Nov. 23, 1943. R. K. JEFFREY 2,334,770

MINING MACHINE

Original Filed July 6, 1934 4 Sheets-Sheet 1

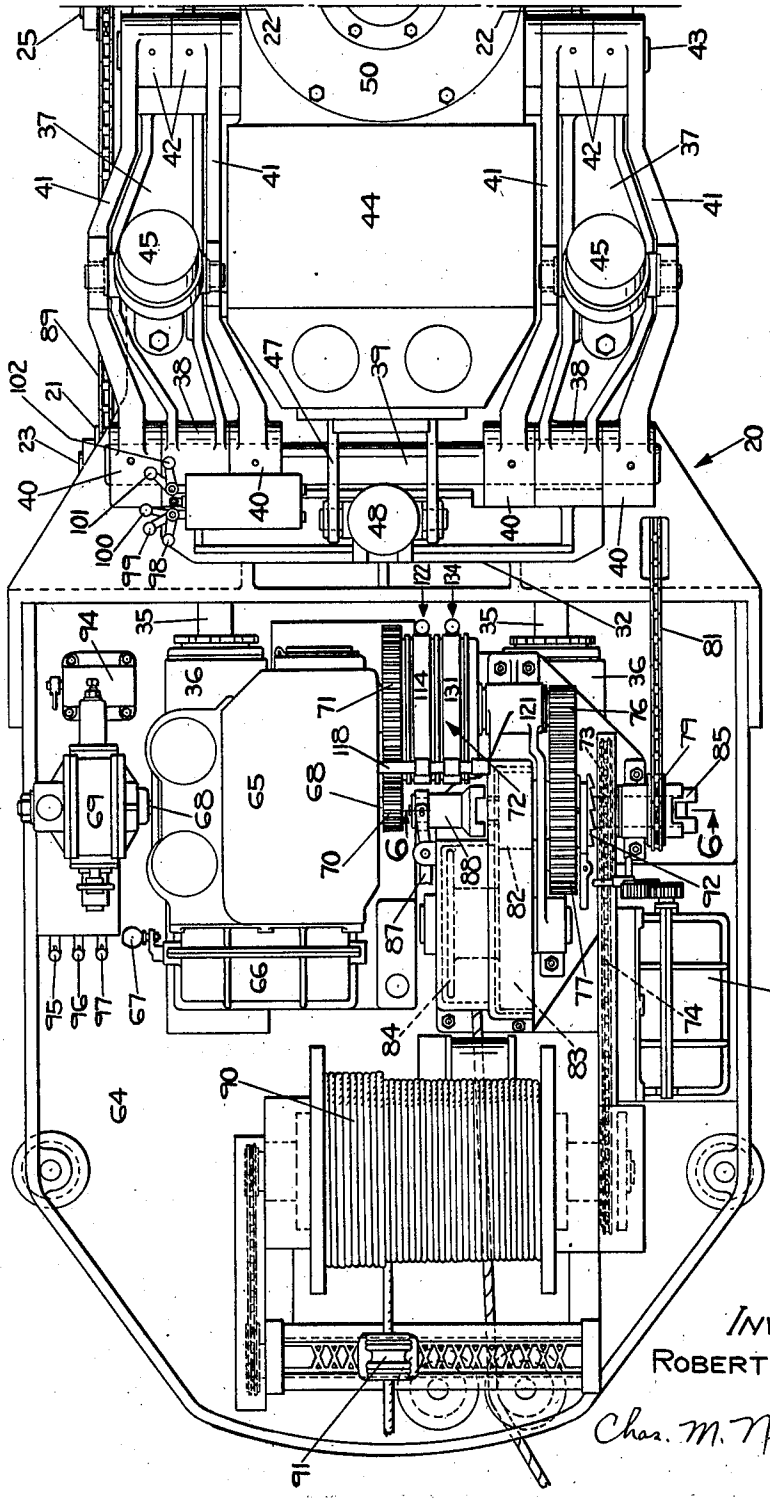


Fig. 1

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Original Filed July 6, 1934 4 Sheets-Sheet 2

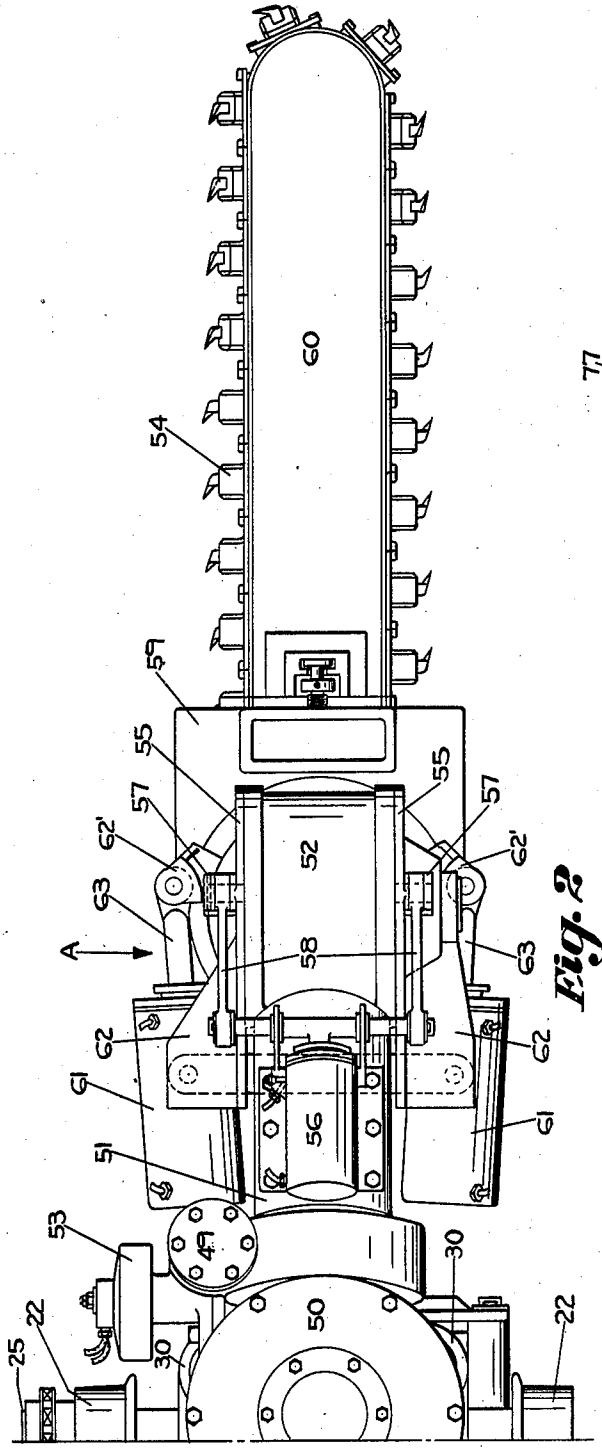


Fig. 2

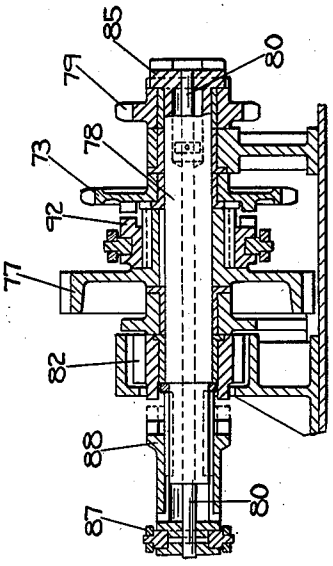


Fig. 6

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Original Filed July 6, 1934 4 Sheets-Sheet 3

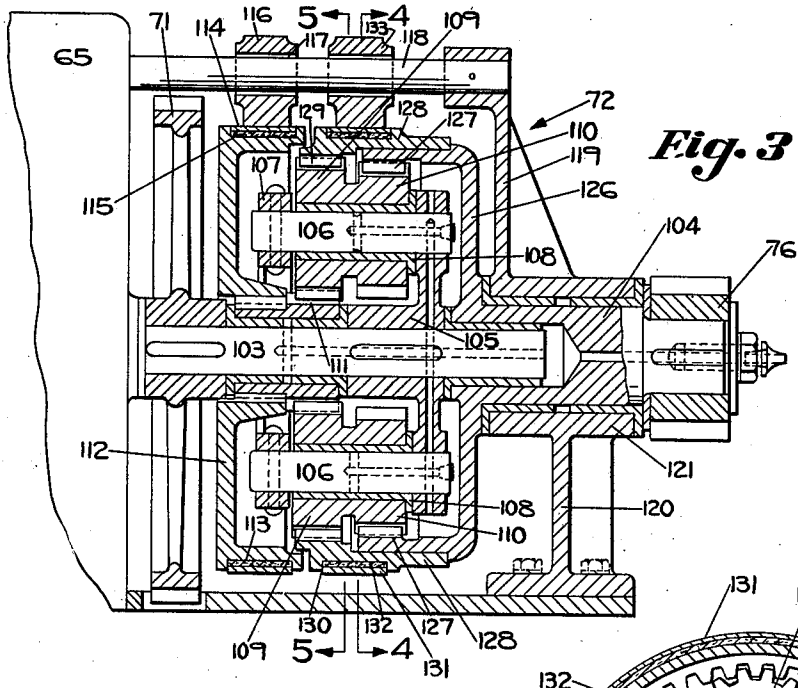


Fig. 3

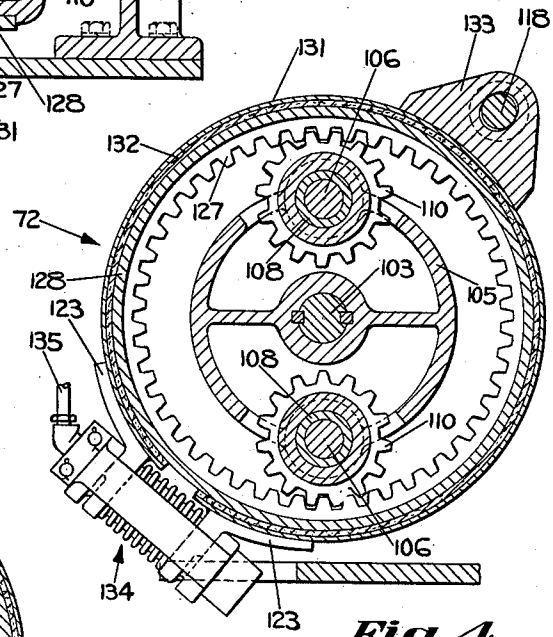


Fig. 4

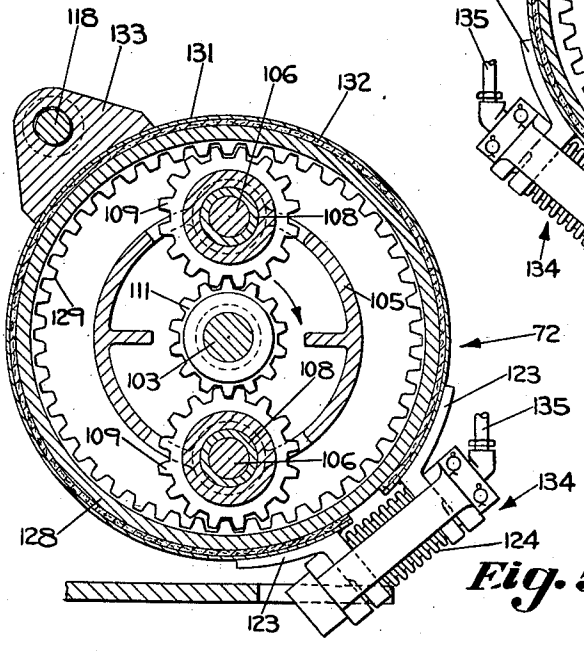


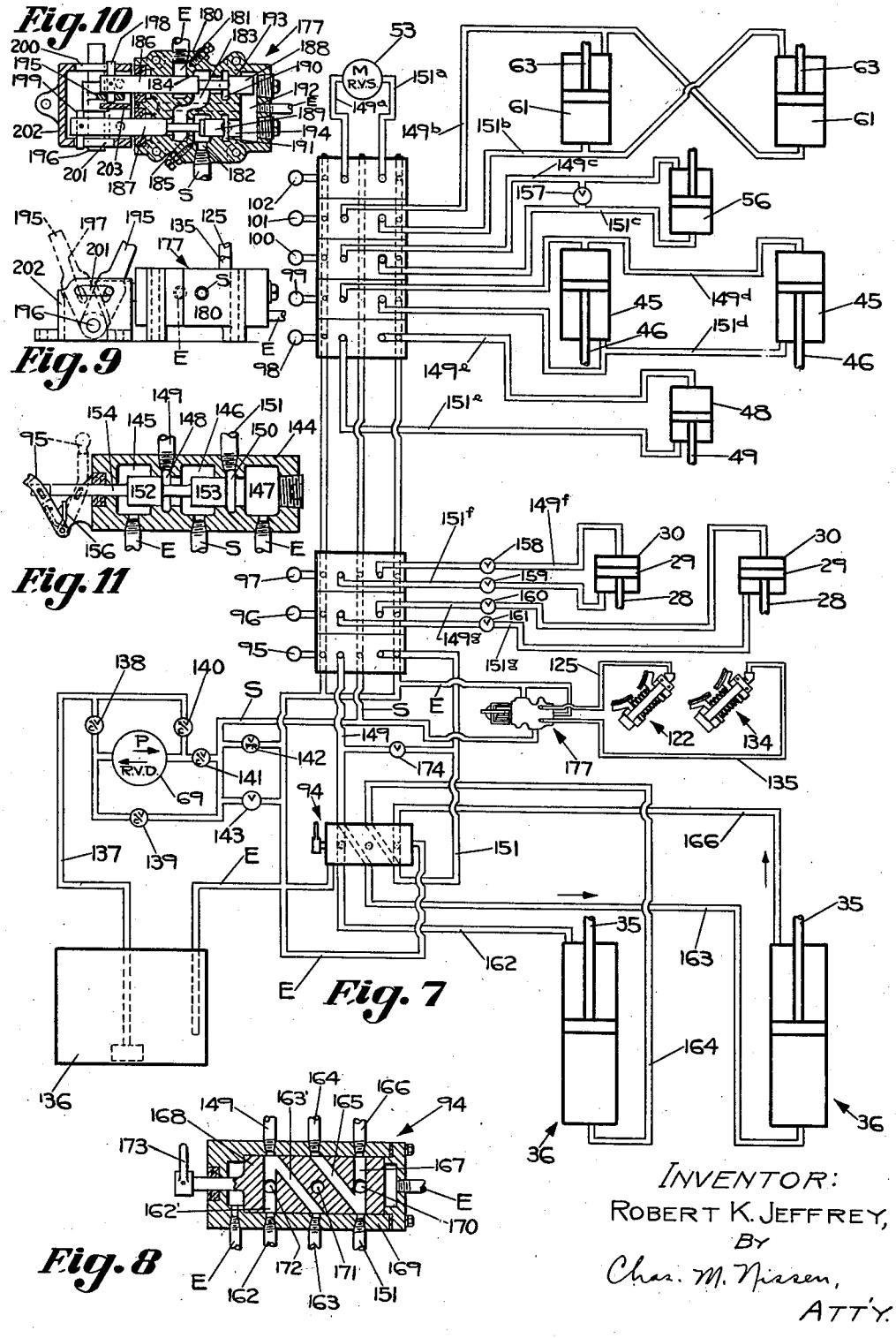
Fig. 5

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MINING MACHINE

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Patented Nov. 23, 1943

2,334,770

UNITED STATES PATENT OFFICE

2,334,770

MINING MACHINE

Robert K. Jeffrey, Columbus, Ohio, assignor to The Jeffrey Manufacturing Company, a corporation of Ohio

Original application July 6, 1934, Serial No. 733,999, now Patent No. 2,263,701, dated November 25, 1941. Divided and this application November 18, 1938, Serial No. 241,239. In Great Britain July 28, 1933

2 Claims. (Cl. 262—28)

My invention relates to a mining machine of the universal type, and one of its objects is the provision of improved and efficient apparatus for controlling the operation of a mining machine by hydraulic means, particularly for feeding the mining machine and swinging the cutter mechanism thereof, both during cutting of a kerf and during transportation or tramming.

Another object of the invention is to provide improved slow speed feeding and high speed tramming mechanism for a mining machine, including a hydraulic system.

Still another object of the invention is to provide a new and improved hydraulic system of control particularly adapted for mining machines.

Other objects of the invention will appear hereinafter, the novel features and combinations being set forth in the appended claims.

In the accompanying drawings,

Figs. 1 and 2 placed end to end combine to make a plan view of the machine shown of my invention;

Fig. 3 is a sectional elevational view of the two speed reduction gearing for the truck drive;

Fig. 4 is a sectional view taken along the line 4—4 of Fig. 3 looking in the direction of the arrows;

Fig. 5 is a sectional view taken along the line 5—5 of Fig. 3 looking in the direction of the arrows;

Fig. 6 is a sectional view taken along the line 6—6 of Fig. 1 looking in the direction of the arrows;

Fig. 7 is a piping diagram of the hydraulic system;

Fig. 8 is a sectional view of the control valve for the turntable hydraulic motors;

Fig. 9 is a plan view of the reduction gearing control valve;

Fig. 10 is a sectional plan view of the valve of Fig. 9; and

Fig. 11 is a sectional view of a hydraulic motor control valve.

This application comprises a division of my application for a Mining machine, Serial No. 733,999, filed July 6, 1934, now Patent No. 2,263,701, dated Nov. 25, 1941.

Referring to Figs. 1 and 2 of the drawings, it will be seen that the mining machine comprises a base frame 20, which is supported on a pair of track engaging rear wheels one of which is seen at 21, and a pair of track engaging front wheels 22, 22, the former being mounted on an axle 23 journalled in bushings in an appropriate housing. The frame 20 is mounted on said housing by trunnions providing pivotal movement of said frame 20 relative to said housing and to said rear wheels 21, 21 along the central longitudinal axis of said machine. The front wheels 22, 22 are supported on an axle 25 carried within an appropriate axle housing which is attached to the base frame 20 by a pair of pivoted arms, one on each side of said machine, the pivotal attachment between the arms and the frame 20 being provided by appropriate knuckles.

Adjacent their forward ends the arms are provided with piston rods 28, 28 (see Fig. 7), which are connected to pistons 29, 29 which extend into cylinders of hydraulic piston motors 30, 30 (see Figs. 2 and 7).

By controlling the hydraulic motors 30, 30, the wheels 22, 22 may be individually adjusted in elevation relative to the frame 20, thereby adjusting the slope of said frame 20 relative to a horizontal plane. This is useful to level the frame 20 when the machine is mounted on an uneven track and is useful to tilt the frame 20 about either a transverse or a longitudinal axis.

Mounted upon the frame 20 for pivotal movement about an upright axis positioned substantially midway between the rear wheels 21, 21 and the front wheels 22, 22, and supported by antifriction rollers is a turntable 32. The turntable 32 has on its lower face a track adapted to take the wear between said rollers and said turntable. On the lower face of the turntable there is provided a downwardly extending drum which is provided with an external gear (not shown) with which cooperate racks formed on the ends of a pair of spaced piston rods 35, 35 (Figs. 1 and 7), which piston rods are associated with pistons of the two piston motors 36, 36. It will thus be evident that by controlling said motors 36, 36 the turntable 32 may be adjusted about its upright axis to any desired position and by locking said motors in any adjusted position the turntable will be held in said position against rotation.

Rigidly mounted upon the upper face of the turntable 32 there is provided a pair of side castings 37, 37, the rear ends of which are provided with journalled bearings 38, 38. Extending between the journalled bearings 38, 38 and loosely journalled therein, is a rock shaft 39. At each side of the bearings 38, 38 there is a bearing 40, 40, which bearings 40 form the ends of a plurality of forwardly extending arms 41, 41, of which there are four, two at each side of the turntable. Said arms 41, 41 are provided with bearings 42, 42 at their forward ends which are rigidly attached to a transversely extending shaft 43. It may also be

pointed out that the bearings 40, 40 are keyed to the shaft 39. The shaft 43 extends into journalled bearings in the housing of an electric motor 44, whereby said motor 44 may rotate on said shaft 43.

Trunnioned between each of the pairs of arms 41, 41 at each side of the turntable and approximately midway between the shafts 39 and 43 is a hydraulic piston motor 45. Each of the piston motors 45 is provided with a piston rod 46 which is pivoted to the adjacent casting 37. It will be evident that by adjusting the piston motors 45, the arms 41, 41 may be pivoted about the rock shaft 39 and thus the forward portion of the electric motor 44 may be adjusted in elevation. At its rear end the motor 44 is provided with a bracket 47, to which is trunnioned a piston motor 48 having a piston rod 49 pivoted to the rear end of the turntable 32. It will be evident that the piston motor 48 may be operated to pivot the motor 44 about the axis of shaft 43. It may be mentioned that the motor 44 rests between the inner pair of side arms 41, thus maintaining the over-all height of the machine as determined by the top of the motor 44, at a minimum.

Rigidly attached to the housing of motor 44 is a gear housing 50, within which are appropriate gears which are part of a train which effects a driving connection between the motor 44 and the cutter chain, as will be hereinafter described in more detail. The gear housing 50 has adjacent its forward end a downwardly sloping neck, not visible in the drawings, upon which is journalled a turn-over head A, formed by a casting 51, which casting 51 is journalled on said neck for rotation about a longitudinally extending and downwardly sloping axis when the machine is in the position illustrated in Figs. 1 and 2. The forward end of the casting 51 terminates in a drum-shaped portion 52.

To provide for turning over said turn-over head A on the aforementioned axis, the rear portion of said casting 51 has attached thereto a worm gear within housing 49 which is adapted to be driven by a rotating type of hydraulic motor 53. It will be evident that by controlling the rotating motor 53, the turn-over head A may be adjusted to any desired position about the axis of said aforementioned neck.

Extending transversely of the drum-shaped portion 52 along the central axis thereof, is a transverse shaft upon which is mounted for rotation a pair of side plates 55, 55 which cover the open ends of said drum-shaped portion 52. Adjustment of said side plates 55, 55 about the axis of said transverse shaft is provided by a hydraulic piston motor 56 mounted upon the casting 51 and connected to brackets 57, 57 carried by said side plates 55, 55 by appropriate connecting links 58, 58. Adjacent their bottoms, the side plates 55, 55 cooperate to provide a circular supporting track which supports the rear plate 59 of a cutter bar 60, upon which rides endless bit carrying cutter chain 54, whereby said cutter bar 60 may be pivoted with respect to said turn-over head A about an upright axis with respect to the plane of cutter bar 60. It will be evident that this axis may be adjusted to and from a vertical position by adjustment of the side plates 55 as directed by piston motor 56.

To swing the cutter bar 60 about said upright axis, I provide a pair of hydraulic piston motors 61, 61, which are trunnioned to brackets 62, 62 carried by side plates 55, 55. Piston rods 63, 63 of said motors 61, 61 are pivotally attached to opposite sides of the plate 59 by brackets 62'. It will thus be evident that by adjusting the piston motors 61, 61, the cutter bar 60 may be swung about an axis permanently at right angles to itself, which axis is at right angles to the transverse axis and intersects both the latter axis and the axis of the turn-over head.

It is also to be noted that the cutter bar 60 may be swung in a horizontal plane about the axis of the turntable 32 by controlling the hydraulic piston motors 36, 36. It is thus possible to cut a relatively horizontal kerf in a plane which has a slight slope to the horizontal by swinging the cutter bar 60 about the axis of the turntable 32 as aforesaid, such slope being predetermined by adjusting the hydraulic piston motors 36, 36 in a manner previously described. Cutting of a kerf at a slope to the horizontal about the axis of the turn-over head A will, of course, be provided by adjusting the casting 51 by motor 53.

It will be evident that due to the numerous adjustments previously described, substantially horizontal kerfs can be cut from a position below the mine tracks to a very great height or along any plane intermediate the two extremes. It is also possible to cut kerfs at any desired slope between the horizontal and vertical position. Furthermore, vertical kerfs may be cut along parallel planes of an appreciable width in a mine room.

Extending rearwardly from the base frame 20 and forming a portion thereof, I provide a supporting platform 64. Upon said platform 64 is mounted a reversible electric motor 65, adapted to be controlled by a control box 66 operable by handle 67. Motor 65 is provided with a shaft 68, which extends laterally from each side thereof, and at one side drives a pump 69 which may be of any desired structure. The shaft 68 carries a pinion 70 adjacent its other end, which pinion meshes with a gear 71. The gear 71 drives a two speed hydraulically controlled planetary clutch and reduction gear mechanism 72 hereinafter described in full detail, which drives a pinion 76 at a relatively fast or relatively slow speed, depending upon how it is operated. The pinion 76 drives a master gear 77 which is keyed to a shaft 78 (Fig. 6). Loosely journalled on said shaft 78 is a sprocket 79 which is connected to a sprocket on one of the rear wheels 21 by a chain 81. Also loosely journalled on the shaft 78 is a gear 82 which meshes with a gear 83 formed integral with a winding drum 84 about which is wrapped a flexible cable adapted to be anchored in the mine extraneous to the machine to effect slow feeding thereof.

Clutches 85 and 88 are interconnected by rod 80 and are operable from a handle 87, and when operated in a position to engage the clutch 85 to effect a driving connection between the shaft 78 and the wheel 21, rod 80 insures that the drum 84 is not in driving relation with said shaft 78. When the clutch 88 is in operating relation to connect the drum 84 to the shaft 78, it insures that the wheel 21 is disconnected from said shaft 78 thus preventing operation of the drum 84 and sprocket 79 at the same time.

It will thus be seen that by actuating the clutch 85 to effect a driving connection between the shaft 78 and a wheel 21, the mining machine may be propelled through the mine by the motor 65 at a relatively slow feeding speed, or at a relatively fast tramming speed, as hereinafter explained more in detail. The machine may move in either direction at either the fast or slow speed

by reversing the direction of rotation of the motor 65.

It may be pointed out that the rear wheels 21 are both keyed to the drive shaft, and thus both of said wheels are driving wheels. Furthermore, both of the front wheels 22 are keyed to the front shaft and by virtue of a chain and sprocket mechanism 89 (Fig. 1), shafts 23 and 25 are connected together. Therefore, the front wheels 22 are also driving wheels.

Also mounted upon the platform 64 is an electrical cable reel 90 provided with an appropriate reel guiding mechanism 91. The reel 90 may be driven from the shaft 78 by drive sprocket 73 which drives chain and sprocket drive mechanism 74 controlled by clutch 92. It may be noted that the clutch 92 has helical teeth to allow the cable from reel 90 to pay out freely, or to reel in the cable by power as the mining machine is being moved under power, or it may be paid out or reeled in while the mining machine is standing still, as the clutch 92 is entirely independent in its operation.

Also mounted upon the platform 64 is a control box 93 for controlling the electric motor 44. Appropriate electric cables, not shown, connect the control box 93 and the motor 44.

In addition to those elements previously described, it may be noted that there is carried on the platform 64 a distributing valve 94, the function of which will be described more in detail hereinafter, and three operating valves having handles 95, 96 and 97 for controlling various hydraulic motors, as hereinafter described in more detail. It may be additionally mentioned that mounted upon the turntable 32 are five valves, having handles 98, 99, 100, 101 and 102, which will also be described more in detail hereinafter.

Before describing in detail the particular hydraulic system comprising my invention, attention is directed to Figs. 3, 4 and 5, and to the structure of the hydraulically controlled planetary clutch and reduction gear mechanism 72. The gear 71 is keyed to and drives a shaft 103 one end of which is journalled in the housing of motor 65 and the other end of which is journalled in a shaft 104 which drives gear 76 which is keyed thereto. Keyed to the shaft 103 is a spider 105 which carries a pair of diametrically positioned shafts 106, the outer ends of which are rigidly attached together by a bracket 107. The shafts 106 are provided with appropriate journal bearings 108 upon which are journalled, integrally formed or connected planetary gears 109 and 110 which have an unequal number of teeth. As illustrated in the drawings, gears 109 have sixteen teeth and gears 110 have fifteen teeth, though these numbers are not critical.

Journalled loosely upon the shaft 103 is a sun gear 111 which meshes with both of the gears 109. Sun gear 111 is keyed to a friction drum 112 provided with a peripheral groove 113 adapted to receive a friction brake band 114 provided with friction brake band lining material 115. By reference particularly to Fig. 3 of the drawings, it will be seen that the brake band 114 is provided with a central attaching lug 116 having an oval shaped aperture 117 therein through which a supporting rod 118 extends, which rod is supported by an extending arm 119 formed integral with a bracket 120 which provides a journal bearing 121 for previously mentioned shaft 104. The free ends of the brake band 114 are connected together by hydraulic piston motor mechanism 122 (see Fig. 1), similar in structure to the hereinafter described mechanism 134, and fed by pipe or conduit 125.

Formed integral with the shaft 104 is a cup shaped member 126 provided with an integral internal ring gear 127 which continuously meshes with the two planetary gears 110. Journalled to rotate freely on the exterior of the cup shaped member 126 is a drum 128 which is provided with an integral internal ring gear 129 which continuously meshes with the planetary gears 109. The drum 128 is provided with a groove 130 adapted to receive a brake band 131 provided with friction brake band lining material 132. The brake band 131 is provided with an attaching lug 133 similar in structure and function to the lug 116 and is provided with a hydraulic piston motor mechanism 134 comprising a pair of brackets 123 one attached to each of the free ends of the brake band 131 between which extend a helical spring 124 urging the two halves of the brake band 131 into a non-braking position. The two brackets 123 are adapted to be forcibly drawn together by a cylinder and piston form of hydraulic piston motor of a type commonly employed with the brakes of an automobile which is supplied with hydraulic fluid by way of a pipe or conduit 135.

It may be stated that the number of teeth on the ring gears 127 and 129 is the same, but this condition is not absolutely essential.

The hydraulically controlled planetary clutch and reduction gear mechanism 72 is operative to effect a two-speed drive between the shaft 103 and the shaft 104. It may be stated generally that whenever hydraulic piston motor mechanism 122 is operating to apply its associated braking mechanism a relatively high speed drive will be effected between said shafts 103 and 104 to increase the speed of shaft 104 over that of shaft 103, and in the instant case the ratio will be 1 to 1.285. On the other hand, when the hydraulic piston motor mechanism 134 is applied, the speed ratio between the shafts 103 and 104 is substantially reduced in the ratio of 16 to 1.

The high speed drive with the hydraulic piston motor mechanism 122 applied operates as follows. Upon the operation of said hydraulic piston motor mechanism 122 the friction drum 112 will be stopped gradually by a well understood clutching and braking action common with planetary gearing, whereupon sun gear 111 will be stationary. Spider 105 being in rotation, will cause the planetary gears 109, 109 to walk around the stationary sun gear 111. Gears 109, being rigid with gears 110, which also walk around with spider 105 and drive the cup shaped member 126 due to their meshing with ring gear 127. Cup shaped member 126 is, of course, integral with shaft 104 and effects a driving action thereof.

As was above mentioned, the ratio of the drive between shafts 103 and 104 is 1 to 1.285. This particular ratio is due to the number of teeth on the gears 109, 110, 111 and 127, there being fifteen teeth on gears 110, sixteen teeth on gears 109, fourteen teeth on gear 111 and forty-six teeth on gear 127. In passing, it may also be noted that gear 129 has forty-six teeth also.

In analyzing this high speed power transfer between shafts 103 and 104 it may be observed that as spider 105 rotates, gear 127 would rotate at the same speed if gears 110 and 127 had no relative rotation. This alone would provide a one to one ratio between shafts 103 and 104.

However, since gear 111 is stationary, there is relative rotation between gears 110 and 127 and for each rotation of the spider 105 the additional rotation of shaft 104 over that of shaft 103 is equal to the number of teeth on gear 127 (46), divided into the number of teeth on gears 110 (15), multiplied by the ratio between the number of teeth on gear 111 (14), to the number of teeth on gears 109 (16). In this latter connection it is evident that a clockwise rotation of the spider 105, as indicated by the arrow in Fig. 5 of the drawings, will cause gears 109 to rotate about its own axis $1\frac{1}{16}$ of a revolution for each revolution of said spider 105.

In effecting the low speed drive the hydraulic piston motor mechanism 134 is energized to apply the brake band 131 which progressively stops rotation of drum 128 and integral ring gear 129. Therefore, a spider 105 rotates, gears 109 walk around gear 129 and, of course, rotate gears 110 in unison with them. When the spider 105 has rotated through an angle sufficient to rotate gears 109 one complete revolution, or through sixteen teeth, gear 127 which meshes with gears 110 will only have rotated through fifteen teeth because gears 110 only have fifteen teeth. As a consequence, during this complete rotation of gears 109 and 110 there will be relative movement between drum 128 and the cup shaped member 126 equal to one tooth. The speed reduction ratio will therefore be sixteen to one since there are sixteen teeth on gears 109.

It is, of course, evident that brake mechanisms 122 and 134 should not be applied together and the hydraulic control system includes a particular type of control valve for controlling these hydraulic control mechanisms 122 and 134 which precludes their operation at the same time.

Referring particularly to Fig. 7 of the drawings, there is seen a complete hydraulic system comprising my invention and referring to Figs. 8, 9, 10 and 11 there is illustrated in more detail certain of the valve mechanisms shown diagrammatically in Fig. 7.

Leading from a hydraulic fluid reservoir 136 is a feed pipe 137 for feeding reversible pump 69, having its output connected to pressure pipe or line S. Four interconnected check valves 138, 139, 140 and 141 so interconnect pipes 137 and S that regardless of the direction of rotation of pump 69, pipe S is always the pressure pipe. Interconnecting pressure pipe S and return pipe E is a high pressure relief valve 142 and a hand operated by-pass valve 143, the latter of which is normally closed but which may be open to relieve the load on pump 69 if it is rotating while doing no useful work.

Referring particularly to Fig. 7 it is to be noted that the supply or pressure line S is common to a plurality of control valves having operating handles numbered 95 to 102 inclusive. The structure of each of these valves is substantially the same and thus a description of one will suffice for all. One such device is disclosed in detail in Fig. 11 and will now be described. Said valve comprises a casing 144 provided with three chambers 145, 146 and 147. The supply line S leads to the central chamber 146 and two branches of the exhaust or return line E lead to the outside chambers 145 and 147. Between the chambers 145 and 146 is a small outlet chamber 148 leading to an outlet conduit 149, and between the chambers 146 and 147 is a small outlet chamber 150, leading to a conduit 151.

Extending into the casing 144 for controlling the flow of the fluid pressure medium or hydraulic fluid to and from the conduits 149, 151 is a pair of valve pistons 152 and 153 carried on a shaft 154. An operating handle 95 is provided for operating the shaft 154, said handle being biased to a neutral position at which pistons 152 and 153 close the chambers leading to conduits 149 and 151 respectively, said bias being provided by a spring 156.

In the neutral position of the valve, the pistons 152 and 153 completely close off the small chambers 148 and 150 respectively and thus seal the conduits 149 and 151. Any hydraulic piston motor which is connected to these conduits will thus be locked in adjusted position. If the handle 95 is moved to the left as illustrated in Fig. 11, the hydraulic pressure from the supply or pressure line S will be directed through chambers 146 and 148 to the conduit 149, and the conduit 151 will be connected to the exhaust or return line E, through chambers 150 and 147. If the handle 95 is operated to the position illustrated in dotted lines, Fig. 11, the pistons 152 and 153 will be moved to the right, under which conditions conduit 151 will be connected to the supply or pressure line S through chambers 146 and 150, while conduit 149 will be connected to the exhaust or return line E through chambers 148 and 145.

Returning to a consideration of the complete system as disclosed in Fig. 7, it will be evident that by controlling the handle 102, the rotating hydraulic motor 53 may be caused to rotate in either direction, depending upon which direction the handle 102 is moved from its neutral position. Said motor 53 is connected to its control valve through conduits 149*a* and 151*a*. The motor 53, of course, controls the turning over of the head A of the mining machine as was previously described. Handle 101 through its control valve controls the two motors 61, 61 which are always operated in unison and in reverse directions through the conduits 149*b* and 151*b*. Said motors 61, 61, of course, control the swinging of the cutter bar 60, as previously described. The valve provided with handle 100 controls the hydraulic piston motor 56 through conduits 149*c* and 151*c*, said motor 56 being operative to adjust the cutter bar 60 about the axis of the transverse shaft extending transversely along the axis of the drum-shaped portion 52 as was previously described.

Associated with the hydraulic piston motor 56 I also provide a valve 157 which may be open to connect the conduits 149*c* and 151*c* to allow free movement of the piston rod of said motor 56, even though the valve associated with the handle 100 is in a closed position. This is useful when the mining machine is employed to cut a vertical kerf while moving along a curved track, under which conditions the cutter bar 60 is allowed to swing freely on the axis of the previously mentioned transverse shaft. It will be obvious, of course, that by closing the valve 157, the motor 56 is under the direct control of the valve associated with handle 100.

Motors 45, 45 which control the tilting of the cutter bar and the electric motor 44 about the axis of shaft 39, are controlled by the valve with handle 99 through conduits 149*d* and 151*d*. These two motors operate in parallel and in the same direction for obvious reasons.

The hydraulic piston motor 48 which controls the tilting of the cutter bar 60 and the electric motor 44 about the axis of shaft 43 is controlled

from the control valve having handle 93 through conduits 149e and 151e.

It will, of course, be obvious that, due to the fact that there is a conduit connected to each end of the motor cylinders 53, 61, 61, 56, 45, 45 and 48, said motors are reversible and also will be locked in any position to which they are adjusted when their respective control valves are in neutral positions. This also applies to the motors 30, 30 and 36, 36.

Said motors 30, 30 which control the tilting of the turntable 32 are provided with separate control valves having handles 97 and 96 respectively and are connected to their respective control valves by conduits 149f and 151f and 149g and 151g, respectively. I also provide individual hand operated valves in each of the lines 149f, 151f, 149g and 151g, numbered 158 to 161, inclusive. Under normal conditions these valves 158 to 161, inclusive, will be open so that motors 30, 30 may be operated by valves with handles 96 and 97, respectively. However, when the mining machine is in an operating position, valves 158 to 161, inclusive, may be closed to insure that the motors 30, 30 will be locked in position. It is, of course, evident that individual control of the motors 30, 30 is desired so that the turntable 32 may be tilted relative to the horizontal plane along either a transverse or a longitudinal axis of the machine.

The control valve provided with handle 95 controls the two hydraulic piston motors 36, 36 which adjust the turntable 32 about its upright axis, but this control is made variable by the inter-position in the control system of the distributor 94 shown in detail in Fig. 8.

The description of the operation of said motors 36, 36 under the control of valve having handle 95 and distributor 94 will best be understood by reference to Figs. 7 and 8. Assuming that the distributor 94 is in the position illustrated in Fig. 8 and the control valve is in the position illustrated in Fig. 11, fluid under pressure will be supplied from the line S to conduit 149 by the control valve handle 95 being moved to its full line position shown in Fig. 11. Hydraulic fluid under pressure in said conduit 149 will be divided by ports 162' and 163' of distributor 94 to conduits 162 and 163. Conduit 162 leads to the piston rod end of left hand motor 36 as viewed in Fig. 7, and conduit 163 leads to the head end of the right hand piston motor 36. It is thus evident that pressure will be applied to the opposite ends of the two motors 36, which will tend to operate them in opposite directions. The head end of the left hand motor 36 is connected by conduit 164 to conduit 151 through port 165 of the distributor 94 and the piston rod end of right hand motor 36 is connected to conduit 151 through conduit 166 and port 167 of distributor 94. It will thus be evident that under these conditions the two hydraulic piston motors 36 are connected in parallel, and thus the fluid delivered by conduit 149 will be divided between them, whereby they will rotate the turntable 32 at a relatively slow speed, but with great power. This is desirable where the turntable is rotated while cutting a kerf.

The distributor 94 includes the piston 168 in which the ports 162', 163', 165 and 167 are cut, which piston is carried in a housing 169, and branches of the exhaust and return line E are connected to each end thereof, thus insuring against unequal pressure on the two ends of said piston 168.

Said piston 168 is also provided with three ports 170, 171 and 172 which are operative when the piston 168 is rotated by handle 173 to a position 90° from that position illustrated in Fig. 8, to provide direct communication between conduits 149 and 162, between conduits 164 and 163, and between conduits 166 and 151. Under these circumstances fluid under pressure supplied to the line 149 will not be divided between the conduits 162 and 163, but will all be directed to conduit 162 and to the piston rod end of left hand motor 36. The piston head end of left hand motor 36 will then be connected through conduit 164, port 171 and conduit 163 to the head end of right hand piston motor 36. The piston rod end of right hand motor 36 will then be connected through conduit 166, port 170 and conduit 151 to the exhaust or return line E via chamber 147 of Fig. 11. Under these circumstances the two piston motors 36, 36 will be connected in series and thus will travel at a faster rate than when connected in parallel. This control is particularly desirable when it is necessary to adjust the turntable as the machine is being transported or trammed through the mine and around curves, under which condition, of course, the cutting mechanism is not performing a kerf cutting operation and a greater speed of operation, requiring less power, is desired.

It will, of course, be evident that by operating the handle 95 in reverse directions, the direction of rotation of the turntable 32 may be reversed, and by operating the distributor 94, the speed of rotation of said turntable may be determined.

In order to permit the turntable 32 to float, which may be desirable when cutting a vertical kerf while the machine is on a curved track as aforesaid, I provide a valve 174 between the conduits 149 and 151 which, when open, will of course, permit free movement of the motors 36, 36.

In addition to the hydraulic control motors previously described as part of my system, there are two further piston motors which are hydraulically controlled and which control the previously described hydraulic piston motor mechanisms 122 and 134. Special control valve 177, disclosed in detail in Figs. 9 and 10 is provided for controlling these hydraulic piston motors so that only one of them may be operated at a time. Said piston motor mechanisms 122 and 134 have only a single conduit leading thereto, conduit 125 leading from valve 177 to mechanism 122, and conduit 135 leading from valve 177 to mechanism 134.

Referring particularly to Figs. 9 and 10, it is to be noted that the valve 177 comprises a casing 180 having ports 181 and 182 therein, connected respectively to the exhaust or return line E and the supply or pressure line S. A chamber 183 connects the ports 181 and 182 through valve openings 184 and 185, respectively, which are controlled by pistons 186 and 187, respectively, which extend outside the casing 180. Rigidly attached to pistons 186 and 187 respectively are further pistons 188 and 189, respectively, which control ports 190 and 191, respectively, leading to conduits 125 and 135, respectively. The ports 190 and 191 also communicate with a discharge chamber 192 connected to a branch of the exhaust or return line E. Communication between the ports 190 and 191 and the chamber 192 is provided by openings 193 and 194, respectively, which are controlled by said pistons 188 and 189, respectively.

A control mechanism is provided for the contral valve 177 which permits pressure to be applied to only one of the conduits 125 or 135 at a time. To this end I provide a single operating handle 195 which is carried on a shaft 196 and which carries an elongated aperture 197.

The pistons 186, 187 carry transversely extending pins 198 and 199, respectively, adapted to slide in elongated slots 200 and 201, respectively, in a bracket 202 upon which shaft 196 is journalled for free longitudinal and rotary motion. The aperture 197 of handle 195 is adapted to cooperate with the pins 198, 199 selectively upon sliding of the shaft 196 along its longitudinal axis whereby one or the other of said pistons 186, 187 may be actuated. It is to be particularly noted that the bracket 202 carries a central partition 203 which requires that the pistons 186, 187 be moved to their extreme lefthand position as viewed in Figs. 9 and 10, before the handle 195 can be shifted laterally from actuating connection with one of said pistons to actuating connection with the other. It is also evident that only one of said pistons can be actuated at one time.

With the handle 195 actuated as illustrated in Fig. 10, the piston motor controlling mechanism 122 will be operated. This will be due to the fact that pressure from the supply or pressure line S flows through port 182, chamber 183, port 190 and conduit 125 to mechanism 122 to operate the brake band 114 controlled thereby. Under these conditions it will also be noted that the conduit 135 will be connected to the chamber 192 whereby the fluid in mechanism 134 may be freely discharged to the exhaust or return line E.

If the handle 195 is operated to the dotted line position of the valve as illustrated in Fig. 9, it will be evident that fluid pressure in the chamber 183 will be cut off from the conduit 125 by the piston 188, and that said conduit 125 will be in communication with chamber 192 whereby fluid in the mechanism 122 may be freely discharged to the exhaust or return line E. If then the handle 195 is moved laterally so that aperture 197 receives pin 199 and piston 187 is then moved to the right as viewed in Figs. 9 and 10, pressure from the pressure line S will be communicated to the conduit 135 and to the mechanism 134 through port 191 as controlled by piston 189. It is thus obvious that the control valve 177 may operate either of the hydraulic piston motor mechanisms 122 and 134 to obtain high speed tramming or low speed feeding of the mining machine, or may leave both in a non-operating condition, but it is impossible to operate both of said mechanisms at the same time.

From the above description of the mining machine and the hydraulic control system therefor, it is obvious that a very flexible machine is provided which may be operated to perform substantially any desired kerf cutting operation such as the cutting of horizontal kerfs from a position below the mine tracks to a relatively high position adjacent the roof or ceiling of a mine room or chamber, and at any intermediate, horizontal or sloping plane between the two extreme positions. Furthermore, either vertical or inclined kerfs may be cut along parallel planes between wide limits. Furthermore, cutting of a vertical or shear kerf while the machine is operating on a curved track is provided.

The electric motor 44 and the power transmission mechanism between the same and the endless chain cutter may be relied on to drive the cutter chain 54 during kerf cutting feeding movements either on the pivotal axis of the cutter bar or on the axis of the turntable, or rectilinearly parallel to the mine track forwardly and rearwardly. All such feeding movements are effected by the truck propelling motor 65 which operates not only the pump 69 but also the truck propelling mechanism as shown in Figs. 3, 4 and 5.

It will thus be seen that the feeding movements of the kerf cutter are independent of the driving of the chain kerf cutter. By reason of this independence of the operation, the speed of feed will regulate itself automatically in accordance with the hardness of the material being cut, the feed being faster when relatively soft material is being cut, and will be automatically slowed down when relatively hard material is encountered. When unusually hard material is encountered in the mine vein, the speed of feed may be automatically slowed down with safety because the hydraulic pressure responsive valve 142 will then act to reduce the pressure in the supply line S and in the feeding hydraulic motors. This is particularly true with respect to the hydraulic motors 61, for effecting swinging feeding movement of the cutter bar on its pivot, and with respect to the turntable motors 36, 36 of Fig. 7 for effecting swinging feeding movement of the cutter bar on the turntable axis. Rectilinear feeding movements for effecting sumping and withdrawal cuts parallel to the mine track are effected by the truck propelling mechanism connected to the motor 65 which is operated in one direction for the forward sumping feeding movement, and in the opposite direction for the withdrawal feeding movement. However, whether the motor 65 is operated in one direction or the reverse, the hydraulic connections including the check valves associated with the pump as shown in Fig. 7, will enable the pump to be fully effective for maintaining full pressure to mechanisms 122 and 134 for controlling the planetary gear power transmission mechanism 72 of the truck propelling means connected to the motor 65 as shown in Fig. 1.

Quick, accurate and efficient control of the feeding movements paraliel to the mine track will thus be obtained as well as quick, accurate and efficient swinging feeding movements of the kerf cutter on the pivot of the cutter bar along the upright axis of the turntable. Such quickness, accuracy and efficiency of control also applies to the hydraulic motors 30, 30 for tilting the mining machine on the longitudinal axis shown in Fig. 1, to the motors 45, 45, 48 for tilting the kerf cutter on the transverse axes 39 and 43, and to the motor 56 for adjusting the kerf cutter transversely of its plane.

During transportation of the machine in the mine from one place to another, the electric motor 65 of Fig. 1 is relied on to operate the truck propelling mechanism at transportation speed, and at such time the pump 69 is being rotated in one direction or the other. During such transportation of the machine along curved portions of the mine track in narrow entries, it is highly desirable to swing the cutter bar at a relatively rapid rate by hydraulic power under the control of the operator, on the upright turntable axis located between the front wheels and rear wheels of the truck. For such purpose the multiple valve 94 is moved by means of the handle 173 to connect the cylinders 36, 36 in series. The operation of the pump 69 will then cause the total volume of flow from the pump to

enter the first cylinder 36, thereby effecting relative rapid swinging movement of the cutter bar on the turntable axis. As hereinbefore explained, when the cutter bar is swung on the turntable axis for feeding movements, the cylinders 36, 36 are connected in parallel which will effect a slower but more powerful swinging movement for feeding purposes because the volume flow from the pump is divided between the two cylinders 36, 36.

Obviously those skilled in the art may make various changes in the details and arrangement of parts without departing from the spirit and scope of the invention as defined by the claims hereto appended, and I therefore wish not to be restricted to the precise construction herein disclosed.

Having thus described and shown an embodiment of my invention, what I desire to secure by Letters Patent of the United States is:

1. In a mining machine, the combination with a base frame, of a turntable mounted thereon, a supplemental frame carried by said turntable and mounted to extend forwardly of said base frame, traction means for supporting and propelling said base frame, a platform extending rearwardly from said base frame, an electric motor mounted on said platform, hydraulic motor means to swing said turntable so said supplemental frame can avoid mine posts while traveling around curves in a mine during transportation thereof, a hydraulic system including a pump driven by said electric motor and also including connections to said hydraulic motor means, and mechanism for effecting a driving connection between said electric motor and said traction means to propel said mining machine at a transportation speed while said turntable is operable as aforesaid, said mechanism being operable by said hydraulic system.

2. In a mining machine, the combination with a base frame, of a turntable mounted thereon, a supplemental frame carried by said turntable and mounted to extend forwardly of said base frame, traction means for supporting and propelling said base frame, a platform extending rearwardly from said base frame, an electric motor mounted on said platform, hydraulic motor means to swing said turntable so said supplemental frame can avoid mine posts while traveling around curves in a mine during transportation thereof, a hydraulic system including a pump driven by said electric motor and also including connections to said hydraulic motor means, and mechanism for effecting a driving connection between said electric motor and said traction means to propel said mining machine, said mechanism being operable by said hydraulic system.

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