

[54] **PULLDOWN MECHANISM FOR ROTARY DRILL APPARATUS**

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[58] Field of Search **173/146, 43; 254/95, 96; 74/422, 242.1 FP**

[56] **References Cited**
UNITED STATES PATENTS

2,547,609	4/1951	Vanderzee	173/147 X
2,869,826	1/1957	Thornburg	173/147 X
3,645,343	2/1972	Mays	173/147 X

Primary Examiner—Ernest R. Purser

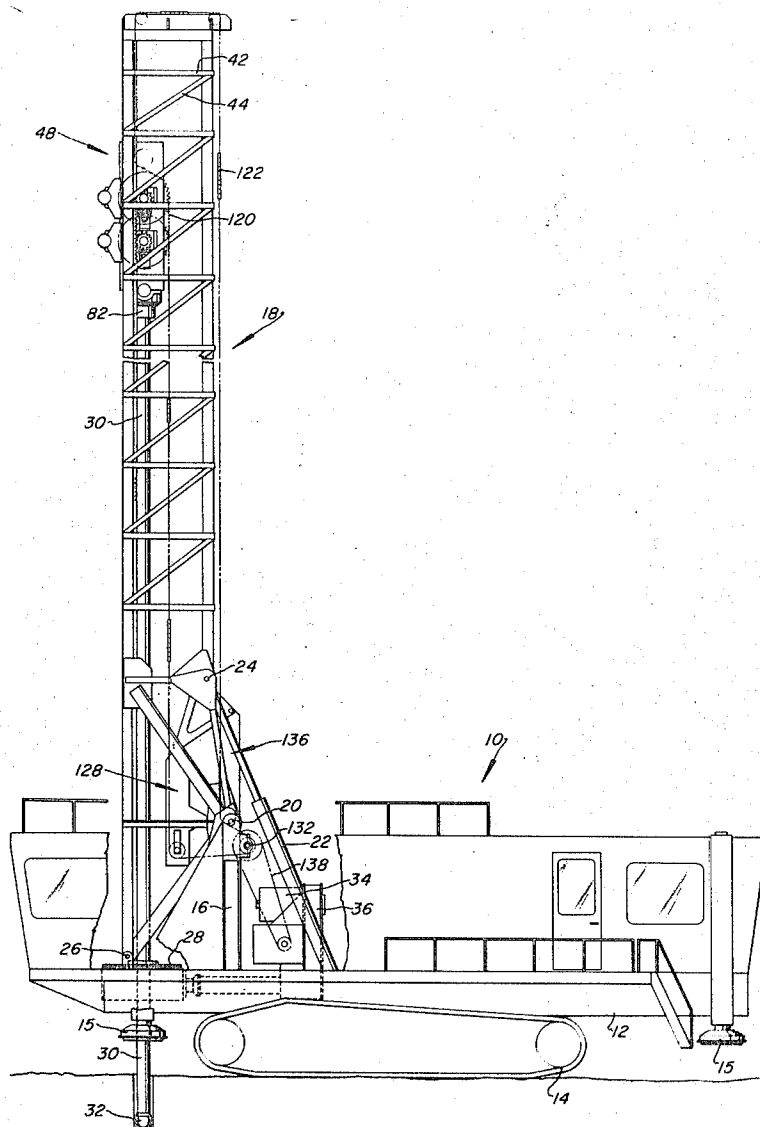
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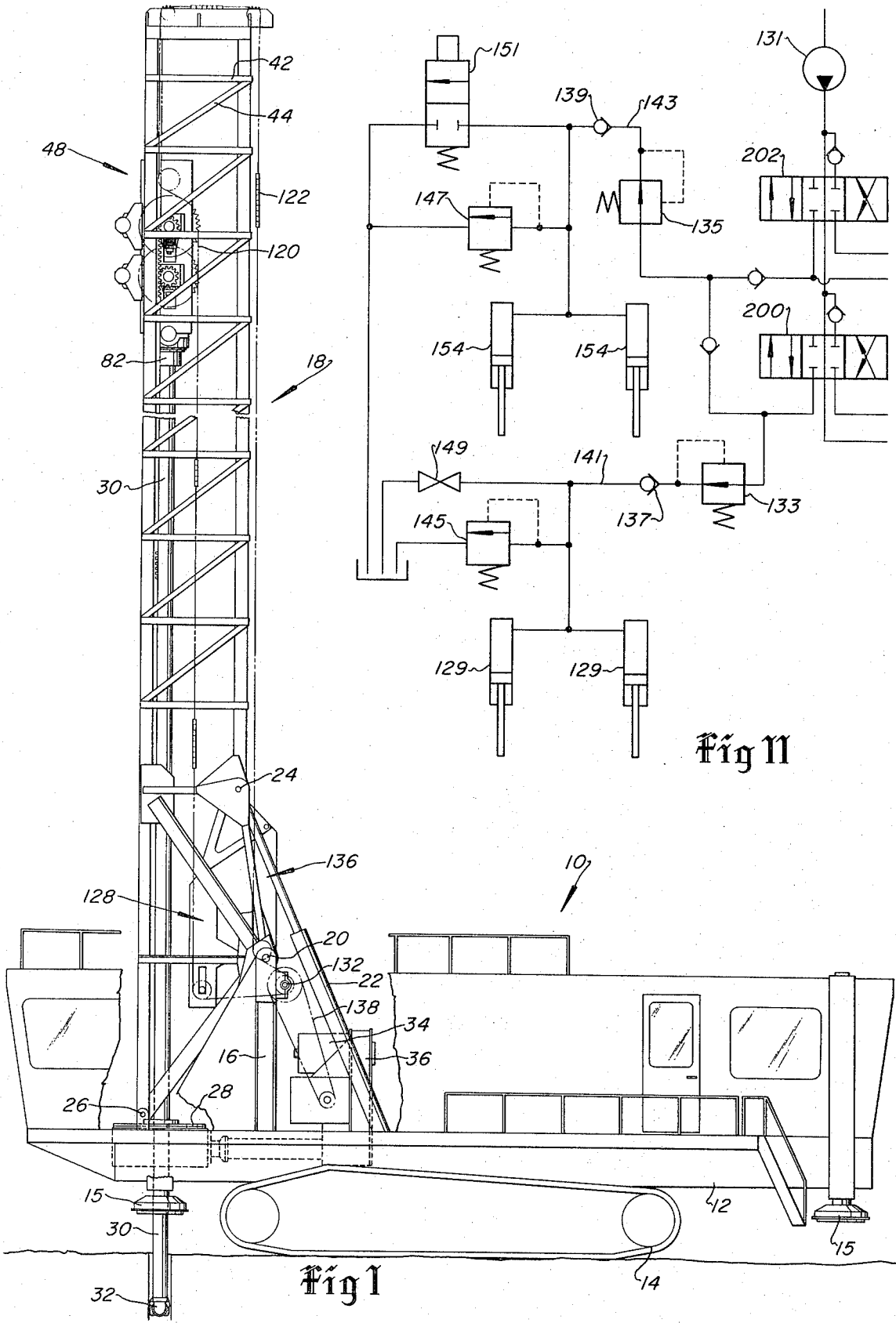
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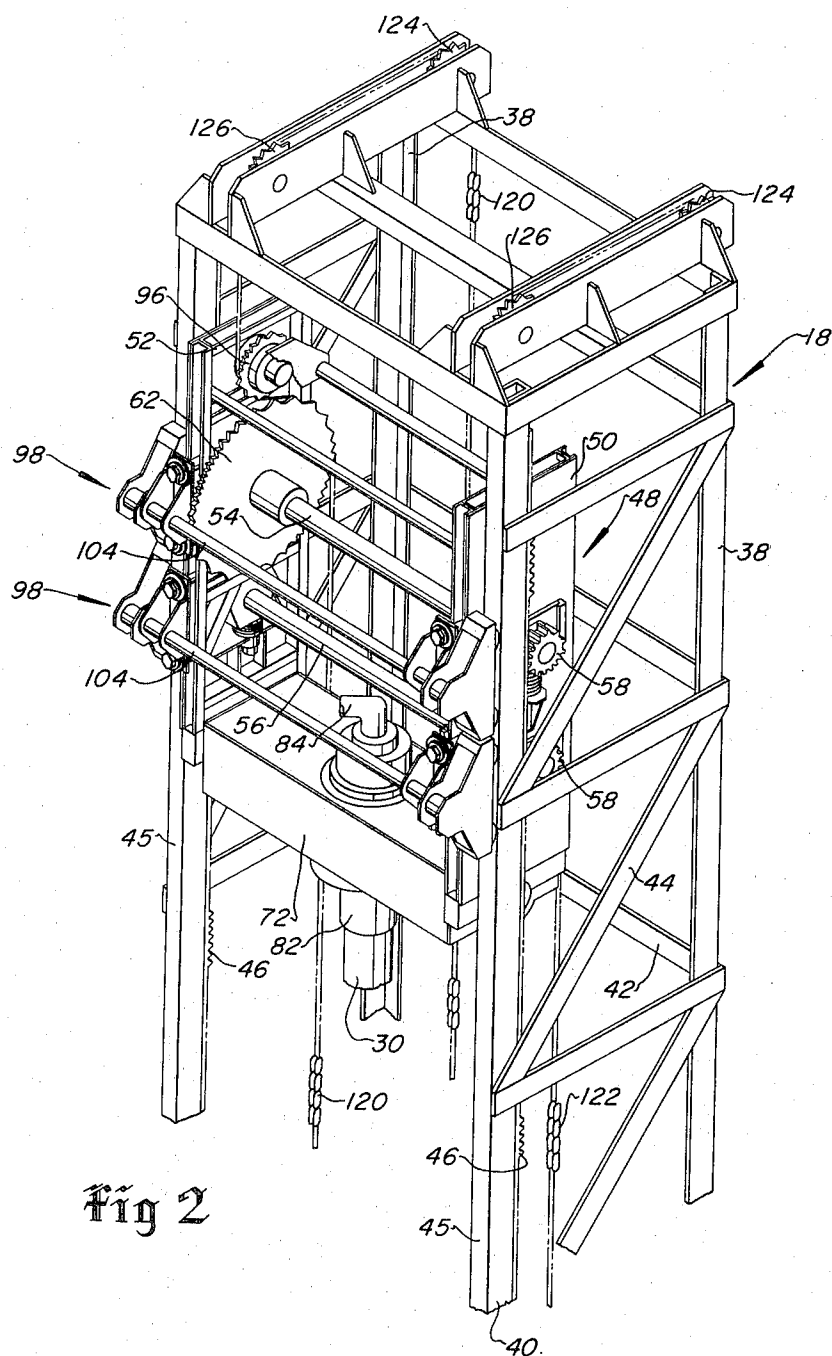
[57] **ABSTRACT**

A frame arranged to traverse a mast on a rotary drill apparatus for exerting an axial feed or pulldown force on a drill pipe and bit assembly and characterized by a pair of rotatable shafts each having two spaced apart pinions mounted thereon which are engaged with parallel gear racks mounted on the mast. The pinion shafts each have a sprocket mounted thereon driven by an endless chain connected to pulldown drive means mounted on the main deck of the apparatus. The pulldown chains are equally tensioned by a pair of hydraulic chain tensioning devices so that equal torque is exerted on the pinion shafts. The pinion shafts are spring mounted on the pulldown frame to compensate for misalignment of the gear racks with respect to each other.

12 Claims, 12 Drawing Figures







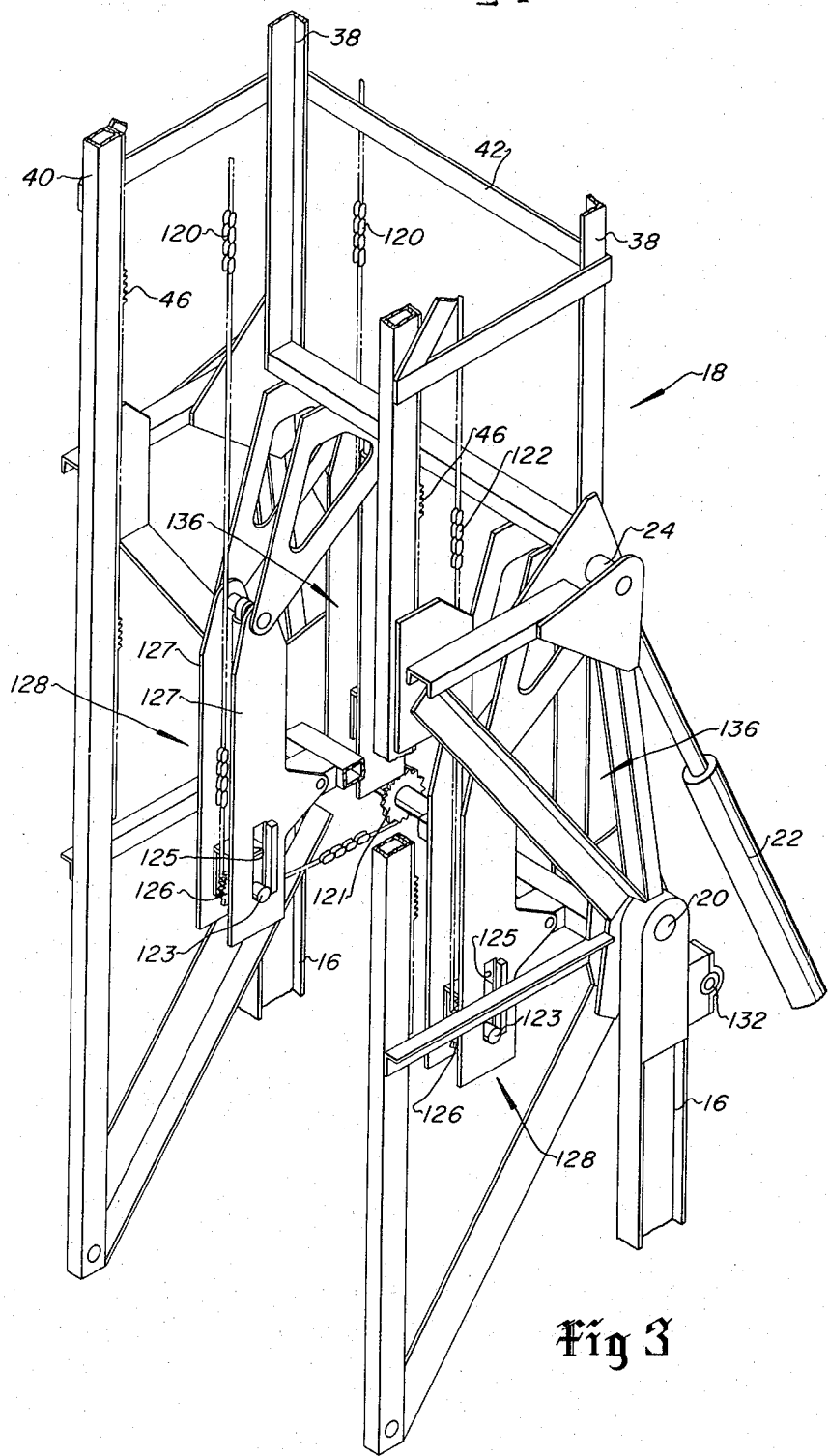
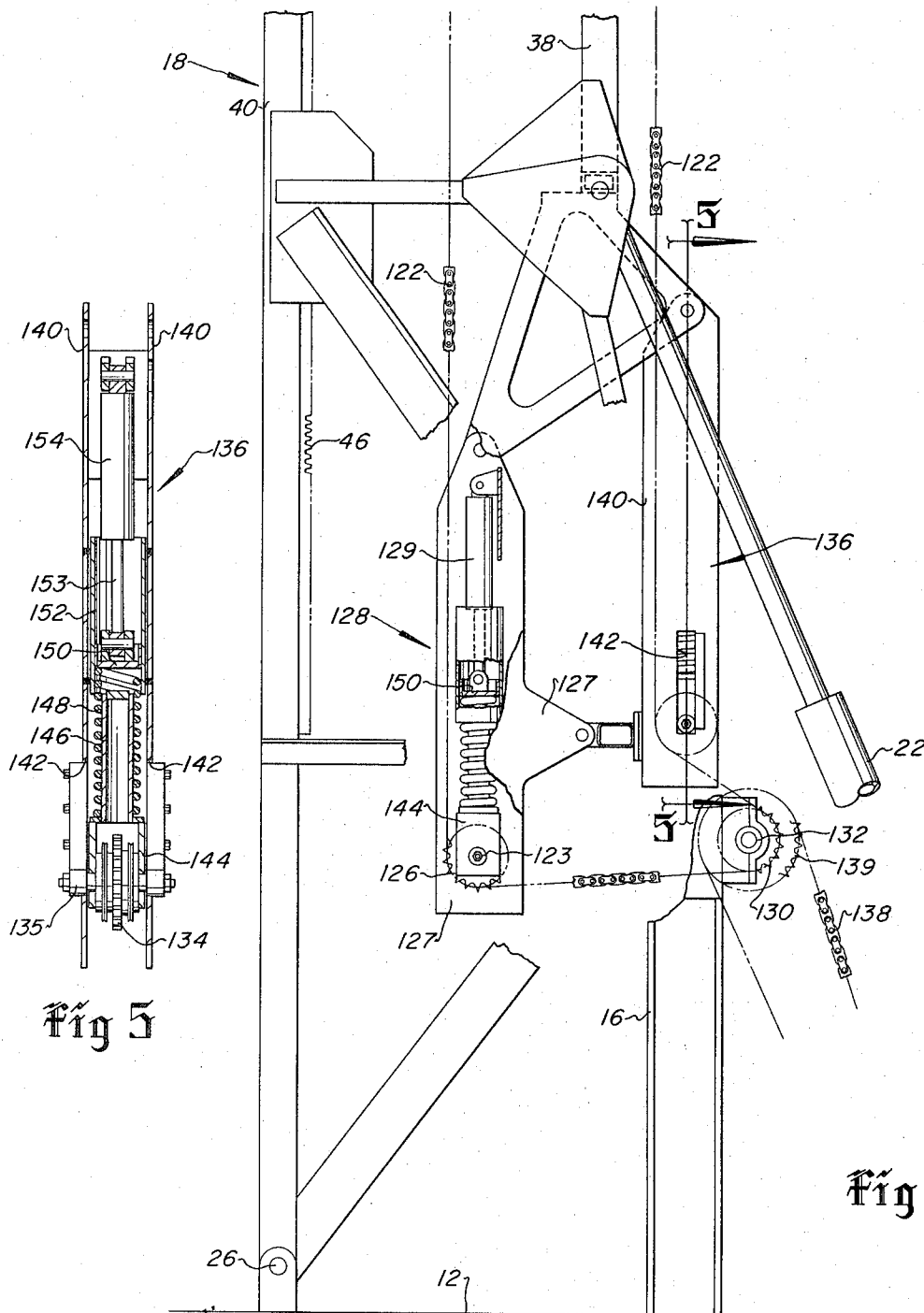
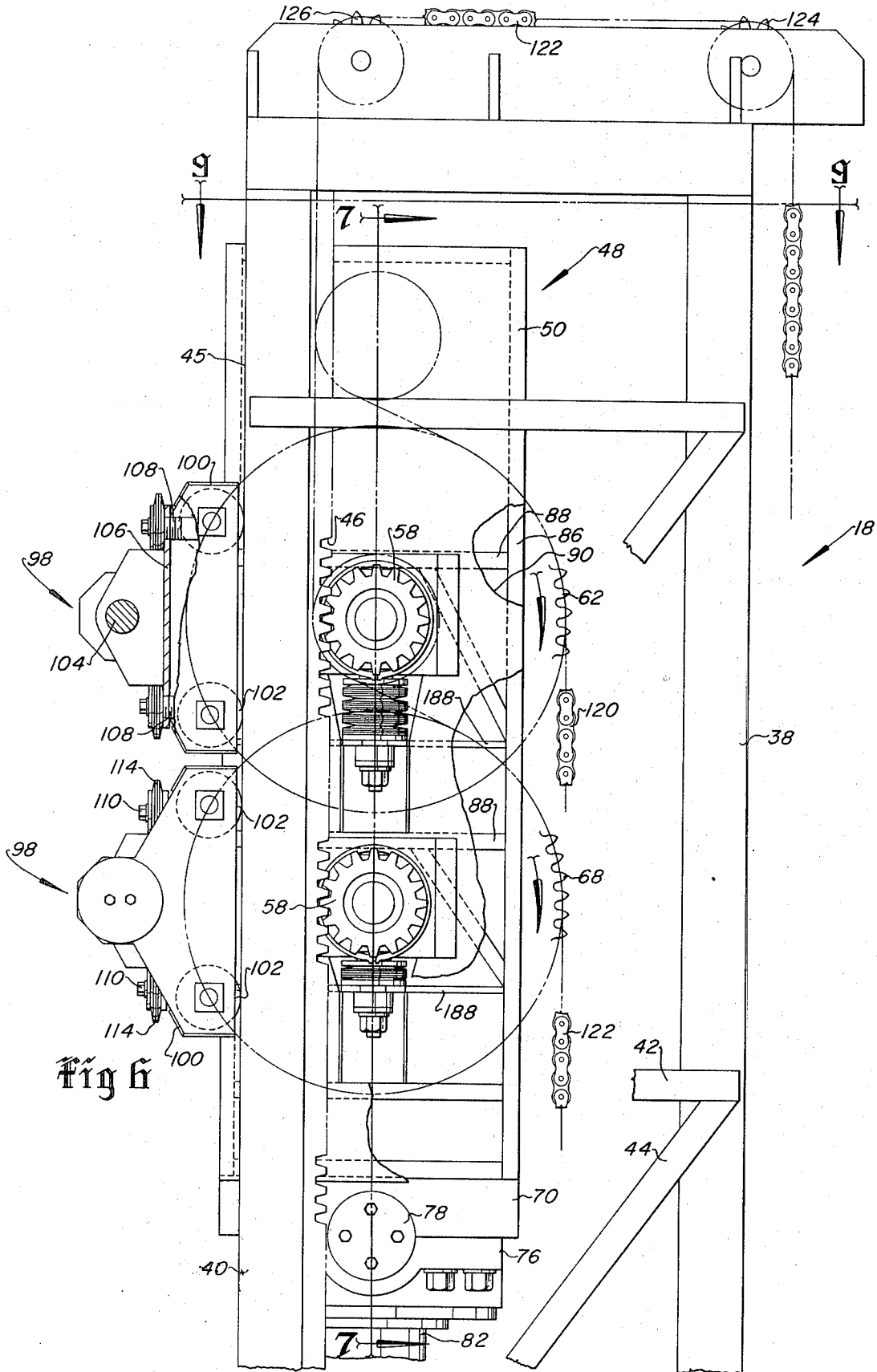
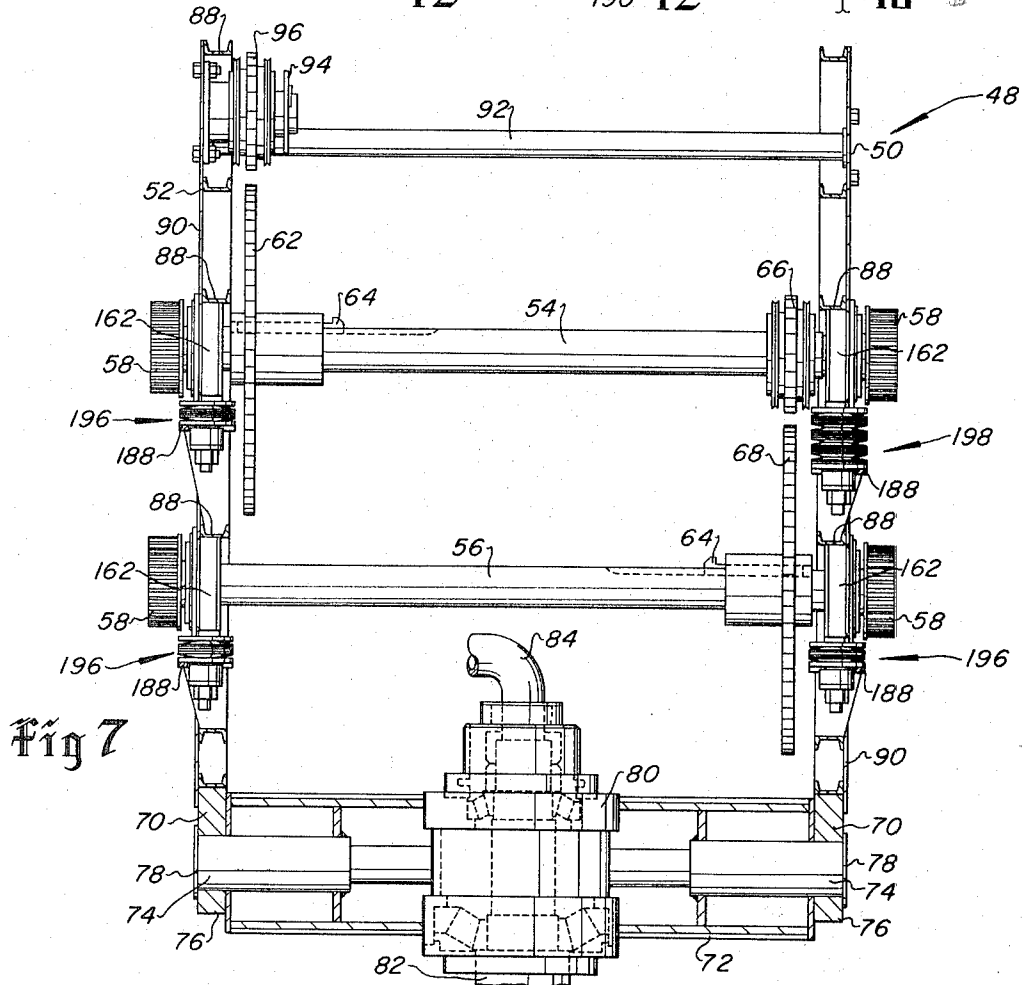
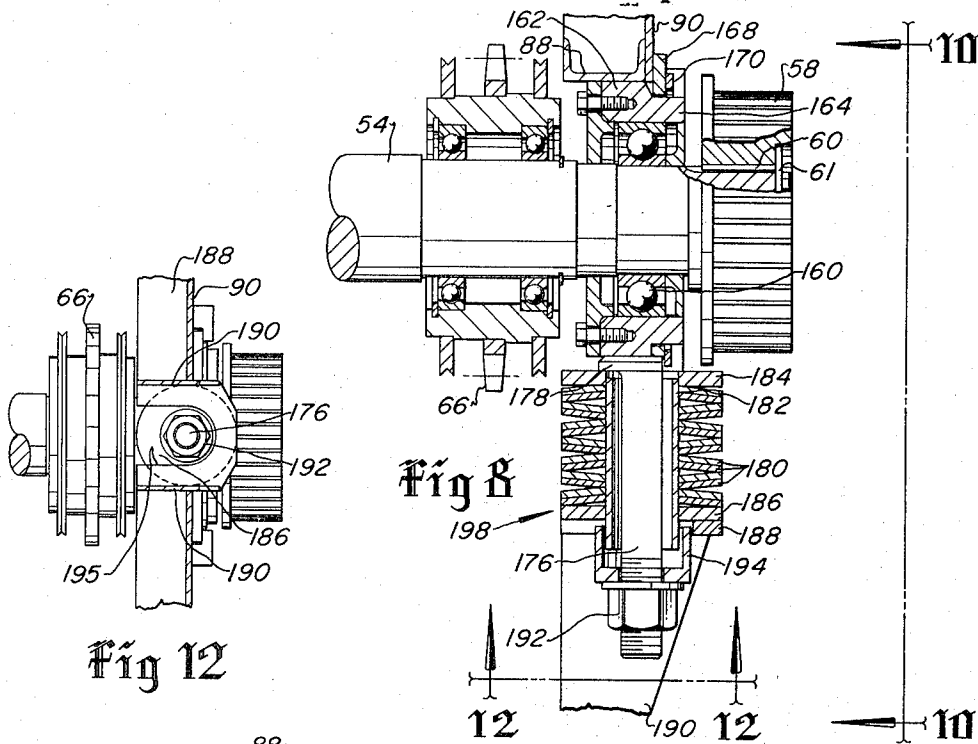


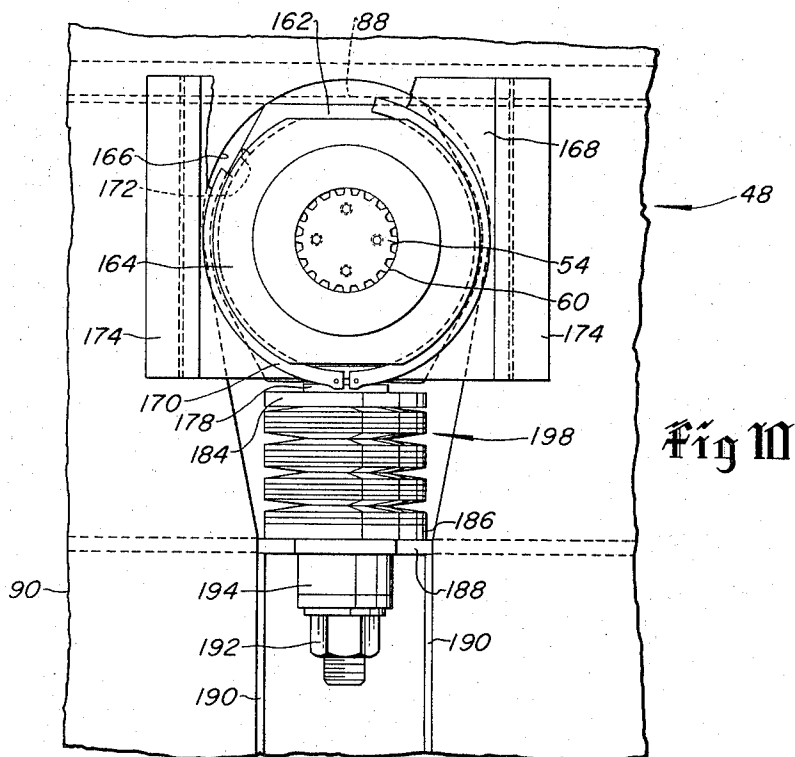
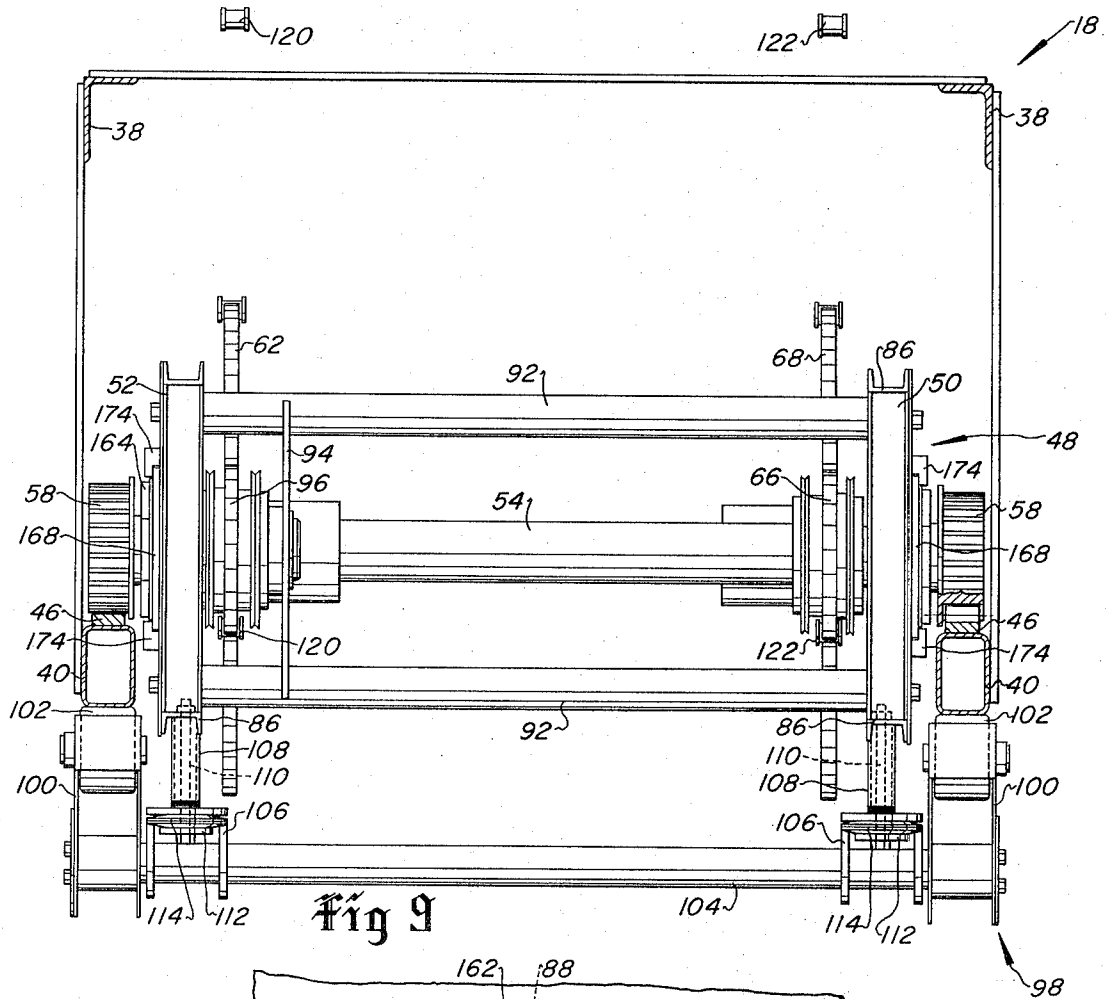
Fig 3





SHEET 6 OF 7





PULLDOWN MECHANISM FOR ROTARY DRILL APPARATUS

BACKGROUND OF THE INVENTION

In rotary earth drilling apparatus it is known to provide a frame or head which is guided for reciprocable traversal of a mast or drill tower and to which one end of the drill string is connected for exerting a feed or pulldown force on the drill string and for hoisting the drill string and bit out of the drill hole. Prior art arrangements of pulldown frames or drilling heads are exemplified in U.S. Pat. No. 2,869,826 to H. W. Thornburg; U.S. Pat. No. 3,181,630 to R. S. Coburn; and U.S. Pat. No. 3,198,263 to K. E. Reischl wherein the prime mover and drive mechanism for rotating the drill string are disposed on the traverse frame for movement therewith. The weight of motors and rotary drive mechanism added to the weight of the traverse frame plus the rotary drive reaction torque exerted on the mast or drill tower requires the mast structure itself to be quite heavy and of complex design in order to withstand the forces exerted thereon. With masts of relatively large rotary blast hole drills required to be from 50 to 100 feet in length the added stiffening members necessary for structural integrity is costly and the weight of the mast presents problems in the design of mast raising and lowering devices as well as keeping the entire rig stable when the mast is erect due to the great weight aloft.

The above problems in rotary drill apparatus design can be overcome to some extent by using rotary drive mechanism which is located on the main frame of the apparatus, such mechanism being generally known as a rotary table drive. Rotary table drives not only remove weight and reaction torque from being imposed on the mast but usually provide for somewhat simpler power transmission arrangements including using one prime mover for hoisting the drill string, driving the rotary table, and propelling the apparatus. Only in drilling apparatus where angle drilling is required do rotary table drives sometimes pose special problems in design.

Even with rotary table drives or similar arrangements it is desirable to further reduce the weight of the mast as much as possible to simplify the structural requirements thereof and to lower the center gravity of the entire drill apparatus. Since large axial feed or pulldown forces are necessary to produce desired drill hole forming or penetration rates longstanding problems have been associated with the design of the pulldown mechanism particularly when consideration is given to achieving a lightweight mast structure.

SUMMARY OF THE INVENTION

The present invention provides for a pulldown mechanism for a rotary drill apparatus which is capable of transmitting large pulldown forces to a drill string and bit assembly, but which is relatively lightweight and provides for a support or mast which may be a comparatively lightweight and uncomplicated structure.

The present invention also provides a pulldown mechanism for a rotary drill apparatus which may be advantageously used in combination with a rotary table drive arrangement to reduce the weight aloft on a drill mast or tower.

The present invention further provides a pulldown mechanism for an earth drill apparatus which is generally characterized by a pair of linear gear racks and co-

operable pinions providing for reciprocable linear traversal of a drill string with respect to a drill mast or tower and which mechanism includes means for substantially evenly distributing the pulldown forces between the two gear racks. The pulldown mechanism of the present invention is also characterized by an arrangement of rotating pinions engageable with a pair of spaced apart gear racks on a mast and including means to compensate for misalignment of the rack gear teeth to provide substantial equal distribution of the gear tooth loads resulting from the pulldown effort.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation of a rotary earth drilling apparatus including a pulldown mechanism in accordance with the present invention;

FIG. 2 is perspective view of the top portion of the mast and the pulldown mechanism of the apparatus of FIG. 1;

FIG. 3 is a perspective view of the lower portion of the mast of the drill apparatus of FIG. 1;

FIG. 4 is a side elevation of the lower portion of the mast partially cut away to illustrate the pulldown chain tensioning devices;

FIG. 5 is a section view taken along the line 5—5 of FIG. 4;

FIG. 6 is a side elevation of the pulldown mechanism showing some structural detail of the traverse frame;

FIG. 7 is a section view through the pulldown mechanism taken substantially along the line 7—7 of FIG. 6;

FIG. 8 is a detail section of one of the pinion shaft supports and is taken along the same line as the view of FIG. 7;

FIG. 9 is a view taken from line 9—9 of FIG. 6;

FIG. 10 is a view taken from line 10—10 of FIG. 8 with the pinion removed from the pinion shaft and a portion of the retainer plate and retainer ring cut away;

FIG. 11 is a hydraulic circuit diagram of the chain tensioning and tension equalizing cylinders; and,

FIG. 12 is a detail section view taken along line 12—12 of FIG. 8.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1, 2, and 3 the present invention is embodied in a rotary earth drilling apparatus or rig of the type used to drill large blastholes such as are required for large scale surface mining and mineral exploitation. The drill rig illustrated in FIG. 1 and generally designated by the numeral 10 comprises a frame 12 mounted for movement on crawlers 14. The frame 12 has a plurality of leveling jacks 15 connected thereto which are shown retracted but normally are lowered preparatory to drilling for leveling and supporting the rig 10. The frame 12 includes support means 16 for supporting an elongated mast 18 about a pivot 20. The mast 18 is adapted to be raised from a substantially horizontal position to the erect or working position shown by a pair of hydraulic cylinders 22 (one shown) connected to the frame 12 and to the mast 18 at pivot 24. The mast 18 is also secured in the erect position by suitable removable pin type connections 26.

The drill rig 10 is characterized by a rotary drive mechanism generally designated by numeral 28 which is mounted on the frame 12 and is adapted to rotate a drill string comprising an elongated drill pipe 30 and a removable bit portion 32 attached to the lower end of

the drill pipe. The rotary drive mechanism may be constructed generally in accordance with well known principles of design for such devices and may be adapted to be driven by a motor 34 by way of suitable power transmission means 36 also mounted on the frame 12.

The mast 18 basically comprises four elongated posts, two of which are preferably formed from structural steel angle sections 38 and two of which are preferably formed of steel rectangular tubing sections 40. The posts 38 and 40 are tied together by plural respective transverse and diagonal bracings 42 and 44. The longitudinal front side of the mast between the pair of posts 40 is open. The mast 18 primarily serves as a support and guide means for a pulldown mechanism to be described herein which is connected to the drill pipe 30 and is adapted to traverse the mast 18 for exerting an axial feed or pulldown force on the drill pipe and for withdrawing the pipe from the drill hole. The rearwardly facing sides of the posts 40 each have elongated parallel gear racks 46 fixed thereon which extend a substantial distance along the mast form the topmost portion thereof.

Referring to FIGS. 2 and 6 through 10 the pulldown mechanism is generally characterized by a traverse frame 48 comprising spaced apart panels 50 and 52 constructed to rotatably support a pair of spaced apart and parallel shafts 54 and 56. The shaft 54 extends at its opposite ends through the respective panels 50 and 52 and has two flanged pinions 58 fixed thereto by interengageable splines 60 as shown in FIGS. 8 and 10. The pinions 58 are retained on shaft 54 by plates 61 suitably removably fastened to the shaft end. A large chain sprocket 62 is fixed on shaft 54 by suitable key means 64 as shown in FIG. 7, and a smaller sprocket 66 is rotatably mounted on said shaft inboard of panel 50. The shaft 56 also extends at its opposite ends through the panels 50 and 52, and also has two pinions 58 similarly fixed thereto. The shaft 56 also has a relatively large chain sprocket 68 fixed thereon and aligned with the sprocket 66 on shaft 54. As shown in FIGS. 2, 6 and 9 the pinions 58 are engageable with gear racks 46 for traversal of the frame 48 along the mast 18.

The lower ends of the frame panels 50 and 52 include plate members 70 formed to support a boxlike yoke 72 which includes a pair of laterally extending trunnions 74. The yoke 72 is retained in assembly with the panels 50 and 52 by suitable bearing caps 76 fastened to the members 70. The yoke 72 is adapted for limited oscillatory motion about the trunnion axes and suitable end caps 78 on the trunnions 74 also hold the yoke 72 and panels 50 and 52 assembled. The yoke 72 includes a housing portion 80 which includes suitable bearing means for rotatably supporting a shank portion 82 connected to the upper end of the drill pipe 30. Pressure fluid for hole cleaning purposes is introduced into the upper end of the drill pipe by way of a conduit 84 connected to the housing 80 and in communication with the shank.

The panels 50 and 52 are each constructed of conventional structural metal shapes including longitudinal channel portions 86 and a plurality of transverse members 88 fastened together, such as by welding, into a substantially rigid assembly. Each panel is covered by a plate 90 on its outwardly facing longitudinal side. The panels 50 and 52 are interconnected near their top ends by tie rod members 92 which have mounted thereon a support plate 94 for partially supporting a ro-

tatable sprocket 96. The sprocket 96 is mounted in vertical alignment with the sprocket 62.

The panels 50 and 52 are also interconnected by a pair of roller truck assemblies 98 which serve to hold the pinions of the pulldown mechanism engaged with the gear racks 46. Referring to FIGS. 6 and 9 the truck assemblies 98 each have support members 100 upon which are mounted pairs of rollers 102 engaged to roll along track surfaces 45 formed by the outwardly facing sides of the mast posts 40 opposite the gear racks 46. The roller support members 100 of each truck assembly are interconnected by a shaft 104 pivotally secured to the support members at its opposite ends. The shaft 104 includes a pair of brackets 106 mounted thereon and generally aligned with spaced apart outstanding tubular members 108 attached to channel portions 86 of the panels 50 and 52. Elongated bolts 110 extend through the tubular members 108 and are secured to the channel portions 86 by suitable nuts. The bolts 110 also extend through the brackets 106 and washers 112 to hold captive therebetween a pair of series stacked conical disc or Belleville type springs 114. This arrangement provides a resilient mounting system for holding the pinions 58 in engagement with the gear racks 46 so that the pulldown mechanism may be operated to traverse the mast 18.

The arrangement of the pulldown mechanism of the present invention advantageously reduces the weight and concomitant structural requirements of the mast 18 by utilizing the parallel shafts 54 and 56 with two pinions 58 on each shaft to transfer the pulldown force from the gear racks 46 to the drill pipe 30. By using two pinion shafts which substantially equally share the load between the pulldown mechanism and the mast 18 the width of each gear rack 46 is required to be only half as great as would be required if the entire pulldown force were to be shared between a total of only two pinions. The savings in mast weight and cost is substantial by the use of the gear racks 46 versus racks which would be required to be twice as wide in order to withstand the gear tooth loads of only one pinion engaged with each rack.

With particular reference to FIGS. 1, 2, 3, 4, 6, and 9 the pulldown mechanism of the present invention further includes drive means for transmitting pulldown and hoisting forces to the pinion shafts 54 and 56, said drive means including a pair of elongated flexible roller chains 120 and 122. The chain 122, which forms a closed loop, is trained over sprockets 124 and 126 on top of the mast 18 then to engagement with sprocket 66 and sprocket 68, then downwardly to engagement with a sprocket 126, FIG. 4, which is mounted on a tensioning device 128 mounted on the mast 18, then around a sprocket 130 drivenly mounted on a rotatable shaft 132, and finally around a sprocket 134 mounted on a chain tensioning device 136 also mounted on the mast 18. The chain 120 which also forms a closed loop is similarly trained over sprockets on top of the mast, and is engaged with sprocket 96 and the sprocket 62 on the shaft 54. Chain 120 is also engaged with a sprocket 126 rotatably mounted on a second tensioning device 128. The chain 120 is further engaged with a sprocket 121, similar to sprocket 130, and mounted on shaft 132, and chain 120 also finally engaged with a second tensioning device 136 identical to the device engaged with chain 122. As shown in FIG. 4 the shaft 132 is rotatably mounted on the support means 16 and is driven

by chain 138 connected to the transmission 36 and a sprocket 139 fixed on the shaft whereby the pulldown and hoist chains 120 and 122 may be reversibly driven to transmit rotary torque to the pinion shafts 54 and 56.

The chains 120 and 122 are adapted to impose substantially equal torque to the pinion shafts 54 and 56 thanks to the tensioning devices 128. Referring to FIGS. 4 and 5 the tensioning devices 128 and 136 are virtually identical in construction as exemplified by the respective cutaway and section views. Referring to FIG. 5 the tensioning device 136 includes support means comprising spaced apart plates 140 mounted on the mast 18. The sprocket 134 is rotatably mounted on a shaft 135 disposed for limited vertical movement in slots 142. The shaft 135 is mounted on an inverted U-shaped bracket 144 which has a tubular extension 146 serving as a guide for a coil spring 148. The upper end of the coil spring 148 is engaged with a plate 150 which is guided for reciprocal movement within a cylindrical tube 152, the latter being fixed to the support plates 140. The plate 150 is connected to the end of a piston rod 153 of a pressure fluid cylinder 154 disposed between the support plates 140. The tensioning devices 128, which are constructed in substantially the same way as the tensioning devices 136, are operable to provide for substantially equal pulldown forces to be exerted on the chains 120 and 122 due to their arrangement in a hydraulic pressure fluid circuit shown schematically in FIG. 11. The sprockets 126 include shaft portions 123 mounted between support plates 127 which have elongated slots 125 to permit limited longitudinal movement of the sprockets. When the chains 120 and 122 are assembled with the tensioning devices 128 the chain length is adjusted so that the sprocket shafts are permitted to move in the slots 127 to tension the chains under load. The tensioning devices 128 have pressure fluid cylinders 129 similar to the cylinders 154 which are interconnected in a hydraulic pressure fluid circuit to exert equal forces on the sprockets 126 and thereby provide for substantially equal tension in the chains 120 and 122. Since the pitch diameters of sprockets 62 and 68 are equal then it follows that equal torques are imposed by the pulldown chains on the pinion shafts 54 and 56.

Referring to FIG. 11 a schematic diagram of a preferred form of a hydraulic circuit is shown. The circuit includes a pump 131 which, by way of operation of suitable three position valves 200 and 202, supplies pressure fluid to pressure reducing valves 133 and 135. The valves 200 and 202 are respectively operable to control other devices on the apparatus 10, for example the jacks 15 and the mast raising cylinders 22. The output line of the pressure reducing valve 133 supplies pressure fluid to the pair of cylinders 129 and the output line of valve 135 supplies pressure fluid to the pair of cylinders 154. The cylinders 129 are fluid connected in parallel as are the cylinders 154. Suitable check valves 137 and 139 are disposed in the supply lines 141 and 143 leading to the respective pairs of cylinders. Pressure relief valves 145 and 147 are respectively in communication with the supply lines 141 and 143. The pressure relief valves 145 and 147 provide simple and effective means for preventing an overpressure failure of the hydraulic circuit or breakage of the pulldown chains 120 and 122 if the tension loads thereon should exceed a predetermined limit. A manually controlled shutoff valve 149 is provided for bleeding fluid from

the cylinders 129 when chain shortening or replacement is required, and a two-way valve 151 is provided for bleeding fluid from the cylinders 154. The valve 151 may be suitably adapted to be automatically or manually opened in conjunction with operation of the hydraulic cylinders 22 to lower the mast 18. This conjoint operation is required to provide for bleeding fluid from the cylinders 154 to allow their piston rods to retract and the sprockets 134 to move to compensate for changes in the chain path length between the shaft 132 and the sprockets 126 and 134 when the mast is moved about the pivot 20.

When the chains 120 and 122 are being driven to produce a pulldown force on the traverse frame 48 and drill pipe 30 they are tensioned from the sprockets 62 and 68 downwardly to sprockets 126 and to the drive sprockets on shaft 132. Accordingly, the parallel fluid supply circuit arrangement or interconnection between the two cylinders 129 as shown in FIG. 11 provides for equal fluid pressures therein and hence equal tension forces to be exerted on the two chains 120 and 122 so that equal torques are exerted on the shafts 54 and 56. The chain tensioning and equalizing system disclosed herein also provides for pretensioning the chains so that even under heavy operating loads a light tensioning of the slack portion of the chains is maintained.

The pinion shafts 54 and 56 are mounted on the traverse frame 48 in such a way that the forces acting on the pinion and rack teeth are substantially equal for all the pinions under the condition of maximum pulldown force being transmitted to the drill pipe 30. Moreover, each pinion is subjected only to a predetermined maximum gear tooth load regardless of irregularities in the alignment of the gear teeth on one of the racks 46 with respect to the other rack. Referring again to FIGS. 6 through 10 the pinion shafts 54 and 56 are rotatably disposed adjacent their opposite ends on bearings 160, as shown by way of example in FIG. 8, which are supported in bearing housings 162. The bearing housings 162 are resiliently mounted on the panels 50 and 52 and include portions 164 which project through openings 166, FIG. 10, in the plates 90. The bearing housings 162 are retained from undergoing displacement from the panels by retainer plates 168 which are disposed over the bearing housing portions 164. The plates 168 are retained on the bearing housings 162 by suitable retaining rings 170 disposed in grooves 172 on the housing portions 164. The retaining plates 168 are retained for longitudinal movement on the exterior of the panels 50 and 52 by means of spaced parallel guides 174 fixed to the plates 90 as shown in FIGS. 9 and 10.

The bearing housings 162 are each resiliently biased into engagement with the transverse members 88 of the panels of the traverse frame 48 by a spring assembly which, as shown by example in FIG. 8, comprises an elongated bolt 176 having a flanged head 178 engaged with the lower side of the bearing housing. A plurality of conical disc or Belleville type springs 180 are disposed over a guide member 182 which includes a flat washer portion 184 engaged with the head 178 of the bolt. The opposite end of the spring stack includes a washer 186 which engages a transverse plate 188 fixed to the panel 52. There are two transverse plates 188 on each panel of the traverse frame 48 and they are partially supported by vertical gussets 190. A nut 192 and collar 194 are disposed over the lower end of the bolt 176 for use in compressing the springs 180 during as-

sembly and disassembly of the bearing housings and pinion shafts on the frame 48. As shown in FIG. 12 the bolts 176 project through a recess 195 formed in each of the plates 188. As shown in FIG. 7 three of the pinion shaft bearing housings are resiliently supported by spring assemblies 196 which comprise two pairs of springs 180 disposed in series arrangement with the springs of each pair arranged in parallel. The fourth spring assembly 198 includes seven pairs of springs 180 disposed in series arrangement.

The spring assemblies 196 and 198 are advantageously used to reduce the shock and vibration loads on the pinions 58 and the gear racks 46 to provide for limiting the pulldown forces acting on each pinion to a predetermined maximum. The springs 180 are proportioned such that when assembled with the traverse frame 48 they are compressed or preloaded to exert a force biasing the bearing housings 162 against the transverse members 88 which is equal to approximately one fourth of the maximum pulldown force which the rig 10 is capable of exerting on the bit 32 minus the weight of the traverse frame and drill pipe assembly. The springs 180 are also proportioned such that with only a slight increase in force exerted on each bearing housing greater than the preloaded force value the spring assemblies will undergo substantial deflection to quickly provide for transfer of the additional pulldown force from one pinion to another to prevent overloading any one pinion or rack tooth. Assuming that there is some misalignment between the racks 46 this may be substantially overcome at assembly of the pulldown mechanism by removing one pinion from each shaft and reassembling the pinions over the splined ends of the shafts until reasonable tooth engagement of each pinion with the associated rack is obtained. A proper number and spacing of splines on the pinions with respect to the pinion teeth may be selected such that rotating a pinion a given number of spline teeth will be equivalent to a predetermined angular displacement of a pinion gear tooth.

Even with the above and well known technique for aligning the two pinions on a shaft to compensate for misalignment of the respective gear racks it is likely that some misalignment will remain and one pinion on each shaft will likely bear half of the total pulldown force exerted on the traverse frame until the pulldown force is increased to the condition which will produce deflection of the spring assembly supporting the bearing housing adjacent that pinion. Thanks to the force-deflection characteristics of the conical disc springs a force exerted on a given pinion beyond the predetermined compression load which is imposed on the spring assembly when it is placed between the transverse plates 188 and the bearing housings will cause deflection of the bearing housing and shaft with respect to the traverse frame until the teeth of the pinion on the opposite end of said shaft fully engages the rack and begins to assume part of the pulldown load. This deflection will occur with only a slight or negligible increase in load on the pinion undergoing deflection. Various combinations of spring free height and disc thickness may be used to obtain the desired force-deflection characteristic but the conical disc or Belleville type spring is advantageously used due to its compact size and its capability of having a basically nonlinear force-deflection characteristic.

The spring assembly 198 is capable of greater deflection than the spring assemblies 196 for a given load increase beyond the force required to overcome the predetermined maximum pulldown force sustainable on each spring assembly without any deflection. This greater deflectability of spring assembly 198 is to further assure that the four pinions will equally share the maximum pulldown effort should any appreciable misalignment of the gear racks 46 with respect to each other be present as a result of unavoidable error in constructing the mast or in the manufacture of the gear racks.

What is claimed is:

1. In an earth drilling apparatus:

an elongated upstanding mast;

a rotatable drill string including at least one elongated drill pipe section;

rotary drive means engaged with said drill pipe for rotating said drill string;

a frame including coupling means mounted thereon and connected to one end of said drill pipe and mounted on said mast for linear movement therealong to transmit pulldown and hoisting forces to said drill string, first and second rotatable shafts independently mounted on said frame in spaced apart and parallel relationship and including means positively engaged with means mounted on said mast for effecting movement of said frame along said mast to exert a pulldown force on said drill string in response to rotation of said shafts;

a pair of elongated flexible chains forming closed loops and respectively drivingly engaged with sprockets fixed on said shafts and on a drive shaft mounted on said apparatus;

a pair of tensioning devices, one engaged with each chain of said pair, each tensioning device including chain engaging means mounted for movement on a frame and a pressure fluid cylinder connected for biasing said chain engaging means to apply tensioning forces to said chain, and said cylinders are interconnected so that the fluid pressure in said cylinders provides equal biasing forces on said chain engaging means to thereby apply substantially equal tensioning forces to each of said chains and substantially equal driving torque on said shafts; and

a second pair of tensioning devices, one tensioning device engaged with each chain of said pair, each tensioning device of said second pair including rotatable chain engaging means disposed for movement on a frame and pressure fluid cylinder means for engaging said rotatable chain engaging means to apply chain tensioning forces thereto and adapted to permit movement of said rotatable chain engaging means in response to a change in chain path length between said drive shaft and said chain engaging means on said tensioning devices.

2. In an earth drilling apparatus:

an elongated upstanding mast including a pair of spaced apart longitudinal members each supporting a gear rack;

a rotatable drill string including at least one elongated drill pipe section;

rotary drive means engaged with said drill pipe for rotating said drill string; and,

a frame connected to one end of said drill pipe and mounted on said mast for linear movement there-

along to transmit pulldown and hoisting forces to said drill string, said frame including first and second rotatable means independently mounted thereon, said first rotatable means including a pair of pinions, one pinion engaged with each rack, and said rotatable means including a pair of pinions, one pinion engaged with each rack for effecting longitudinal movement of said frame along said mast, and a roller truck assembly including rollers disposed to roll along said longitudinal members on respective track surfaces parallel and opposed to said gear racks, said truck assembly including spring means interconnecting said truck assembly and said frame for resiliently biasing said pinions into engagement with said gear racks.

3. In an earth drilling apparatus:
 an elongated upstanding mast;
 a rotatable drill string including at least one elongated drill pipe section;
 rotary drive means engaged with said drill pipe for rotating said drill string; and,
 traverse means connected to one end of said drill pipe and mounted on said mast for linear movement therealong to transmit pulldown and hoisting forces to said drill string, said traverse means including a frame, first and second rotatable shafts, each shaft including a pair of pinions mounted thereon and positively engaged with spaced apart longitudinal gear racks mounted on said mast for effecting movement of said traverse means along said mast to exert a pulldown force on said drill string in response to rotation of said shafts, and resilient mounting means supporting said shafts independently on said frame for limited movement with respect to said frame.

4. The invention set forth in claim 3 wherein:
 said traverse means includes spaced apart bearing means for rotatably supporting said first and second shafts respectively on said frame and said resilient mounting means includes spring means engaged with said bearing means and said frame for supporting said first and second shafts for movement with respect to said frame in response to a predetermined pulldown force being transmitted from said mast to said frame.

5. The invention set forth in claim 4 wherein:
 said first and second shafts each include spaced apart bearing support housings supported by said frame and disposed adjacent said pinions, and said spring means comprises plural spring assemblies disposed in engagement with each of said housings for resiliently urging said housings in engagement with said frame.

6. The invention set forth in claim 5 wherein:
 said spring assemblies are formed to provide a preload force acting on each housing of said first and second shafts which is substantially equal to one fourth of a predetermined maximum pulldown force to be transmitted from said mast to said tra-

verse frame without deflection of said spring assemblies.

7. The invention set forth in claim 6 wherein:
 said spring assemblies comprise Belleville springs.

8. The invention set forth in claim 7 wherein:
 said Belleville springs are formed to provide for movement of said shafts with respect to said frame when a predetermined tooth load on said pinions corresponding to the preload force acting on the adjacent spring assembly is reached, said movement taking place without substantially any additional load being imposed on said pinions.

9. The invention set forth in claim 6 wherein:
 at least one of said spring assemblies is formed to undergo greater deflection than the remainder of said spring assemblies for a given force greater than the preload force.

10. In an earth drilling apparatus:
 an elongated mast including a pair of spaced apart gear racks thereon;
 a rotatable drill string including at least one elongated drill pipe section;
 means drivably engaged with said drill pipe section for rotating said drill string;
 traverse means connected to one end of said drill string and disposed on said mast for linear movement therealong to transmit pulldown and hoisting forces to said drill string, said traverse means comprising a frame, and first and second rotatable shafts mounted on said frame and including respectively, on each shaft, a pair of pinions engaged respectively with said spaced apart gear racks;
 drive means comprising a pair of elongated flexible chains, each chain forming a continuous closed loop and being engaged with drive sprocket means mounted on said apparatus, one of said chains being engaged with a sprocket fixed on said first shaft and the other chain being engaged with a sprocket fixed on said second shaft; and,
 means for causing said chains to exert substantially equal driving torque on said first and second shafts.

11. The invention set forth in claim 10 wherein:
 said means for causing said chains to exert substantially equal driving torque on said first and second shafts comprises a pair of tensioning devices engaged with the respective chains of said pair and operable to exert substantially equal chain tensioning forces on said chains.

12. The invention set forth in claim 11 wherein:
 said tensioning devices are each characterized by chain engaging means mounted for movement on a frame and a pressure fluid cylinder connected for biasing said chain engaging means to apply tensioning forces to said chain, and said cylinders are interconnected so that the fluid pressure in said cylinders provides equal biasing forces on said chain engaging means.

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