April 20, 1965 E. H. KURT 3,179,015

CONTROL FOR ROCK DRILL MOUNTING

Filed Feb. 11, 1963 6 Sheets-Sheet 1

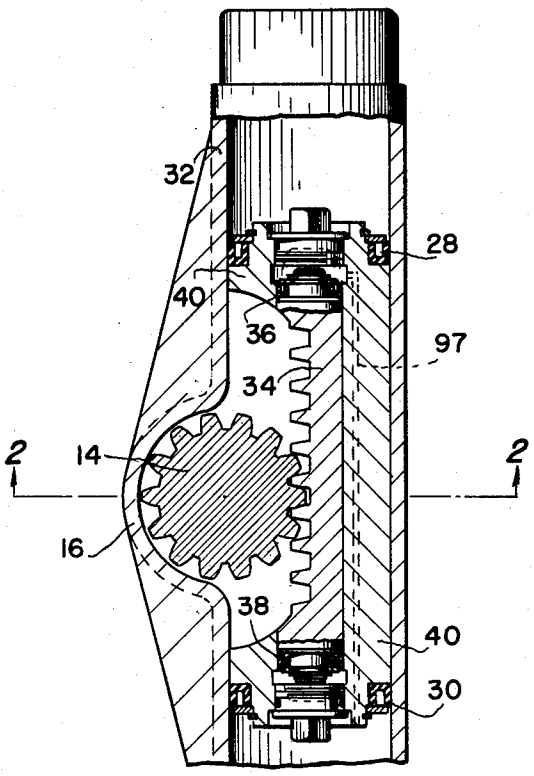


FIG. 1

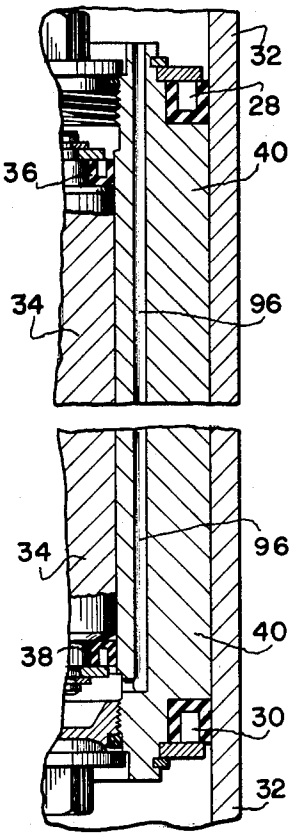


FIG. 3

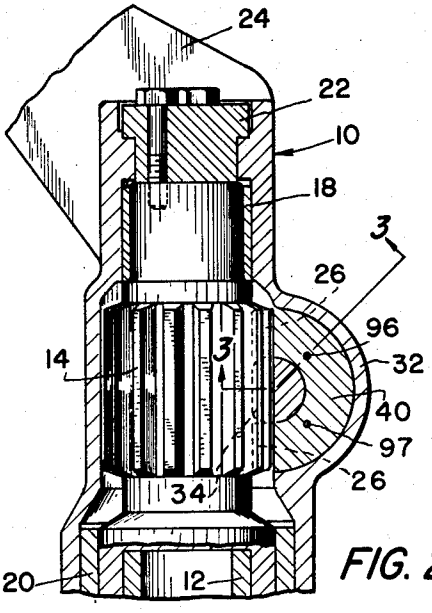


FIG. 2

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CONTROL FOR ROCK DRILL MOUNTING

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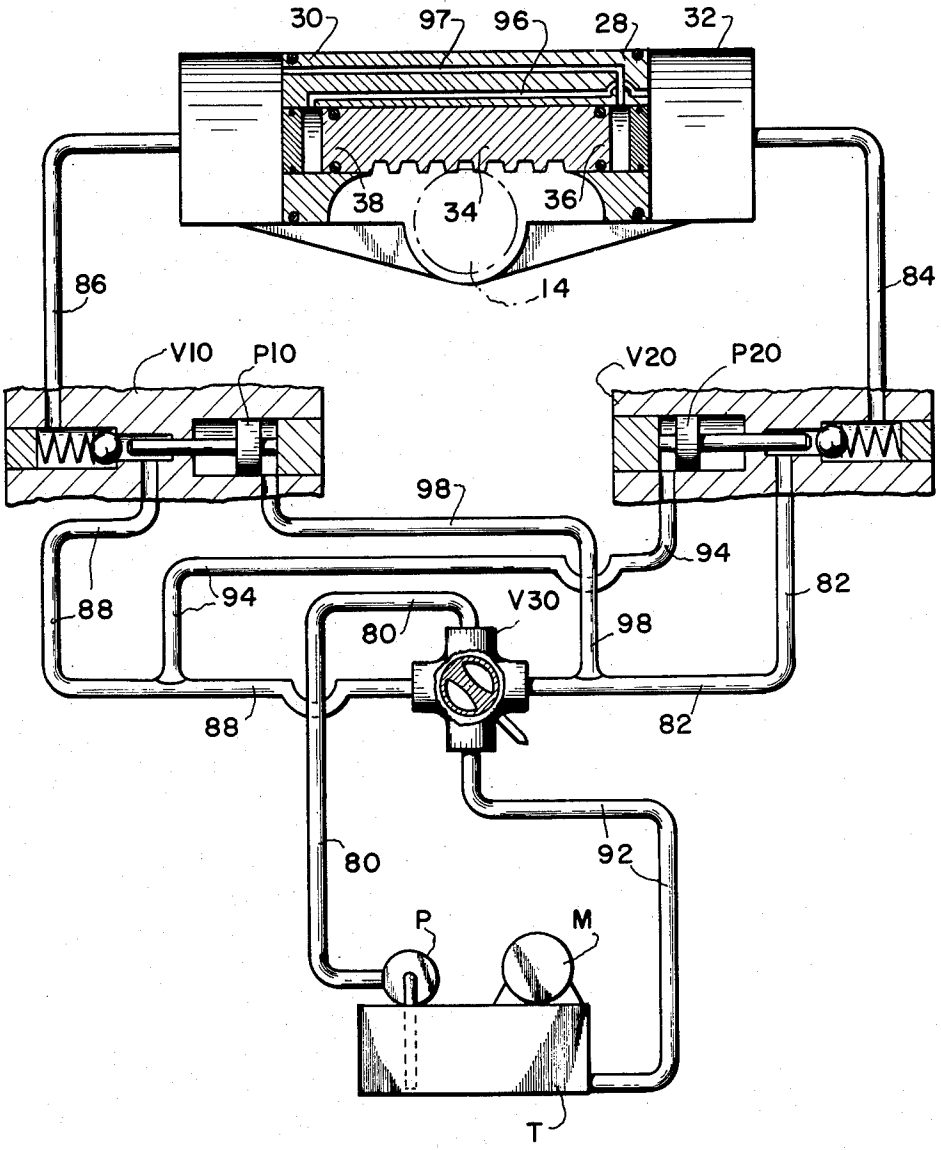


FIG. 4

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CONTROL FOR ROCK DRILL MOUNTING

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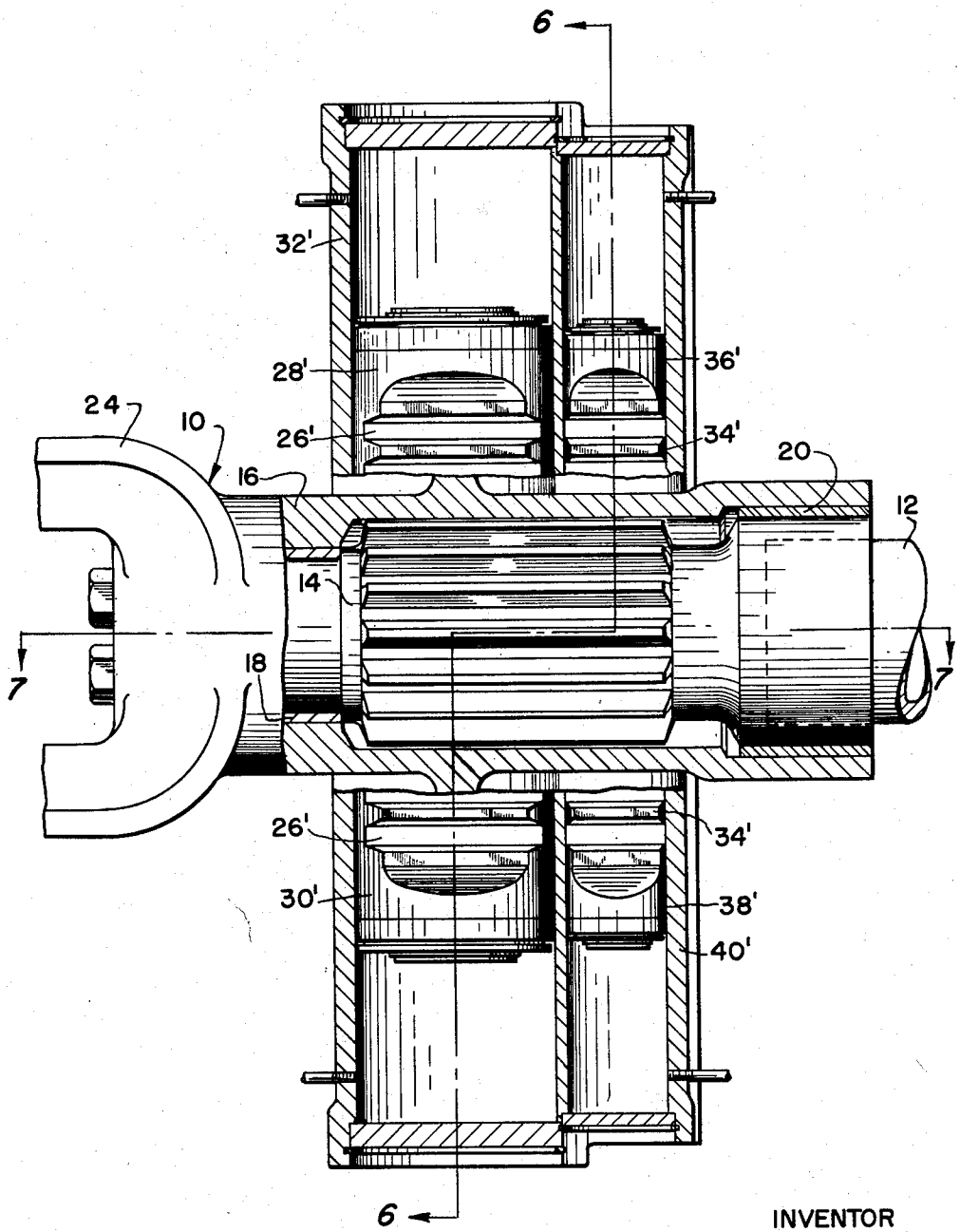


FIG. 5

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CONTROL FOR ROCK DRILL MOUNTING

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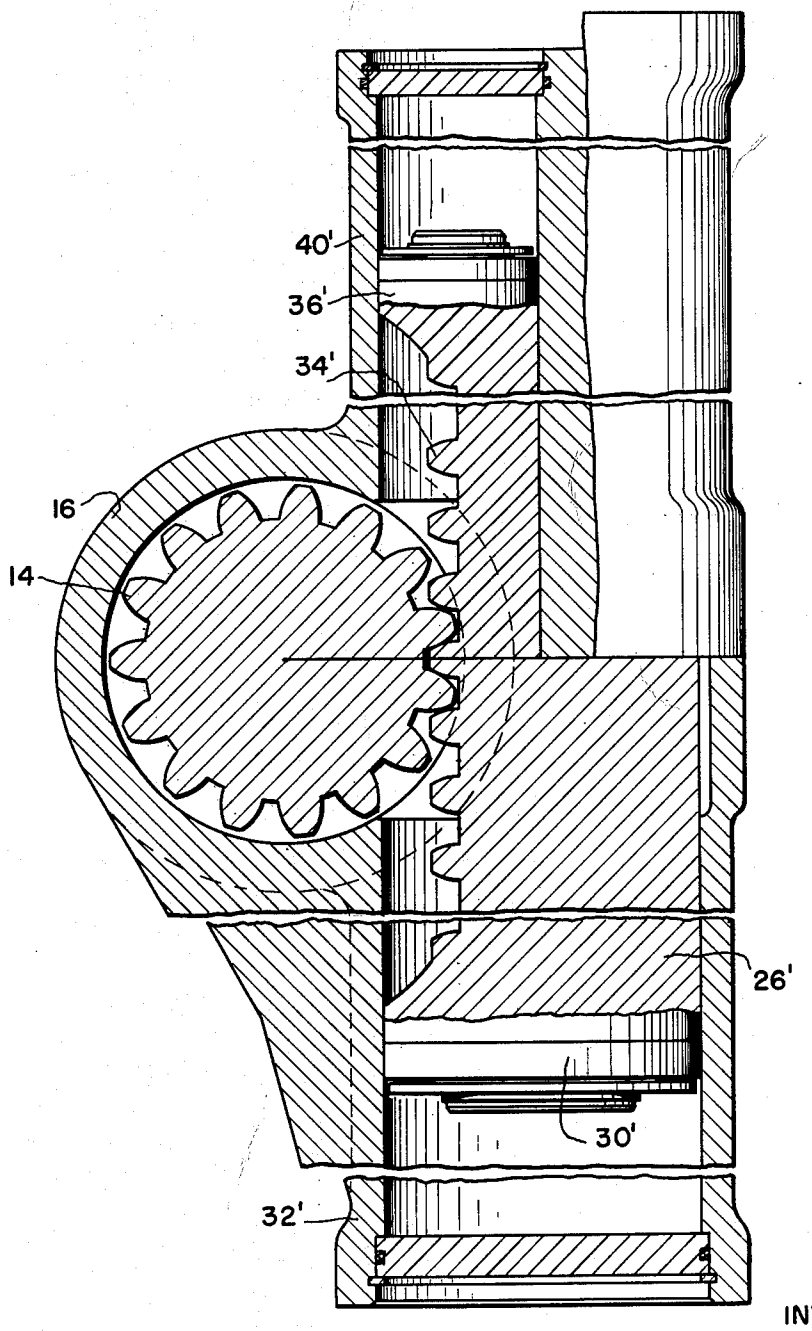


FIG. 6

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CONTROL FOR ROCK DRILL MOUNTING

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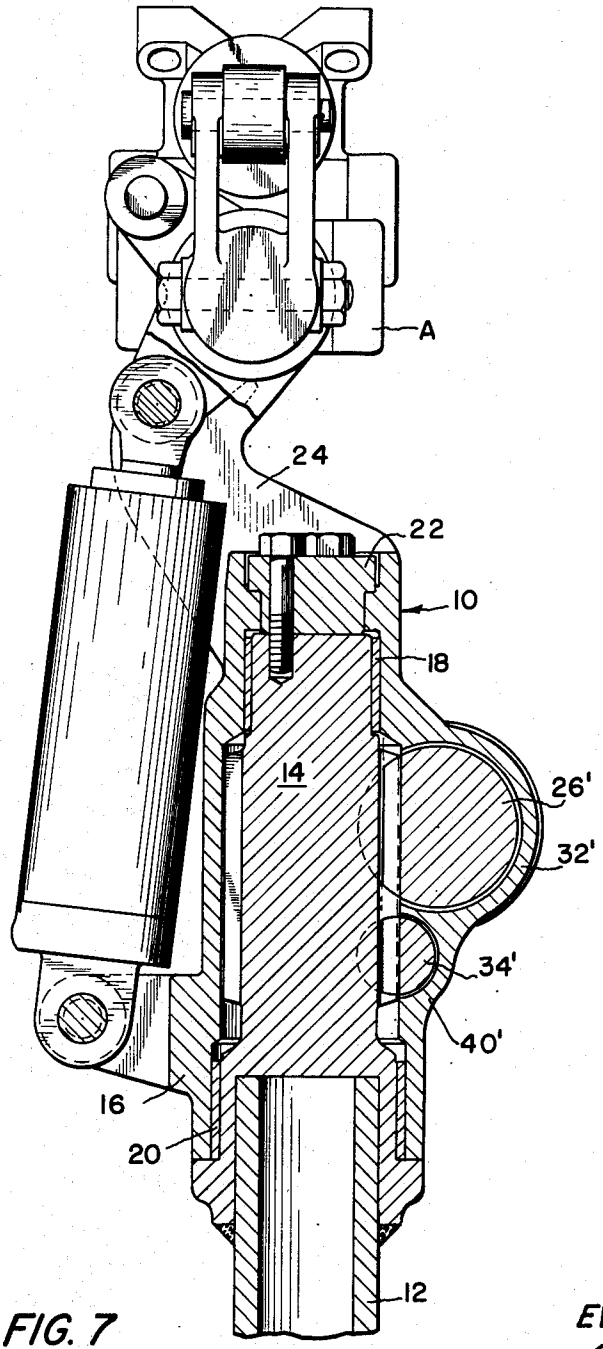


FIG. 7

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CONTROL FOR ROCK DRILL MOUNTING

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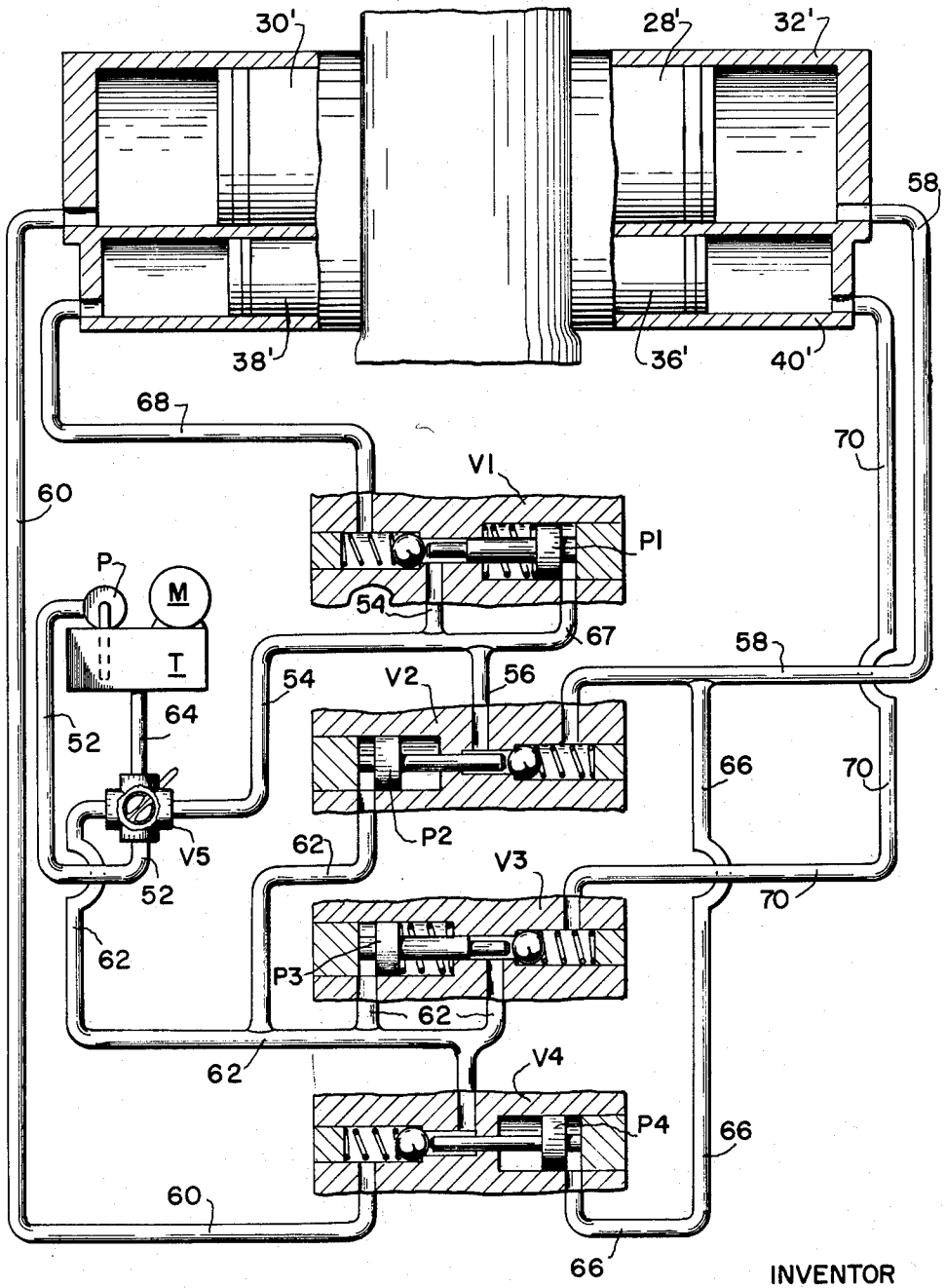


FIG. 8

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3,179,015
Patented Apr. 20, 1965

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3,179,015

CONTROL FOR ROCK DRILL MOUNTING

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Filed Feb. 11, 1963, Ser. No. 257,564
10 Claims. (Cl. 91—172)

This invention relates to rock drilling apparatus and more particularly to an arrangement for adjusting the position of the rock drill mounted on the rock drilling apparatus relative to the rock face.

In rock drilling apparatus of the type provided with a swingable boom, a support for the rock drill of the rock drilling apparatus is mounted adjustably on the extreme end of the boom, the said support being adapted to provide for movement of the rock drill into various drilling positions with respect to the rock face. In the construction of such boom type rock drilling apparatus, a common expedient for adjusting the position of the rock drill support mounted on the end of the boom consists of a gear arrangement by means of which the rock drill support is caused to roll about the end of the boom to properly position the rock drill for drilling operations. Inasmuch as the rock drill and its guide are of considerable weight and length, any looseness in the components of the rock drill support, or clearance in the gearing, affects the efficiency of drilling. In addition, the backlash of the gears as a result of such clearance is harmful, causing breakage and other inconveniences.

It is an object of this invention to provide a rock drill mounting with an improved rock drill supporting arrangement to provide for greater efficiency of drilling than heretofore experienced.

Another object of this invention is to provide a rock drill mounting with which the rock drill is firmly held in drilling position.

Yet another object of this invention is to provide a rock drill mounting with which the rock drill is readily and expeditiously movable into various drilling positions.

Still another object of this invention is to provide a rock drill mounting with which the rock drill is firmly locked in drilling position.

Another object of this invention is to provide a rock drill mounting with which wear of the various components thereof is substantially reduced.

Other objects and advantages of the invention will be in part obvious and in part pointed out hereinafter.

The accompanying drawings illustrate two embodiments of the invention in which:

FIGURE 1 is a longitudinal section of one embodiment of the rock drill mounting according to the invention;

FIG. 2 is a cross-sectional view of FIG. 1 taken along the line 2—2 and looking in the direction of the arrows;

FIG. 3 is a sectional view of FIG. 2 taken along the line 3—3 and looking in the direction of the arrows;

FIG. 4 is a diagrammatical view of the pressure fluid control system as applied to the rock drill mounting shown in FIGS. 1–3;

FIG. 5 is a longitudinal section of another embodiment of the rock drill mounting;

FIG. 6 is a section taken along the line 6—6 of FIG. 5 looking in the direction of the arrows;

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FIG. 7 is a section taken along the line 7—7 of FIG. 5 looking in the direction of the arrows; and

FIG. 8 is a diagrammatical view of the pressure fluid control system as applied to the rock drill mounting shown in FIGS. 5–7.

Since the invention does not reside in the entire rock drilling apparatus but in the mounting of the support for the rock drill on the outer end portion of the boom of the rock drilling apparatus, only that portion of the rock drilling apparatus is shown and described, the other portion of the rock drilling apparatus being of a well-known conventional design. The mounting according to the invention, as shown in FIGS. 1, 2 and 3, and FIGS. 5, 6 and 7, is designated 10 and includes a commonly known type boom 12 (partly shown), an extension element in the form of a pinion gear 14 rigidly connected to the end portion of boom 12, and a rock drill supporting member 16 in the form of a housing mounted rotatably on pinion gear 14, the latter being provided at its outer end portions with suitable sleeve bearings 18 and 20 for rotation of the rock drill supporting member 16 about pinion gear 14. A locking member 22 is mounted on the free end of pinion gear 14 to cooperate with the corresponding end portion of the rock drill supporting member 16 to hold the supporting member against axial movement. The free end portion of the rock drill supporting member 16 is in the form of a yoke 24, which is suitably formed for attachment to a swivel arrangement A upon which a rock drill (not shown) is mounted in a commonly known manner, see FIGS. 5 and 7.

A suitable gearing arrangement is provided to cause rotation of the rock drill supporting member 16, and therewith the rock drill swivel arrangement A, with respect to boom 12 to provide for adjustment of the drilling position of the rock drill (not shown). For this purpose pinion gear 14 connected to the outer end portion of boom 12 is engaged by a meshing rack gear 26 positioned transversely of pinion gear 14. Rack gear 26 is positioned between and connected to two opposing pistons 28, 30 to form an integral unit therewith. This unit is slidably housed in a cylinder 32 positioned transversely of the axis of pinion gear 14 and forming an integral part of the housing or rock drill supporting member 16 within which also pinion gear 14 is disposed. Each piston 28, 30 is provided with an end face exposed to hydraulic motive fluid, such as oil, introduced at either end of cylinder 32 depending upon the direction in which rock drill supporting member 16 is desired to be rotated with respect to boom 12.

When pressurized fluid is admitted either into the right-hand side end portion of cylinder 32 or into the left-hand side end portion of cylinder 32, the resultant forces exerted by the pressurized fluid in either one of the end portions of cylinder 32 cause cylinder 32 and rack gear 26 to rotate about pinion gear 14. Since cylinder 32 forms an integral part of the housing or rock drill supporting member 16, rotation of cylinder 32 and rack gear 26 results in rotation of the rock drill supporting member 16 about pinion gear 14 providing for adjustability of the rock drill swivel arrangement A relative to the boom.

When a desired drilling position of the rock drill (not shown) is reached, a common expedient to hold the rock drill supporting member against rotary motion is to prevent movement of rack gear 26 relative to pinion gear

14 by preventing the hydraulic fluid in each end portion of cylinder 32 from escaping therefrom. However, since there is clearance between the mating teeth of the rack gear 26 and the pinion gear 14, movement of the rack gear relative to the pinion gear and, consequently, movement of the drill supporting member relative to the pinion gear are unavoidable. Accordingly, when the rock drill operates, an injurious chattering of the gear teeth is produced, which chattering is a result of the rapid collisions between the associated gear teeth.

By this invention means is provided to eliminate such collisons between the gear teeth by insuring that the associated mating gear teeth are held constantly in engagement with each other and locked against movement with respect to each other during operation of the rock drill (not shown). For this purpose a locking arrangement in the form of a second rack gear 34 is provided in meshing relationship with pinion gear 14 and positioned to cooperate with rack gear 26 to provide for constant engagement between the associated mating teeth of rack gear 26 and pinion gear 14.

As shown in FIGS. 1 and 2, a bore is provided in the unit formed by rack gear 26 and pistons 28, 30 to form cylinders 40, 40 to slidably accommodate pistons 36, 38, piston 36 being disposed within pistcn 28, and piston 38 within piston 30. The rack gear 34 is positioned between and connected to the opposing pistons 36, 38 to form an integral unit therewith, the teeth of rack gear 34 meshing with the teeth of pinion gear 14. The teeth of rack gear 26 are formed in two rows transversely spaced from each other to engage the outer end portions of the teeth of pinion gear 14. In this manner a space is formed between the two rows of teeth of rack gear 26 to provide for the teeth of the locking rack gear 34 to engage the intermediate portion of pinion gear 14. Two passages 96 and 97 are formed in the wall of cylinder 40, passage 96 to communicate the cylinder space to the right of piston 28 with the cylinder space to the left of piston 38, and passage 97 to communicate the cylinder space to the left of piston 30 with the cylinder space to the right of piston 36, see FIG. 4. The purpose of passages 96, 97 will appear hereinafter.

A suitable hydraulic arrangement, as shown schematically in FIG. 4, is provided to adjust the position of the rock drill swivel arrangement A as well as to lock the associated gears against movement relative to each other to prevent backlash of the gears. The hydraulic arrangement comprises a pump P driven by a motor M to pump hydraulic fluid from a tank T through a discharge conduit 80 to a directional valve V30. Directional valve V30 is of a commonly known manually operated type and is connected to conduits 80, 82, 88 and 92, the hydraulic fluid from discharge conduit 80 being directed selectively to either conduit 82 or conduit 88. The design of directional valve V30 is such that, when conduit 80 is communicated with conduit 82, conduit 88 is automatically communicated with conduit 92 which is connected to tank T, and, when conduit 80 is communicated with conduit 88, conduit 82 is automatically communicated with conduit 92 and tank T. Conduits 82 and 88 are connected to control valves V10, V20 which in turn are connected to the end portions of cylinder 32. Each control valve V10, V20 includes a spring-loaded ball type check valve and an operatively related spring loaded piston P10, P20, respectively, each piston having opposing pressure surfaces of different areas exposed to hydraulic fluid pressure to cause the piston to force the associated check valve into an open position when necesary, as will be explained hereinafter.

When the rock drill supporting member is to be adjusted and rotated in a clockwise direction, directional valve V30 is set to communicate the discharge conduit 80 of pump P with conduit 82, and to communicate conduit 88 with conduit 92 and tank T. Pressurized hydraulic fluid is conducted from conduit 80 to conduit 82, past the check valve in valve V20, to conduit 84 and into the right-hand side of cylinder 32. The pressurized fluid within the space to the right of piston 28 is further conducted through passage 96 to the space to the left of piston 38. Since the hydraulic fluid present in the space to the left of piston 30 is permitted to flow freely into tank T, as will be explained hereinafter, the action of the pressurized fluid within the space to the right of piston 28 results in cylinder 32 and the associated pistons and rack gears to rotate about pinion gear 14 in a clockwise direction, causing the space to the right of piston 28 to increase while the space to the left of piston 30 decreases. During clockwise rotation of rack gear 34 about the pinion gear, the space to the left of piston 38 increases while the space to the right of piston 36 decreases. The hydraulic fluid present in the decreasing spaces to the left of piston 30 and to the right of piston 36 is returned to tank T by flowing through passage 97 and conduit 86 and into valve V10 past the check valve therein. The check valve is held in an open position by piston P10 which is actuated by pressurized fluid conducted to valve V10 from conduits 82 and 98. From valve V10 the return fluid is conducted through conduits 88 and 92 into tank T.

When a desired drilling position is reached, directional valve V30 is closed to prevent communication between conduits 82 and 88 with conduits 80 and 92, respectively, preventing the escape of hydraulic fluid from the spaces to the right of pistons 28, 36 and to the left of pistons 30, 38. Cylinder 32, which supports the rock drill, is prevented from rotary movement relative to pinion 14 and boom 12. It is to be noted that the pressurized fluid in the space to the right of piston 28 urges piston 28 to the left causing rack gear 26 to engage pinion gear 14 from the right, while the pressurized fluid in the space to the left of piston 38 urges piston 38 to the right causing rack gear 34 to engage pinion gear 14 from the left. With the arrangement of constantly engaging pinion gear 14 by two opposing forces, movement of rack gears 26 and 34 relative to pinion gear 14 is prevented and backlash of the associated gear teeth is eliminated.

When the rock drill supporting member is to be adjusted and rotated in a counter-clockwise direction, directional valve V30 is set to communicate the discharge conduit 80 of pump P with conduit 88, and to communicate conduit 82 with conduit 92 and tank T. Pressurized fluid is conducted from conduit 80 to conduits 88, 88, past the check valve in valve V10, conduit 86 and into the space to the left of piston 30. Pressurized fluid in the space to the left of piston 30 is further conducted through passage 97 into the space to the right of piston 36. Rotation of the rock drill support in a counterclockwise direction is effected and the spaces to the left of piston 30 and to the right of piston 36 increase while the spaces to the right of piston 28 and to the left of piston 38 decrease. Return flow of fluid from the decreasing space to the left of piston 38 is conducted through passage 96 into the space to the right of piston 28, the return flow of fluid from the decreasing space to the right of piston 28 being conducted to tank T by way of conduit 84, past the check valve in valve V20 which is held in an open position by the action of pressurized fluid admitted to valve V20 through conduits 94, 88, to actuate piston P20. From valve V20 the return fluid flows through conduit 82 and conduit 92 into tank T. When a desired drilling position is reached, directional valve V30 is closed to prevent the pistons and rack gears from movement relative to each other and relative to the pinion gear, as explained hereinbefore with respect to rotation of the rock drill support in a clockwise direction.

Another embodiment of the invention is shown in FIGS. 5, 6 and 7 in which the cylinder for the locking rack gear arrangement is positioned in a side-by-side relation with the cylinder for the rack gear arrangement for adjusting the position of the rock drill instead of the cylinder-within-

cylinder (or piston-within-piston) arrangement shown in FIGS. 1, 2 and 3. The arrangement of the pinion gear 14 and that part of housing 16 for the pinion gear as shown in FIGS. 5, 6 and 7 is identical to that described hereinbefore in connection with FIGS. 1, 2 and 3, the additional structure with respect to that shown in FIGS. 5, 6 and 7 being as follows: Two cylinders 32' and 40' are positioned side by side as a unit and connected transversely to the housing for pinion gear 14 to form an integral part therewith. Within cylinder 32' are slidably disposed two opposing pistons 28', 30' with a rack gear 26' positioned therebetween to engage one outer end portion of pinion gear 14. Within cylinder 40' are slidably disposed two opposing pistons 36', 38' with a rack gear 34' positioned therebetween to engage the other outer end portion of pinion gear 14.

A suitable hydraulic arrangement, as shown schematically in FIG. 8, is provided to adjust the position of the rock drill as well as to lock the associated gear teeth against movement relative to each other to prevent backlash of the gear. The hydraulic arrangement comprises a pump P driven by a motor M to pump hydraulic fluid from a tank T through a discharge conduit 52 to a directional valve V5. Directional valve V5 is of a commonly known manually operated type and is connected to conduits 52, 54, 62 and 64, the hydraulic fluid from discharge conduit 52 being directed either to conduit 54 or conduit 62. The design of directional valve V5 is such that when conduit 52 is communicated with conduit 54, conduit 62 is automatically communicated with conduit 64 which is connected to tank T, and, when conduit 52 is communicated with conduit 62, conduit 54 is automatically communicated with conduit 64 and tank T. Conduits 54 and 62 are connected to control valves V1, V2, V3 and V4 which in turn are connected to the end portions of cylinders 32' and 40' to control the flow of hydraulic fluid thereto to actuate the rock drill supporting member as well as to lock the associated gear teeth against backlash. Each of the control valves V1, V2, V3 and V4 includes a spring-loaded ball type check valve and an operatively related spring-loaded piston P1, P2, P3 and P4, respectively, each piston having opposing pressure surfaces of different areas exposed to hydraulic fluid to provide for actuation of the associated check valve into an open position when necessary, as will be explained hereinafter.

When the rock drill supporting member is to be adjusted and rotated in a counter-clockwise direction, directional valve V5 is set to communicate conduit 52 with conduit 54 to conduct pressurized hydraulic fluid, and to communicate conduit 62 with conduit 64 to conduct return fluid to tank T. Pressurized hydraulic fluid flows from conduit 52 to conduits 54 and 56 past the ball check valve of valve V2 to conduit 58 and into the right-hand side end portion of cylinder 32'. Simultaneously, pressurized hydraulic fluid from conduit 54 is introduced into the left-hand side end portion of cylinder 40' by way of valve V1 past the check valve therein and conduit 68. As a result of the pressure of the pressurized hydraulic fluid exerted on the greater pressure area of piston 28' relative to the pressure area of piston 38', cylinder 32' and cylinder 40' as a unit with the rock drill supporting member move counter-clockwise about pinion gear 14 causing not only the space to the left of piston 30' but also the space to the left of piston 38' to decrease, thereby forcing out the hydraulic fluid present in the space to the left of piston 30', and the pressurized hydraulic fluid present to the left of piston 38'. The pressurized fluid in the space to the left of piston 38' is forced into conduit 68 and is permitted to flow past the check valve in valve V1 because the check valve is forced into an open position by piston P1 of valve V1, piston P1 being forced to the left as a result of introducing pressurized fluid from conduit 54 through conduit 67 to the greater pressure area on the right-hand side of the piston P1 relative to the pressure area adjacent the check valve. The pressurized fluid from conduit 68 flows past the check valve in valve V1 into conduit 56 to be recirculated past the check valve in valve V2, conduit 58 and into the increasing space to the right of piston 28'. The return fluid present in the decreasing space to the left of piston 30' flows through conduit 60 into valve V4 past the check valve which is held in an open position by the pressurized fluid conducted from conduit 58 through conduit 66 into valve V4 to cause piston P4 to hold the check valve in an open position. From valve V4 the hydraulic fluid flows through conduit 62, valve V5 into conduit 64 and tank T. As the space to the right of piston 36' is increasing, the hydraulic fluid therein is supplemented by drawing in hydraulic fluid from tank T by way of conduit 64, valve V5, conduit 62, past the check valve in valve V3, and conduit 70.

After a predetermined drilling position is reached, valve V5 is closed to prevent communication between conduits 54 and 52, and between conduits 62 and 64. The pressurized fluid in the spaces to the right of piston 28' and to the left of piston 38' and the return fluid to the right of piston 36' and to the left of piston 30' are trapped therein preventing backlash by maintaining constant opposing forces on pistons 28' and 38' for a constant engagement between the mating teeth of rack gears 26', 34'.

When the rock drill supporting member is to be rotated in a clockwise direction, valve V5 is adjusted to communicate conduit 52 with conduit 62, and to communicate conduit 64 and tank T with conduit 54. Pressurized hydraulic fluid is conducted to conduit 62, past the check valve in valve V4, to conduit 60, and into the left-hand side end portion of cylinder 32'. Simultaneously, pressurized fluid is conducted from conduit 62 past the check valve in valve V3 through conduit 70 and into the right-hand side end portion of cylinder 40' for creating the opposing forces to prevent backlash as hereinbefore explained with respect to counter-clockwise rotation of the rock drill supporting member. As cylinders 32', 40' rotate clockwise about the pinion gear, the spaces to the left of pistons 30' and 38' increase while the spaces to the right of pistons 28' and 36' decrease. The pressurized fluid being forced out of the decreasing space to the right of piston 36' is conducted through conduit 70 into valve V3 past the check valve therein which is being held in an open position by piston P3, then to valve V4 past the check valve therein and through conduit 60 into the increasing space to the left of piston 30'. Return fluid from the decreasing space to the right of piston 28' is conducted through conduit 58 into valve V2 past the check valve therein which is being held in an open position by piston P2, then to conduits 56, 54 and into tank T by way of valve V5 and conduit 64. The hydraulic fluid in the increasing space to the left of piston 38' is supplemented by drawing in fluid from tank T by way of conduit 64, valve V5, conduit 54, past the check valve in valve V1, and conduit 68. When a desired drilling position is reached, valve V5 is closed to prevent communication between conduits 62 and 52, and between conduits 64 and 54 to maintain the constant opposing forces on pinion gear 14 for the prevention of backlash as explained hereinbefore.

Thus by the above construction are accomplished among others the objects hereinbefore referred to.

While two preferred embodiments of the invention are shown and described, it is understood that various changes and modifications may be made therein without departing from the scope of the invention.

I claim:

1. A transmission mechanism for a rock drill mounting having a drill support member mounted on a boom for movement relative to the latter, said transmission mechanism comprising:

(*a*) a pinion rigidly connected to the boom member and axially aligned therewith,

(*b*) a casing connected to the rock drill support mem-

ber and rotatably mounted on said boom member to rotate about said pinion,

(c) a first rack positioned in said casing and connected to two opposing pistons,

(d) said first rack being in mesh with said pinion,

(e) a first pair of opposing cylinders for the pistons of said first rack formed in said casing,

(f) a second rack positioned in said casing in meshing relationship with said pinion and mounted between and connected to two opposing pistons, both of said racks being located to simultaneously engage the same teeth on said pinion,

(g) each of said pistons associated with said first rack having a coaxial bore to form opposing cylinders for said pistons associated with said second rack,

(h) a groove formed in said first rack to receive said second rack, and

(i) means for controlling the flow of the pressure fluid to said cylinders and for causing said first rack to urge said pinion in one direction and effect rotation of said casing and said rock drill support member in the opposite direction, and for causing said second rack to urge said pinion in said opposite direction to prevent the backlash of said racks relative to said pinion.

2. The device claimed in claim 1 in which:

(a) said means to conduct the pressure fluid to said cylinders includes passage means to communicate the cylinder associated with the piston connected to one end of said first rack with the cylinder formed in the piston connected to the other end of said first rack and to communicate the cylinder associated with the piston connected to said other end of said first rack with the cylinder formed in the piston connected to said one end of said first rack.

3. A transmission mechanism for a rock drill mounting having a drill support member mounted on a boom for movement relative to the latter, said transmission mechanism comprising:

(a) a pinion rigidly connected to said boom member and axially aligned therewith,

(b) a casing connected to the rock drill support member and rotatably mounted on said boom member to rotate about said pinion,

(c) a first rack positioned to mesh with said pinion and mounted between two opposing pistons to form a unit therewith,

(d) a first pair of opposing cylinders for the pistons of said first rack formed in said casing,

(e) a second rack positioned to mesh with said pinion and mounted between two opposing pistons to form a unit therewith,

(f) each of said pistons associated with said first rack and having a coaxial bore to form opposing cylinders for said pistons associated with said second rack,

(g) a groove formed in said first rack to receive said second rack,

(h) passage means to communicate the cylinder associated with the piston connected to one end of said first rack with the cylinder formed in the piston connected to the other end of said first rack and to communicate the cylinder associated with the piston connected to said other end of said first rack with the cylinder formed in the piston connected to said one end of said first rack, and

(i) means for controlling the flow of the pressure fluid to one of said cylinders and the associated piston of said first rack to cause said first rack to urge said pinion in one direction and thereby effect rotation of said casing and said rock drill support member in the opposite direction, and simultaneously controlling the flow of the pressure fluid to one of said cylinders and the associated piston of said second rack to cause said second rack to urge said pinion in said opposite direction and maintain engagement between the associated teeth of said racks and said pinion and thus prevent the backlash of said racks relative to said pinion.

4. A transmission mechanism comprising:

(a) a pinion rotatably mounted on a support;

(b) a casing mounted on the support to house said pinion;

(c) a rack in said casing positioned to mesh with said pinion;

(d) a first double-acting hydraulic motor in said casing operatively associated with said rack to urge said rack in one direction to cause said casing to rotate in the opposite direction about said pinion;

(e) a second rack in said casing positioned to mesh with said pinion;

(f) both of said racks being located to simultaneously engage the same teeth on said pinion;

(g) a second double-acting hydraulic motor in said casing operatively associated with said second rack to urge said second rack in engagement with said pinion, said second hydraulic motor being able to apply substantially less force to said second rack than said first hydraulic motor applies to said first rack when both motors are supplied with equal hydraulic pressures; and

(h) control means for said motors to effect the urging of said racks simultaneously in opposite directions relative to each other and relative to said pinion and thereby maintain engagement between the associated teeth of said racks and said pinion to prevent the backlash of said racks relative to said pinion while said first hydraulic motor overcomes said second motor and causes the pinion to rotate relative to said support.

5. A transmission mechanism comprising:

(a) a pinion rotatably mounted on a support;

(b) a casing mounted on the support;

(c) a first rack positioned in meshing relationship with said pinion and mounted between and connected to two opposing pistons;

(d) a first pair of opposing cylinders for the pistons of said first rack formed in said casing;

(e) a second rack positioned in meshing relationship with said pinion and mounted between and connected to two opposing pistons;

(f) both of said racks being located to simultaneously engage the same teeth on said pinion;

(g) a second pair of opposing cylinders for the pistons of said second rack formed in said casing;

(h) means to conduct pressure fluid to said cylinders; and

(i) means for controlling the flow of the pressure fluid to said cylinders to urge said first rack in one direction against the pinion and to simultaneously urge said second rack in the other direction against said pinion with a differential force relative to said first rack whereby one of said racks overcomes the opposing force of the other rack to cause said pinion to rotate while preventing the backlash of said racks relative to said pinion.

6. The transmission mechanism of claim 5 wherein:

(a) the opposing pistons of said second rack have a substantially smaller hydraulic actuating area than the pistons of said first rack so that the application of equal hydraulic pressures to the pistons of both racks causes the first rack to overcome the second rack to rotate said pinion.

7. The transmission mechanism of claim 6 wherein:

(a) said racks are mounted side-by-side in said casing.

8. The transmission mechanism of claim 6 wherein:

(a) said second rack is slidably mounted in said first rack.

9. The transmission mechanism of claim 8 wherein:

(a) said second pair of opposing cylinders is formed in said first rack.

10. The transmission mechanism of claim 9 wherein: (*a*) said first rack contains passages interconnecting each of the first pair of cylinders with a cylinder of the second pair of cylinders with the thus interconnected cylinders acting in opposite directions.

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