

May 11, 1965

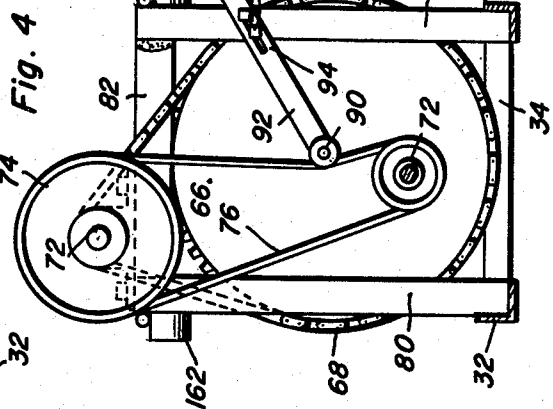
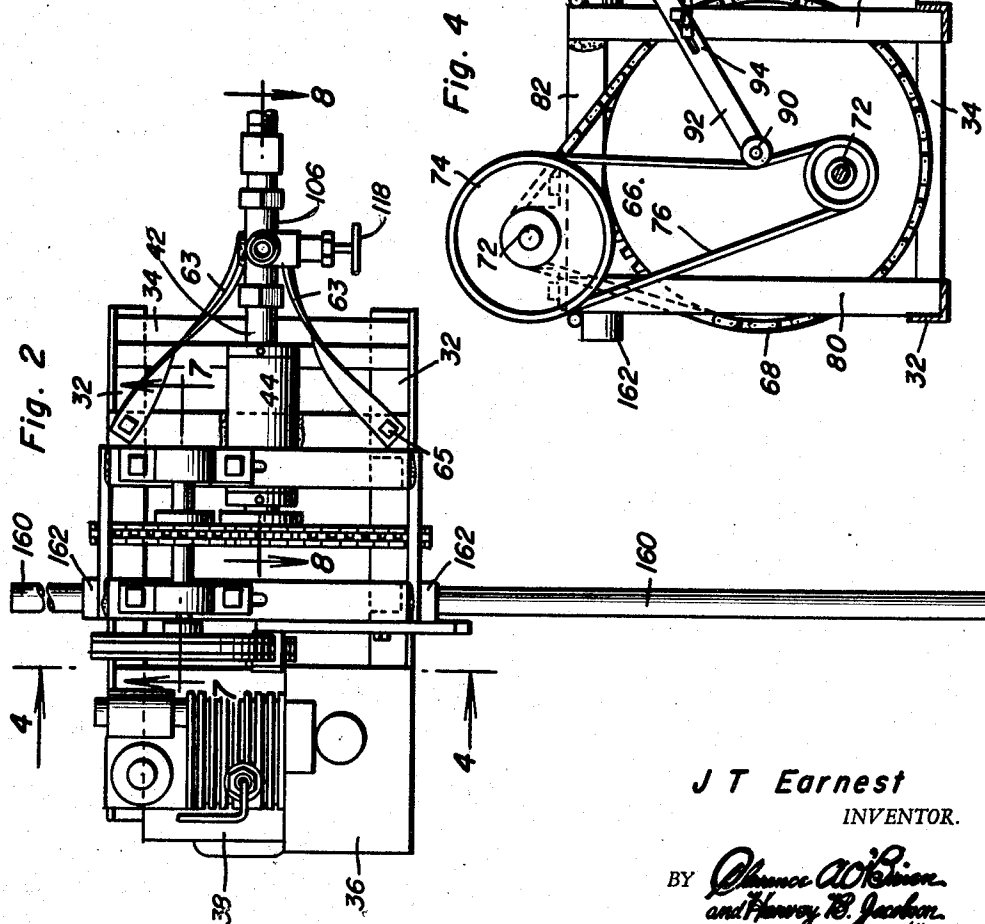
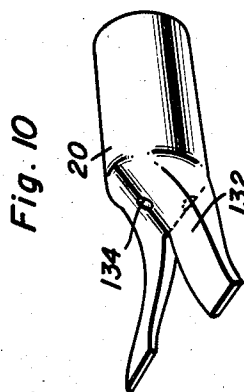
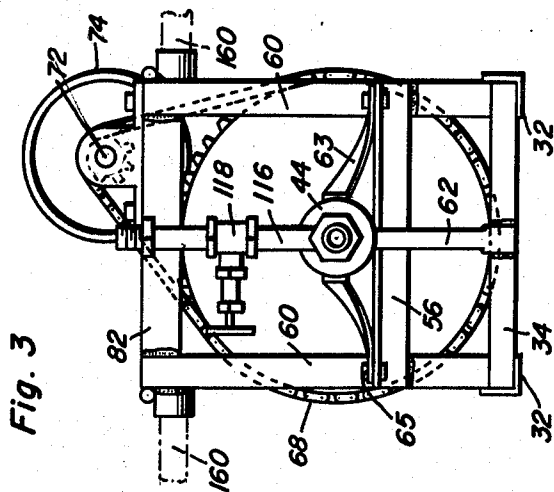
J T EARNEST

3,182,732

HORIZONTAL EARTH BORING MACHINE

Filed July 23, 1962

3 Sheets-Sheet 2



J T Earnest

INVENTOR.

BY *Chance A. Olson*
and *Harvey B. Jacobson*
Attorneys

May 11, 1965

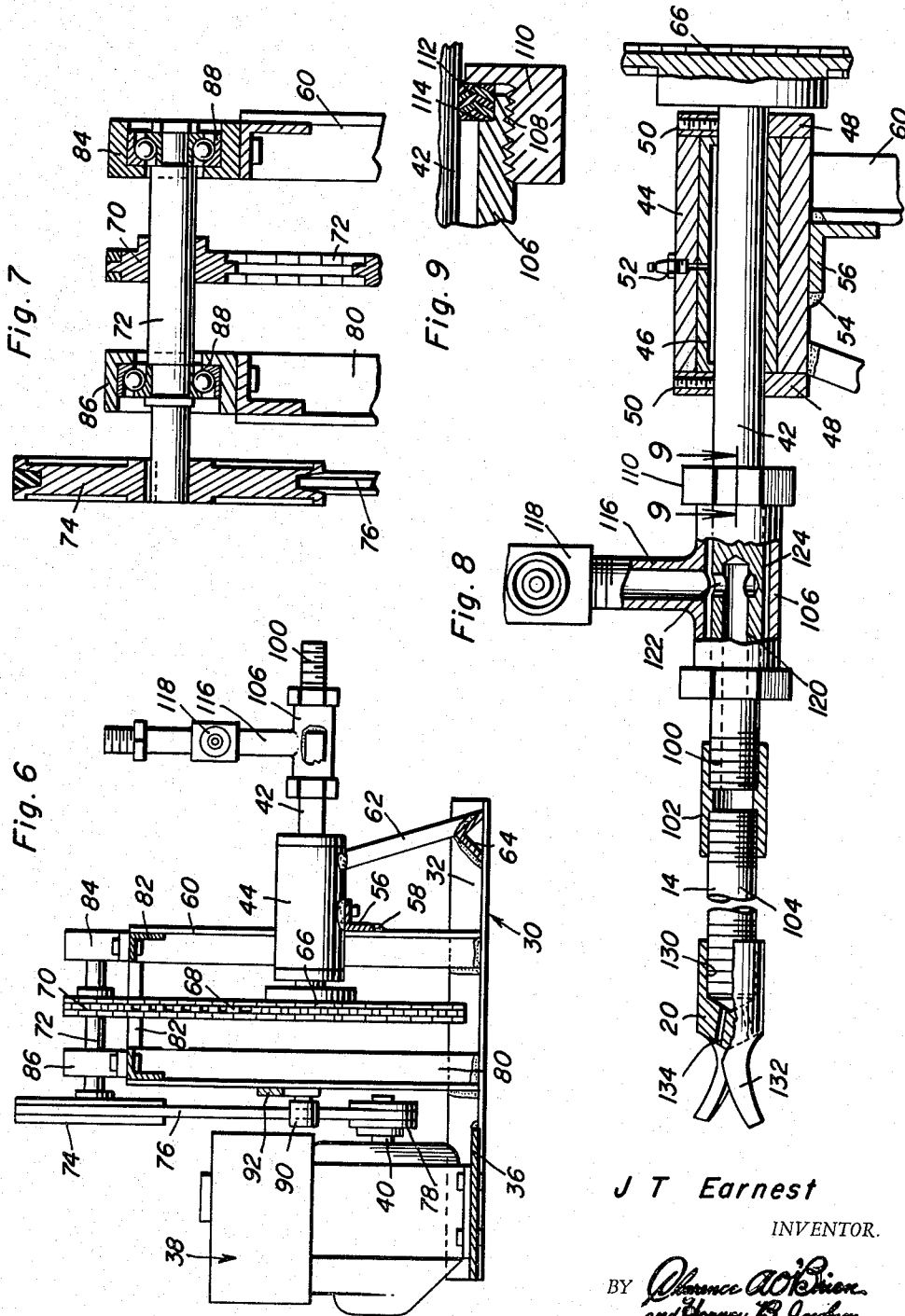
J T EARNEST

3,182,732

HORIZONTAL EARTH BORING MACHINE

Filed July 23, 1962

3 Sheets-Sheet 3



J T Earnest

INVENTOR.

BY *Clarence A. O'Brien*
and Harvey B. Jackson
Attorneys

1

3,182,732
HORIZONTAL EARTH BORING MACHINE
J T Earnest, 14th Ave., Jasper, Ala.
Filed July 23, 1962, Ser. No. 211,571
11 Claims. (Cl. 173-57)

This invention comprises a novel and useful horizontal earth boring machine and more particularly pertains to a portable drilling apparatus adapted to be readily carried and maneuvered by two men and specifically designed to effectively drill horizontal bores of considerable length under the surface of the ground.

It is frequently desirable to quickly effect the boring of a passage or tunnel beneath the surface of the ground in a horizontal direction for a considerable distance, as for example underneath road beds or the like. Conventional power operating equipment for effecting horizontal drilling is usually expensive, bulky in size and requires considerable time to bring it to the location desired, arrange the equipment for drilling and then drill the desired horizontal passage.

It is therefore the primary purpose of this invention to provide a relatively lightweight inexpensive and readily portable apparatus which may be quickly and easily and with a minimum of manpower be utilized to effect the drilling of relatively long horizontal bores below the surface of the ground.

A further object of the invention is to provide a horizontal drilling apparatus of a portable nature which will include a portable supporting frame readily carried by and manipulated by two men and upon which is mounted the power plant, a drilling spindle and a reduction gearing assembly connecting the plant and the spindle.

A further object of the invention is to provide a portable drilling apparatus in accordance with the preceding objects which shall have a pair of oppositely projecting support handles each adapted to be carried and supported by a man on opposite sides of the device and which handles are positioned closely adjacent to the center of gravity of the device to thereby facilitate ready maneuvering of the device in preparation for and during a drilling operation.

A further object of the invention is to provide an improved portable drilling apparatus in accordance with the preceding objects wherein an exceptionally sturdy and rugged frame structure shall be provided to effect the mounting and journalling of a reduction gear assembly connecting the power plant to the drill spindle, and will adequately journal and support the latter despite the considerable side thrust which may be imparted to the spindle during the drilling operation.

Still another object of the invention is to provide a device in accordance with the preceding objects in which provision is made for supplying a stream of water under pressure through the drill string to the drill bit for supplementing the action of the latter by removing and excavating the material from the bore or passage to be drilled.

A still further object of the invention is to provide a device in accordance with the preceding objects wherein the power operated drilling spindle on the support frame includes means for effecting the introduction of water under pressure into the drilling string attached to the spindle.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

FIGURE 1 is an elevational view partly in vertical section illustrating the manner in which the portable drill-

2

ing apparatus of this invention is utilized to effect the drilling of a horizontal bore or passage below the surface of the ground, part of the drilling string being broken away;

FIGURE 2 is a top plan view of the drilling apparatus, one of the support handles being broken away;

FIGURE 3 is an end elevational view of the drilling apparatus of FIGURE 2 taken from the right end thereof;

FIGURE 4 is a detail view in a vertical transverse section taken substantially upon the plane indicated by section line 4-4 of FIGURE 2 and showing in particular a power control clutch associated with the gear reduction assembly of the apparatus;

FIGURE 5 is a view in side elevation of the apparatus of FIGURE 2;

FIGURE 6 is a view in side elevation taken from the other side of the apparatus from that of FIGURE 5;

FIGURE 7 is a detail view in vertical longitudinal section taken substantially upon the plane indicated by section line 7-7 of FIGURE 2 and showing in particular the mounting of the lay shaft forming a part of the gear reduction assembly of the device;

FIGURE 8 is a further detail view in vertical longitudinal section taken upon an enlarged scale substantially upon a plane indicated by section line 8-8 of FIGURE 2, parts being broken away, and illustrating details of the bearing sleeve for journalling the drill spindle and the water supplying means associated therewith, a midportion of the drilling string being broken away;

FIGURE 9 is a further detail view in vertical longitudinal section taken upon an enlarged scale substantially upon the plane indicated by section line 9-9 of FIGURE 8;

FIGURE 10 is a perspective view of an initial or pilot form of drill bit which is employed with the apparatus;

FIGURE 11 is a detail view in vertical section showing the manner in which a replacement bit is provided for the purpose of enlarging an initially drilled horizontal bore by effecting a back flow of water and a reverse movement of the drilling string therethrough; and

FIGURE 12 is a perspective view of the modified reamer type of drill bit employed in FIGURE 11.

Referring first to FIGURE 1 it will be observed that the numeral 10 designates generally the portable drilling apparatus in accordance with this invention, the apparatus being shown as supplied with water as a drilling fluid by means of a flexible hose or conduit 12 which may be a garden hose or the like and having an extensible hollow drilling string 14 connected to and driven by the apparatus for effecting the formation of a horizontal bore or passage 16 beneath the surface of the soil 18. It may be here understood that a relatively short first hollow section of drill string may be connected to the apparatus for initiating the drilling operation so that the apparatus may be used in relatively confined quarters as for example when it is desired to tunnel underneath the road bed from a ditch on either side thereof. As the drilling operation progresses additional sections of the drilling string are added, the entire drilling string being rotated by the apparatus and advanced forwardly under the surface of the ground until the bore 16 is completed. In FIGURE 1, however, there is illustrated the use of the apparatus for effecting a horizontal bore for which it is necessary to initiate the drilling operation from the surface. Under this condition, there is shown a shallow excavation 19 such as trench, pit or the like which is cut downwardly to a depth sufficient to enable the end of the drill to be applied against the earth at the desired location and thus begin the horizontal passage therethrough.

In a manner to be set forth hereinafter, the drilling operation may be effected in either a single stage or in two stages. Thus, if the diameter of the bore 16 of the drill is not too great, a drill 20 of sufficient size and preferably

3

of the type shown in FIGURE 10 is attached to the end of the drill string and as the latter is moved forward this drill penetrates the soil and forms the desired horizontal bore 16. However, if it is desired to produce a tunnel or passage of a greater size than is practical for the excavation by a single drill bit 20, then the operation is preferably performed as a two stage operation. First, the passage is drilled to its desired length and destination under the soil, through the use of the drill bit 20. When this passage is completed, the drill bit 20 is removed and a reamer bit of a particular construction indicated generally by the numeral 22 and which is shown in FIGURES 11 and 12 is then attached to the drill string in place of the drill bit 20. Thereupon, the drill is then started and the drill string is pulled in a reverse direction through the bore with the reamer bit 22 enlarging the bore to the desired diameter. During this operation successive sections of the drill string are removed as the drill is retracted through the bore in the reverse direction until the bore has been completely reamed out to the desired size.

Referring now primarily to FIGURES 2, 5 and 6 it will be observed that the drilling apparatus 10 consists of a supporting frame of a lightweight and readily portable character. Thus, the frame includes a platform or base 30 which may conveniently comprise a pair of conventional angle members 32 formed on the opposite sides of the base and which are rigidly connected together by suitable cross members 34 rigidly secured and extending therebetween. Mounted upon this base at one end as upon a cross plate 36 thereon is a power plant 38 which may conveniently consist of a lightweight gasoline engine. Obviously, however, an electric motor may be utilized in lieu of the gasoline engine. The power plant includes a driving shaft 40 by means of which its power output is transmitted to the drilling string in a manner to be subsequently described.

At the opposite end of the base 30 from the power plant there is rotatably supported and journaled a drill spindle 42. For this purpose there is provided a bearing sleeve 44, see also FIGURE 8, there being a suitable journal bearing 46 disposed in the sleeve and retained therein as by means of the end plates 48 which are detachably secured to the spindle 42 as by set screws 50. The end plates thus serve to close the ends of the bearing sleeve 44 and retain the bearing journal 46 therein, and a conventional lubricant supply means indicated by the nipple 52 may be utilized to supply the necessary lubricant to this bearing. The bearing sleeve 44 is secured as by welding 54 to a transversely extending angle member 56, which latter in turn is secured as by welding 58 at its ends to a pair of vertical standards 60 rising from the side frame members 32. Further brace means are provided for assuring a rigid fixed support of the bearing sleeve 44 upon the base. Thus, a strut 62 is secured to a transverse angle member 64 at that end of the base 30 and to the underside of the bearing sleeve 44 by means of welding or the like.

The drill spindle 42 extends completely through the bearing sleeve and upon its extremity which is adjacent to the power plant it is provided with a sprocket gear 66 over which is entrained a sprocket chain 68 which is driven by a sprocket 70 carried upon a lay shaft 72. The lay shaft in turn is connected by a belt and pulley drive to the power plant, having a driven pulley 74 thereon which is connected by the driving belt 76 to the driving pulley 78 of the power output shaft 40 of the power plant.

The support frame further includes means for supporting the reduction gearing assembly just described. Thus, in addition to the two standards 60, there is provided a second pair of standards 80 welded or otherwise secured to the side frame members 32 adjacent the power plant. At their upper ends, the standards are rigidly secured to each other by appropriate angle members 82 to provide a rectangular supporting framework. A pair of journal bearings 84 and 86 are mounted upon the frame members 82 at the upper ends of the support standards 60 and 80

4

respectively as shown in FIGURE 7 and receive therein roller bearing assemblies as at 88 by means of which the lay shaft 72 is rotatably journaled and secured in place in a generally parallel relation to the horizontal axes of the power take-off shaft 40 of the power plant and the spindle 42 of the drill string.

It will be observed that the sprocket chain which constitutes a direct positive drive between the lay shaft and the spindle extends downwardly within the support structure 60, 82 and between the spindle and the power plant. The belt and pulley drive however lies outside of this support structure and is disposed between the power plant and the support standards 80. The belt and pulley drive may also be adapted to constitute a clutch mechanism for controlling the application of the power from the power plant to the spindle. Thus, as shown best in FIGURE 4, the belt 76 may be sufficiently loose to have slack therein and an idler pulley 90 journaled upon a clutch lever 92 is adapted to engage the belt and by varying the slack renders the pulley drive operative or inoperative as desired. The clutch lever is provided with a longitudinal extending slot 94 therein through which pass a pair of fastening bolts or the like 96 by which this lever is secured to one of the support posts 80. The lever is thus manually adjusted to vary the tension of the belt and thus control or vary the connection of the power plant to the spindle.

The drill spindle 42 provides a detachable connection to the adjacent section of the drill string 14. Thus, as shown in FIGURES 5 and 8, the outer extremity of the spindle 42 is externally threaded as at 100 to receive the internally threaded nipple or coupling 102 by means of which the adjacent section 104 of the drill string is detachably connected to the spindle. As will be appreciated, successive sections of the drill string are connected to each other by corresponding couplings 102 to provide the desired length of drill string with the drill bit 20 or 22 being detachably connected to the open end of the outermost section of the drill string.

In addition to its function as providing a readily engageable and disengageable driving member for the drill string, the spindle also serves as a means to effect the introduction of drilling fluid thereto. Thus, there is provided a sleeve 106, see FIGURES 8 and 9 in particular, which loosely encircles the drill spindle 42. This sleeve is externally threaded as at 108 at its opposite extremities to receive packing glands 110 thereon which serve to retain packings 112 tightly compressed between the spindle and a cooperating annular shoulder 114 which is counter-bored in the interior of the sleeve 106 as shown in FIGURE 9. Thus a fluid tight rotatable seal is established between the sleeve 106 and the drill spindle 42 passing therethrough.

The sleeve has a tubular neck 116 projecting laterally from a mid-portion thereof and the interior of this neck is in continuous communication with the interior of the sleeve. By means of the manually operated valve member 118 of any conventional design, the previously mentioned water conduit or hose 12 is connected to and the supply of water therefrom to the sleeve is thus controlled.

The outer end of the spindle is provided with an axial bore or passage 120 therethrough and lateral bores 122 continuously connect this passage with the interior of the sleeve and the annular space 124 therein disposed between the spindle and the sleeve and the inlet passage of the tubular portion 116.

Referring now to FIGURES 8 and 10 in particular it will be observed that the drill bit 20 provided for forming bore 16 during the initial drilling operation as the drill string is advanced into the bore is internally threaded as at 130 for detachable connection to the extremity of the outermost section 104 of the drill string. This drill bit is provided with any suitable type of cutting blades 132 and there are provided passages or orifices 134 connecting the interior of the drill string with the exterior

5

of the drill bit closely adjacent the blades 132. The arrangement is such that as suggested in FIGURE 1, as the rotating drill string is advanced into the bore 16, the flow of water under pressure therethrough will soften the ground in advance of the drill bit and assist in excavating and removing this material, with the flow of water being then rearwardly from the drill bit and bore 16 into the sump provided by the trench or excavation 19.

In this manner it will be apparent that by merely advancing manually the drill string, and adding additional sections of drill string thereto as necessary, a horizontal bore may be readily advanced for a considerable distance, as for example 200 feet or more beneath the surface of the ground in a horizontal manner. After the bore is completed, if it is of sufficient size operation may then be discontinued and the bore placed into desired use. On the other hand, if it is desired to produce a larger bore so that the bore thus drilled is merely a pilot bore for that purpose, the drill bit 20 is removed and the bit 22 is applied in place thereof upon the drill string. As shown best from FIGURE 12, the bit 22 is a reverse action reamer bit. It includes a sleeve 140 which is internally threaded for engagement upon the end of the outermost drill string section in the same manner as the bit 20, but is closed at its outer end as by an end wall or plug 142. It is provided with plates 144 secured as by welding to its outer surface and continuing longitudinally thereof, to which plates there are removably secured as by fastening bolts 146 cutter elements in the form of plates 148 having cutting edges 150 on their inward surfaces. The arrangement is such that once this reamer-type of bit is applied to the drill string 14, the latter may be retracted through a previously formed bore 16, in the direction indicated by the arrow 152 in FIGURE 11, and thus will ream out or enlarge the pilot bore to the desired size. During this operation, the flow of water through the drill bit may be continued in the manner previously described, emerging from the bit 22 by suitably located apertures, not shown, and collecting in the pit 19. On the other hand, it may be preferred to effect the reaming operation without the flow of water in some instances.

In order to more easily manipulate the drill apparatus, there is secured to the support frame a pair of oppositely projecting aligned handles 160. Conveniently, these handles may be detachably secured in sockets 162 which latter are secured to and project laterally from the vertical support standards 80 adjacent the power plant. In any event, the location of these handles is such that they are positioned to support the apparatus at a proximate center of gravity to permit easy tilting of the apparatus about the handles when the latter are carried by two men, one on each side of the apparatus. Thus, the apparatus will be readily lifted, tilted about the horizontal transverse axis of the handles to position the drill spindle and the attached drill bit or drilling string at the desired angle for penetration of the soil, as suggested in FIGURE 1 and for forwardly advancing or rearwardly retracting the drill string during the previously mentioned drilling operations.

As will be understood, the strut 62 braces the spindle bearing sleeve against vertical upward or downward movement relative to the base 30. Additional rigidity against lateral deflection, when desired, is obtained by the braces 63, each of which may be formed by a strap of metal, twisted about its longitudinal axis as shown in FIGURES 2, 3 and 5. The outer ends of the straps are secured as by welding to the opposite sides of the sleeve 44 while their inner ends are detachably fastened by bolts 65 to the opposite ends of the cross member 56. In this manner, the bearing sleeve 44 is rigidly secured against either vertical or lateral displacement relative to the support frame, an essential condition necessary to withstand the

6

strains and rough handling incident to a manually portable apparatus.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. A manually portable power operated horizontal drilling apparatus comprising a supporting frame with support means attached thereto, a source of power mounted upon said frame and including a generally horizontal rotatable power shaft, a drill spindle, said power shaft and drill spindle having longitudinally spaced adjacent ends, means supporting and journaling said spindle upon said frame for rotation about an axis in side-by-side relation and generally parallel to that of said power shaft, a reduction gear assembly connecting said adjacent ends, said spindle having a passage extending longitudinally thereinto from said spindle adjacent end and terminating inwardly of the other spindle end, a water jacket comprising a hollow body surrounding said spindle in sealed engagement therewith and defining a water chamber thereabout, means establishing continuous communication between said passage and water chamber, means supplying water into said water chamber, a hollow drill string secured to and driven by said spindle and having communication with said spindle passage, a drill bit including jet orifices secured to the outer end of said drill string, said drill string having sufficient lateral flexibility to enable said drill bit and drill string to operate in a substantially horizontal position below ground when said power shaft is positioned substantially horizontally above ground and while said apparatus is being manually supported and moved along the general direction of said drill string, said water jacket being spaced from and lies between said spindle adjacent end and said spindle supporting and journaling means.

2. A manually portable power operated horizontal drilling apparatus comprising a supporting frame with support means attached thereto, a source of power mounted upon said frame and including a generally horizontal rotatable power shaft, a drill spindle, said power shaft and drill spindle having longitudinally spaced adjacent ends, means supporting and journaling said spindle upon said frame for rotation about an axis in side-by-side relation and generally parallel to that of said power shaft, a reduction gear assembly connecting said adjacent ends, said spindle having a passage extending longitudinally thereinto from said spindle adjacent end and terminating inwardly of the other spindle end, a water jacket comprising a hollow body surrounding said spindle in sealed engagement therewith and defining a water chamber thereabout, means establishing continuous communication between said passage and water chamber, means supplying water into said water chamber, a hollow drill string secured to and driven by said spindle and having communication with said spindle passage, a drill bit including jet orifices secured to the outer end of said drill string, said drill string having sufficient lateral flexibility to enable said drill bit and drill string to operate in a substantially horizontal position below ground when said power shaft is positioned substantially horizontally above ground and while said apparatus is being manually supported and moved along the general direction of said drill string, said frame including a base and a support structure mounted upon and rising from a mid-portion of said base, said power source being mounted on said base and said spindle being mounted on said support structure on the opposite side thereof from said power source.

3. A manually portable power operated horizontal

7

drilling apparatus comprising a supporting frame with support means attached thereto, a source of power mounted upon said frame and including a generally horizontal rotatable power shaft, a drill spindle, said power shaft and drill spindle having longitudinally spaced adjacent ends, means supporting and journaling said spindle upon said frame for rotation about an axis in side-by-side relation and generally parallel to that of said power shaft, a reduction gear assembly connecting said adjacent ends, said spindle having a passage extending longitudinally thereinto from said spindle adjacent end and terminating inwardly of the other spindle end, a water jacket comprising a hollow body surrounding said spindle in sealed engagement therewith and defining a water chamber thereabout, means establishing continuous communication between said passage and water chamber, means supplying water into said water chamber, a hollow drill string secured to and driven by said spindle and having communication with said spindle passage, a drill bit including jet orifices secured to the outer end of said drill string, said drill string having sufficient lateral flexibility to enable said drill bit and drill string to operate in a substantially horizontal position below ground when said power shaft is positioned substantially horizontally above ground and while said apparatus is being manually supported and moved along the general direction of said drill string, said spindle supporting and journaling means is mounted upon said support structure and extends both inwardly and outwardly thereof, brace members upon the exterior of said support structure connecting said spindle supporting and journaling means to said base.

4. The combination of claim 3 further including brace means connecting opposite sides of said water jacket body to said support structure, said body being supported directly by said spindle.

5. A manually portable power operated horizontal drilling apparatus comprising a supporting frame with support means attached thereto, a source of power mounted upon said frame and including a generally horizontal rotatable power shaft, a drill spindle, said power shaft and drill spindle having longitudinally spaced adjacent ends, means supporting and journaling said spindle upon said frame for rotation about an axis in side-by-side relation and generally parallel to that of said power shaft, a reduction gear assembly connecting said adjacent ends, said spindle having a passage extending longitudinally thereinto from said spindle adjacent end and terminating inwardly of the other spindle end, a water jacket comprising a hollow body surrounding said spindle in sealed engagement therewith and defining a water chamber thereabout, means establishing continuous communication between said passage and water chamber, means supplying water into said water chamber, a hollow drill string secured to and driven by said spindle and having communication with said spindle passage, a drill bit including jet orifices secured to the outer end of said drill string, said drill string having sufficient lateral flexibility to enable said drill bit and drill string to operate in a substantially horizontal position below ground when said power shaft is positioned substantially horizontally above ground and while said apparatus is being manually supported and moved along the general direction of said drill string, said frame including a base with a support structure mounted thereon and rising from a midportion thereof, said adjacent ends being disposed at the lower portion of said support structure adjacent said base with one of said spindle adjacent ends extending into said support structure, said reduction gear assembly being carried by said frame and including a lay shaft mounted upon the top of standards and having its ends each overlying one of said adjacent ends, first and second means connecting each of the opposite ends of said lay shaft to one of said adjacent ends.

8

6. The combination of claim 5 wherein said first means is disposed within said standards and drives said spindle and said second means is exterior of said standards and connects said power source and lay shaft.

7. The combination of claim 6 wherein one of said first and second means includes a belt and pulley drive, a belt tensioning device mounted on said support structure and connected to said belt and pulley drive and constituting a clutch device controlling the delivery of power from said power source to said spindle.

8. A manually portable power operated horizontal drilling apparatus comprising a supporting frame with support means attached thereto, a source of power mounted upon said frame and including a generally horizontal rotatable power shaft, a drill spindle, said power shaft and drill spindle having longitudinally spaced adjacent ends, means supporting and journaling said spindle upon said frame for rotation about an axis in side-by-side relation and generally parallel to that of said power shaft, a reduction gear assembly connecting said adjacent ends, said spindle having a passage extending longitudinally thereinto from said spindle adjacent end and terminating inwardly of the other spindle end, a water jacket comprising a hollow body surrounding said spindle in sealed engagement therewith and defining a water chamber thereabout, means establishing continuous communication between said passage and water chamber, means supplying water into said water chamber, a hollow drill string secured to and driven by said spindle and having communication with said spindle passage, a drill bit including jet orifices secured to the outer end of said drill string, said drill string having sufficient lateral flexibility to enable said drill bit and drill string to operate in a substantially horizontal position below ground when said power shaft is positioned substantially horizontally above ground and while said apparatus is being manually supported and moved along the general direction of said drill string, said water jacket body having its opposite ends disposed between and in spaced relation to said spindle supporting and journaling means and the end of said spindle to which said drill string is connected.

9. The combination of claim 8 wherein said water jacket body comprises a T-fitting including a sleeve with a tubular neck projecting laterally from intermediate its ends, said water supply means including said tubular neck, sealing means with each end of said sleeve engaging and having a fluid-tight seal with the exterior surface of said spindle.

10. The combination of claim 9 wherein said means establishing communication between said spindle passage and said water chamber comprise a plurality of ports in said spindle.

11. The combination of claim 5 wherein said support means comprise a pair of laterally and oppositely projecting handles secured to the upper portion of said support structure and adjacent the center of gravity of the apparatus.

References Cited by the Examiner

UNITED STATES PATENTS

1,377,575	5/21	Greve	173—163 X
1,704,053	3/29	Miller	173—57
2,016,667	10/35	Crowell	173—31
2,027,063	1/36	Reifel	173—51 X
2,136,152	11/38	Parrish	173—163 X
2,598,565	5/52	Lagant	173—170 X
2,697,457	12/54	Lawrence	173—170 X
2,919,899	1/60	Hitchcock	173—57 X

BROUGHTON G. DURHAM, *Primary Examiner.*

C. O'CONNELL, *Examiner.*