Feb. 16, 1960 S. H. MINOR 2,925,252

TURBINE DRIVEN DRILL BIT

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Fig. 1.

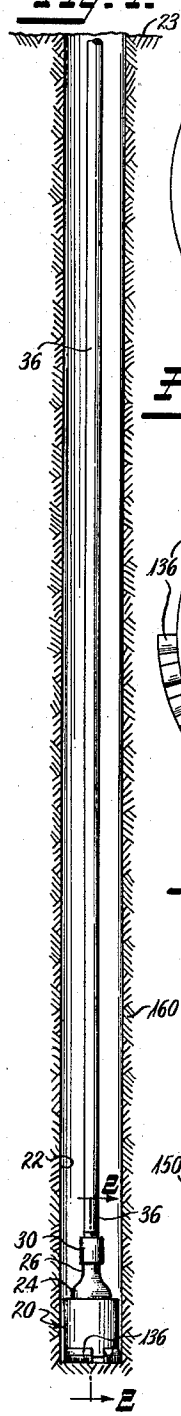


Fig. 4.

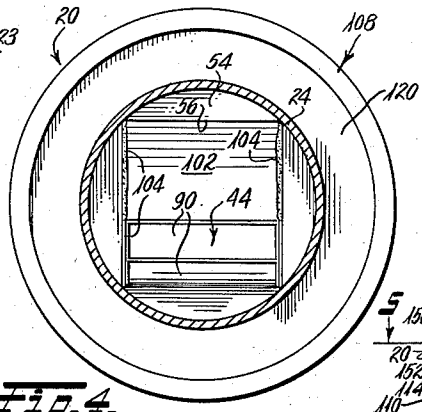


Fig. 6.

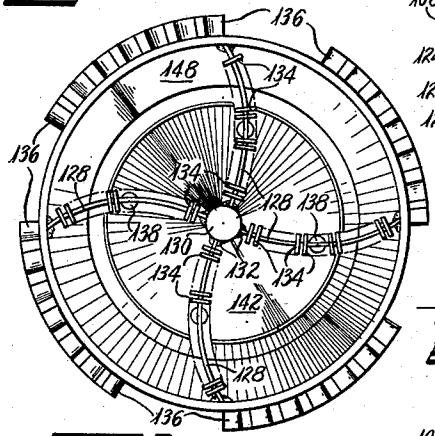


Fig. 5.

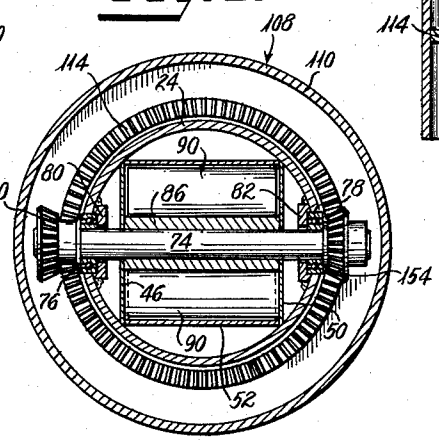


Fig. 2.

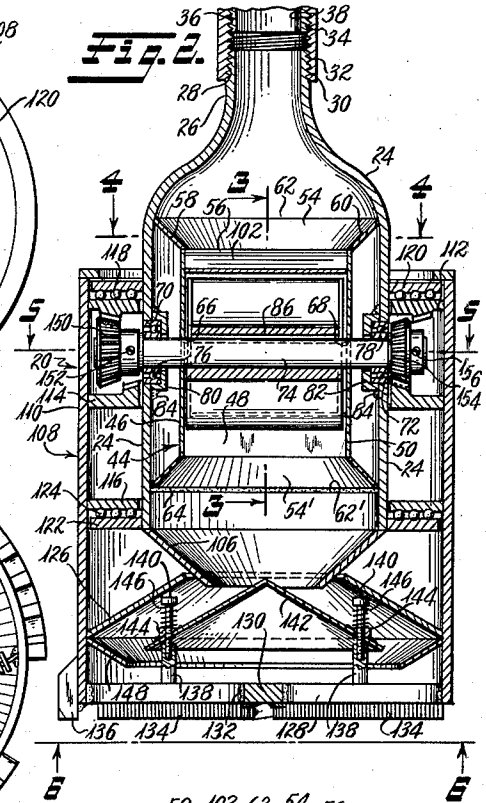
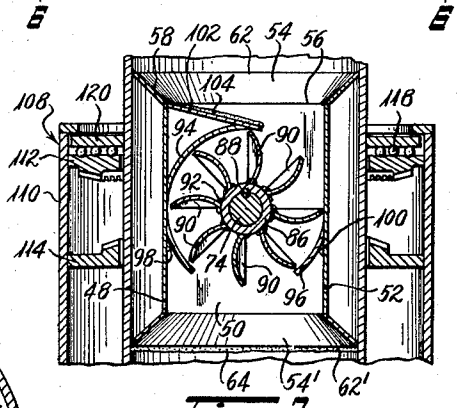


Fig. 3.



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TURBINE DRIVEN DRILL BIT

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Fig. 7.

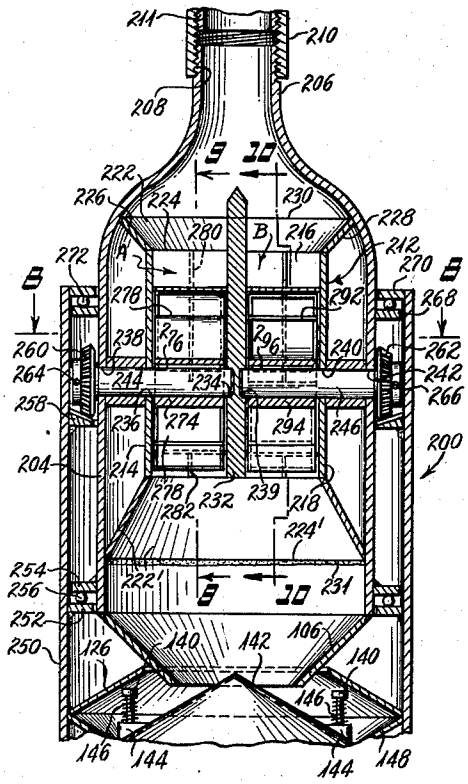

Fig. 8.

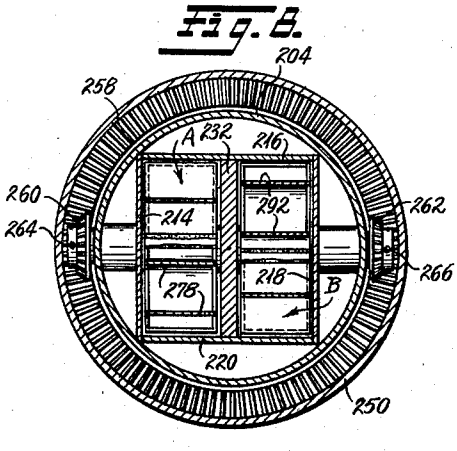

Fig. 9.

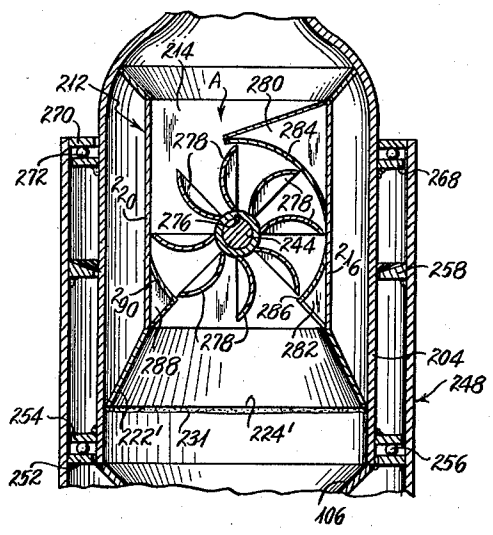

Fig. 10.

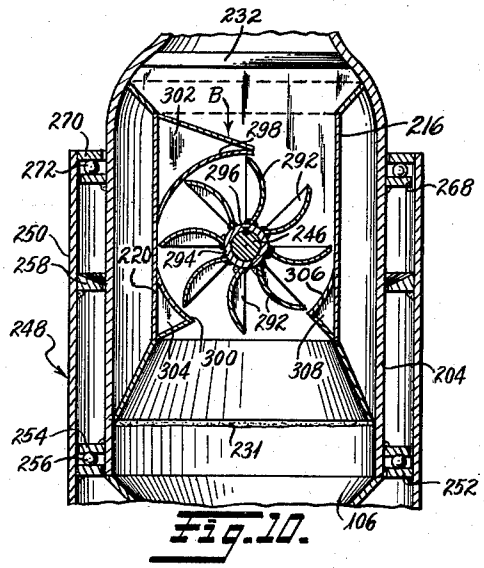

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Fig. 13.

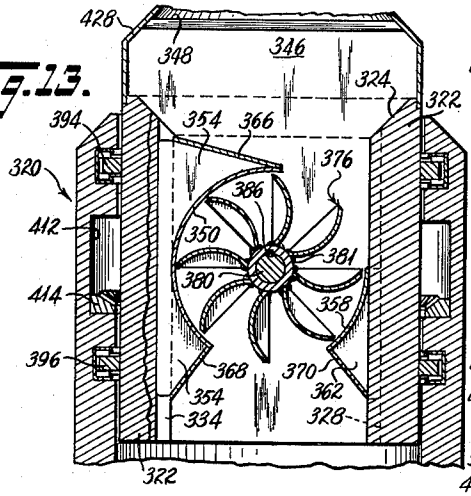


Fig. 11.

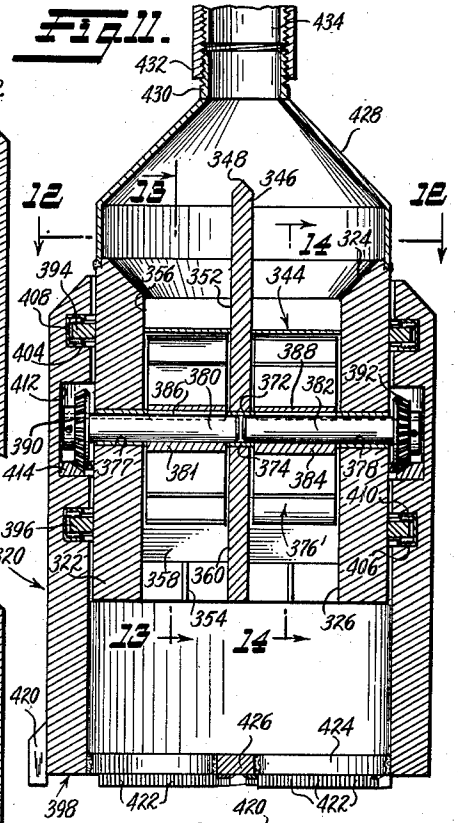


Fig. 14.

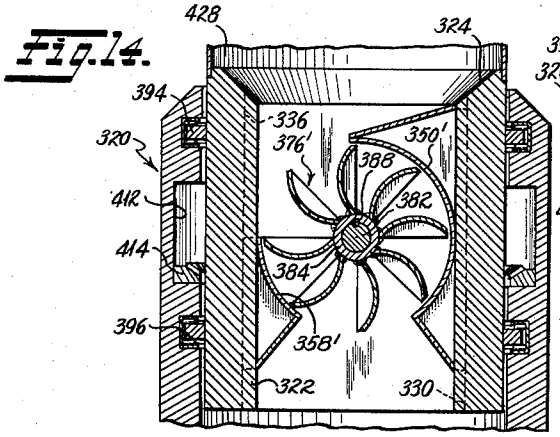


Fig. 15.

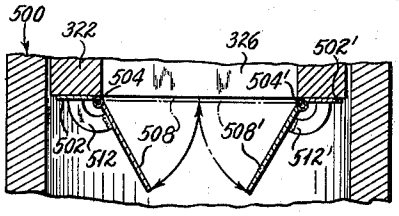


Fig. 16.

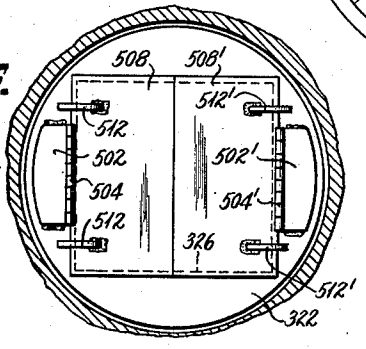
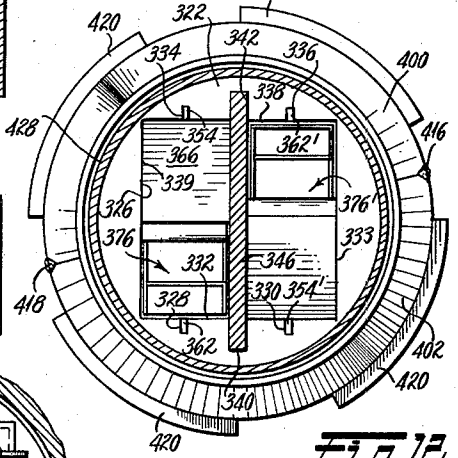


Fig. 12.



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Patented Feb. 16, 1960

2,925,252

TURBINE DRIVEN DRILL BIT

Sid H. Minor, Barnwell, S.C.

Application February 15, 1957, Serial No. 640,475

15 Claims. (Cl. 255—4)

This invention relates to a power-driven drill or bit, and more specifically, the present invention pertains to a turbine-driven drill or bit for drilling wells.

One of the primary objects of this invention is to provide a well-drilling, turbine-actuated, substantially hollow cylindrical bit which may be operated by any fluid medium source under pressure such as, for example, water, steam, compressed air, or other gases and fluids.

A further object of this invention is to provide a turbine-actuated bit of the type described wherein the fluid medium employed serves the additional functions of preventing the bit teeth from overheating and of flushing away drillings which may accumulate within the hollow bit.

Another object of this invention is to provide, in a device of the type referred to above, means for closing the fluid discharge side of the turbine housing to prevent damage to the impeller in the event the drillings are not flushed from the bit and accumulate therein.

A still further object of this invention is to provide a rotary turbine-driven drill bit wherein one or more sets of turbine impeller blades are mounted within the bit for rotation about a horizontal axis.

Other and further objects and advantages of the present invention will become more evident from a consideration of the following specification when read in conjunction with the annexed drawings, in which:

Fig. 1 is a side elevational view of a power-driven bit constructed in accordance with this invention and illustrating the same in a well digging operation;

Fig. 2 is an enlarged detail cross-sectional view of the bit shown in Fig. 1, this view being taken on the vertical plane of line 2—2 of Fig. 1, looking in the direction of the arrows;

Fig. 3 is a fragmentary detail cross-sectional view of the bit taken substantially on the vertical plane of line 3—3 of Fig. 2, looking in the direction of the arrows;

Fig. 4 is a top plane view of the power bit, partly in section, and taken on the horizontal plane of line 4—4 of Fig. 2, looking in the direction of the arrows;

Fig. 5 is a detail cross-sectional view of the bit taken on the horizontal plane of line 5—5 of Fig. 2, looking in the direction of the arrows;

Fig. 6 is a bottom plan view of the power bit taken on the horizontal plane of line 6—6 of Fig. 2, looking in the direction of the arrows;

Fig. 7 is a medial, longitudinal, cross-sectional view of a power driven bit constructed in accordance with a second embodiment of this invention;

Fig. 8 is a detail cross-sectional view taken on the horizontal plane of line 8—8 of Fig. 7, looking in the direction of the arrows;

Fig. 9 is a fragmentary cross-sectional view taken on the vertical plane of line 9—9 of Fig. 7, looking in the direction of the arrows;

Fig. 10 is a fragmentary cross-sectional view taken on the vertical plane of line 10—10 of Fig. 7;

Fig. 11 is a vertical, medial, cross-sectional view of another embodiment of this invention;

Fig. 12 is a detail cross-sectional view of the bit taken on the horizontal plane of line 12—12 of Fig. 11, looking in the direction of the arrows;

Fig. 13 is a detail cross-sectional view taken on the vertical plane of line 13—13 of Fig. 11, looking in the direction of the arrows;

Fig. 14 is a detail cross-sectional view taken on the vertical plane of line 14—14 of Fig. 11, looking in the direction of the arrows;

Fig. 15 is a fragmentary cross-sectional view of the modification illustrated in Fig. 11, Fig. 15 disclosing a still further embodiment of this invention; and

Fig. 16 is a bottom view of the structure shown in Fig. 15, certain parts thereof being shown in a different position.

Referring now more specifically to Figs. 1 to 5, inclusive, reference numeral 20 designates, in general, a power-driven drill bit assembly constructed in accordance with the teachings of a first embodiment of this invention, and especially designed for the drilling of wells, as is indicated at 22 in Fig. 1.

The assembly 20 is seen to comprise a vertically-elongated, substantially-hollow cylindrical casing 24, reduced in diameter at its upper end to form a neck portion 26 which is externally threaded at 28. A coupling element 30 internally threaded at 32 at its lower end is threadedly connected with the neck portion 26. The upper end of the coupling element 30 is internally threaded at 34 to provide a threaded connection with the lower end of an elongated, hollow and substantially cylindrical conduit 36 externally threaded at 38.

Disposed within the casing 24 is a substantially hollow rectangular turbine housing, designated generally by the numeral 44, with opposed open upper and lower ends. The housing 44 comprises four vertically extending side walls 46, 48, 50, 52. The upper ends of the side walls 46, 48, 50, 52 are welded, or otherwise secured, by conventional means, to the lower ends of a plurality of flat plates 54. The plates 54 are of identical configuration and are inclined upwardly and outwardly from the side walls 46, 48, 50 and 52. Plates 54 are constructed with straight lower ends 56, oppositely disposed and inwardly converging sides 58, 60, and an arcuate upper end 62 which conforms with the inner surface of casing 24. The plates 54 are assembled with their respective adjacent pairs of sides fixedly secured to each other and the lower ends thereof are connected with the upper ends of the side walls 46, 48, 50, 52 as described above. The resulting structure comprises a fluid inlet for the turbine housing having a hollow, truncated, inverted substantially pyramidate configuration with a continuous circular upper end 62 engaging the inner surface of the casing 24 adjacent the upper end thereof.

A second set of plates 54', identical with respect to the plates 54 are arranged and secured together in the manner described above and are secured to the lower ends of the side walls 46, 48, 50, 52 with the lower arcuate ends 62' thereof forming a continuous circular end engaging the inner side of the casing 24 adjacent its lower end. This set of plates forms a fluid discharge structure having a hollow, truncated, substantially pyramidate configuration. Welding 64 secures the ends 62' to the adjacent side of the casing 24 to rigidly secure the turbine housing 44 in place.

The side walls 46, 50 of the turbine housing 44 are formed with oppositely disposed coaxially aligned apertures 66, 68, respectively, which are spaced from and are coaxially aligned with a pair of diametrically opposed apertures 70, 72 formed in the casing 24. A turbine

shaft 74 extends transversely across the housing 44 and the casing 24 and is journalled for rotation in the apertures 66, 68, 70, 72. Bearings 76, 78 are mounted in the apertures 70, 72 and support the shaft 74 adjacent the outer ends thereof. Bearing keepers 80, 82 surround the shaft 74 and are fixedly secured to the inner side of the casing 24 as by welding 84.

A turbine impeller hub 86 is telescoped over the shaft 74 and is keyed thereto by a spline 88 for rotation therewith. A plurality of impeller blades 90 extend axially of the hub 86 and are fixedly mounted thereon by welding 92. The turbine blades work between a pair of spaced and oppositely disposed arcuate plates 94, 96 having their opposed ends affixed to the side walls 46, 50, and the convex surface of the former welded at 98 to the side wall 48. The convex surface of the latter plate 96, is secured to the side wall 52 by welding as at 100.

A substantially rectangular fluid guide plate 102 is welded at 104 to the side walls 46, 48, 50. This plate (see Figs. 2 and 3) is downwardly inclined from the upper end of the side wall 48 and terminates at a point slightly beyond one-half the distance between the side walls 48 and 52, and its lower terminal end is welded or otherwise rigidly connected to the upper terminal end of the arcuate plate 94. This structure results in the formation of a substantially rectangular water inlet slot for the turbine housing 44 which is defined by the lower end of the guide plate 102, the side walls 46, 50 and the side wall 52. The discharge port from the turbine is defined by the lower confronting ends of the plates 94, 96 and the side walls 46, 50.

An inverted, hollow frusto-conical member 106 is mounted below casing 24 with its upper end rigidly connected to the lower end of said casing.

The rotary bit member is designated, in general, by the reference numeral 108 and comprises an axially elongated, substantially hollow cylindrical member 110, open at either end, surrounding the casing 24 in spaced relation relative thereto.

The cylindrical member 110 has an inwardly projecting annular gear ring 112 rigidly connected thereto adjacent the upper end thereof, and a second gear ring 114 also fixedly secured to the cylindrical member 110 in downwardly spaced relation relative to the first gear ring. Both of the gear rings surround the casing 24 in spaced relation with respect thereto.

Intermediate the ends of the cylindrical member 110 is rigidly secured an annular flange 116, the function of which will become more apparent below.

In assembling the device, the flange 116 is first affixed to the cylindrical member 110 by conventional means such as, for example, by welding (not shown). The ring gear 114 is also fixedly secured to the cylindrical member 110 in a similar manner. This assembly is slidably mounted over the casing 24 after which a plurality of ball bearings 118 are disposed on the ring gear 112 and an annular flange 120 is then welded to the casing 24. The ring gear 112 and the flange 120 serve as races for the bearings 118.

An annular flange 122 is rigidly secured, as by welding, to the lower end of the casing 24 and this flange taken together with the flange 116 serve as races for the ball bearings 124 which are interposed therebetween.

A frusto-conical member 126 has the base thereof rigidly secured to the cylindrical member 110 adjacent the lower end thereof. As is seen in Fig. 2 of the drawings, the open upper end of the frusto-conical member 126 surrounds the lower end of the inverted frusto-conical element 106 in spaced relation relative thereto.

A plurality of teeth 136 is secured to the outer side of the cylindrical member 110 extending downwardly from the lower end thereof. As is seen in Figs. 2 and 6, the teeth 136 are arranged in a plurality of sets circumferentially spaced from each other, for a reason which will appear hereinafter.

Arcuately shaped ribs 128 are rigidly secured at their outer ends to the inner surface of cylindrical member 110 and extend inwardly therefrom, the inner ends of said ribs being secured to a circular hub 130 as by welding 132. As seen in Figs. 2 and 6, each of the ribs 128 carries a plurality of depending teeth 134.

Each of the ribs 128 has fixedly secured thereto an upstanding hollow cylindrical boss 138 internally threaded to receive a bolt 140. The bolts 140 serve as vertical guides for a substantially hollow conical member 142 which is mounted thereon. As is seen in Fig. 2 of the drawings, the conical member 142 has secured to the upper side thereof a plurality of lugs 144 which surround the bolts 140. Interposed between the bolts 140 and the lugs 144 are a plurality of helical springs 146 which tend to constantly bias the conical member 142 in a downwardly direction.

An annular flange 148 has its outer edge fixedly secured to the cylindrical member 110 adjacent the base of the frusto-conical element 126. From Fig. 2 it will be seen that the annular flange 148 is downwardly inclined and the nature of the flange 148 will be set forth more specifically below.

The shaft 74 projects diametrically across and beyond the casing 24. A bevel gear 150 is fixedly secured to one end of the shaft 74 by means of a set screw 152 and the other projecting end of the shaft 74 receives a bevel gear 154 which is fixedly secured thereto by means of a set screw 156. The bevel gear 150 is displaced outwardly away from the casing 24 at a greater distance then is the bevel gear 154, whereby the bevel gear 150 is meshed with the ring gear 112 while the bevel gear 154 meshes with the ring gear 114.

The operation of the device is now deemed to be apparent from the foregoing specification.

The upper end of the conduit 36 is connected with a source of water, air, gas, steam, mud or any other fluid medium, under pressure. As the selected fluid passes downwardly through the conduit 36, the fluid enters the casing 24 through the neck 26 thereof. The fluid is then guided by means of the plates 54 and the plate 102 towards and into the rectangular turbine inlet slot. As fluid passes through the slot it impinges against the turbine blades 90 to effect rotation of the shaft 74. As the shaft 74 is rotated, the bevel gears 150, 154 being in mesh with the ring gears 112, 114 effect the rotation of the cylindrical member 110. As the cylindrical member 110 is rotated, the teeth 134, 136 drill into the ground 160 to produce the cylindrical well bore 22.

The fluid after impinging upon the impeller blades 90 passes downwardly through the inverted frusto-conical element 106 from whence it is discharged to pass between the lower edge of the frusto-conical member 106 and the conical member 142. The discharge force of the fluid passing from the inverted frusto-conical member 106 normally tends to assist the helical springs 146 to maintain the conical member 142 in its downward open position relative to the outlet end of the inverted frusto-conical member 106. Under normal operating conditions, the fluid discharged from between the frusto-conical member 106 and the conical member 142 impinges against the annular plate or flange 148 which reverses the direction of the flow of the fluid in such a manner that the fluid is directed inwardly toward the center of the cylindrical member 110.

The fluid discharging from the plate 148 is directed toward the ribs 128 and their respective drill teeth 134. As the drill teeth 134 and 136 bore through the ground, there is a natural tendency for drillings to accumulate within the cylindrical member 110 at the lower end thereof. However, any tendency for this matter to accumulate within the cylindrical 110 is normally obviated since the fluid medium employed mixes with the drillings and forces the same outwardly below the lower end of the casing 24, upwardly through the spaces between each of the ad-

jacent sets of drill teeth 136. Thereafter, the drillings entrained in the fluid pass upwardly between the wall of the well bore 22 and the adjacent side of the cylindrical member 110 and eventually rise to the surface of the ground 23. This fluid backwash may be led by means (not shown) to storage means for reuse. In the event water is employed as the power medium, conduits may lead the backwash to a settling pit.

In addition to the flushing operation, the fluid medium is also suitably adapted to maintain the drill teeth 134, 136 at a low temperature despite the heat generated by frictional contact thereof with the ground during the drilling operation.

In the event the fluid medium employed is not supplied to the cylindrical member 110 in sufficient volume or without sufficient force to effectively flush the drilled material from within the cylindrical member 110, the drillings will tend to accumulate within cylindrical member 110 at the lower end thereof. As this mass increases, it will engage against the underside of the hollow conical member 142 and will tend to force the same upwardly against the tension of the helical springs 146 and the added force generated by the fluid medium. The upward movement of the conical member 142 causes it to seat against and to close the lowermost opening of the inverted frusto-conical member 106. In closing this opening, the frusto-conical member 142 prevents the entry of the drillings within the casing 24 and the housing 44 so that the drillings cannot reach the turbine blades 90 and damage the same. Suitable gauges (not shown) connected with the source of fluid under pressure may be employed to detect malfunctioning of the drill 20. Also, suitable gauges (not shown) can be employed to detect this condition by connection with the return means for the backwashing fluid.

A second embodiment of this invention is illustrated in Figs. 7 to 10, inclusive. In these figures, the power driven drill bit assembly is designated, in general, by the reference numeral 200 and is seen to comprise an axially elongated hollow cylindrical casing 204 having an upper reduced neck portion 206 externally threaded at 208 to receive the lower end of a coupling 210. The upper end of the coupling 210 is threadedly connected with the lower end of an elongated hollow conduit 211, as described in the first embodiment of this invention, the upper end of the conduit 211 being connected with a source of fluid under pressure.

The casing 204 surrounds a turbine housing 212 having a substantially rectangular configuration and comprises the rectangular side walls 214, 216, 218, 220.

As in the original embodiment of this invention, the side walls 214, 216, 218, 220 are welded or otherwise secured by conventional means to the lower ends of a plurality of flat plates 222. These plates have identical configurations and are inclined upwardly and outwardly from side walls, 214, 216, 218, 220. Plates 222 are constructed with straight lower ends 224, oppositely disposed and inwardly converging sides 226, 228 and an arcuate upper end 230 which conforms with the inner surface of casing 204. Assembly of these plates with their respective adjacent pairs of sides fixedly secured to each other and with their respective lower ends connected with the upper ends of the side walls 214, 216 218, 220 gives rise to a fluid inlet structure having a hollow, truncated, substantially pyramidate configuration with a continuous upper end engaging the inner surface of the casing 204 adjacent the upper end thereof.

A second set of plates 222' having identical configurations with respect to the plates 222 are arranged and secured together in the manner described above and are affixed to the lower ends of the side walls 214, 216, 218, 220 with the lower arcuate ends thereof 224' forming a continuous circular end engaging the inner side of the casing 204. This set of plates form a fluid discharge structure having a hollow, truncated, substantially pyramidate configuration. Welding 231 secures the arcuate ends 224' of the plates to adjacent sides of the casing 204 to rigidly secure the turbine housing 212 in place.

A substantially vertically extending divider plate 232 is disposed within the turbine housing 212 and has a pair of opposed edges thereof rigidly secured to the side walls 216, 220. As is seen in Figs. 7 and 8, the divider plate is positioned substantially centrally between the side walls 214 and 218. The divider plate 232 has a circular recess 234 formed in one side thereof which is coaxially aligned with an opening 236 formed in the side wall 214 and with an opening 238 formed in the casing 204. A similar recess 239 is formed in the opposite side of the divider plate 232 and is coaxially aligned with the opening 240 formed in the side plate 218 and with the opening 242 formed in the casing 204. The openings 236, 238, 240, 242 and the recesses 234 and 238 are all coaxially aligned, one with respect to the others.

A shaft 244 has one of its ends rotatably journalled within the recess 234 and the other end thereof is rotatably received within the openings 236, 238, the shaft 234 projecting laterally beyond the casing 204. In a similar manner, a shaft 246 has one of its ends rotatably journalled within the recess 239 and the other end thereof is rotatably received within the openings 240, 242. As is seen in Fig. 7, the other end of the shaft 246 also projects beyond the casing 204.

The rotary bit member is designated, in general, by the reference numeral 248 and is seen to comprise an axially elongated hollow, cylindrical member 250. Adjacent the lower end of the cylindrical member is fixedly secured a flange 252 which cooperates with a flange 254 fixedly secured to the casing 204, the flanges 252, 254 serving as races for the ball bearing 256 interposed therebetween. The drill bit 248 has an annular ring gear 258 fixedly secured to the inner side thereof, the ring gear being adapted to mesh with the bevel gears 260, 262 which are mounted on said other ends of the shafts 244, 246. Screws 264, 266 fixedly secure the gears 260, 262, respectively, to the shafts 244, 246 for rotation therewith.

An annular flange 268 is rigidly secured to the casing 204 adjacent the upper end thereof and cooperates with an annular flange 270 fixedly secured to the rotary bit member 248 to form a bearing race for the ball bearings 272.

As is seen in the drawings, the divider plate 232 divides the turbine housing 212 into a pair of compartments disposed in side-by-side relationship. For convenience, the two compartments have been indicated by reference letters A, B. In compartment A and mounted on the shaft 244 is a hub 274 secured to the shaft by a spline 276 for rotation therewith. The hub 274 has fixedly secured thereto one end of a plurality of impeller blades 278.

Upper and lower ribs 280, 282 are fixedly secured to the side wall 216 and are adapted to support a pair of arcuately shaped plates 284, 286, respectively, which confront the outer edges of the impeller blades 278. In a similar manner a rib 288, secured to the side wall 220, supports an arcuately shaped plate 290 which also confronts the impeller blades 278. As is seen in Fig. 7 of the drawings, the plates 284, 286 and 288 extend transversely across the chamber A between the adjacent sides of the side wall 214 and the divider plate 232.

The chamber B has disposed therein a plurality of impeller blades 292 having their inner ends fixedly secured to a hub 294 which is, in turn, splined at 296 to the shaft 246 for rotation therewith. It is important to note at this point that while the impeller blades 278 and 292 are of identical construction, the working face of the impeller blades 292 is reversely directed with respect to the working face of the impeller blades 278.

The impeller blades 292 work between the plates 298 and 300 which are rigidly secured to the side wall 220 by means of a pair of upper and lower ribs 302, and 304, respectively, and a third plate 306, rigidly supported from the side wall 216 by means of a rib 308.

The remaining structure of the turbine-driven drill bit is identical with respect to that described in the first embodiment of this invention, and from the foregoing description the operation of this second embodiment of the invention is believed to be evident.

As fluid under pressure enters the upper end of the casing 204, the volume thereof is divided by the divider plate 232 between compartments A and B. As descending fluid impinges against the impeller blades 278, 292, the shafts 244 and 246 are rotated in opposite directions. The rotation imparted to the shafts 244, 246 introduces rotation of the bevel gears 260, 262 which are in mesh with the ring gear 258. Since ring gear 258 is fixedly secured to the rotary bit member 248, this member will be rotated to effect the drilling operation previously described.

Referring now more specifically to Figs. 11 to 14, inclusive, of the drawings, reference numeral 320 designates, in general a turbine-driven drill bit assembly constructed in accordance with the teachings of another embodiment of this invention. As illustrated therein, the assembly 320 is seen to comprise an elongated, hollow cylindrical casing 322 having a pair of opposed open ends. The upper end of the casing 322 is tapered to provide a fluid inlet opening 324, the base of which communicates with the upper end of an axially elongated rectangular passage 326, having side walls 332, 333, 338, 339.

Opposed vertical guide slots 340, 342 are formed in walls 332 and 338 respectively. A pair of smaller vertical guide slots 328, 330 are formed in side wall 332 in spaced relation to and on opposite sides of slot 340. A similar pair of vertical guide slots 334 and 336 are formed in side wall 338 in spaced relation to and on opposite sides of slot 342.

Reference numeral 344 generally indicates a fluid-driven turbine unit. The unit 344 is preassembled and is seen to comprise a centrally positioned divider plate 346 having a substantially rectangular configuration. The upper end of the divider plate 346 tapers to a point at 348.

Referring now more specifically to Figs. 11 and 13, an arcuate turbine housing plate 350 has one side edge 352 thereof rigidly welded to one side of the divider plate 346. A longitudinal rib is rigidly secured on the convex outer surface of housing plate 350 and extends outwardly therefrom in spaced parallel relation with respect to divider plate 346. A second smaller arcuate turbine housing plate 358 is similarly secured along one side edge 360 thereof to the same side of divider plate 346 in generally confronting relation to housing plate 350 and is provided with a rib 362 rigidly secured to its convex outer surface and extending outwardly therefrom in spaced parallel relation with respect to divider plate 346.

A substantially rectangular fluid deflector plate 366 has one of its ends rigidly secured to the upper end of the turbine housing plate 350 and slopes upwardly and outwardly therefrom along the upper edge of rib 354, to which it is fixedly secured. The outer marginal edge of the rib 354 extends a short distance beyond the outer edge of plate 366.

The lower end of the turbine housing plate 350 is secured to the upper end of a substantially rectangular stabilizer plate 368. This plate slopes downwardly and outwardly from the lower end of housing plate 350 along the lower edge of the rib 354, the outer marginal edge of rib 354 extending a short distance beyond the outer edge of stabilizer plate 368.

In a similar manner, a substantially rectangular stabilizer plate 370, has one of its ends fixedly secured as by welding to the lower end of the turbine housing plate 358. This plate slopes downwardly and outwardly away from the housing plate 358 along the lower edge of the rib 362, the outer marginal edge of rib 362 extending a short distance beyond the outer edge of stabilizer plate 370. Divider plate 346 is preferably secured by welding or the like to the adjacent side edges of deflector plate 366 and stabilizer plates 368, 370.

The turbine unit 344 has a similar assembly on the opposite side of the plate 346 with the exception that the described elements are reversed from left to right. This is readily borne out by an examination of Fig. 14 of the drawings. These last-referred to elements may be differentiated from the described structure by identical reference numerals to which has been added a prime mark.

The divider plate 346 is provided with a transversely extending opening 372 in which is disposed a bushing 374. Turbines 376, 376' are now disposed on opposite sides of divider plate 346 between their respective confronting housing plates and the described turbine unit 344 is now inserted within the housing 322; the marginal edges of the ribs 354, 362 being received within the guide slots 334 and 328 respectively, the marginal edges of the divider plate 346 being received within the guide slots 340, 342 and the marginal edges of the ribs 354', 362' being received within the guide slots 330, 336 respectively. The free edges of housing plates 350, 350', 358, 358' and their associated deflector and stabilizer plates are adapted to fit tightly against the respective adjacent side walls 333, 339.

The turbine unit 344 is slid into the casing 322 until the opening 372 is coaxially aligned with a pair of diametrically opposed openings 377, 378 formed in the side wall of the housing 322. Thereafter the shaft 380 is extended through the opening 377 and is passed through the hub 381 of the impeller 376, the inner end thereof extending to and being journalled in the bushing 374. In a similar manner a shaft 382 is passed through the opening 378 and through the hub 384 of the turbine 376' and the inner end thereof is also journalled in the bushing 374. The impellers 376, 376' are keyed to their respective shafts by means of splines 386, 388. Bevel gears 390, 392 are fixedly secured to the outer ends of the shafts 380, 382.

To serve a purpose to be described, the casing 322 has secured thereto a pair of radial flanges 394, 396 which are disposed in vertically spaced relation.

Reference numeral 398 designates, in general, the rotary bit member of the assembly. The member 398 is formed of two elongated semi-circular members 400, 402 of identical construction. Each of the semi-circular members has a pair of axially spaced annular recesses 404, 406 formed in the inner side thereof and each of the recesses receives a bearing unit 408, 410. Each of the semi-circular members 400, 402 also have formed therein a semi-circular recess 412 to the bottom of which is rigidly secured a semi-circular ring gear 414.

The two semi-circular members 400, 402 are disposed in surrounding relation relative to the casing 322, the flanges 394, 396 entering and being mounted in the bearing units 408, 410 respectively. Simultaneously, the gears 390, 392 are placed in mesh with the ring gear 414. With the parts thus assembled, the two semi-circular members 400, 402 are secured together by means of two lines of welding 416, 418 to form the substantially cylindrical drill bit 398.

Sets of integrally formed drill teeth 420 are fixedly secured to the lower end of the rotary bit member 398 in circumferentially spaced relation. Additional drill teeth 422 are provided, the drill teeth 422 depending from arms 424 each having one of its ends fixedly secured to the inner surface of the rotary bit member 398 and the other of its ends fixedly secured to a central hub portion 426. The construction of these drill teeth and their assembly is exactly the same as that illustrated in Fig. 6.

Means (not shown) similar to those disclosed in the embodiments of Figs. 1–6 and 7–10 may be employed for closing the fluid discharge side of the turbine housing to prevent accumulated drillings from entering said turbine housing and causing damage to the impeller blades.

The turbine-driven drill bit is completed by securing a substantially cylindrical cap 428 to the upper end of the casing 322, the cap being necked down at 430 and externally threaded to receive one end of a connector 432.

The other end of the connector **432** is coupled to the lower end of an elongated conduit **434**. The other end of the conduit **434** is connected with a source of fluid under pressure and the operation of the turbine driven drill bit is the same as has been set forth above.

Figs. 15 and 16 illustrate a further embodiment of this invention. As shown therein, the turbine-driven drill assembly **500** is identical in construction to the drill **320** with the exception of added means for protecting the impellers **376, 376'** from damage by preventing drillings from accumulating in the lower ends of the assembly. To this end a bottom plate **502** is welded to the lower end of the casing **322** at one side of the passage **326** and a substantially rectangular closure plate **508** disposed across passage **326** is pivotally secured thereto by means of a hinge **504**.

An arcuately shaped stop member **512** is provided for each end of the plate **508**. As illustrated, one end of the stop members **512** is welded to the plate **508** while the other end thereof normally engages the lower end of the casing **322** keeping the closure plate **508** from opening to any position more than about 60° from the horizontal.

A similar closure plate **508'** provided with a stop member **512'** is pivotally secured by means of a hinge **504'** to a bottom plate **502'** which is secured to the bottom of casing **322** on the opposite side of passage **326**.

As the drillings build up below the plates **508, 508'** within the casing, the plates **508, 508'** are pushed upwardly and will pivot towards each other until they are in closed position and the discharge end of the passage **326** is effectively sealed. With the discharge end of the passage **326** closed, fluid flow no longer rotates impellers **376, 376'** and the drilling operation is halted. The operator now raises the drill **320** and removes the accumulated drillings and thereafter returns it to the well hole.

Having described and illustrated several embodiments of this invention, it is to be understood that the same are offered merely by way of example, and that this invention is to be limited only by the scope of the appended claims.

I claim:

1. Drilling apparatus comprising: a casing having a fluid inlet and a fluid outlet and being adapted for the passage of fluid therethrough from said inlet to said outlet; a fluid driven impeller device mounted in said casing for rotary movement with respect to said casing upon actuation by fluid flow from said inlet to said outlet, a substantially cylindrical bit member surrounding said casing and rotatably mounted with respect thereto; and a shaft having one end thereof drivingly connected with said impeller device and having the other end thereof extending generally horizontally through an opening in said casing and being connected with said bit member to effect rotation thereof upon actuation of said impeller device.

2. Drilling apparatus as defined in claim 1, wherein said impeller device rotates about a normally horizontal axis.

3. Drilling apparatus as defined in claim 1, including means for closing said outlet to prevent an accumulation of drillings from entering said impeller device.

4. Drilling apparatus as defined in claim 1, wherein said bit member includes a plurality of ribs extending transversely of said casing adjacent the lower end thereof, said ribs having a plurality of longitudinally spaced drill teeth depending therefrom, and wherein said bit member is also provided with a plurality of circumferentially spaced sets of drill teeth outwardly offset with respect thereto.

5. A turbine-driven drill bit comprising: an elongated casing having a fluid inlet opening and an oppositely disposed fluid outlet opening; an elongated turbine housing fixedly secured within said casing, said turbine housing having a fluid inlet opening and an oppositely disposed outlet opening; a shaft extending across said turbine housing and said casing and having its opposed ends projecting laterally beyond said casing, said shaft being mounted for rotation on said casing and said housing and being disposed intermediate said fluid inlet and outlet openings of said turbine housing; means actuated by the flow of fluid through said turbine housing to effect rotation of said shaft; an elongated bit member surrounding and being mounted for rotation on said casing; and means connecting said ends of said shaft with said bit member in driving relation.

6. A turbine driven drill bit as defined in claim 5, wherein said connecting means includes a gear fixedly mounted on one end of said shaft for rotation therewith, and a gear ring fixedly secured to said bit member in spaced relation relative to said casing, said gear and gear ring being meshed with each other.

7. A turbine device as defined in claim 5, wherein said connecting means includes a pair of axially spaced gear rings fixedly secured to said drill bit in off-set relation relative to each other, and gears fixedly secured to the opposite ends of said shaft, each of said gears meshing, respectively, with one of said gear rings.

8. A turbine-driven drill bit comprising an elongated casing; an elongated turbine housing mounted in said casing and having oppositely disposed inlet and outlet openings; means dividing said housing into a pair of compartments, an impeller device rotatably mounted in each of said compartments, means for directing fluid flow against said impellers to effect rotation thereof in opposite directions; a bit member surrounding said casing and being rotatably supported thereon in spaced relation relative thereto, and means connecting said impeller devices in driving relation with said bit member to effect rotation thereof.

9. A turbine-driven drill bit as defined in claim 8, wheren said impeller devices are each provided with a shaft having one end thereof extending exteriorly of said casing, a gear being mounted, respectively, on each of said shaft ends and both of said gears meshing with a gear ring fixedly secured to said bit member.

10. A turbine-driven drill bit as defined in claim 9 wherein said impeller devices are mounted for rotation about substantially horizontal axes.

11. A turbine-driven drill bit as defined in claim 8, including means for preventing an accumulation of drillings within said casing from entering said turbine housing.

12. A turbine-driven drill bit as defined in claim 8, wherein said bit member includes a plurality of ribs extending transversely of said casing adjacent its lower end, said ribs having a plurality of longitudinally spaced drill teeth depending therefrom, and wherein said bit member is also provided with a plurality of circumferentially spaced sets of drill teeth outwardly offset with respect thereto.

13. A turbine-driven drill bit comprising: an elongated substantially cylindrical casing having a substantially rectangular passage extending axially therethrough; means dividing said passage into a pair of side-by-side compartments; an impeller device rotatably mounted in each of said compartments for rotation in opposite directions relative to each other; a substantially cylindrical bit member surrounding said casing and being rotatably supported thereon in spaced relation relative thereto; means connecting said impeller devices in driving relation with said bit member to effect rotation thereof around the axis of said cylindrical casing; and means for connecting one end of said casing with a source of fluid under pressure.

14. A turbine-driven drill bit comprising: an elongated substantially cylindrical casing having an axially extending substantially rectangular passage formed therein and having opposed open ends, said casing having a plurality of longitudinally extending recesses formed in a pair of opposed side walls of said passage: a turbine unit com-

prising; a first pair of arcuately-shaped oppositely disposed turbine housing sections; a rib secured to each of said sections intermediate the ends thereof; a substantially rectangular divider plate; said first pair of sections having one of their respective ends fixedly secured to one side of said divider plate; a second pair of arcuately shaped turbine housing sections, said second pair of housing sections having one of their respective ends secured to the other side of said divider plate, said divider plate having an opening extending transversely therethrough; a turbine having a hollow hub disposed between each of said first and second turbine housing sections, said unit being disposed within said passage with the outer ends of said ribs and said divider plate disposed in said recesses; said casing having a pair of diametrically opposed openings formed therein, said openings being aligned with said opening formed in said divider plate and with said hubs; a shaft rotatably mounted in one of said openings formed in said casing and having an end thereof projecting through one of said turbine hubs and journalled within said opening formed in said divider plate; a second shaft having one of its ends extending through the other of said openings formed in said casing and projecting through said hub of said second turbine and journalled within said opening formed in said divider plate; means fixedly securing said hubs to said shafts; a gear mounted on the other end of each of said shafts; a cylindrical bit member; means supporting said bit member for rotation on said casing; a gear ring fixedly secured to the inner side of said bit member and meshing with said gears, and means for connecting one end of said casing with a source of fluid under pressure.

15. A turbine-driven drill bit as defined in claim 14, and means mounted on the other end of said casing to automatically close said other end thereof upon accumulation of drillings within said bit.

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