

Nov. 28, 1967

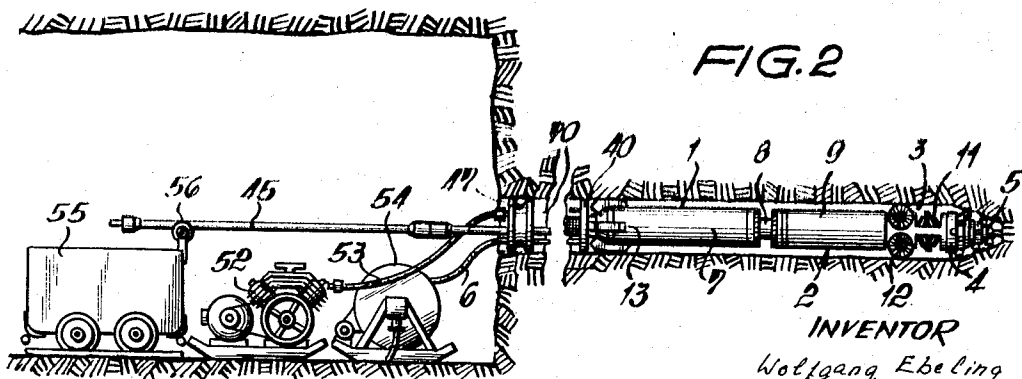
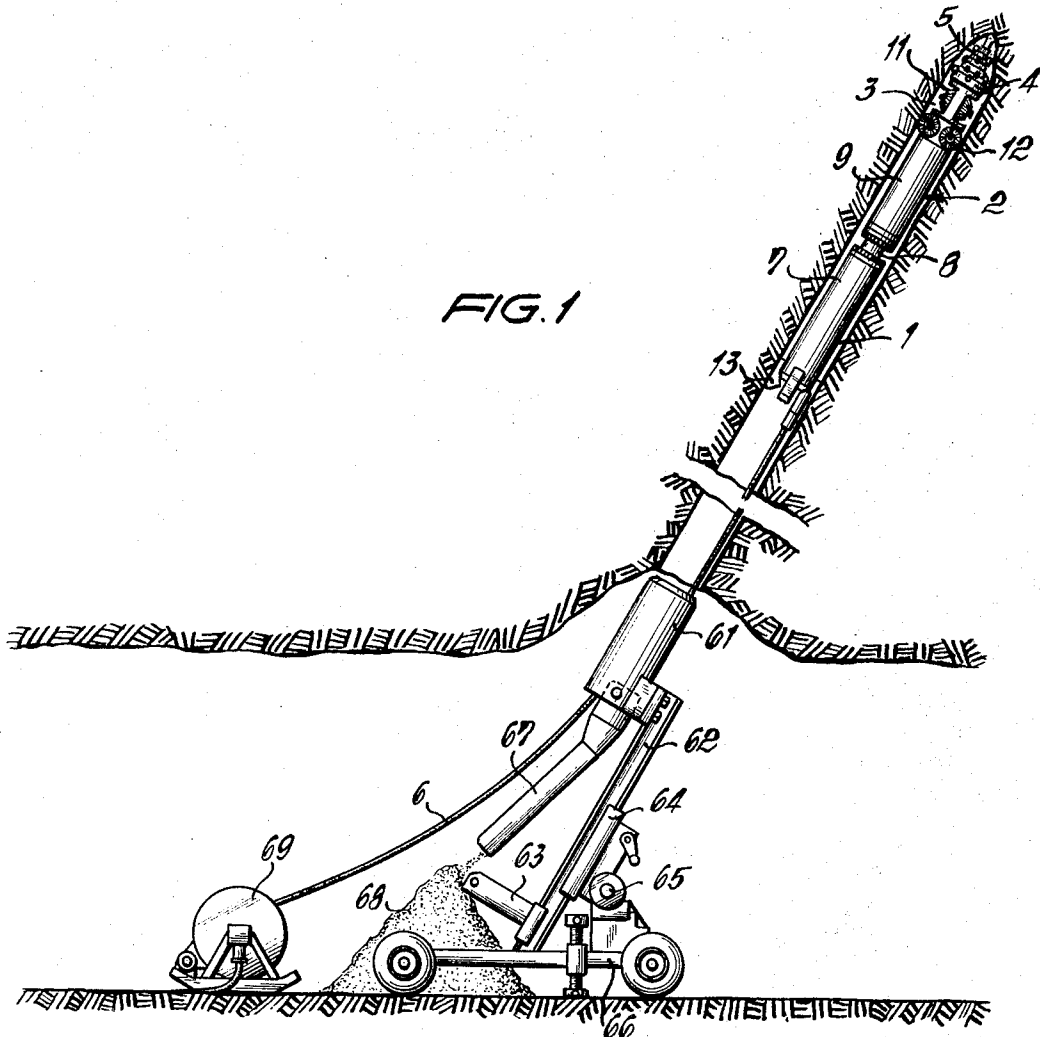
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3,354,969

SELF-PROPELLED DRILLING MACHINE

Filed Sept. 25, 1963

6 Sheets-Sheet 1



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FIG. 3

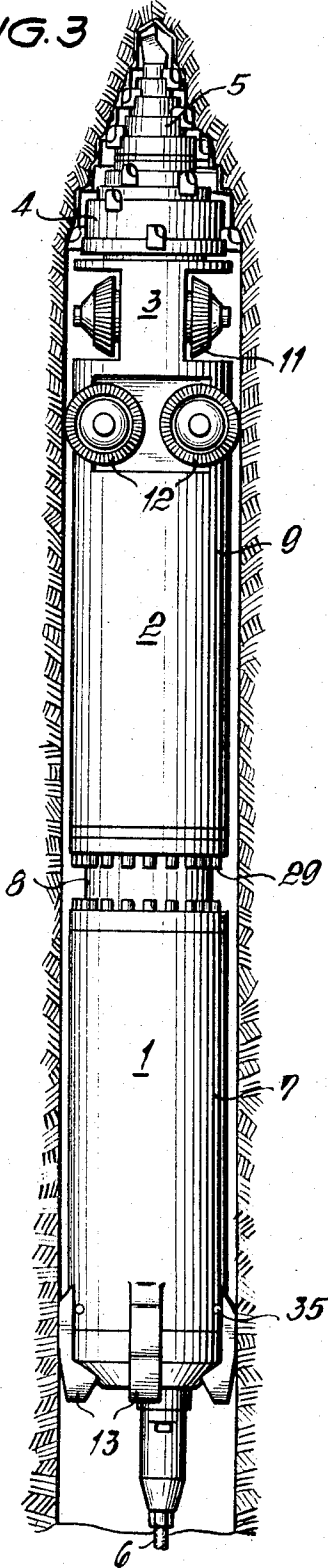
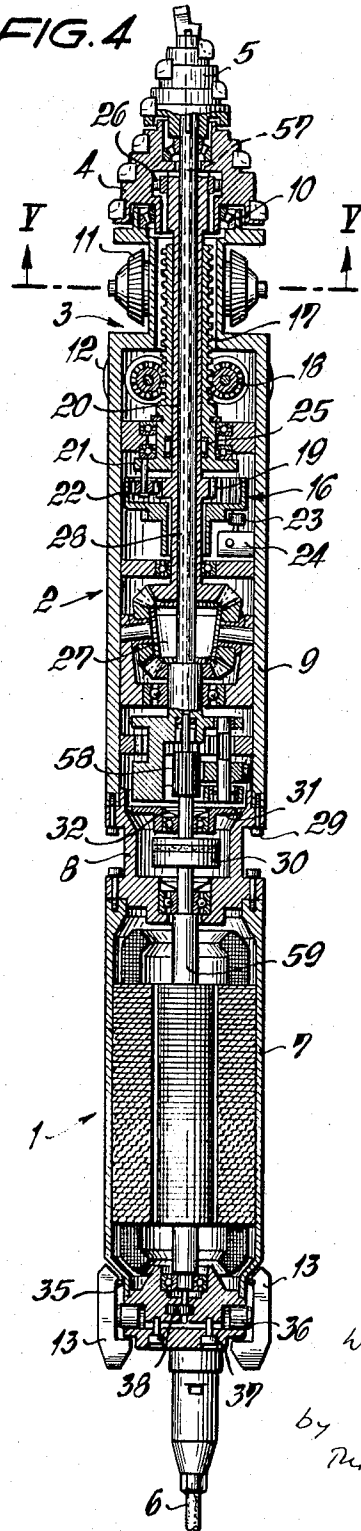


FIG. 4



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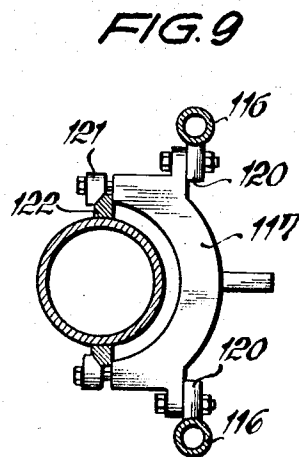
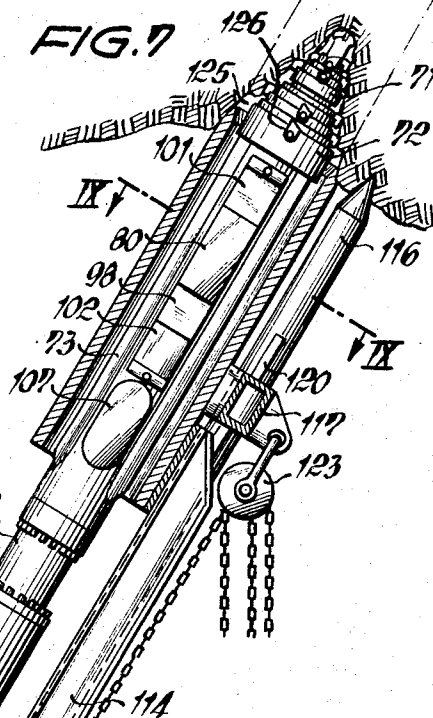
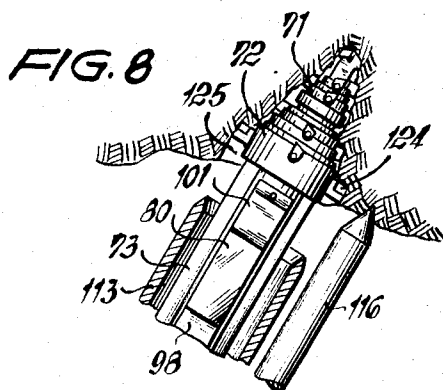
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SELF-PROPELLED DRILLING MACHINE

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6 Sheets-Sheet 4



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SELF-PROPELLED DRILLING MACHINE

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FIG. 10

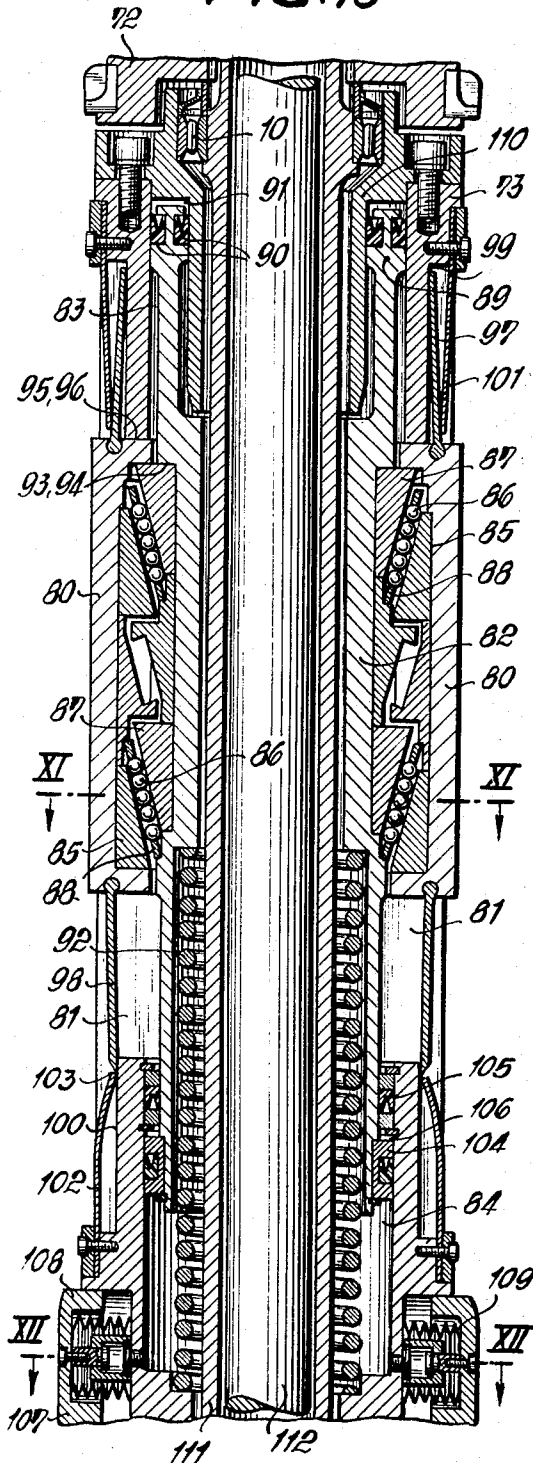


FIG. 11

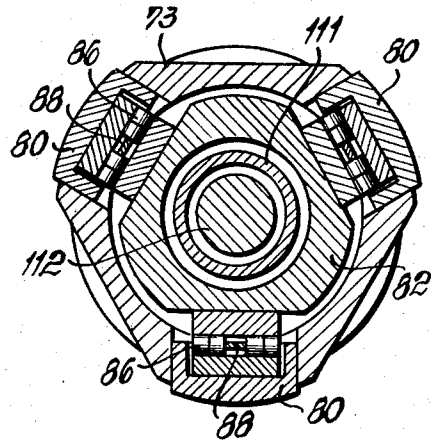
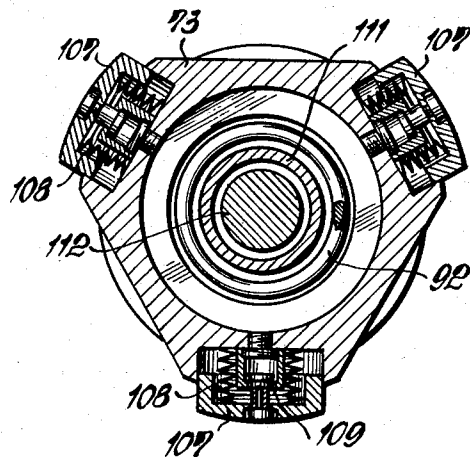


FIG. 12



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SELF-PROPELLED DRILLING MACHINE

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FIG. 10a

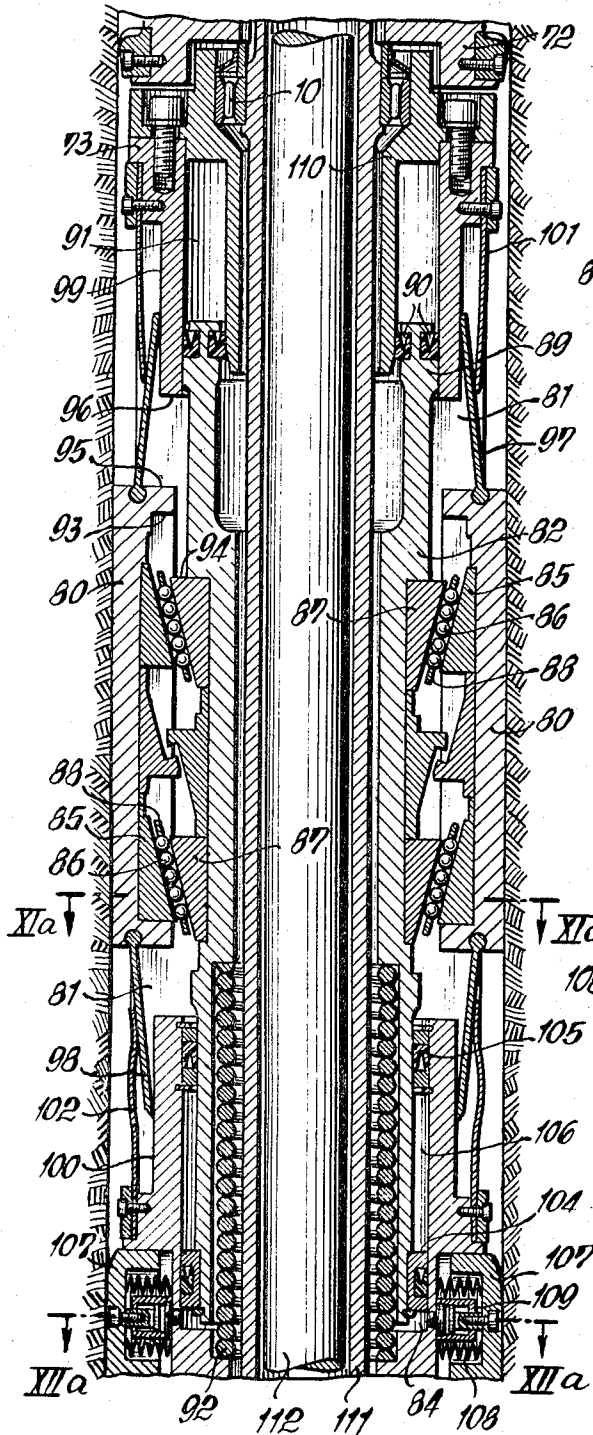


FIG. 11a

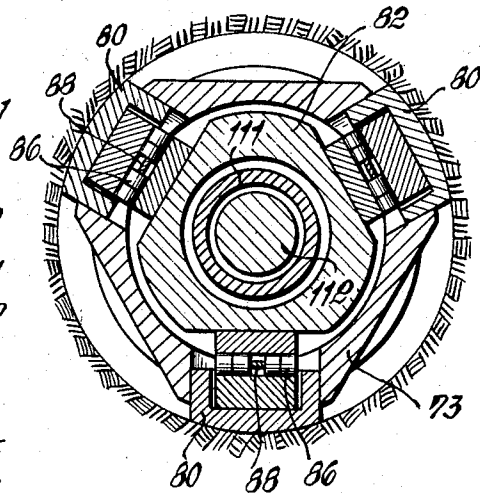
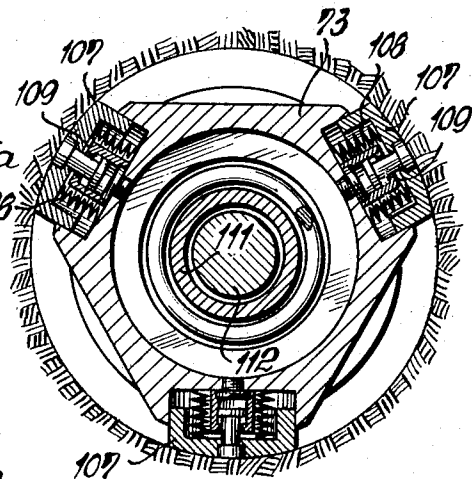


FIG. 12a



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SELF-PROPELLED DRILLING MACHINE

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ABSTRACT OF THE DISCLOSURE

A self-propelled drilling machine having at the front end of its rigid elongated housing a drilling tool for drilling a hole into which the elongated housing of the machine can pass and provided with means on the housing for advancing and guiding the latter in the bore hole.

The present invention concerns a self-propelled drilling machine having a drilling tool and a housing which slides in the drill hole and in which the driving mechanism for the drilling tool and the advancing mechanism are accommodated. Self-propelled drilling machines are known per se. However, they suffer from the disadvantage of requiring an external force such as gravity and therefore, they can drill practically only downwardly. In addition, they are very unreliable with regard to maintaining the desired drilling direction.

The object of the present invention is to avoid the above mentioned disadvantages and to provide a self-propelled drilling machine which can work under its own power in any desired direction, e.g. upwardly, and which, in addition, maintains the desired drilling direction with great accuracy.

This object is achieved by the present invention in that the housing is constructed rigid throughout from one end to the other, furthermore, the radial guide bearing for the drilling tool is provided at the front of the rigid housing and, finally for guiding the housing in the bore hole a guide device is used at the front and another guide device at the rear of the housing.

In one embodiment of the invention the guide device at the front of the rigid housing consists of rollers which are driven mechanically and are pressed against the wall of the bore hole for producing the necessary forward motion.

In another embodiment of the invention the front guide device comprises clamping members which are guided both radially and axially displaceably in the rigid housing and are driven in the manner of a striding mechanism.

Another embodiment of the invention is achieved by using an auxiliary mechanism for supporting and guiding the drilling machine during the initial drilling operation, said auxiliary device comprising a guide way for the drilling machine resting on a support.

The invention will now be described further, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a side elevation of the drilling machine with an auxiliary device for the initial drilling;

FIG. 2 is a similar view of the drilling machine according to FIG. 1, but shown in a different application;

FIG. 3 is the same side elevation of the drilling machine as in FIG. 1, but on a larger scale;

FIG. 4 is an axial longitudinal section of the drilling machine shown in FIG. 3;

FIG. 5 is a cross-section, on a larger scale, taken on the line V—V of FIG. 4;

FIG. 6 is as an axial section, of a detail of FIG. 2 also on a larger scale;

FIG. 7 is a side elevation of the second embodiment of

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the drilling machine showing a second embodiment of the auxiliary mechanism for the initial drilling;

FIG. 8 shows the drilling crown and a portion of the auxiliary mechanism with guide sleeve withdrawn;

5 FIG. 9 is a section taken on the line IX—IX of FIG. 7;

FIG. 10 shows, on a larger scale, an axial section through a portion of the drilling machine according to FIG. 7; and

10 FIG. 11 shows a section of the drilling machine on the line XI—XI of FIG. 10;

FIG. 12 shows another section of the drilling machine shown in FIG. 10 along line XII—XII;

15 FIG. 10a shows an axial section through a portion of the drilling machine shown in FIG. 10 in another position;

FIG. 11a shows a section on the line XIa—XIa of the drilling machine in the position shown in FIG. 10a; and

FIG. 12a shows another section of the drilling machine in the position shown in FIG. 10a along line XIIa—XIIa.

20 The embodiment of the drilling machine shown in FIGS. 1 to 6 comprises the driving mechanism 1, 2, the advancing mechanism 3 and the drilling tool 4, 5. In the embodiment illustrated, the drill motor 1, which together with the reduction gearing 2 forms the driving mechanism, is an electric motor which is fed through the lead 6. The motor housing 7 forms, with the intermediate flange 8 and the gear casing 9, a rigid housing throughout, the front end of which receives a radial guide and axial pressure bearing 10 for the drilling tool 4, 5. Immediately behind these is a front guide device 11, 12 for radially guiding the machine in the bore hole, which device consists of four pairs of rollers 11, 12. Another guide device 13 is mounted on the rear end of the housing and consists, in the embodiment illustrated, of four skids 13.

30 In order to hold the drilling machine in any position in the bore hole and to support it against the drilling pressure and the reaction moment of the drilling tool, a clamping device is provided which co-operates with the walls of the bore hole and is combined, in the illustrated embodiment with the front guide mechanism 11, 12 while the rollers 11, 12 are provided with pointed teeth 14 for improving the grip on the wall of the bore hole and are constantly pressed outwardly by axial springs 15 (FIG. 5).

45 To produce the forward motion, the roller system is also the advancing mechanism, the worm 17 and worm gears 18 are driven by the driving mechanism through a feed gearing 16. The feed gearing 16 comprises a planetary gearing, the sun gear 19 of which is disposed on the hollow shaft 20 driving the outer drilling bit 4, while a flange 21 is connected to the worm 17, the gearing 22 is retarded by the throttled hydraulic pump 24 by way of a gear 23, whereby an automatically controlled advance is obtained dependent upon the drilling pressure.

50 A remotely controlled rapid operation is possible in this embodiment through the one way clutch 25 which, during the drilling operation allows the hollow shaft 20 to rotate more rapidly than the worm shaft 17 but, when the motor rotates in the opposite direction, couples both shafts together, whereby the rollers 11, 12, run backwardly at increased speed.

A one-way clutch 26 couples the hollow shaft 20 with the outer bore crown 4 and allows the crown to be stationary during reversed rapid operation.

65 The inner bore crown 5 rotates in the opposite direction to the outer bore crown 4 and also at a higher speed. This partly compensates the torque reaction moment on the one hand, and keeps the cutting speed within finer limits. For this purpose a differential gearing 27 is used, which drives the hollow shaft 20 and consequently the outer bore crown 4, while a center shaft 28 driving the

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inner bore crown 5, extends direct from the reduction gear 9.

To facilitate transport, the embodiment is provided with the possibility of division between the drill motor 1 and the gear casing 2. Both parts are separated by loosening the flange screws 29, both halves of the shaft coupling 30 being drawn apart. The driving gear remains sealed by the wall 31 secured separately to the gear casing 2 with shaft packing 32.

The advancing and guiding rollers 11, 12 are provided in pairs on the ends of a shaft 33 journalled in the casing 2 and are coupled to their shaft by coarse threads 34. In this way the pressure force of the rollers against the bore wall is increased with increasing drilling pressure and it is compensated in the shaft itself.

The pairs of rollers are arranged with their shafts in their respective planes in pairs and in the following plane at a relative angular displacement. Each shaft carries in the center its respective worm-gear 18. All these worm-gears 18 mesh in the common worm 17. In this manner, a comparatively large number of symmetrical advancing rollers can be accommodated in a very small space with a favorable distribution of force in the driving mechanism.

The direction of the drilling can be influenced during the drilling operation if one or both guide devices are provided with remotely controlled adjusting means which render possible radial displacement of the drilling machine housing in the bore hole. In the embodiment illustrated the rear guide skids 13 are radially displaceably hinged to the bolts 35 and are pressed outwardly by the pistons 36. Electrically remote-control valves 37 are inserted in the supply lines to each piston. The hydraulic control system is fed from the pump 38 which is driven by the drill motor 1.

To assist the initial boring operation, this embodiment uses a tubular guide member 61 which is mounted on a rail 62. The guide member 61 serves to receive the front guiding and advancing device 3 of the drilling machine. The rear part of the drilling machine, at first projecting from the rear of the guide body 61, is supported in a clip 63 which is axially displaceable on the rail 62. The rail 62 is also axially displaceable in a bearing 64 which is pivotable about the point 65 (FIG. 1). The entire initial drilling mechanism rests on a mobile chassis 66 and thus can also be used as a means for transporting the drilling machine. A chute 67 connected to the pipe 61 serves to remove the earth 68 displaced by the drilling. A winch 69 serves to wind and unwind the power supply line 6 during the drilling.

In the embodiment shown in FIGS. 2 and 6 the housing of the drilling machine is provided at its rear end with a sealing member 40 which seals relatively to the wall 39 of the bore hole and has a sleeve 41. A compressed air supply pipe 43 leads into the thus sealed front part 42 of the bore hole and a discharge pipe 44 leads out of it. From the compression chamber 70 the compressed air flows through the filter 51 and the supply line 43 using the appropriate suitable parts of the drilling machine such as shafts 28, 58, 59, which for this purpose are made hollow (cavity 57 of the shaft 28 and cavity 60 of the shaft 59) to the front end of the drilling machine, i.e., to the tip of the drilling crown 5. The return of the scavenging air is between the outer wall of the drilling machine and the wall of the bore hole as far as the sealing member 40 and from there through the outlet opening 44 and the blast pipe 45 into the open air. In this manner the earth is blown into the discharge pipe 45 and can be pneumatically removed. The discharge pipe 45 is drawn along by the drilling machine and consists of separate interconnected tubular members which are added during the drilling operation.

The scavenging air may be fed externally through a hose drawn along by the drilling machine. However, in accordance with the present invention the air may be fed through the bore hole itself if a further sealing member

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47 is fitted at the beginning 46 of the bore hole and is pressed against the wall of the bore hole and has openings 48 for the intake of compressed air and for the passage of the scavenging air pressure pipe line 45 and if desired, the power supply line 6. In the illustrated embodiment the sealing body 47 is braced by a hose 49 subjected to internal pressure. Resilient sleeves 50 are provided for the sliding, but sealed passage of the scavenging air pipe line 45 and the supply line 6.

The compressor 52 is connected through the hose 53 with the inlet opening 48 of the sealing member 47. The winch 54 stores the supply line 6. The expelled earth is received in a truck 55, for example, on which the blast pipe 45 is supported by means of a roller 56.

If the driving motor of the drilling machine is a compressed air motor, the discharge air thereof can be used for removing earth, its exhaust air pipe being arranged in the front sealed bore hole portion 42.

This last method of use is particularly suitable for advancing horizontal and downwardly inclined bores.

The embodiment of the drilling machine shown in FIGS. 7 to 11 consists of the bipartite, oppositely rotating drilling tool 71, 72 and a quadripartite housing 73, 74, 75, 76. The housing member 73 contains the advancing mechanism, the member 74 a hydraulic pump for the advancing mechanism, the member 75 the reduction gearing and the member 76 the electric driving motor. The parts 73, 74, 75, 76 of the housing are tightly bolted together. At the rear end of the motor housing 76 a guide device is provided in the form of guide skids 77 and a power supply line 78 and a traction rope 79 are also connected to this end.

The advancing mechanism fitted in the front member 73 of the housing is constructed as a clamping device operating step by step and serving simultaneously also as a second guide device.

In FIG. 10 the starting position of the clamping members is shown while the clamping position of the clamping members in the bore hole is shown in FIG. 10a.

Three clamping jaws 80 provided on the periphery are radially and axially displaceable in windows 81 of the housing 73 and guided laterally. They are radially supported on a hollow cylinder 82 which in turn is axially displaceable at both ends in the cylinder bores 83, 84 of the housing 73. Mounted on each clamping jaw 80 are two spreading wedge-shaped members 85 which rest by means of rollers 86 on corresponding wedges 87. The rollers 86 move in cages 88.

The head end of the hollow cylinder 82 is constructed as a ring piston 89 with sleeves 90 and is moved axially rearwardly relative to the housing 73 by pressure oil introduced into the cylindrical space 91. An initially tensioned return spring 92 presses the hollow cylinder 82 constantly forwardly and throws it back into the starting position on the completion of the working stroke.

The clamping jaws 80 and the front spreading wedges 87 rigidly connected to the hollow cylinder 82 on the one hand and to the housing 73 on the other hand, are provided with stops 93, 94 and 95, 96 respectively associated with each other which are all in contact when the hollow cylinder 82 is in its foremost outlet position. Hinged to the front ends of the clamping jaws 80 are cover plates 97, 98 which cover the parts of the window openings 81 not covered by the clamping jaws and slide by their free side on plane surfaces 99, 100 of the housing 73. The cover plates 97, 98 are pressed on by leaf springs 101, 102 which are mounted on the housing 73 and have the width of the windows and thereby contribute to the better sealing of the inner parts of the striding mechanism.

The free edges 103 of the lower cover plates 98 are bevelled and the length of the leaf springs 102 is selected so that their front edges rest on these bevelled portions when the clamping jaws 80 are in the starting position.

The hollow cylinder 82 at its rear end has a second smaller annular ring piston surface 104 which seals the

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cylindrical space 106 jointly with the seal 105 provided in the housing. By reversing the supply line, the pressure oil of the pump is fed to this small cylinder 106. Thus, with the same delivery quantity of the pump, the stepping speed is increased, for example, for use when the drilling machine is returned to the drill hole after a change of cover.

A ring of three separate spring jaws 107 is always under the pressure of the initially tensioned spring assembly 108. The spring jaws are guided laterally in accurately shaped recesses in the housing 73 but are axially displaceable until they come into contact with the stops 109.

The hollow cylinder 82 and the inner cylinder bush 110 are constructed hollow in order to permit the passage of the concentric driving shafts 111, 112 for the two drilling bits.

The hydraulic pump for feeding the hydraulic advancing mechanism is fitted in the member 74 of the housing and is driven, together with the drilling bits 71, 72 by way of the reduction gear 75 from the driving motor 76.

In the initial drilling operation, the drilling machine is guided in an initial drilling mechanism 113-123 which consists of a tubular bead member 113 with its guide rail 114 mounted thereon, a guide carriage 115, two rams 116, a yoke 117 and a support 118 for the guide rails 114 and a base plate 119. The yoke 117 is mounted on the bars 120 of the rams 116 and holds the head member 113 against the clamping bar 122 (FIG. 9) by the clamps 121. The head member 113 and the guide rail 114 are axially displaceable by the lifting mechanism 123.

At the beginning of the initial drilling (FIG. 8), the outer drilling crown 72 is fitted with special enlarging blades 124 which extend the beginning 125 of the hole to the outer diameter of the head member 113. In the second phase of the initial drilling (FIG. 7), the enlarging blades 124 are exchanged for normal drilling blades 126 and a head member 113 is drawn into the beginning 125 of the hole. In this manner perfect transition of the head member into the bore hole and good stability of the initial drilling mechanisms are ensured. Both are essential for perfect initial drilling and for accuracy in the direction of drilling.

The base plate 119 connecting the two rams 116 carries a roller support 127. This serves to guide the traction rope 79 to its distant winch. The drilling machine can be withdrawn by the rope 79 from the drill hole at any time, when it is necessary to overcome the friction of the spring jaws 107 against the wall of the bore hole.

I claim:

1. A self-propelled drilling machine comprising, in combination, a rigid housing; a radial guide bearing at the front end of said housing; a drilling tool rotatably mounted in said radial guide bearing and of a size suitable to bore a hole into which said housing can pass; a driving mechanism in said housing and coupled to said drilling tool for driving the same; an advancing mechanism disposed in said housing for advancing the machine in the bore hole and comprising rollers disposed on the periphery of said housing, shafts transversely mounted in said housing and each carrying a pair of said rollers respectively on opposite end portions of said shafts, steep-pitch screw threads formed at said end portions of said shafts and in engagement with corresponding steep-pitch screw threads formed in bores of said rollers, springs acting on said rollers for urging the same outwardly, and gear means coupling said rollers to said driving mechanism; and a guide device at the rear of said housing for guiding said housing in said bore hole.

2. A drilling machine as defined in claim 1, wherein said gear means comprises a worm disposed in the axis of the machine and a worm gear provided centrally on each shaft and meshing with said worm gear.

3. A self-propelled drilling machine, comprising, in combination, a rigid housing; a radial guide bearing at

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the front end of said housing; a drilling tool having several contra-rotating parts of different diameters rotatably mounted by said radial guide bearing and of an overall size suitable to bore a hole in which said housing can slide; a driving mechanism disposed in said housing and coupled to said drilling tool parts for driving the same in opposite directions; a one-way clutch disposed between said driving mechanism and said drilling tool; an advancing mechanism disposed in said housing for advancing said machine in the bore hole; and a guide device at the rear of said housing for guiding said housing in said bore hole.

4. A drilling machine as defined in claim 3, wherein said driving mechanism comprises a driving motor having a motor shaft and a reduction gearing having an input shaft, disposed in respective portions of said housing, and releasable connecting means coupling said shafts for joint rotation.

5. A drilling machine as defined in claim 3, wherein said housing is composed of a plurality of portions connected to each other for separation of said housing into said portions.

6. A self-propelled drilling machine comprising, in combination, a rigid housing formed with windows therein; a radial guide bearing at the front end of said housing; a drilling tool rotatably mounted by said radial guide bearing and of a size suitable to bore a hole into which said housing can pass; a driving mechanism disposed in said housing and coupled to said drilling tool for driving the same; an advancing mechanism disposed in said housing for advancing said machine in the bore hole and comprising stepping members disposed in said windows and adapted to engage the wall of the bore hole, means located entirely within said housing and guiding said stepping members for radial and axial movement in said windows relative to said housing, and mechanical operating means imparting said radial and axial movements to said stepping members in a sequential manner such that a stepping motion of said machine relative to said bore hole is obtained; and a guide device at the rear of said housing for guiding said housing in said bore hole.

7. A drilling machine as defined in claim 6, and including clamping means comprising a plurality of clamping jaws mounted for radial movement outward of said housing, and preloaded spring means urging the jaws outwardly.

8. A drilling machine as defined in claim 6, wherein said housing is tubular, said stepping members being in the form of clamping jaws and said operating means comprise a longitudinally displaceable hollow cylinder carrying spreading wedges, said clamping jaws being laterally guided and supported on said cylinder with the interposition of said spreading wedges.

9. A drilling machine as defined in claim 8, wherein the front end of said hollow cylinder is constructed as an annular piston.

10. A drilling machine as defined in claim 6, wherein said hollow cylinder at its rear end carries a further annular piston effective in the same direction as the first said annular piston.

11. A drilling machine as defined in claim 8, wherein each clamping jaw has a face disposed for abutting against the housing and a face disposed for abutting against the hollow cylinder, said faces being in their abutting positions when said hollow cylinder is in its forward end position.

12. A drilling machine as defined in claim 11, comprising cover plates pivotally connected by one end to front ends of said clamping jaws, for covering portions of said windows not occupied by said clamping jaws, said cover plates being slidable with their other end on said housing.

13. A drilling machine as defined in claim 12, and comprising leaf springs mounted on the housing and en-

gaging said cover plates for urging said other ends of said cover plates into slidable engagement with said housing.

14. A drilling machine as defined in claim 13, wherein said cover plates have bevelled end edges providing engagement ramps for the free ends of said leaf springs.

15. A self-propelled drilling machine comprising in combination, a rigid housing; a radial guide bearing at the front end of the housing; a drilling tool rotatably mounted by said radial guide bearing and of a size suitable to bore a hole into which said housing can pass; a driving mechanism disposed in said housing and coupled to said drilling tool for driving the same; an advancing mechanism disposed in said housing for advancing said machine in the bore hole; and a guide device at the rear of the housing for guiding the housing in said bore hole, said guide device comprising a plurality of elongated skid members mounted in the region of the front ends thereof on a rear end portion of said housing each tiltable about a tilting axis transverse to the axis of the housing, and remote control adjusting means acting at least on one of said skid members for tilting the same about its tilt-

ing axis to thereby change the drilling direction of the machine.

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