4. A drill head adapted for rotating and advancing and lowering of drill pipe into and from bore holes for wells drilled in the earth, which

comprises a housing, a hollow drive shaft in said housing, means for rigidly connecting said drive shaft to said drill pipe, a drill pipe advancing and withdrawing means, means for mounting said housing on said advancing and withdrawing means with said hollow drive shaft in axial alignment with the drill pipe, a drive gear in said housing, a spline connection between said drive shaft and said drive gear, a plurality of pinion gears peripherally spaced about said drive gear in meshing relation therewith, a thrust bearing for said shaft mounted on said housing, means for transferring the axial load on said drive shaft to said gear in one axial direction only, said means including a load disc on said hollow shaft abutting said drive gear and mounted on said shaft between said drive gear and said thrust bearing, the shaft being mounted for relatively free movement in said gear in the opposite axial direction, and a thrust bearing in said housing mounted on the opposite side of said gear.

5. In a power transmission device, a drive shaft, means for connecting said drive shaft to drill pipe, a drive gear, a spline connection between said shaft and said drive gear, said shaft being driven by said gear through said spline connection, pinion gear in meshing engagement with said drive gear, a power shaft for said pinion gear, a thrust bearing for said drive shaft, means for transferring the axial load on said drive shaft only in one axial direction to said gear, said means including a load disc on said drive shaft abutting the side of said drive gear between said gear and said thrust bearing, the shaft being mounted for relatively free movement in said gear in the opposite axial direction, and a thrust bearing for said gear mounted against the opposite side of said drive gear.

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