Dec. 17, 1940. J. F. JOY 2,224,872

MINING APPARATUS

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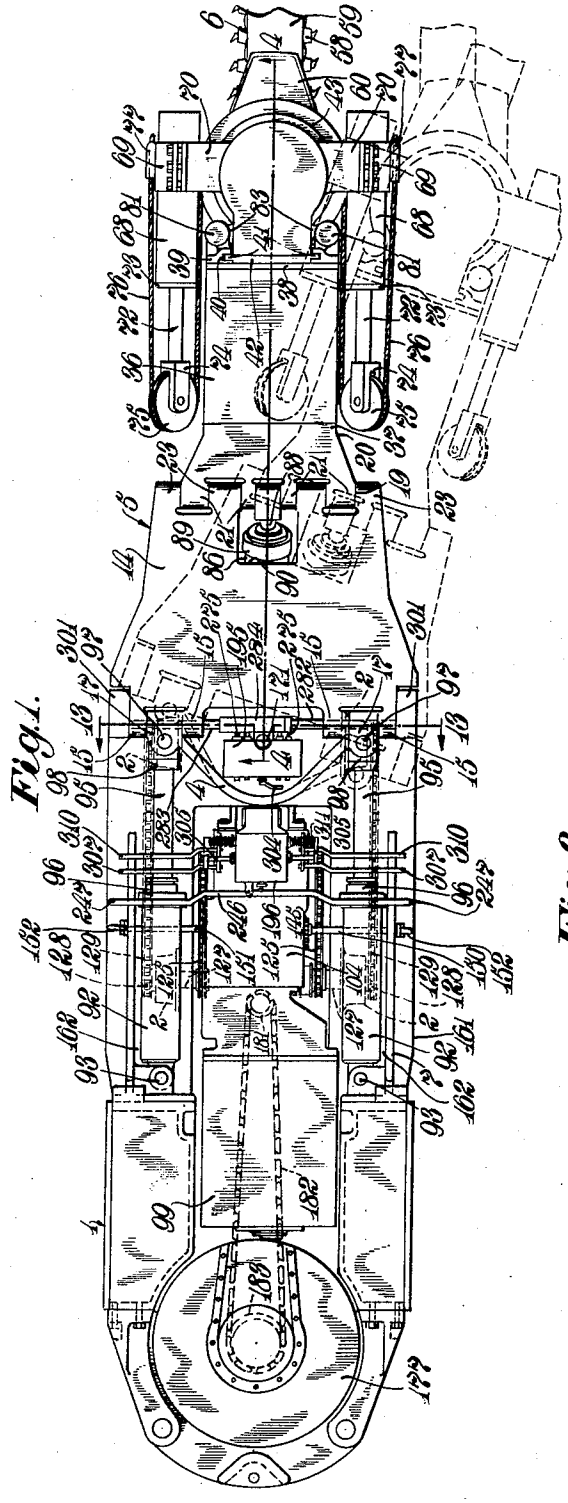


Fig. 1.

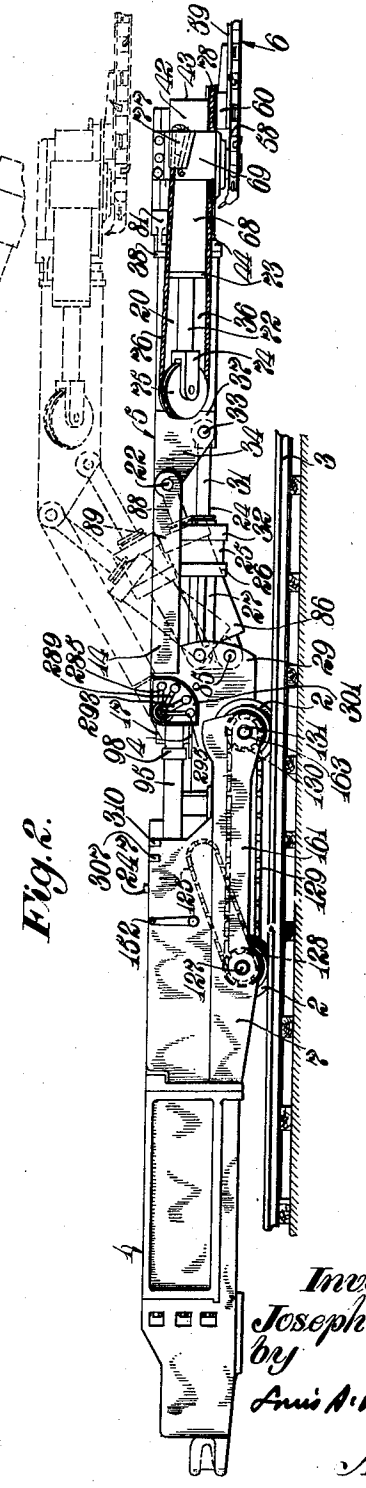


Fig. 2.

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MINING APPARATUS

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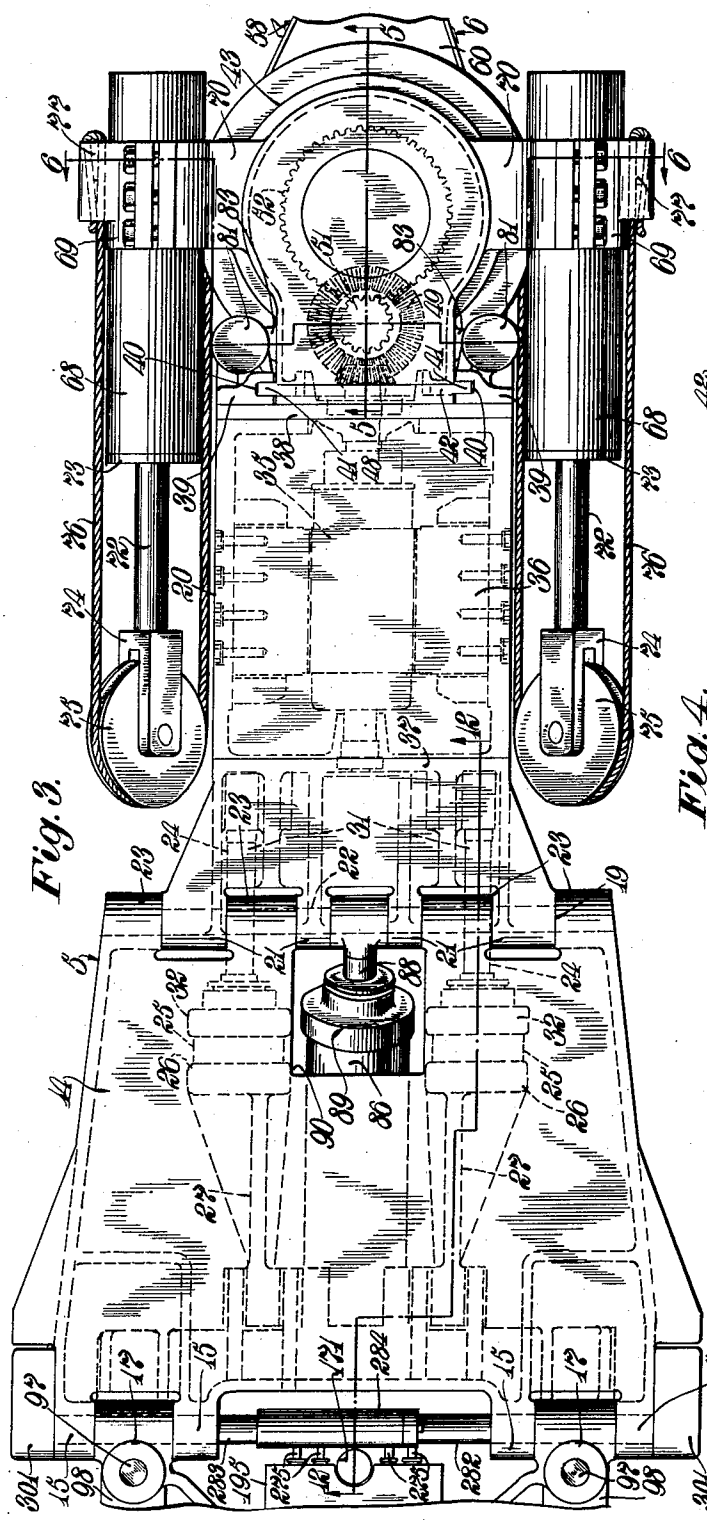


Fig. 3.

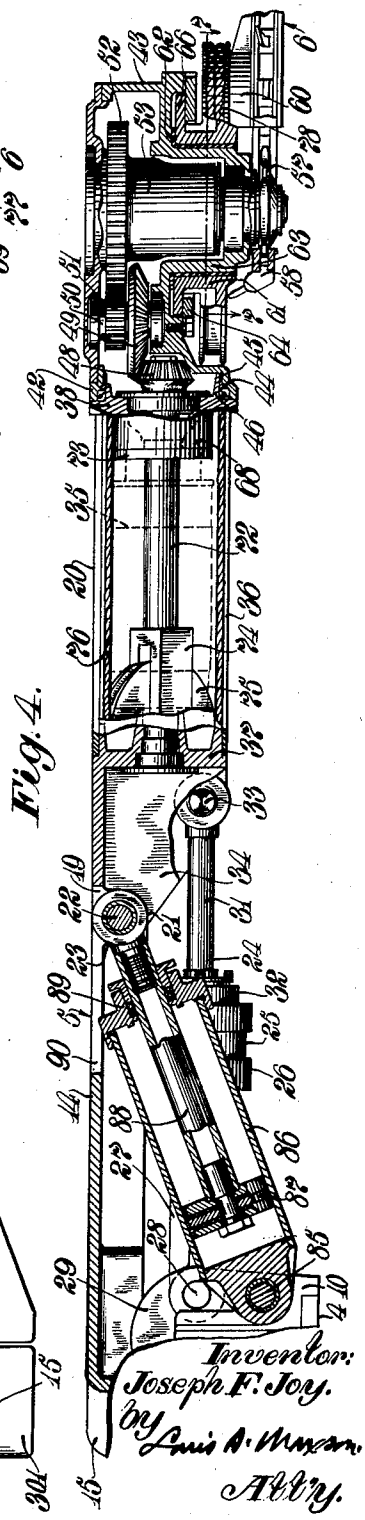


Fig. 4.

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Fig. 5.

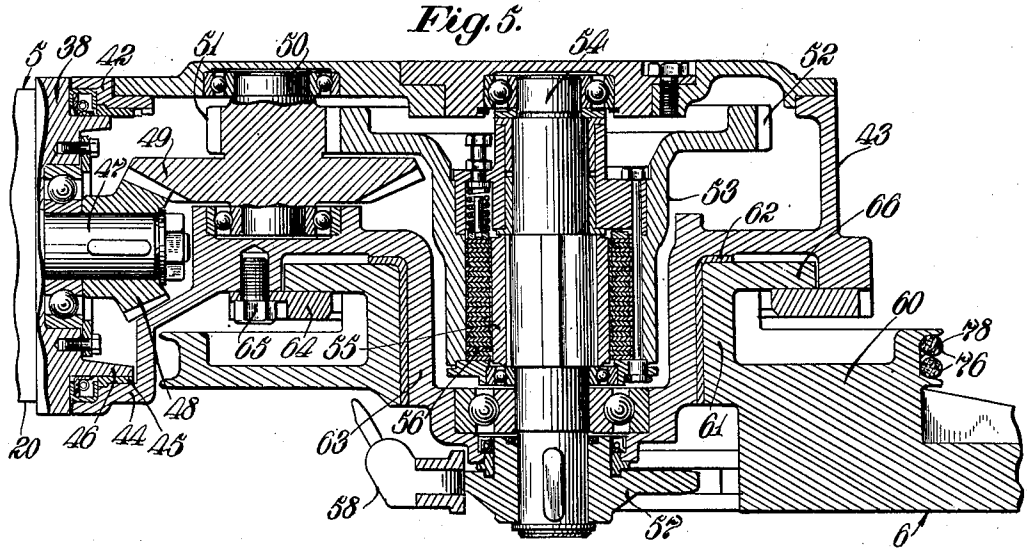


Fig. 6.

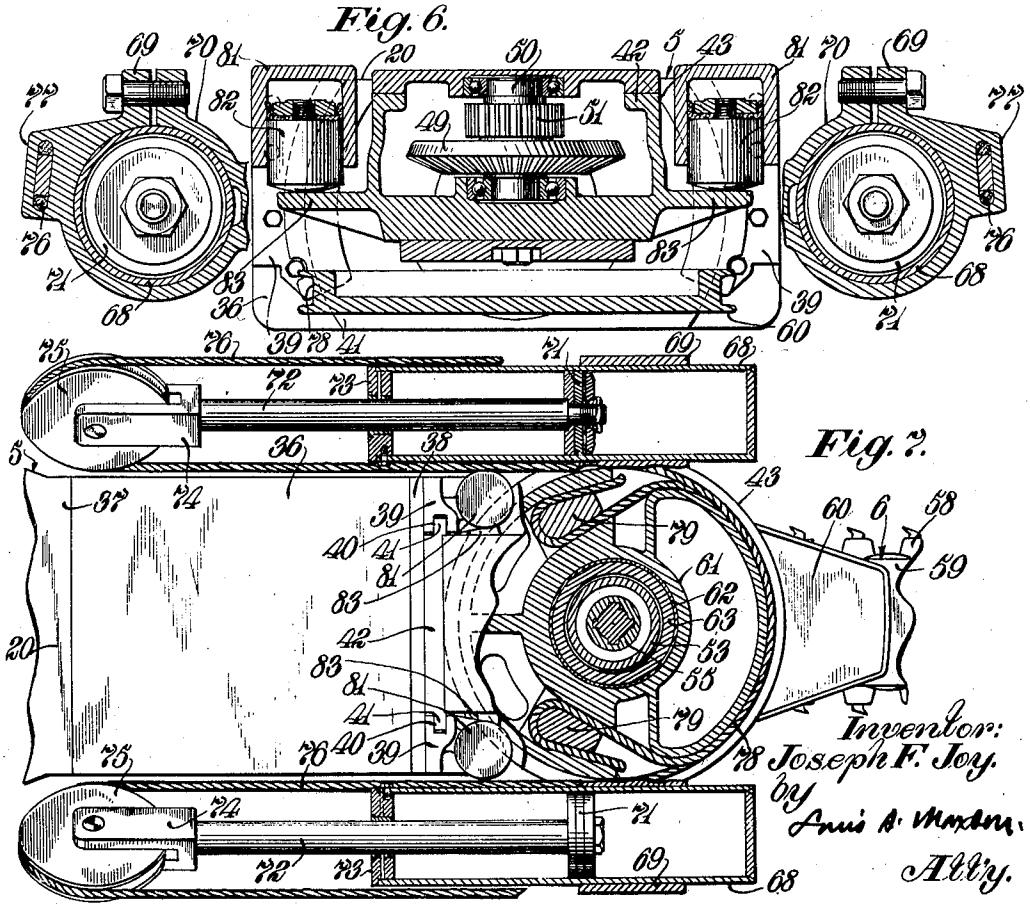


Fig. 7.

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MINING APPARATUS

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Fig. 8.

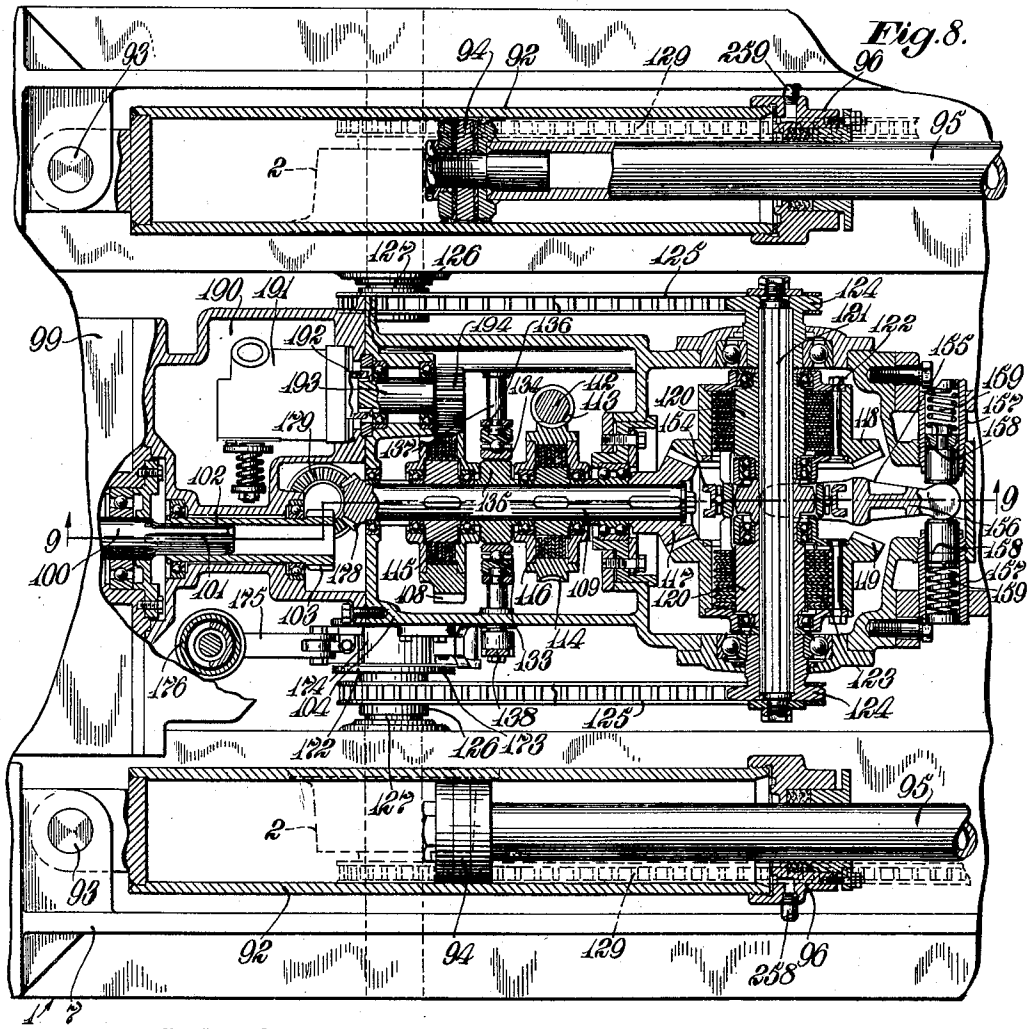
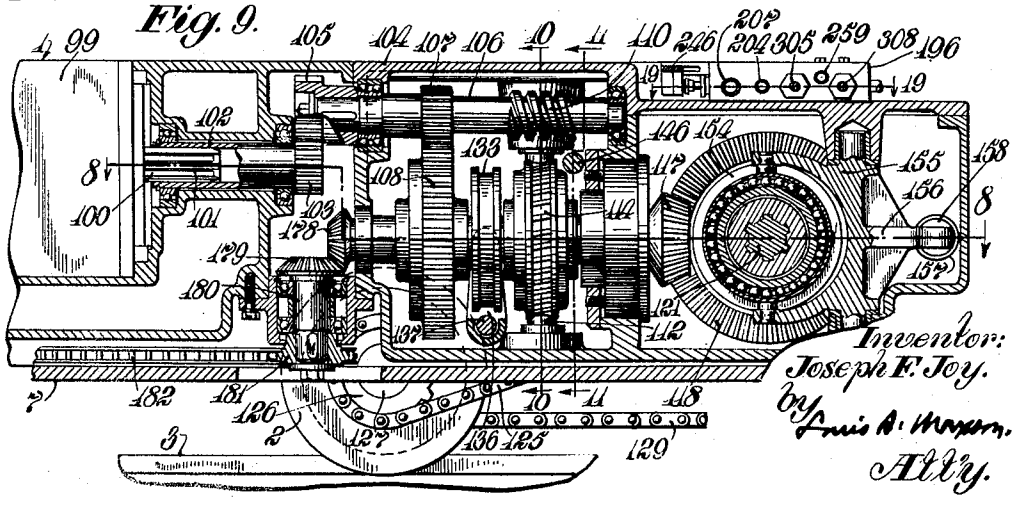


Fig. 9.



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Fig. 10.

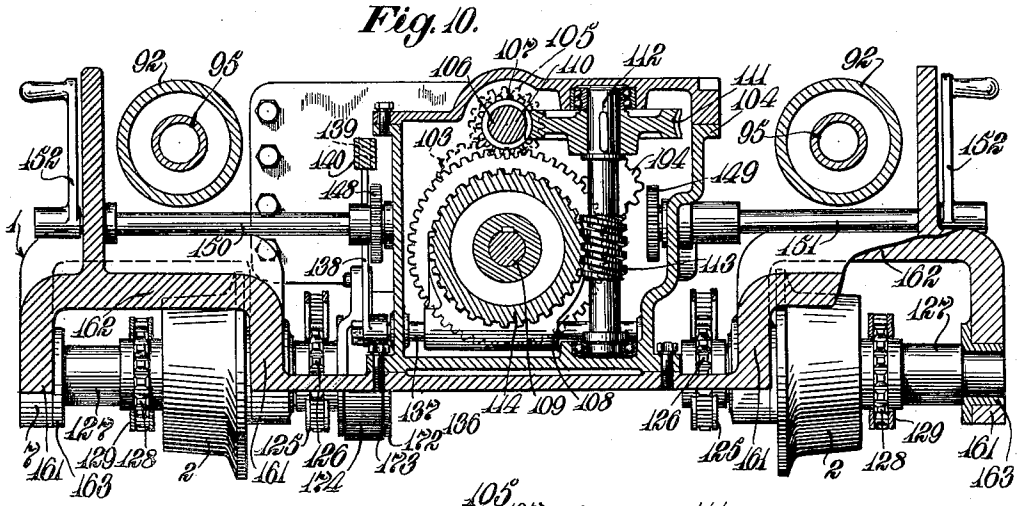


Fig. 11.

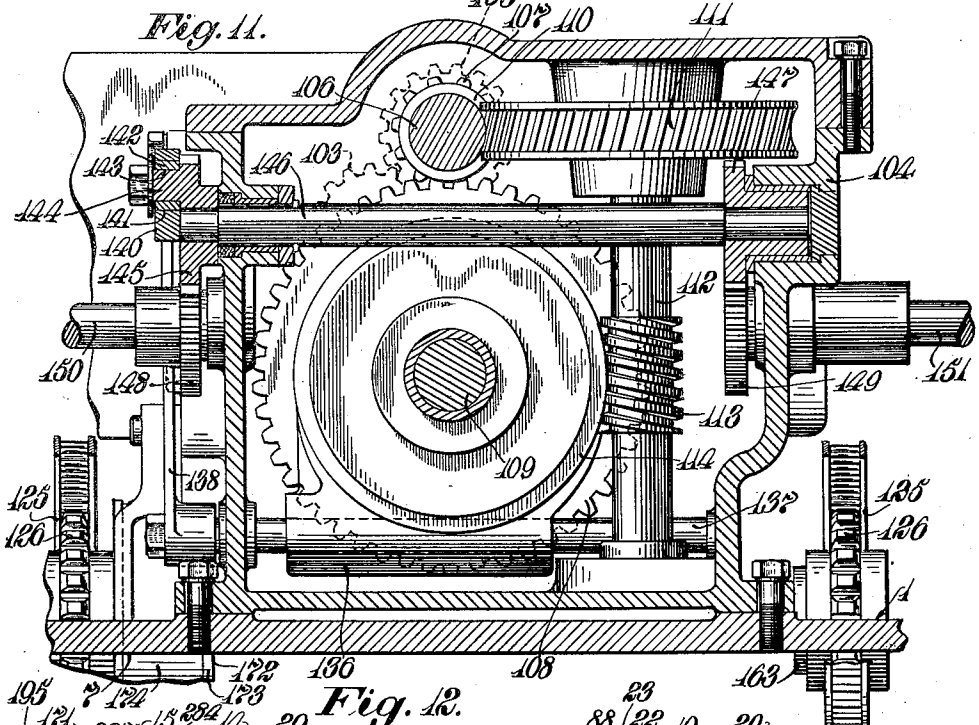
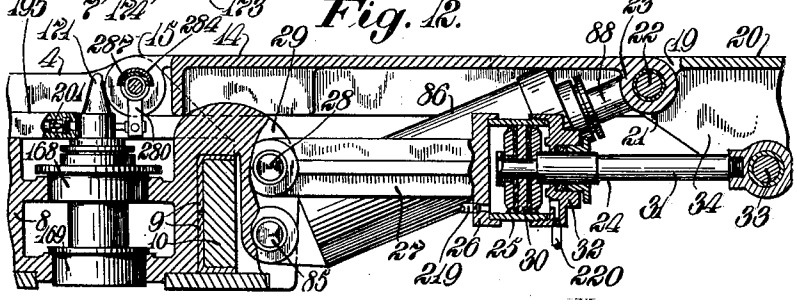


Fig. 12.



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Dec. 17, 1940. J. F. JOY 2,224,872

MINING APPARATUS

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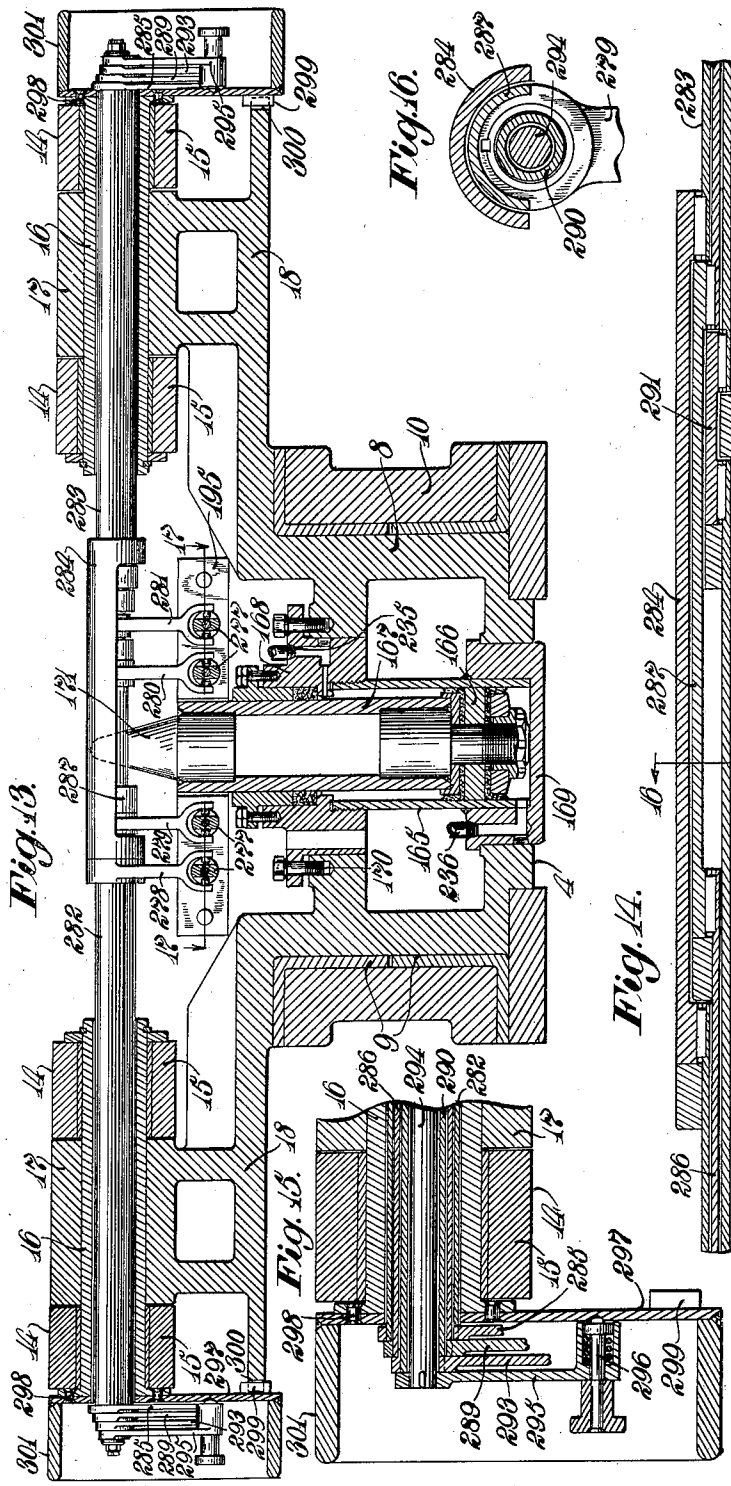


Fig. 13.

Fig. 16.

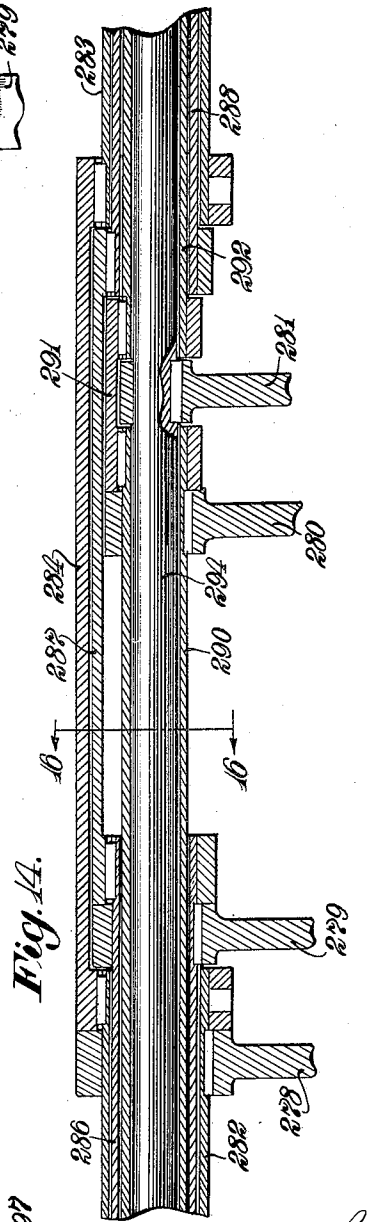


Fig. 14.

Fig. 15.

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Dec. 17, 1940. J. F. JOY 2,224,872

MINING APPARATUS

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Fig. 17.

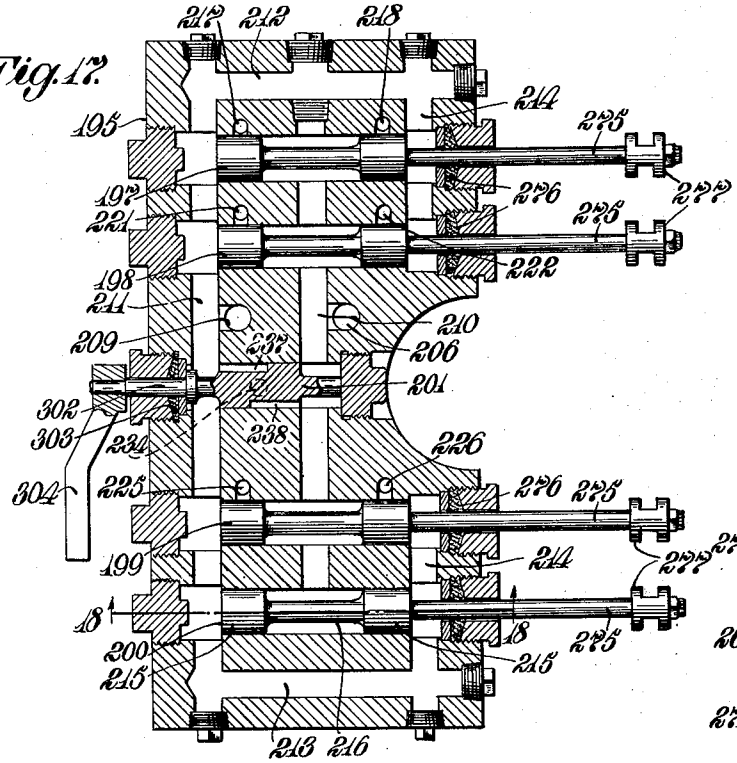


Fig. 20.

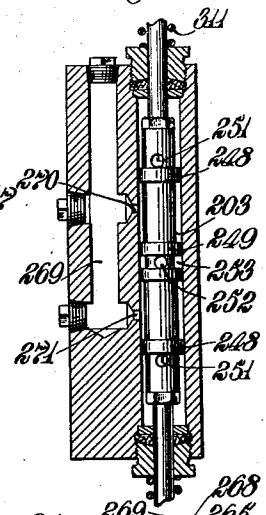


Fig. 18.

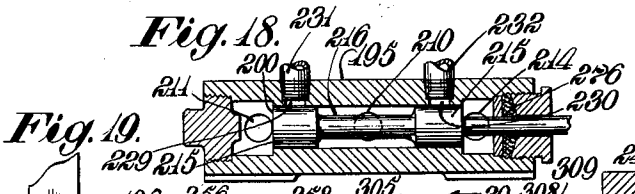


Fig. 19.

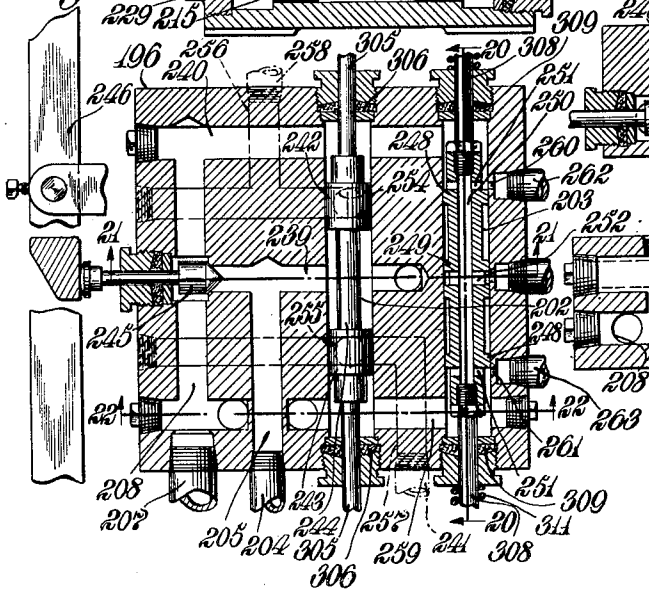


Fig. 21.

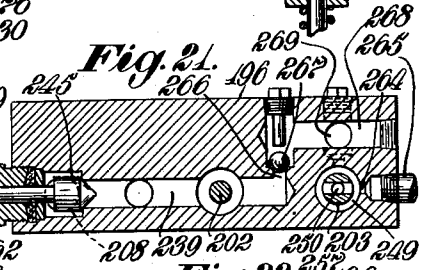
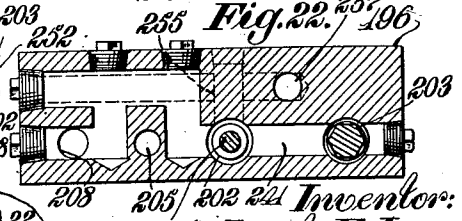


Fig. 22.



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MINING APPARATUS

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Fig. 23.

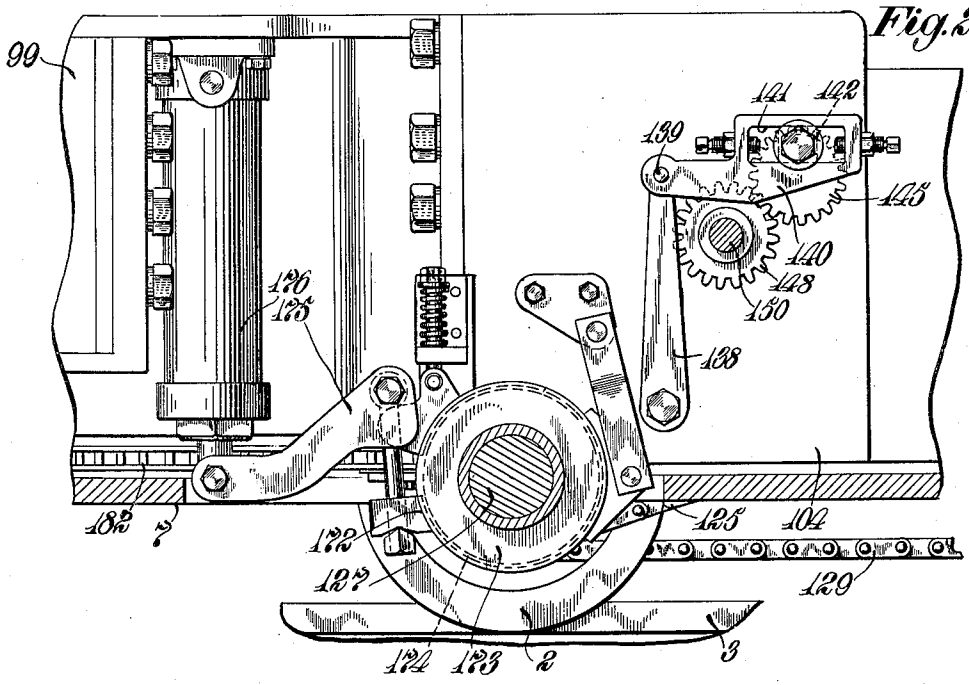
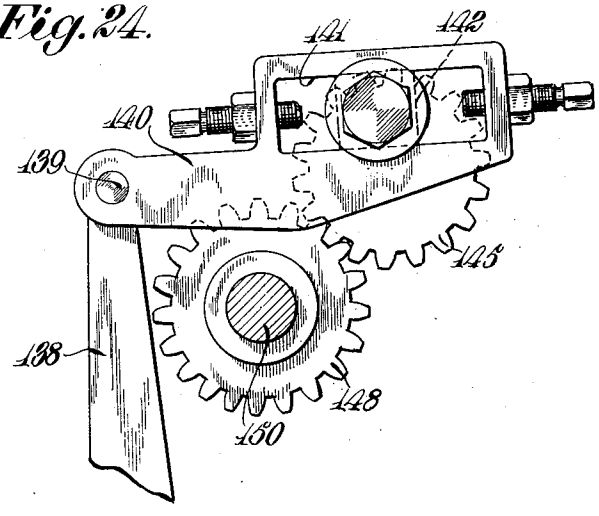


Fig. 24.



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MINING APPARATUS

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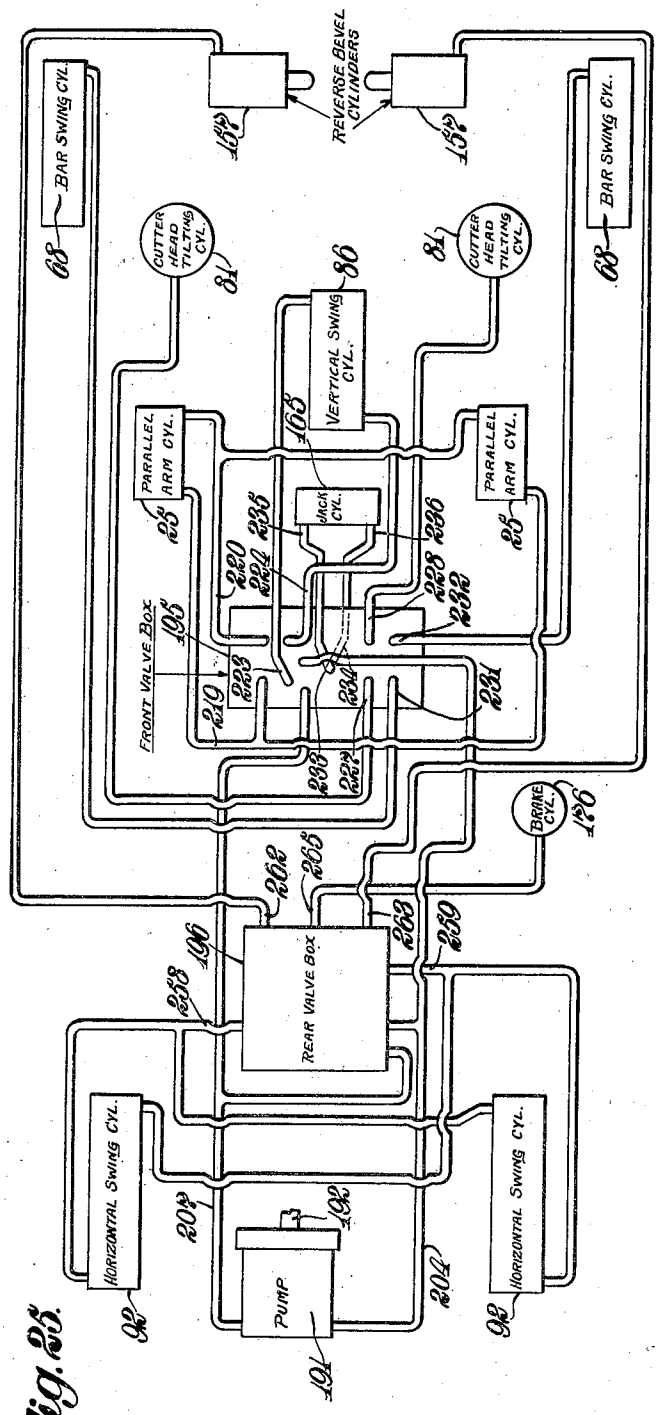


Fig. 25.

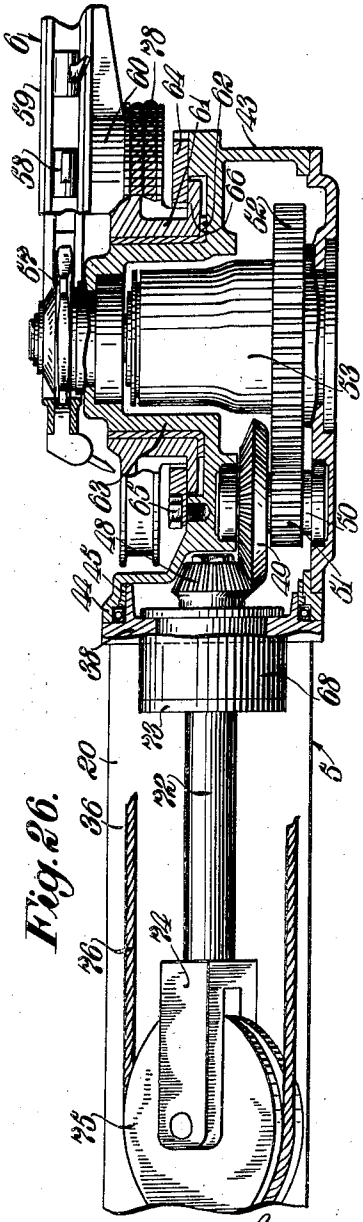


Fig. 26.

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Patented Dec. 17, 1940 2,224,872

UNITED STATES PATENT OFFICE

2,224,872

MINING APPARATUS

Joseph F. Joy, Claremont, N. H., assignor to Sullivan Machinery Company, a corporation of Massachusetts

Application March 9, 1937, Serial No. 129,856

1 Claim. (Cl. 262—28)

This invention relates to mining apparatus, and more particularly, but not exclusively, to improvements in a coal mining apparatus of the horizontal cutting, track cutter type adapted to operate while supported and guided by a mine trackway.

An object of this invention is to provide an improved coal mining apparatus of the type commonly known as a track cutter. Another object is to provide an improved coal mining apparatus of the truck mounted, track supported and guided type especially designed to use in cutting horizontal, or substantially horizontal kerfs in a mine wall. A further object is to provide an improved coal mining apparatus having improved kerf cutting means, together with improved means for adjustably supporting and moving the kerf cutter. Another object is to provide an improved adjustable supporting and moving structure of the hydraulically operated and controlled type for adjusting and moving the kerf cutter in an improved manner. A further object is to provide an improved hydraulically operated and controlled swinging and tilting means for the kerf cutter, whereby the kerf cutter may be swung about its pivot and tilted about an axis extending longitudinally of the kerf cutter. Yet another object of the invention is to provide improved coal mining apparatus of an extremely low compact design having a novel arrangement of parts, and especially adapted to low vein work. Other objects and advantages of the invention will, however, hereinafter more fully appear.

In the accompanying drawings there are shown for purposes of illustration one form and a modification thereof which the invention may assume in practice.

In these drawings—

Fig. 1 is a plan view of an illustrative embodiment of the improved mining apparatus, with the kerf cutter shown in bottom cutting position.

Fig. 2 is a side elevational view of the mining apparatus shown in Fig. 1.

Fig. 3 is an enlarged fragmentary plan view of the forward portion of the mining apparatus shown in Fig. 1, showing the kerf cutter supporting and moving structure.

Fig. 4 is an enlarged view in longitudinal section taken substantially on line 4—4 of Fig. 1.

Fig. 5 is an enlarged, longitudinally extending, vertical sectional view taken substantially on line 5—5 of Fig. 3.

Fig. 6 is a transverse vertical sectional view taken substantially on line 6—6 of Fig. 3.

Fig. 7 is a horizontal sectional view, with parts shown in elevation, taken substantially on line 7—7 of Fig. 4.

Fig. 8 is an enlarged horizontal sectional view taken substantially on line 8—8 of Fig. 9.

Fig. 9 is a longitudinally extending vertical sectional view taken substantially on line 9—9 of Fig. 8.

Fig. 10 is a transverse vertical sectional view taken substantially on line 10—10 of Fig. 9.

Fig. 11 is an enlarged, fragmentary, transverse, vertical sectional view taken substantially on line 11—11 of Fig. 9.

Fig. 12 is a view in longitudinal section taken substantially on line 12—12 of Fig. 3.

Fig. 13 is an enlarged transverse vertical sectional view, with parts shown in elevation, taken substantially on line 13—13 of Fig. 1.

Fig. 14 is an enlarged detail sectional view taken in the plane of Fig. 13, showing details of the valve control means.

Fig. 15 is an enlarged detail sectional view taken in the plane of Fig. 13, showing the details of the valve operating means.

Fig. 16 is a detail cross sectional view taken on line 16—16 of Fig. 14.

Fig. 17 is a horizontal sectional view showing the front valve box, the view taken in the plane of line 17—17 of Fig. 13.

Fig. 18 is a detail sectional view taken on line 18—18 of Fig. 17.

Fig. 19 is a horizontal sectional view showing the rear valve box, the view taken in the plane of line 19—19 of Fig. 9.

Fig. 20 is a detail sectional view taken on line 20—20 of Fig. 19.

Fig. 21 is a detail sectional view taken on line 21—21 of Fig. 19.

Fig. 22 is a detail sectional view taken on line 22—22 of Fig. 19.

Fig. 23 is an enlarged side elevational view, with parts shown in longitudinal vertical section, showing a portion of the clutch operating means and the hydraulic brake.

Fig. 24 is a detail view of a portion of the clutch operating means.

Fig. 25 is a diagrammatic view showing a hydraulic fluid system and the associated control means.

Fig. 26 is a view similar to Fig. 4, of a modified form of construction showing the kerf cutter in its top cutting position.

In this illustrative embodiment of the invention, there is shown a coal mining apparatus of the horizontal cutting, track cutter type, although it will be evident that various features

thereof may be incorporated in mining apparatus of various other types, and that the apparatus may be crawler tread mounted, or mounted to slide on its bottom over the mine floor, in a well known manner. The improved coal mining apparatus disclosed herein generally comprises a self-propelled portable base, herein designated 1, in the form of a truck mounted on wheels 2 adapted to travel along a trackway 3 laid on the mine floor. Supported on the truck at the forward end thereof is a horizontally swingable frame in the form of a turntable 4 overlying the front truck wheel axle, and in turn having pivotally supported thereon for swinging movement in a vertical direction with respect thereto, an elongated arm structure or boom 5 of an improved design, carrying at its outer extremity horizontal kerf cutting means generally designated 6. The truck 1 comprises a truck frame 7 of an extremely low compact construction, and the turntable 4 is mounted in a relatively low position at the front end of the truck frame, and has a depending circular bearing portion 8 journaled for rotation about a vertical axis with respect to the truck frame within bearing sleeves 9, 9 supported by a circular bearing support 10 formed integral with the truck frame, as shown in Figs. 12 and 13. Pivotally mounted on the turntable at widely spaced points, in an extremely rugged and stable manner, is the improved arm structure or boom 5. This arm structure or boom comprises a relatively wire, upper, inwardly located arm or boom portion 14 mounted in a relatively low position and having spaced bearing lugs 15, 15 at each side thereof pivotally mounted on horizontal tubular shafts 16, 16 arranged in axial alinement in bearing lugs 17 secured by bracket arms 18 to the opposite sides of the turntable frame, in the manner clearly shown in Figs. 3 and 13. Hinged at 19 on a horizontal axis parallel with the pivotal axis of the upper arm 14, at the outer extremity of the upper arm, is an outer arm or boom portion 20, the latter having bearing lugs 21 journaled on a horizontal shaft 22 parallel with the shafts 16, 16 and supported within bearing supporting lugs 23 formed integral with the upper arm 14. As previously mentioned, the upper inwardly located arm 14 is widely laterally extended, as shown in Figs. 1 and 13, and the hinged connection between the inwardly located upper and outer arms 14 and 20 is extremely rugged, due to its relatively wide bearing point distribution. A pair of bottom arms 24, 24 cooperate with the upper arm 14, and are so pivotally connected to the turntable frame and the outer arm 20 as to provide parallel motion means for maintaining the outer arm 20 always horizontal and parallel to a given straight line during swinging of the arms in a vertical direction about their pivots. Each of the lower parallel motion arms 24, 24 comprises a cylinder 25 having a rear head 26 formed integral with an elongated arm portion 27 pivotally mounted on a pivot pin 28 arranged parallel with the horizontal shafts 16 and 22, and supported within a depending bracket 29 integral with the turntable frame. The cylinders 25 contain reciprocable pistons 30 of the double-acting type having their piston rods 31 passing through the front packed heads 32 of the cylinders and pivotally connected to a horizontal shaft 33 supported within depending brackets 34 at the bottom of and integral with the outer arm 20, and likewise arranged parallel with the shafts 16 and 22. The points of pivotal connection of the arm 14 and the arms 24 with the turntable frame and their points of pivotal connection with the outer arm 20 are equally and fixedly spaced, so that when the pistons 30 are in their midway position within the cylinders, the upper arm 14 and the lower arms 24 are parallel. When pressure fluid is supplied to one end or the other of the cylinders 25, in a manner to be later described, the pistons move in one direction or the other within the cylinders, to swing the horizontal outer arm 20 about its pivotal connection with the upper arm 14 either upwardly or downwardly to change the angle in altitude of the outer arm 20, for a purpose to be later described.

Now referring to the kerf cutting means 6, and more particularly to the driving and mounting means therefor, it will be noted that carried by the outer horizontal arm 20 is a low compact horizontal motor 35 having its casing 36 forming an intermediate portion of the arm 20, and the rear motor head 37 is, in this instance, formed integral with the rear arm portion which supports the bearing lugs 21. The motor casing is provided with a front motor head 38 having secured thereto, as by bolts, guide brackets 39, 39 having arcuate guideways 40 in which are guided arcuate guides 41 formed integral with the frame 42 of the tiltable cutter head 43, which supports the kerf cutting means. The cutter head frame is provided with a circular bearing portion 44 journaled on a bearing sleeve 45 supported by a circular bearing support 46 formed integral with the front motor head 38, and the guide brackets 39 retain the cutter head frame in position on its bearing. The means for tilting the cutter head about its bearing on the front motor head will be later described. The power shaft 47 of the motor 35 extends longitudinally of the outer arm 20 and has keyed to its forward end a bevel pinion 48 meshing with a horizontal bevel gear 49, herein formed integral with a vertical shaft 50 suitably journaled within the cutter head frame. Formed integral with the shaft 50 and driven thereby, is a horizontal spur gear 51 meshing with a large spur gear 52 having its hub 53 journaled on bearings supported by a vertical shaft 54. The spur gear 52 has its hub 53 connected to a clutch member 55, keyed to the shaft 54, by a multiple disc clutch 56 set at a predetermined load, so that when the shaft 54 is overloaded, the clutch will automatically slip to permit relative rotation between the gear and shaft. The shaft 54 is suitably journaled in bearings supported by the cutter head frame, and has keyed thereto, at its lower end, a chain sprocket 57. This chain sprocket engages and drives an endless cutter chain 58 guided for circulation about the margin of an elongated, horizontal, plane cutter bar 59 of the kerf cutting means. The cutter bar 59 is supported by a swiveled hanger frame 60 having a circular bearing portion 61 journaled on a bearing sleeve 62 supported by a circular bearing support 63 formed integral with the cutter head frame. The cutter bar hanger frame is retained in position on its bearing on the cutter head frame by a thrust ring 64, preferably composed of two semi-circular parts and secured, as by screws 65, to the cutter head frame, and this thrust ring cooperates with an annular flange 66 formed integral with the bar hanger frame. It will thus be seen that the cutter bar is swingable horizontally relative to the cutter head about an axis coincident with the longitudinal axis of the vertical shaft 54.

The means for swinging the cutter bar about its pivot comprises a pair of hydraulic cylinders 68, 68 secured as by clamps 69 to lateral lugs 70 formed integral with the cutter head frame at the opposite sides thereof, in the manner clearly shown in Fig. 3. These cylinders 68 are arranged in horizontal parallel relation at the opposite sides of the outer horizontal arm 20 of the arm structure and respectively contain reciprocable single-acting pistons 71, 71 (see Fig. 7) having their piston rods 72 extending rearwardly through the packed rear heads 73 of the cylinders. Secured to the rearward ends of the piston rods 72 are brackets 74 on which are journaled roller sheaves 75. A pair of cables 76 fixed at one end at 77 to the cylinder clamps 69, pass around these roller sheaves 75, and extend forwardly along the sides of the outer arm 20 and around an annular cable guiding groove 78 formed on a circular portion of the cutter bar hanger frame 60 (see Fig. 5), and the opposite ends of these cables are fixed at 79 to the bar hanger frame, in the manner clearly shown in Fig. 7. It will thus be seen that when hydraulic pressure is supplied to the forward end of one of the cylinders and is exhausted from the forward end of the other cylinder, one of the cables may be deflected rearwardly, while the other cable is slackened, to effect swinging of the cutter bar hanger frame on its bearing on the cutter head frame, and as a result, the cutter bar may be swung horizontally in one direction or the other about its pivot. By trapping the liquid in the cylinders the cutter bar may be locked against swinging movement about its pivot relative to the arm structure.

The means for rocking the kerf cutter carrying cutter head 43 on its bearing to tilt the cutter bar about a longitudinal axis relative to the outer arm comprises, as shown most clearly in Fig. 6, a pair of vertical cylinders 81, 81 secured to the arm and preferably formed integral with the guide brackets 39 and containing piston-like plungers 82. These plungers extend downwardly from the cylinders and engage lateral shelf-like lugs 83 formed integral with the cutter head frame at its opposite sides. It will be evident that when hydraulic pressure is supplied to the upper end of one or the other of the cylinders 81 and the upper end of the other cylinder is connected to exhaust, one of the plungers moves downwardly to rock the cutter head in one direction or the other relative to the outer arm 20. By trapping the liquid within the cylinders the cutter head may be locked against tilting movement relative to the arm structure. The means for supplying hydraulic pressure to the cylinders 68 and 81 will be hereinafter described.

Now referring to the means for swinging the arm structure or boom 5 in a vertical direction relative to the swiveled turntable frame 4, it will be noted that pivotally mounted on a horizontal shaft 85 (see Fig. 4) supported by the bracket 29 in parallelism with the shaft 28 and below the latter, is a relatively large, centrally located, hydraulic cylinder 86 containing a reciprocable double-acting piston 87 having its piston rod 88 extending forwardly and upwardly through the front packed head 89 of the cylinder. The forward end of the piston rod 88 is pivotally connected to the horizontal shaft 22 at a point midway between the lower parallel arms 24, 24, the upper arm 14 being cut away at 90 to provide clearance for the cylinder head as the arm structure is swung in a vertical direction about its pivotal mounting. It will thus be seen that when hydraulic pressure is supplied, in a manner to be later explained, to one end or the other of cylinder 86 the arm structure may be swung either upwardly or downwardly, and by trapping the liquid within the cylinder 86 the arm structure may be locked in its adjusted position. It will further be evident that when the arm structure is swung either upwardly or downwardly about its pivot and the pistons of the lower parallel arms 24 are in their mid-way positions, shown in Fig. 12, the outer arm 20, together with the kerf cutter supported thereby, will always be maintained horizontal.

The mechanism for rotating the swiveled turntable frame 4 about its axis to swing the cutter supporting arm structure horizontally relative to the truck comprises a pair of hydraulic cylinders 92 arranged in longitudinal parallel relation at the opposite sides of the truck frame and having their rear ends pivotally mounted on vertical pivot pins 93 supported within lugs integral with the truck frame, so that the cylinders are permitted to swing horizontally. Reciprocable within these cylinders are double-acting pistons 94 having their piston rods 95 extending forwardly through the front packed cylinder heads 96 and pivotally connected at their forward extremities by vertical pivot pins 97 to lugs 98 integral with the bearing lugs 17. It will be evident that when hydraulic pressure is supplied, in a manner to be later described, to one end of one cylinder and to the opposite end of the other cylinder, the pistons may be moved in relatively opposite directions to effect turntable rotation. By trapping the liquid in the cylinders, the turntable frame may be locked against rotation.

Now referring to the improved propelling means for the apparatus, it will be noted that supported on the rearward portion of the truck frame at a substantial distance rearwardly of the swiveled turntable frame for the arm structure, is a horizontal motor 99 having its power shaft 100 horizontally disposed and extending longitudinally of the apparatus. As shown in Fig. 8, splined at 101 to the forward end of the motor power shaft is a sleeve-like hub 102 of a spur motor pinion 103. The hub of the spur motor pinion is suitably journaled within bearings supported within the frame of a transmission gear housing 104 supported on the truck frame in advance of the motor, and the motor pinion meshes with a spur gear 105 keyed to the rear end of a horizontal transmission shaft 106. The transmission shaft 106 is herein arranged in parallelism with the motor power shaft, and likewise suitably journaled within the transmission gear housing 104. Secured to and driven by the shaft 106 is a spur gear 107 meshing with a large spur gear 108 having its hub journaled on bearings supported on a horizontal transmission shaft 109. The shaft 109 is arranged in parallelism with the transmission shaft 106 below the latter, and is likewise suitably journaled within the transmission housing. Also fixed to and driven by the transmission shaft 106 is a worm 110 meshing with a horizontal worm wheel 111 (see also Figs. 10 and 11), keyed to the upper end of a vertical shaft 112. The shaft 112 is suitably journaled within the transmission housing and has fixed thereto and drives a worm 113 meshing with a worm wheel 114 arranged coaxially with

the spur gear 108 and likewise having its hub journaled on bearings supported by the transmission shaft 109. The spur gear 108 herein constitutes the high speed terminal driving element of the high speed transmission, while the worm wheel 114 constitutes the low speed terminal driving element of the low speed transmission, and these gears 108 and 114 are connectible by multiple disc clutches 115 and 116, respectively, to the shaft 109. It will thus be seen that when one or the other of the clutches 115, 116 is applied, the shaft 109 may be driven either at a relatively low speed or at a relatively high speed. As shown in Fig. 8, keyed to the forward end of the transmission shaft 109 is a bevel gear 117 meshing with reverse bevels 118 and 119 and driving the latter in relatively opposite directions. The hubs of these bevel gears 118 and 119 are journaled on bearings supported by clutch members 120 keyed to a horizontal transmission shaft 121, and the reverse bevels are alternately connectible in driving relation with the shaft 121 by multiple disc clutches 122 and 123, respectively, so that the shaft may be driven in one direction or the other. The shaft 121 extends transversely of the transmission housing and is suitably journaled in bearings supported therein, and has keyed thereto, at its opposite ends, chain sprockets 124, 124 connected by endless drive chains 125 to chain sprockets 126, 126 keyed to rear stub axles 127, 127, respectively. These stub axles also have keyed thereto chain sprockets 128 which are connected by endless drive chains 129 to chain sprockets 130, keyed to the front axle 131. The rear stub axles 127 and the front axle 131 have fixed thereto and drive the truck wheels 2. From the foregoing it will be evident that through the transmission gearing above described, the truck wheels may be driven at either a relatively low speed or a relatively high speed and in either of opposite directions at either speed.

The operating means for the high and low speed disc clutches 115, 116 comprises a clutch shipper ring 133 surrounding the shaft 109 between the high and low speed terminal gears 108 and 114, as shown in Fig. 8, and this ring is journaled on ball bearings supported by a sleeve 134 in turn slidably mounted on a cylindrical member 135 supported by the shaft, and this clutch shipper ring has projections engaging the adjacent end discs of the clutches, so that when the shipper ring is moved in one direction or the other, one of the clutches is applied, while the other is released. Engaging the clutch shipper ring is a shipper yoke 136 secured to an operating shaft 137 rotatably mounted at its opposite ends within the side walls of the transmission housing, and keyed to one end of this operating shaft is an upstanding lever 138 pivotally connected at its upper end at 139 to a swingable frame 140. This frame has a guideway 141 in which is slidably mounted a block 142 having a socket 143 for receiving an eccentric 144 formed integral with a spur gear 145. This spur gear is fixed to a horizontal shaft 146 extending transversely of and suitably journaled within the transmission housing. Fixed to the other end of the horizontal shaft 146 is a similar spur gear 147, and meshing with these spur gears are spur gears 148 and 149 fixed to operating shafts 150 and 151 herein arranged in alinement on horizontal axes extending transversely of and suitably journaled within the opposite sides of the gear housing. Fixed to the outer ends of the operating shafts 150 and 151 are operating handles 152 conveniently located at the opposite sides of the apparatus. It will thus be seen that when the operator grasps one of the handles and rotates the gears, the shipper yoke lever 138 is swung about its pivot to move the shipper ring in one direction or the other to apply one or the other of the disc clutches. The operating means for the reverse bevel clutches 122, 123 comprises a similar clutch shipper ring 154 with which engages a pivoted shipper yoke 155 having an integral operating lever 156. Mounted within the transmission housing are alined horizontal cylinders 157, 157 containing pistons 158, 158 having plunger-like piston rods engaging the opposite sides of the outer end of the shipper yoke lever 156. Acting on the pistons are coil springs 159 for constantly urging the plungers into engagement with the shipper yoke lever for normally maintaining the clutch shipper ring in its neutral position. When hydraulic pressure is supplied, in a manner to be later explained, to one or the other of the cylinders 157, one of the pistons 158 may be moved to swing the clutch shipper yoke about its pivot, thereby to move the clutch shipper ring in one direction or the other to apply one of the reverse clutches.

The journal structure for the stub axles 127 is clearly shown in Fig. 10 and comprises spaced vertical inner and outer frame portions 161 formed integral with the truck frame and connected by an upper horizontal integral frame portion 162, and the vertical frame portions support alined bearing sleeves 163 in which the stub axles 127 are journaled. In this instance, the chain sprockets 126 are arranged at the inner adjacent sides of the inner vertical frame portions 161, while the truck wheels and the chain sprockets 128 are secured to the stub axles between the vertical frame portions 161. By rearranging the position of the wheels and sprockets with respect to the stub axles, the track gauge may, of course, be varied.

A hydraulic jack is provided for jacking the apparatus in position on the mine trackway during the cutting operation, and this jack is arranged coaxially with the swiveled turntable frame 4 and is supported thereby. As shown in Fig. 13, this jack comprises a vertical cylinder 165 containing a double-acting piston 166 having its piston rod 167 projecting upwardly through the packed upper head 168 of the cylinder. The lower cylinder head 169 is seated within a bore formed within the circular bearing portion 8 of the swiveled turntable frame, and the upper head is arranged in an alined bore, and the cylinder heads are secured in position by screws 170 engaging lugs integral with the upper head and threadedly secured within the turntable frame. The upper extremity of the piston rod is formed with a point 171 adapted for reception within a socket formed within a conventional mine roof jack, and when it is desired to jack the apparatus in position on the trackway, hydraulic pressure may be supplied, in a manner to be later described, to the lower end of the cylinder to effect upward movement of the piston, thereby causing rigid engagement of the mine roof jack with the mine roof. When hydraulic pressure is supplied to the upper end of the cylinder, the jack is, of course, released. For braking the truck wheels there is provided a truck wheel brake 172 comprising a brake drum 173 fixed to one of the rear stub axles 127, and with which is engageable a contractible brake band 174. This brake band

is operated through usual lever and link mechanism 175 by a hydraulic brake release cylinder 176. The cylinder houses a coiled spring (see Fig. 8) for always urging the brake operating means toward brake applying position.

Mounted for rotation about a vertical axis on the rearward portion of the truck frame rearwardly of the truck driving motor 99 is a horizontal reel 177 for the motive power conducting element for the motors 35 and 99, and this power conductor reel is adapted to be driven through the high and low speed transmission gearings above described, by a bevel gear 178 secured to the transmission shaft 109 (see Fig. 8). As shown in Fig. 9, the bevel gear 178 meshes with a bevel gear 179 secured to a vertical shaft 180 suitably journaled within the transmission housing. Keyed to the lower end of the vertical shaft 180 and driven thereby is a chain sprocket 181 connected by an endless drive chain 182 to a chain sprocket 183 fixed to the reel drive shaft. The reel drive shaft may be frictionally connected in driving relation with the reel in the manner disclosed in my copending application, Ser. No. 82,154, filed May 27, 1936, patented Sept. 17, 1938, No. 2,161,818. It will thus be seen that as the apparatus is propelled rearwardly along the mine trackway at either a high or a low speed, the reel 177 will be simultaneously driven at a similar speed to wind in the power conductor element under the control of the high and low speed disc clutches 115 and 116. When the apparatus is propelled forwardly along the trackway, the friction reel drive slips to pay out the power conductor element.

Now referring to the improved hydraulic fluid system and the associated control means for supplying liquid under pressure to the various hydraulically operated devices, it will be observed that formed in the gear housing 104 is a chamber 190 (see Fig. 8) providing a reservoir for containing a liquid, preferably oil, and arranged in this reservoir is a pump 191 of a conventional design, having its pump drive shaft 192 connected through a splined coupling connection to a drive shaft 193. Fixed to the shaft 193 is a spur gear 194 meshing with and driven by the high speed terminal gear 108 of the high speed transmission. As shown in Figs. 1 and 13, supported on the top of the swivelled turntable frame 4 is a front valve box 195 containing valves for controlling the bar swinging cylinders 68, the cutter head tilting cylinders 81, the parallel arm cylinders 25, the cylinder 86 for vertically swinging the arm structure, and the jack cylinder 165, while supported on the top of the gear housing is a rear valve box 196 containing valves for controlling the supply of hydraulic pressure to the brake cylinder 176, the cylinders 157 for controlling the reverse bevel clutches and the cylinders 92 for horizontally swinging the arm structure. As shown in Fig. 17, the front valve box 195 has formed therein a series of parallel horizontal bores having reciprocably mounted therein slide valves 197, 198, 199 and 200 and a rotary valve 201, while, as shown in Fig. 19, the valve box 196 has formed therein parallel horizontal bores containing slide valves 202 and 203. As shown in Fig. 25, the pump 191 has its pressure side connected through a conduit 204 to a liquid pressure supply passage 205 in the valve box 196 and a liquid pressure supply passage 206 in the valve box 195, while the discharge side of the pump is connected through a conduit 207 to the discharge passage 208 of the valve box 196, and the discharge passage 209 of the valve box 195. Formed in the valve box 195 and extending in parallel relation substantially thereacross are supply and discharge passages 210 and 211 communicating respectively with the passages 206 and 209, and these passages 210 and 211 communicate with all of the valve bores. The supply passage 210 communicates with the bores containing the slide valves midway between the ends thereof and with one end of the bore containing the rotary valve 201, while the discharge passage 211 communicates with the valve bores at the left hand ends thereof, as viewed in Fig. 17, and is connected through passages 212 and 213 with discharge passages 214 communicating with the right hand ends of the bores for the slide valves, as viewed in Fig. 17. The slide valves are herein of the balanced spool type comprising spaced end spools 215, 215 connected by a reduced portion 216, and the supply passage 210 communicates with the annular spaces encircling the reduced portions between the end spools, while the exhaust passages communicate with the valve bores at the remote ends of the valve spools. Communicating with the bore containing the slide valve 197 are ports 217 and 218 (Fig. 17), respectively connected by conduits 219 and 220 (Fig. 25) with the opposite ends of the cylinders 25 of the lower parallel arms 24. Communicating with the bore containing the slide valve 198 are ports 221 and 222 (Fig. 17), respectively connected by conduits 223 and 224 (Fig. 25) to the opposite ends of the cylinder 86 for vertically swinging the arm structure. Communicating with the bore containing the slide valve 199 are ports 225 and 226 (Fig. 17) respectively connected by conduits 227 and 228 (Fig. 25) to the upper ends of the cylinders 81 for rocking the cutter head frame about the longitudinal axis of the outer arm. Communicating with the bore containing the slide valve 200 are ports 229 and 230 (Figs. 17 and 18), respectively connected by conduits 231 and 232 (Fig. 25) to the forward ends of the bar swinging cylinders 68. The bore containing the rotary valve 201 has communicating therewith, respectively at the top and bottom thereof, ports 233 and 234, respectively connected by conduits 235 and 236 (Fig. 25) to the opposite ends of the jack cylinder 165, and the rotary valve has longitudinal grooves 237 and 238 opening out through the opposite ends thereof respectively, for connecting the ports 233 and 234 with either the supply passage or the exhaust passage.

In the rear valve box 196, the liquid pressure supply passage 205 communicates with a supply passage 239 (Figs. 19 and 21), in turn communicating with the bore containing the slide valve 202 midway between the ends thereof, while the discharge passage 208 communicates with discharge passages 240 and 241 (Fig. 19) in turn communicating with the bores containing the slide valves 202 and 203 at the remote ends thereof. The slide valve 202 is similar to the slide valves above described, and similarly has spaced end spools 242 and 243 connected by a reduced portion 244, and the supply passage 239 communicates with the annular space surrounding the reduced portion between the spools. The supply passage 239 is communicable with the discharge passage 208 under the control of a bypass valve 245 (see Fig. 19) operable by a pivoted lever 246 extending across the top of the truck and provided with handles 247, 247 conveniently located at the opposite sides of the apparatus in adjacency to the control handles 152 for the high and low speed transmission clutches. This by-

pass valve 245 may be opened to connect the supply conduit 204 with the discharge conduit 207 to relieve the pressure in the supply passages in both valve boxes, so that the liquid pressure in the system may be reduced at will. The slide valve 203 is herein of the three-spool type having end spools 248, 248 (Fig. 19) and a central spool 249 connected by reduced portions, and an axial passage 250 in the valve is connected at its ends by radial ports 251 with the discharge passages 240, 241 respectively, at the ends of the valve bore, and radial ports 252 communicate with an annular groove 253 formed centrally on the periphery of the central valve spool 249 and communicating with the valve bore. Communicating with the bore containing the slide valve 202 are ports 254 and 255 (Fig. 19) communicating, respectively, with passages 256 and 257 connected by conduits 258 and 259, respectively, (Fig. 25) with the cylinders 92 for horizontally swinging the arm structure, the conduit 258 being connected to one end of one cylinder and the opposite end of the other, and the conduit 259 connected to the opposite end of the first cylinder and the opposite end of the other. Communicating with the bore containing the slide valve 203 are ports 260 and 261 (Fig. 19) connected by conduits 262 and 263 (Fig. 25) to the outer ends of the cylinders 157 for controlling the reverse bevel clutches, and communicating with the valve bore, midway between the ports 260 and 261, is a port 264 connected by a conduit 265 to the brake cylinder 176. The supply passage 239 in the rear valve box 196 is connected through a port 266 controlled by a ball check valve 267 (see Fig. 21) with a passage 268 in turn communicating with a transverse passage 269 (Fig. 20) connected through ports 270 and 271 with the annular spaces surrounding the reduced portions of the valve 203 between the valve spools. The ball check valve permits flow of liquid pressure from the supply passage 239 to the passage 268, while liquid flow in the reverse direction is automatically prevented thereby. In Figs. 17 and 19, all of the slide valves and the rotary valve are shown in their closed or neutral position, so that the liquid pressure in the supply passages may flow past the by-pass valve 245 through the discharge passages back to the pump intake or reservoir. When the slide valves in the front control box 195 are slid in one direction or the other, certain of the ports may be connected to the liquid pressure supply, while the other ports are connected to the discharge passage, so that the various hydraulic devices controlled thereby may be operated in one direction or the other, and when the valves are in the neutral position shown, the liquid is trapped within the hydraulic devices controlled thereby. The ports communicating with the bore containing the rotary valve 201, upon rotation of the valve in one direction or the other, may be connected either with the pressure supply passage or with the discharge passage, so that the hydraulic jack may be moved either upwardly or downwardly, as desired, and when the valve is in the position shown, the liquid is trapped within the cylinder to lock the jack in position. When the slide valve 202 in the rear valve box 196 is slid in one direction or the other, one or the other of the ports is connected with the supply passage, while the other port is connected with the discharge passage, thereby to effect movement of the pistons of the hydraulic swinging cylinders 92 for the arm structure in one direction or the other to swing the arm structure horizontally in either of opposite directions. When the slide valve 203 in the rear valve box 196 is in the position shown, the reverse bevel clutch-operating cylinders 157 and the brake cylinder 176 are connected to the discharge passage, and when the slide valve is slid in one direction or the other, liquid under pressure is supplied to one or the other of the reverse bevel clutch operating cylinders and to the brake cylinder to effect application of one or the other of the clutches and to release the brake. When one reverse bevel clutch is applied, the brake is always maintained released.

Now referring to the improved operating means for the slide valves 197, 198, 199, and 200, in the front valve box 195, it will be noted that each valve has a valve stem 275 (Fig. 17) projecting outwardly from the valve box through a sealing packing 276, and secured to the outer end of each valve stem is a grooved member 277, and engaged in the grooves in these members are shipper yokes 278, 279, 280 and 281, respectively (Fig. 13). The shipper yoke 278 for the slide valve 200 is keyed to a tubular operating shaft 282 (Fig. 14) rotatably mounted in the bore of and extending centrally through one of the tubular shafts 16 on which the arm structure is pivotally mounted. Rotatably mounted in and extending centrally through the bore of the other tubular shaft 16 at the opposite side of the apparatus, is a tubular operating shaft 283 alined with the shaft 282 and having keyed thereto a connecting member 284, of semi-circular cross section (Fig. 16), keyed at its opposite end to the shaft 282, and the remote ends of the tubular shafts 282 and 283 have fixed thereto operating levers 285 conveniently located at the opposite sides of the apparatus in adjacency with the control handles 247 and 152 for the by-pass valve and the speed control clutches of the transmission. The shipper yoke lever 279 for the valve 199 is keyed to a tubular operating shaft 286 rotatably mounted in and extending centrally through the tubular shaft 282, and this shaft 286 has keyed thereto a connecting member 287 likewise of semi-circular cross section (Fig. 16) and extending transversely within the member 284 and keyed at its opposite end to a tubular operating shaft 288, alined with the shaft 286 and extending centrally through and rotatably mounted in the bore of the tubular shaft 283, and the remote ends of the operating shafts 286 and 288 have fixed thereto operating levers 289 located in adjacency to the operating levers 285. The shipper yoke lever 280 for the slide valve 198 is keyed to a tubular operating shaft 290 extending centrally through and rotatably mounted in the tubular shaft 286 and keyed to a connecting member 291, in turn keyed to a tubular operating shaft 292 extending centrally through and rotatably mounted in the tubular operating shaft 288, and these operating shafts 290 and 292 have fixed thereto at their remote ends, in adjacency to the levers 285 and 289, operating levers 293. The shipper yoke lever 281 for the slide valve 197 is keyed to an operating shaft 294 extending centrally through and rotatably mounted in the tubular operating shafts 290 and 292 and have fixed thereto, at its remote ends in adjacency to the other levers, operating levers 295. Each of the operating levers has a spring-pressed locking plunger 296 engageable with notches in the outer face of a side plate 297 secured to, at 298, and supported

by the bearing shafts 16 for the arm structure and having projecting lugs 299 interlocked at 300 with notches in the adjacent sides of the swiveled turntable frame, so that the slide valves may be locked in their different operative positions. Fixed to the plates 297 and projecting outwardly over the operating levers, are shields 301 for protecting the levers. The rotary control valve 201 for the hydraulic roof jack has a valve stem 302 (Fig. 17) projecting outwardly through a sealing packing 303 and having a manual operating lever 304. As shown in Fig. 19, the slide valve 202 has valve stems 305 projecting outwardly from the rear valve box 196 through sealing packings 306, and secured to these valve stems are valve operating rods 307 having grasping portions conveniently located at the opposite sides of the apparatus in adjacency to the control levers above described. Threadedly secured within the opposite ends of the slide valve 203 (Fig. 19) are valve stems 308 projecting outwardly from the valve box through sealing packings 309 and having operating rods 310 (Fig. 1) provided with grasping portions located at the opposite side of the machine in adjacency to the grasping portions for the operating rods 307. Encircling the valve stems and interposed between the operating rods in the outer sides of the valve box are oppositely acting coil springs 311 for maintaining the slide valve 203 in its midway neutral position.

In the modified form of construction shown in Fig. 26, the cutter head is inverted, with respect to the outer arm or boom portion 20, with the kerf cutter in its top cutting position instead of in the bottom cutting position shown in Figs. 4 and 5. In this construction, the bolts securing the cutter head frame to the front motor head 38 are detached and the head turned through 180° on its bearing 44, 45 and 46 on the motor head 38, and the holding bolts thereafter reinserted and tightened to hold rigidly the cutter head in position on the outer end of the arm. In this modified form of construction, the arm structure may be operated to adjust the kerf cutter in a horizontal cutting position at the roof level and through a series of parallel horizontal cutting planes between the roof level position and a horizontal cutting position spaced a substantial distance below the roof level, while in the embodiment of the invention above described, the kerf cutter operates to cut through a series of lower horizontal cutting planes including a horizontal cutting position at the floor level. The cutter head is, of course, tiltable with respect to the arm about the longitudinal axis of the arm by means of the hydraulic tilting cylinders 81. Otherwise, this form of the invention is identical to that above described. It will thus be evident that instead of detaching the head and inverting the same, the cutter head may be mounted on the outer extremity of the horizontal outer arm for rotation within its bearing so as to make a complete revolution about its axis relative to the arm, and, if desired, power operated means of the type well known to those skilled in the art, may be provided for effecting complete head rotation.

The general mode of operation of the improved coal mining apparatus will be clearly apparent from the description given. The apparatus may be propelled along the mine trackway from one working place to another by the truck propelling mechanism under the control of the high speed friction clutch 115 of the high speed transmission mechanism driven by the motor 99, or at a relatively low speed under the control of the friction clutch 116 of the low speed transmission mechanism, and the apparatus may be propelled along the trackway in either of opposite directions at either speed under the control of the reverse bevel friction clutches 122 and 123. When the working place is reached and it is desired to cut a horizontal kerf at the level of the mine floor outside and below the level of the mine trackway in accordance with the arcwall method of cutting, the operator operates the slide valve 202 to supply hydraulic pressure from the pump 191 to the swinging cylinders 92 to effect swinging of the arm structure 5 horizontally about the turntable axis relative to the truck from the centrally located transport position shown in Fig. 1 to a position wherein the cutter bar 59 is located at the right-hand side of the trackway with its pivot lying outside the trackway. As the arm structure 5 is swung horizontally about the turntable axis relative to the truck frame, hydraulic pressure may be supplied to one of the bar swinging cylinders 68, under the control of the slide valve 200, to effect swinging of the cutter bar 59 about its pivot in the opposite direction until the tip end of the cutter bar assumes a position at the right hand rib. Hydraulic pressure may then be supplied to the cylinder 86, for vertically downwardly swinging the arm structure, to move the cutter bar into a horizontal cutting position at the level of the mine floor outside of the trackway, under the control of the slide valve 198. When the cutter bar is in a position to cut a horizontal kerf at the level of the mine floor outside and below the level of the mine trackway, the operator applies the low speed clutch 116 and the forward feed reverse bevel clutch 119 of the truck propelling mechanism, and the apparatus may be propelled bodily along the mine trackway to effect sumping of the cutter bar beneath the coal seam. Upon completion of the sumping cut, the low speed clutch 116 is released and the slide valve 203 moved into a position to effect release of the reverse bevel clutch and to effect application of the truck wheel brake. A mine roof jack may then be engaged with the hydraulic jack piston on the apparatus, and the rotary valve 201 may then be operated to supply hydraulic pressure to the lower end of the jack piston rigidly to jack the apparatus in stationary position on the mine trackway. The operator then moves the slide valve 202 into a position to supply hydraulic pressure to the cylinders 92 for horizontally swinging the arm structure about the turntable axis, thereby effecting swinging of the kerf cutter from its position at the right hand rib transversely across the coal face into a position wherein the tip end of the cutter bar is in adjacency to the left hand rib. During horizontal swinging of the cutter bar from right to left, the operator may move the slide valve 200 into a position to supply hydraulic pressure to one of the bar swinging cylinders 68 to effect swinging of the cutter bar about its pivot in the opposite direction to first straighten up the bar and thereafter to move the bar into an opposite angular relation, so that upon completion of the transverse swinging cut the cutter bar is located at the left hand rib with its tip end at the left hand rib and its pivot located outside and below the level of the trackway. The valves 200 and 202 are then moved into their neutral position, and the valve 203 is moved into a position to apply the reverse feed bevel clutch and to effect release of the brake, and

upon application of the low speed transmission clutch 116, the apparatus is propelled bodily rearwardly along the mine trackway to effect withdrawal of the cutter bar from beneath the coal face. Upon proper adjustment of the valves 198, 200 and 202, the arm structure and cutter bar are then returned to their transport position indicated in full lines in Fig. 2. During the horizontal cutting operation if it is desired to tilt the cutter bar to change its angle in altitude and to rock the cutter bar edgewise about the longitudinal axis of the outer arm 20, this may be accomplished by supplying hydraulic pressure to the cylinders 25 of the lower parallel arms 24 to change the length of the latter and move the arms 24 and 14 out of parallelism, thereby to tilt the outer arm 20 and cutter bar either upwardly or downwardly about the axis of the pivotal connection between the outer arm 20 and the upper arm 14, and by supplying hydraulic pressure to one or the other of the rocking cylinders 81, to tilt edgewise the cutter bar about the longitudinal axis of the outer arm 20. If it is desired to cut horizontal kerfs in the coal seam at different elevations with respect to the mine floor, hydraulic pressure may be supplied to the cylinder 86 to swing the arm structure 5 upwardly about its pivotal connection with the turntable, and in any elevated position of the cutter bar, the latter may be sumped in, swung transversely in its plane across the coal face and withdrawn from the coal face in the manner clearly described above. During adjustment of the kerf cutter into different horizontal cutting positions in horizontal planes at different elevations, the parallel motion arm structure, intervening the turntable and outer arm 20, acts automatically to maintain the arm 20 and cutter bar in a horizontal position, regardless of the angular position of the arm structure about its pivotal connection with the turntable frame. By rocking the cutter bar about its transverse and longitudinal axes relative to the parallel motion arm structure during the cutting operation, it is possible to move the cutter bar to accommodate itself to a rolling bottom or pitching coal seam. When the cutter head frame is inverted with respect to the outer arm 20, as disclosed in the modification shown in Fig. 26, the cutter bar may be operated to cut a horizontal kerf at the level of the mine roof or in horizontal cutting planes at different elevations with respect to the mine roof, and, as in the form of the invention above described, the cutter bar may be rocked about transverse and longitudinal axes during the cutting operation in any adjusted position of the bar.

As a result of this invention, it will be noted that an improved coal mining apparatus of the type known as a track cutter is provided, wherein horizontal kerfs may be cut in a mine wall at various elevations in an improved manner. It will further be noted that by the provision of the adjustable supporting structure for the kerf cutter, a horizontal cutting apparatus is attained having relatively great universality. It will still further be evident that by the provision of the improved swinging and tilting mechanism for the kerf cutter, it is possible to move the kerf cutter into different cutting positions in an improved manner. It will also be noted that by the provision of the hydraulic adjusting means for the swinging and tilting mechanisms for the kerf cutter, it is possible to move the kerf cutter at any desired speed under perfect control and to maintain the kerf cutter in its adjusted position. Other uses and advantages of the improved coal mining apparatus will be clearly apparent to those skilled in the art.

While there are in this application specifically described one form and a modification thereof which the invention may assume in practice, it will be understood that this form and modification of the same are shown for purposes of illustration and that the invention may be further modified and embodied in various other forms without departing from its spirit or the scope of the appended claim.

What I claim as new and desire to secure by Letters Patent is:

In a mining apparatus, in combination, a support, a second support mounted on said first support to rock relative thereto about an axis extending longitudinally of said first support, a kerf cutter pivotally mounted on said second support to swing horizontally relative thereto about a vertical axis perpendicular to the plane of the kerf cut thereby, means for swinging said kerf cutter in either of opposite directions about its pivot comprising a pair of parallel cylinders mounted on said latter support and extending longitudinally along the opposite sides of said first support, the forward ends of said cylinders extending forwardly in advance of a transverse vertical plane including the kerf cutter pivot axis, pistons reciprocable in said cylinders and operatively connected to said kerf cutter, and means for supplying fluid under pressure selectively to said cylinders to actuate one or the other of said pistons, and means for rocking said second support in either of opposite directions relative to said first support comprising a pair of parallel cylinders mounted on said first support and arranged in a vertical position at the opposite sides of said second support at the inner sides of said first mentioned cylinders, pistons contained in said vertical cylinders and engaging said second support, and means for supplying fluid under pressure selectively to said vertical cylinders.

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