Nov. 25, 1941. R. K. JEFFREY 2,263,701

MINING MACHINE

Original Filed July 6, 1934 12 Sheets-Sheet 1

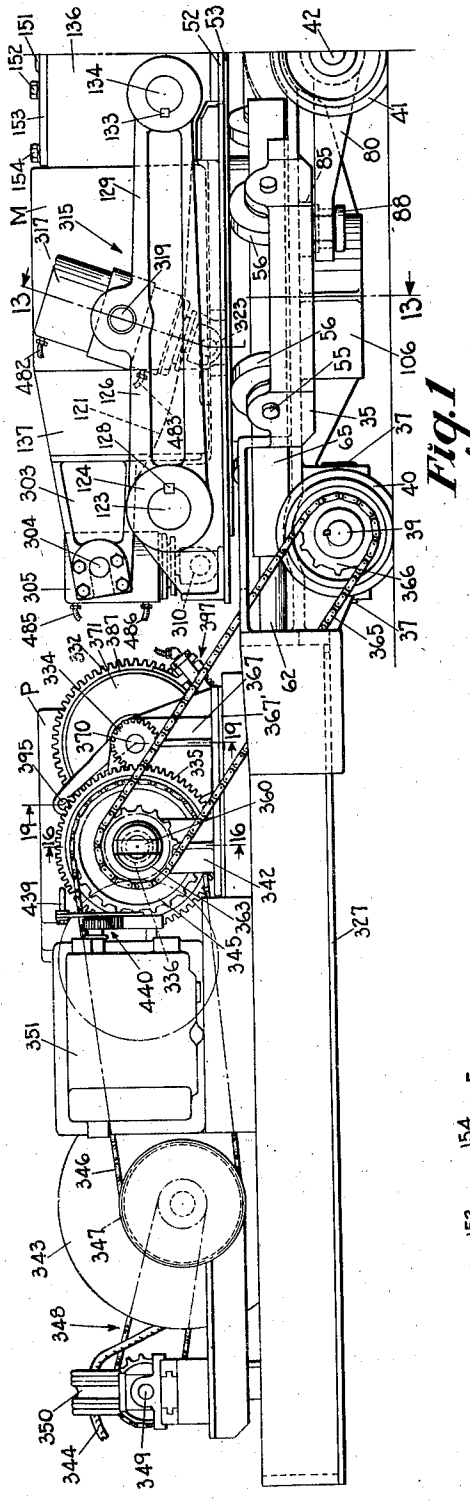


Fig. 1

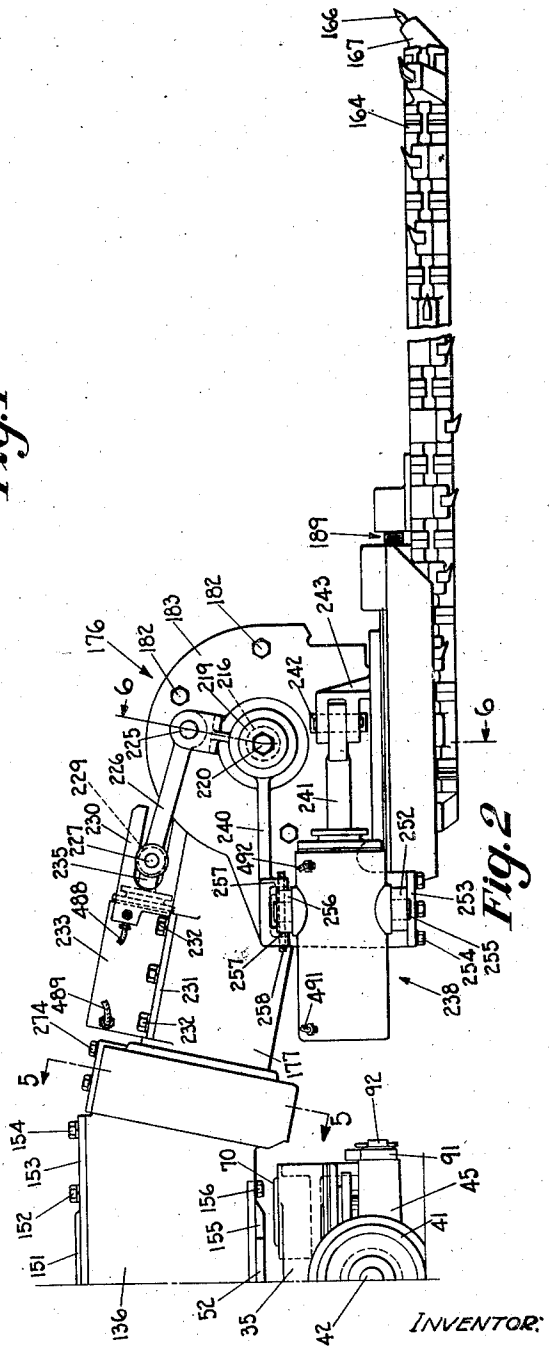


Fig. 2

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ATTY.

Nov. 25, 1941. R. K. JEFFREY 2,263,701

MINING MACHINE

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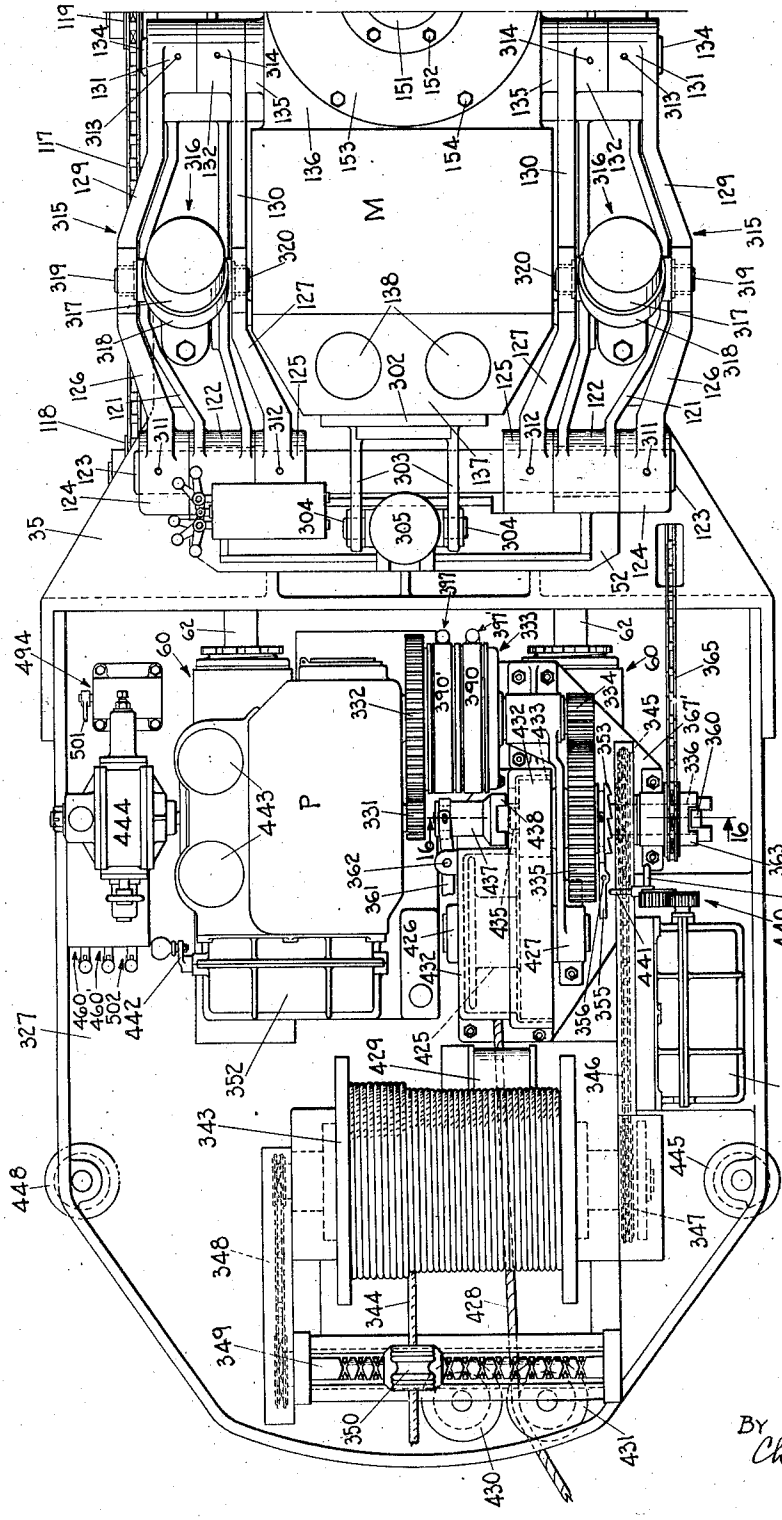


Fig. 3

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Nov. 25, 1941. R. K. JEFFREY 2,263,701

MINING MACHINE

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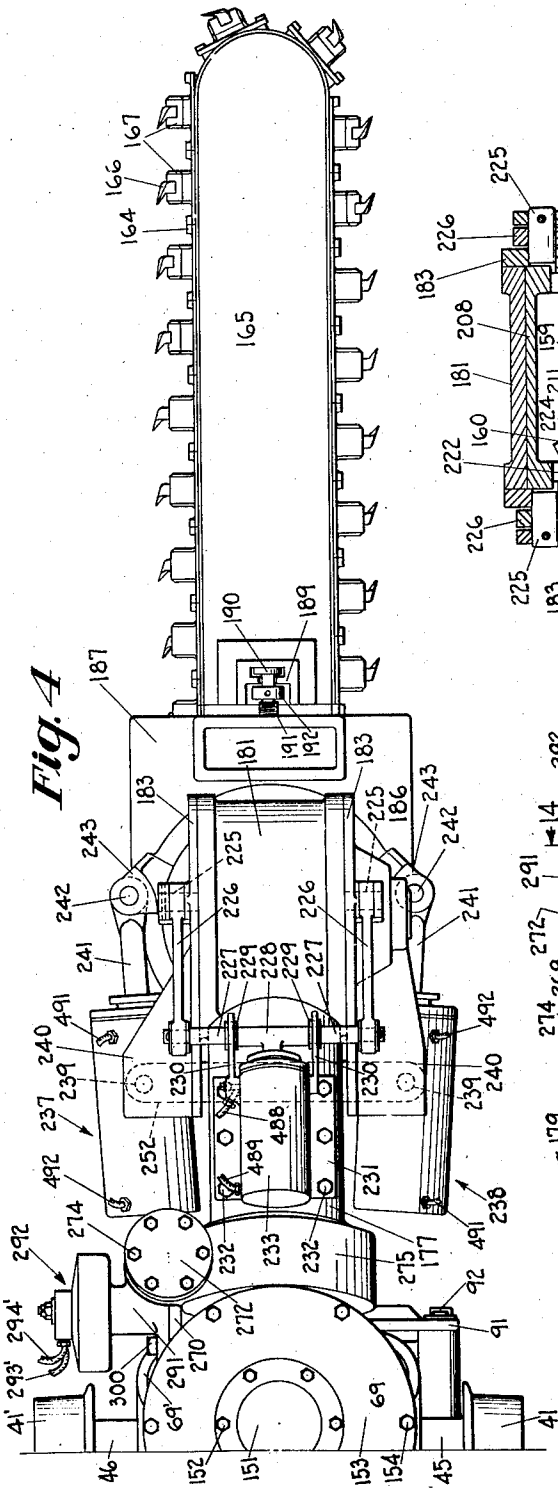


Fig. 4

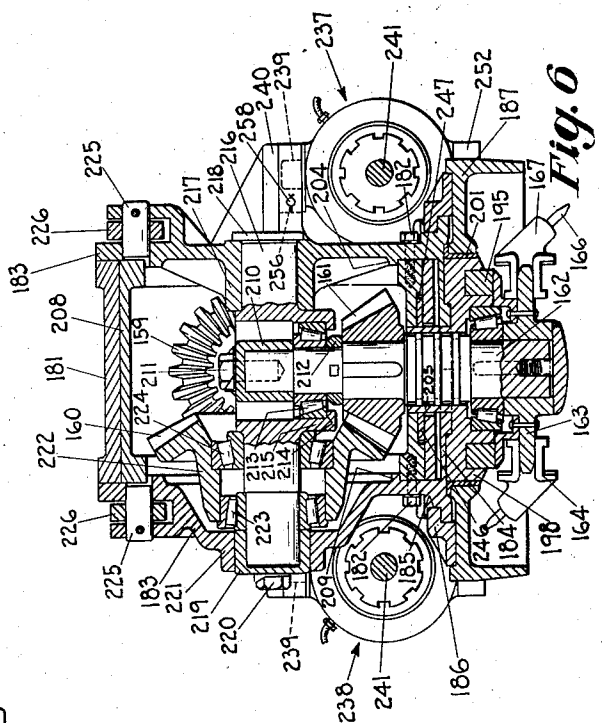


Fig. 6

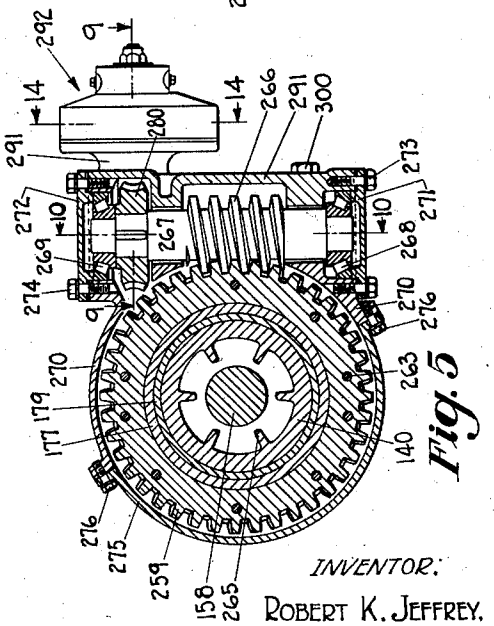


Fig. 5

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Nov. 25, 1941. R. K. JEFFREY 2,263,701

MINING MACHINE

Original Filed July 6, 1934 12 Sheets-Sheet 4

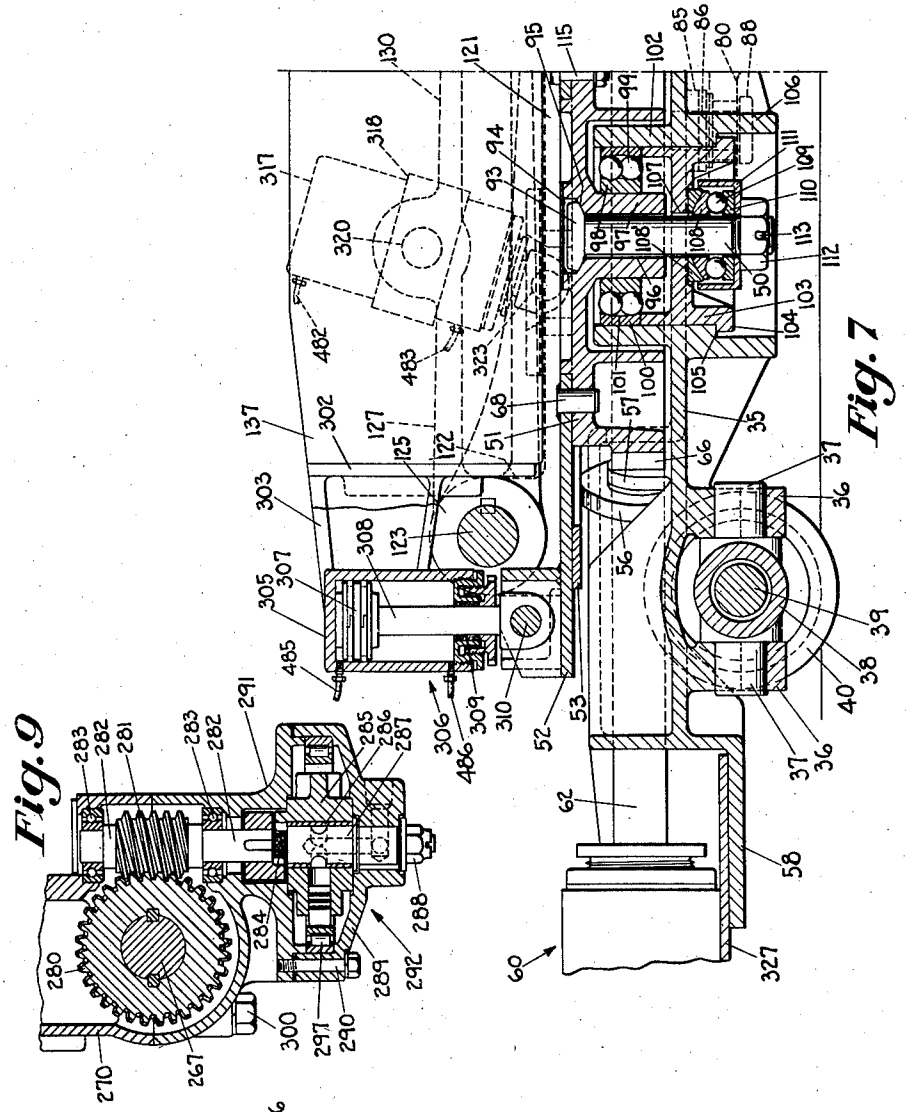


Fig. 7

Fig. 9

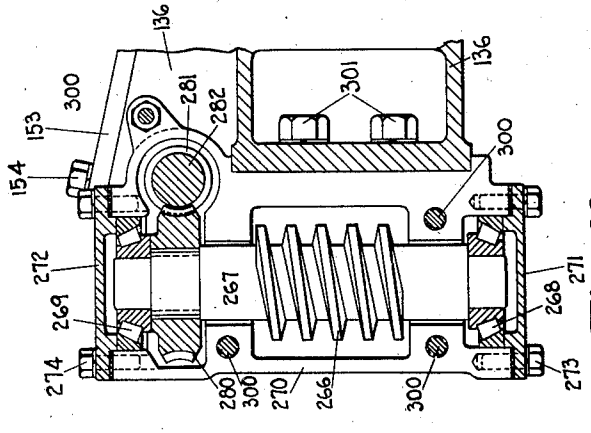


Fig. 10

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Nov. 25, 1941. R. K. JEFFREY 2,263,701

MINING MACHINE

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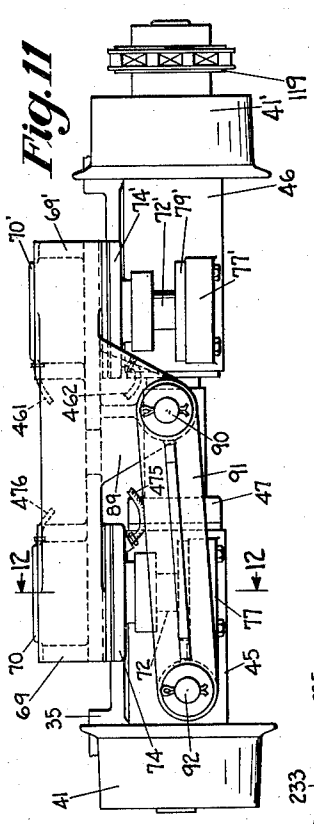


Fig. 11

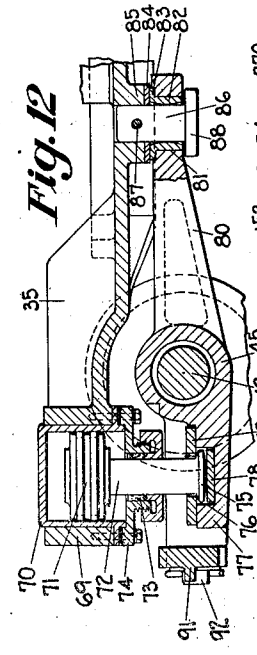


Fig. 12

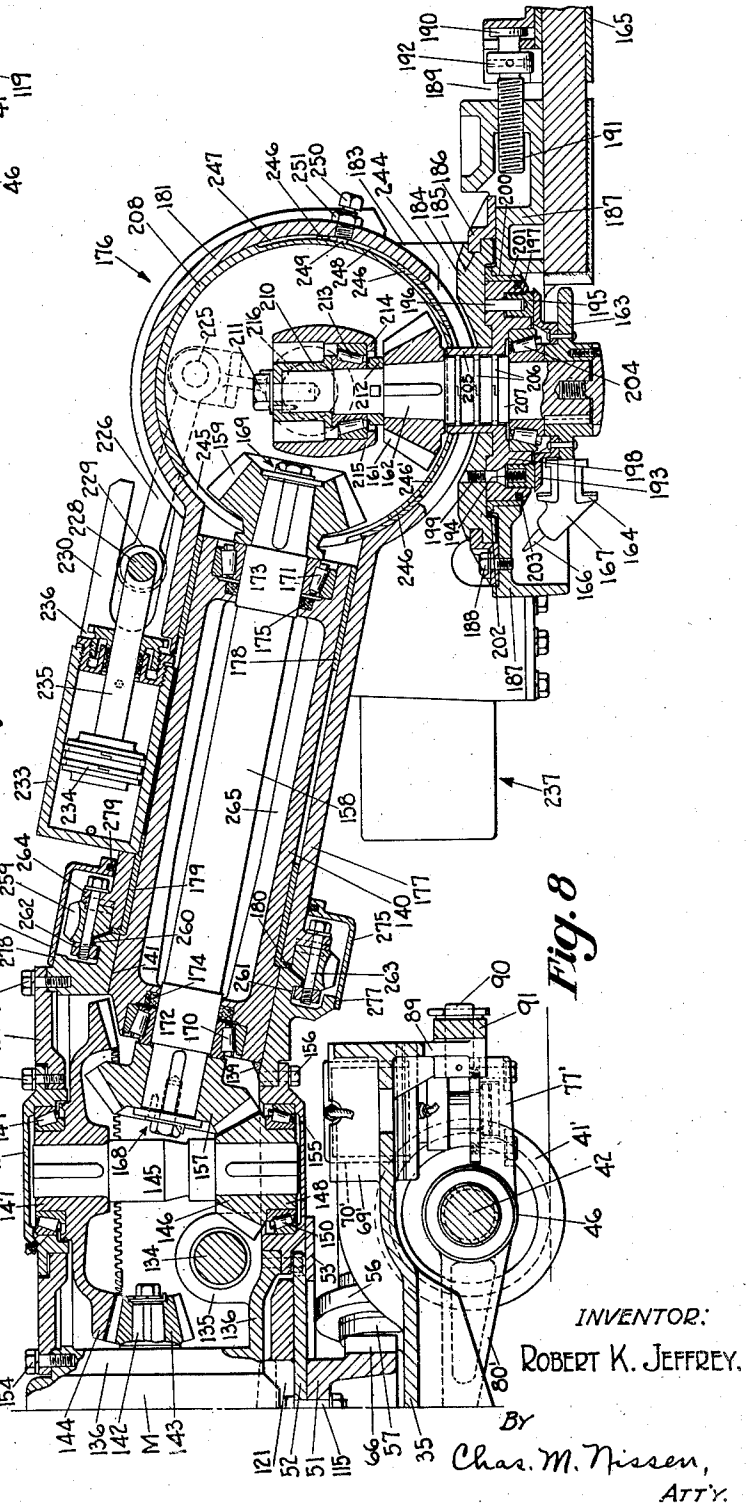


Fig. 8

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Nov. 25, 1941. R. K. JEFFREY 2,263,701

MINING MACHINE

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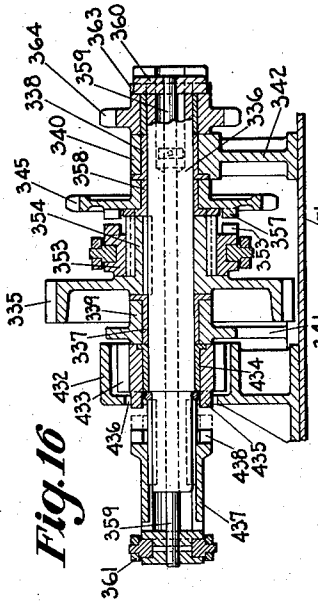


Fig. 16

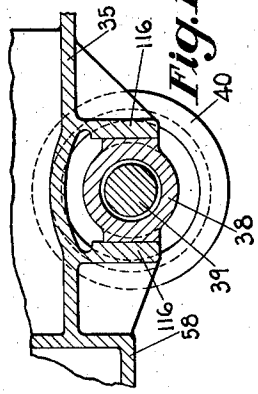


Fig. 15

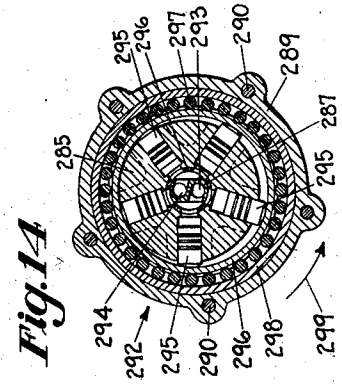


Fig. 14

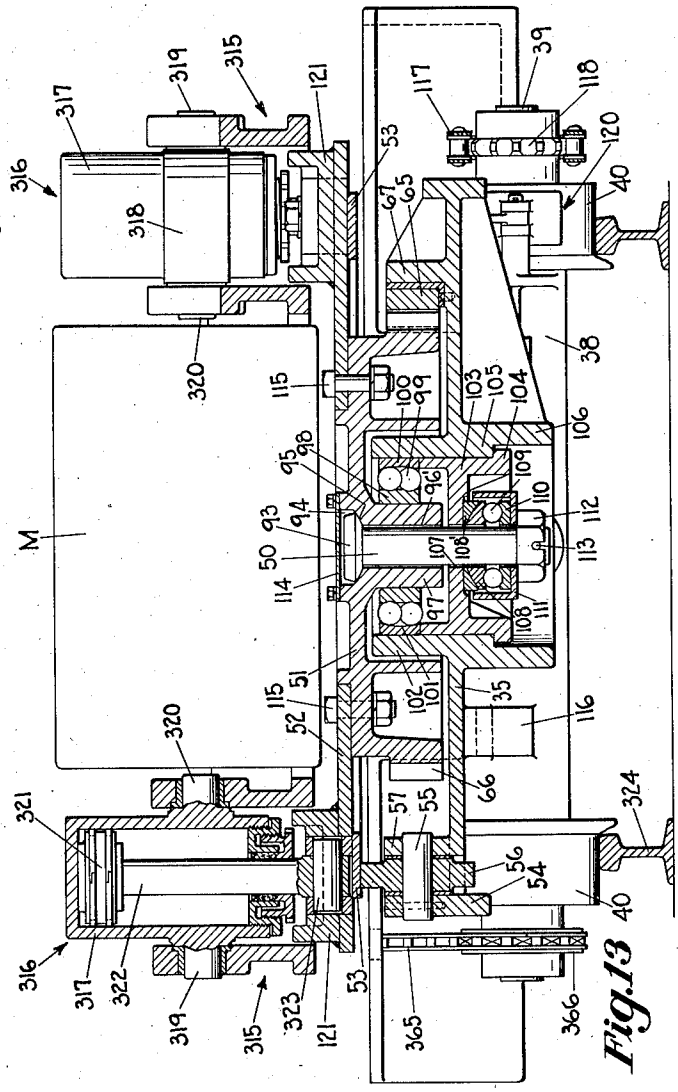


Fig. 13

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Nov. 25, 1941. R. K. JEFFREY 2,263,701

MINING MACHINE

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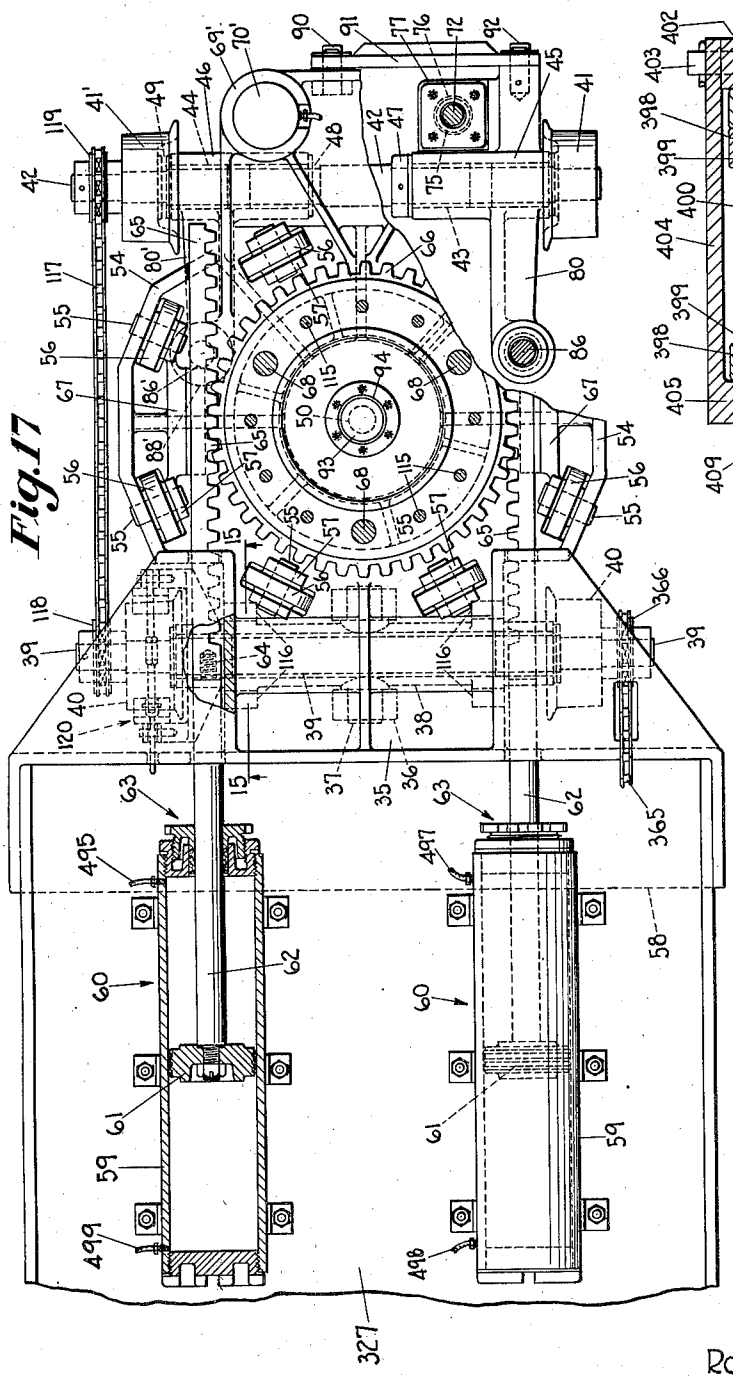


Fig. 17

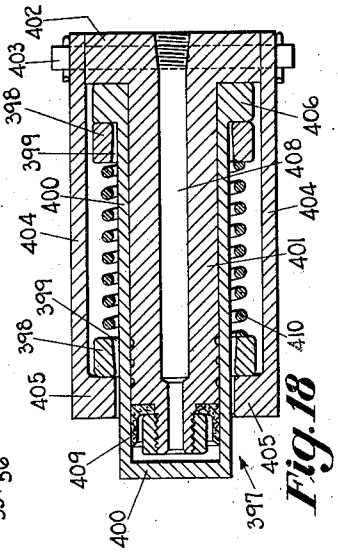


Fig. 18

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MINING MACHINE

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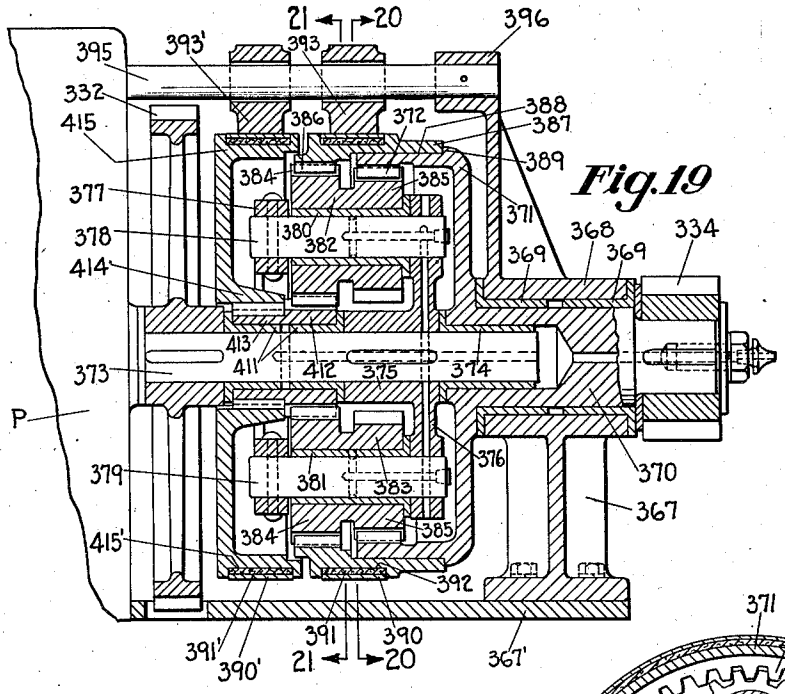


Fig. 19

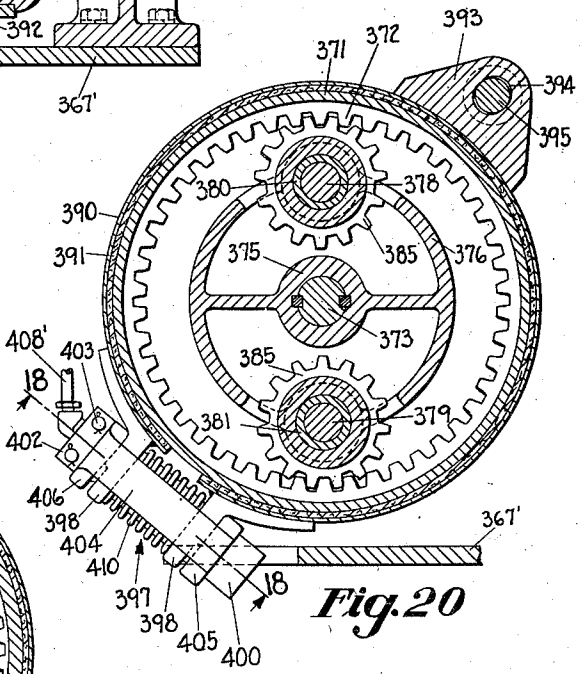


Fig. 20

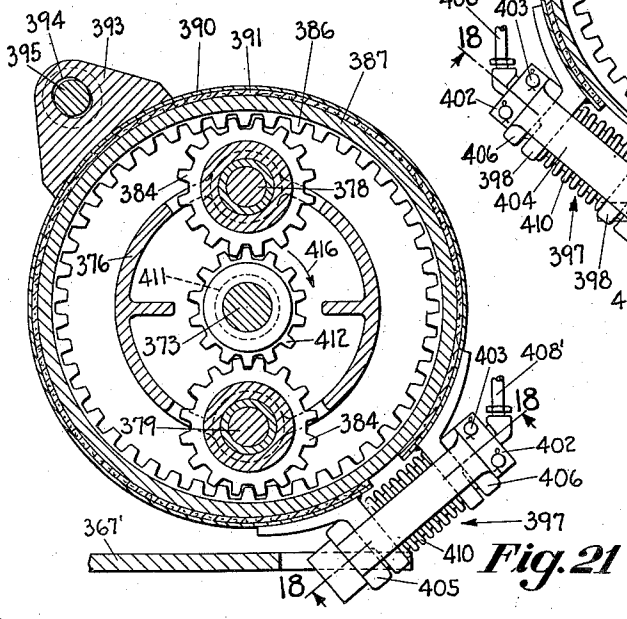


Fig. 21

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MINING MACHINE

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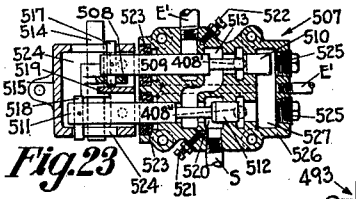


Fig. 23

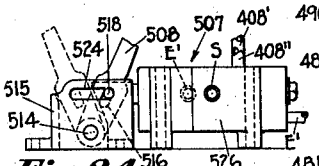


Fig. 24

Fig. 25

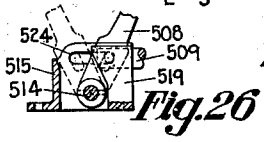


Fig. 26

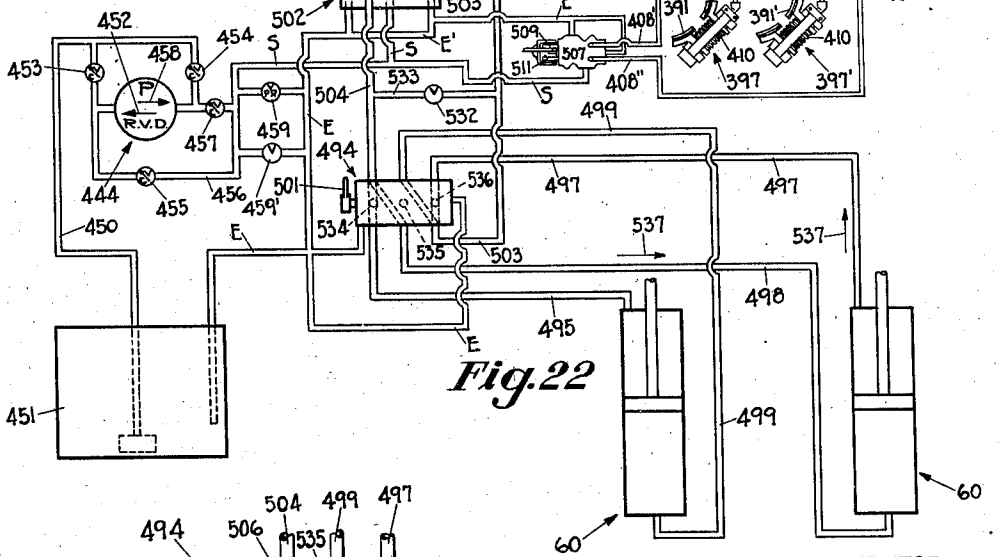


Fig. 22

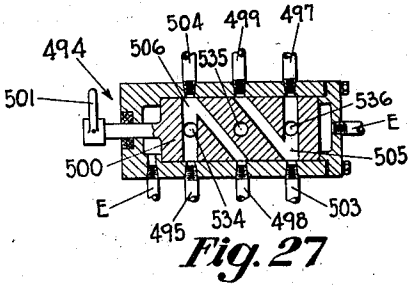


Fig. 27

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Nov. 25, 1941. R. K. JEFFREY 2,263,701

MINING MACHINE

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Fig. 28

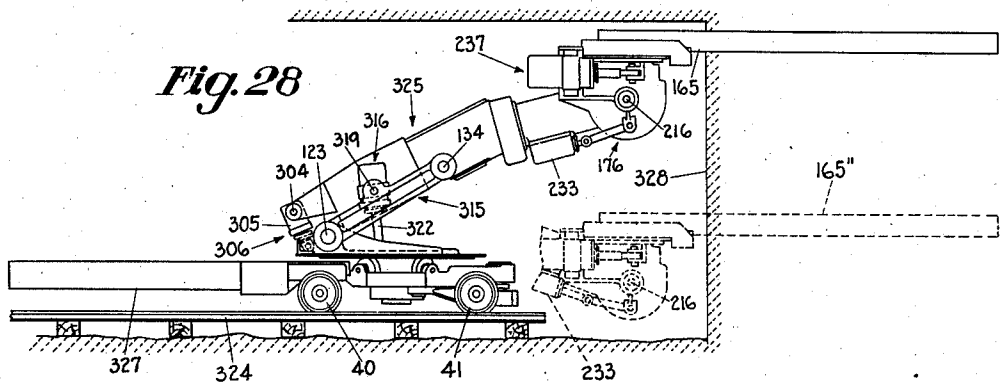


Fig. 29

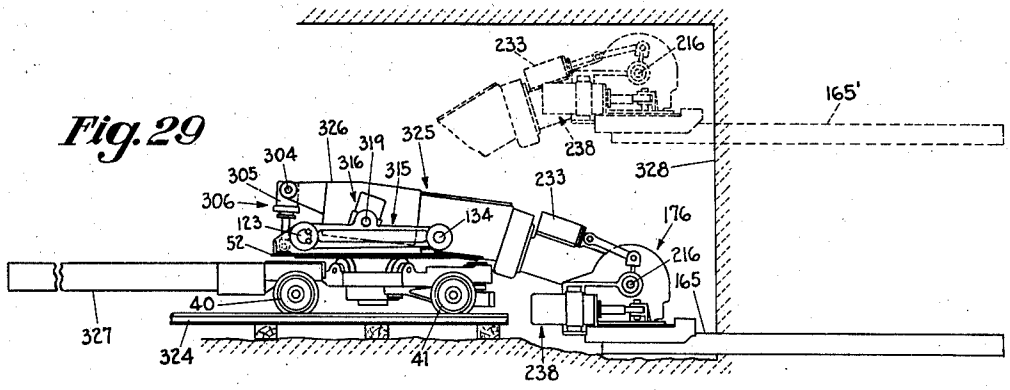
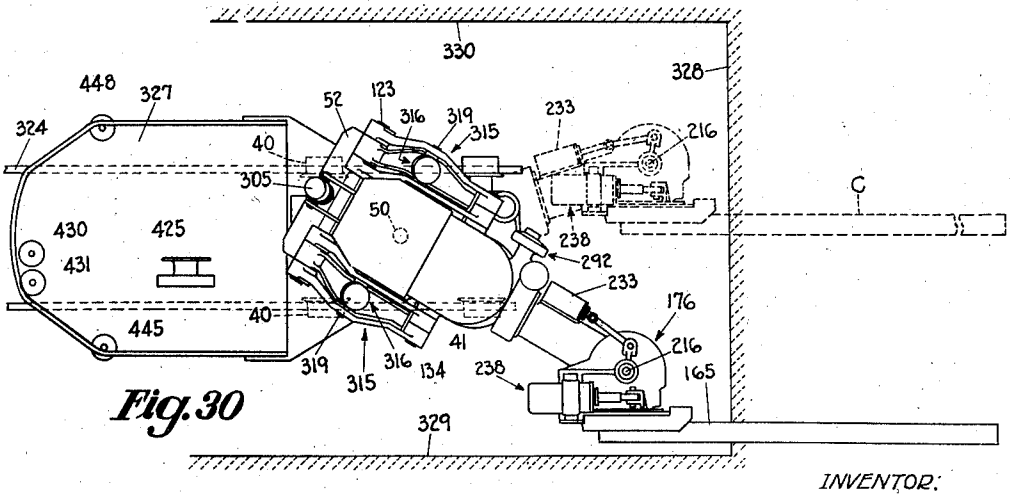


Fig. 30



INVENTOR:

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BY

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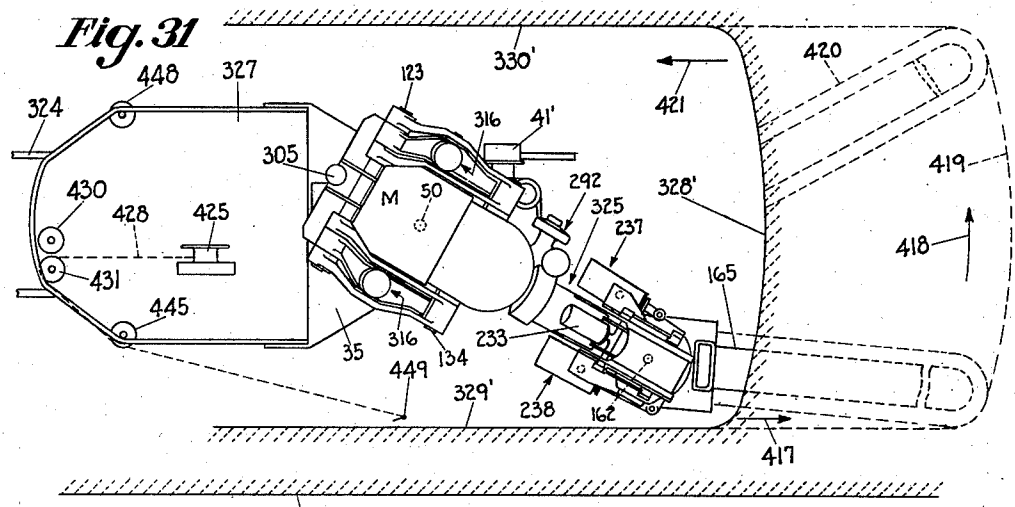
ATT'Y.

Nov. 25, 1941. R. K. JEFFREY 2,263,701

MINING MACHINE

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Fig. 31



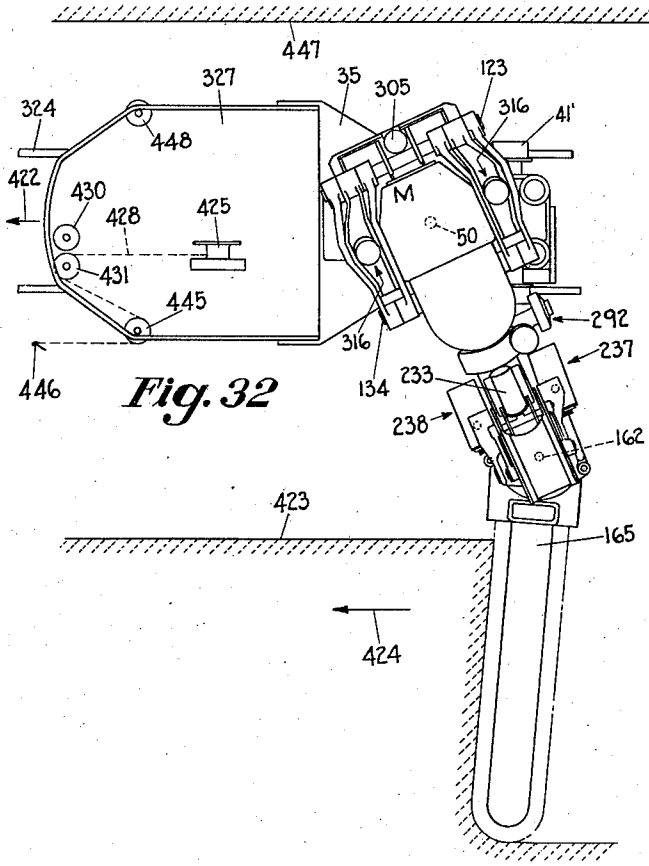


Fig. 32

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MINING MACHINE

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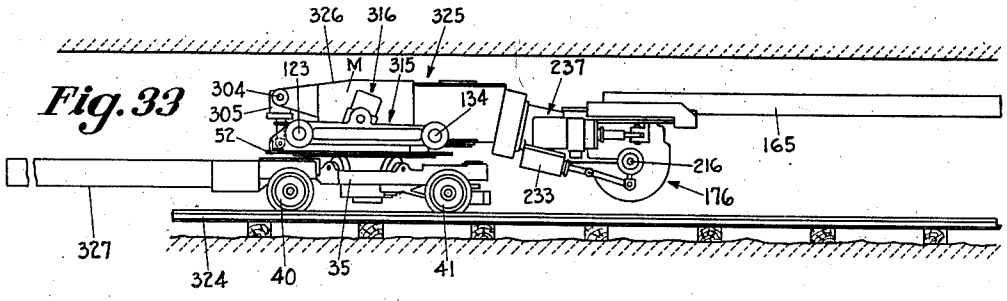


Fig. 33

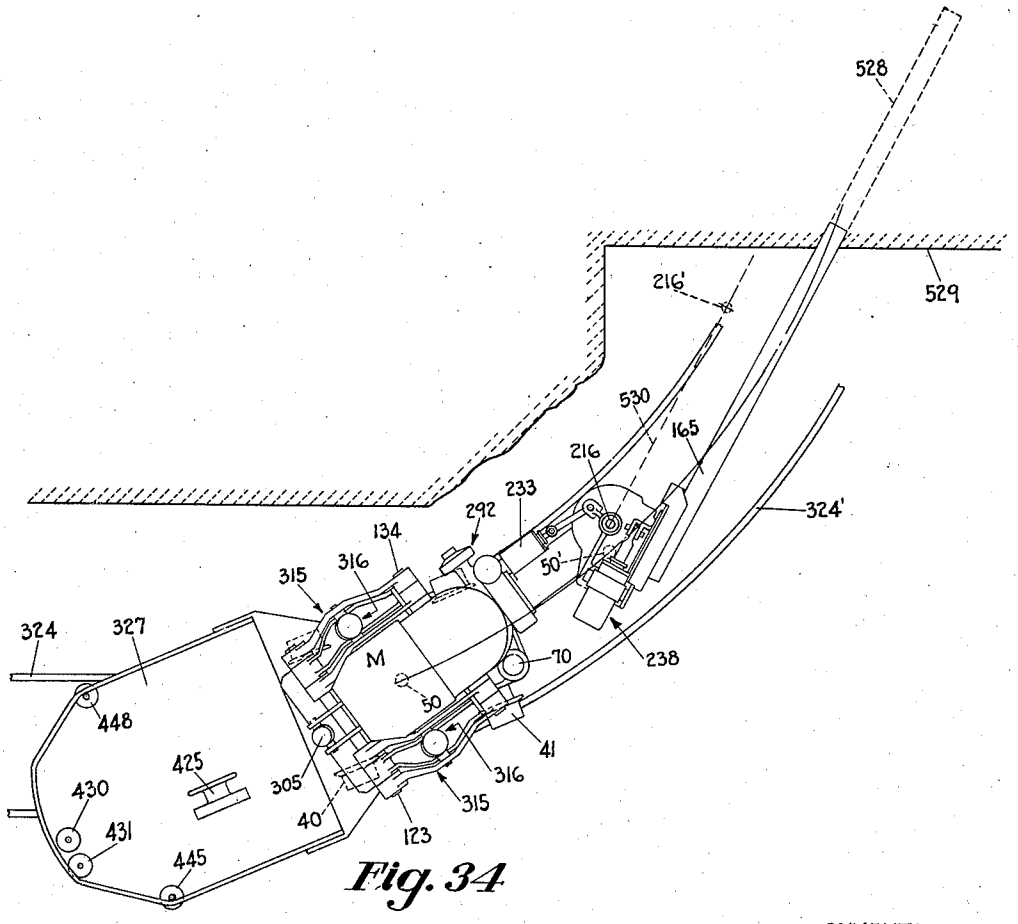


Fig. 34

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BY Chas. M. Nissen,
ATT'Y.

Patented Nov. 25, 1941 2,263,701

UNITED STATES PATENT OFFICE

2,263,701

MINING MACHINE

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

Application July 6, 1934, Serial No. 733,999. Renewed August 9, 1939. In Great Britain July 28, 1933.

36 Claims. (Cl. 262—28)

My invention relates to mining machines of the universal type, and one of its objects is the provision of improved and efficient apparatus for adjusting and controlling the operation of the cutting of kerfs in any one of various intersecting planes including horizontal planes anywhere between the floor and roof of mine chambers of varying heights, and also the cutting of kerfs in vertical or shearing planes anywhere between the ribs of mine chambers of varying widths.

Another object of the invention is the provision of mining machines of the universal type with the parts compactly arranged for operation with safety, efficiency and economy in mines where the available space for operation of the machine is limited.

Another object of the invention is the provision of a mining machine of the universal type mounted for travel on a mine track and capable of cutting kerfs in planes approximately at the level of the mine bottom, or in the planes of a mine roof, or in any intermediate horizontal planes, and also capable of cutting shearing kerfs in various upright planes intersecting the planes of the horizontal kerfs, and providing safe controlling and operating mechanism for the cutting of such kerfs and embodying in the machine, mechanism for safely and quickly effecting adjustments of the kerf-cutter with a minimum amount of skill and manual labor.

A further object of the invention is the provision of improved and efficient means for the tilting relatively to the base frame, of a supporting frame on which mining mechanism is mounted.

Another object of the invention is the provision of improved and efficient fluid-pressure motor mechanism for rotating on a vertical axis relative to the base frame a supporting frame carrying mining mechanism and locking said supporting frame in adjusted position relative to the base frame.

A further object of the invention is the provision of improved and efficient fluid-pressure motor mechanism for turning over a kerf cutter on a longitudinally extending axis and combining therewith mechanism for adjusting the elevation and inclination of the mechanism defining such longitudinal axis.

Another object of the invention is the provision of fluid-pressure motor mechanism for adjusting a kerf-cutter on spaced-apart vertical axes and locking the kerf-cutter in adjusted position relative to the base frame, combined with mechanism for driving the kerf-cutter from a source of power located above the base frame.

A further object of the invention is the provision of fluid-pressure motor mechanism for adjusting a kerf-cutter on a vertical axis relative to the base frame and also on rectangularly related axes located adjacent to the kerf-cutter and operating the kerf-cutter in its adjusted positions.

Another object of the invention is the provision of fluid-pressure operating and controlling mechanism for planetary power transmission gearing connected between a motor and truck propelling mechanism in a track-mounted mining machine for effecting either transportation movements or feeding movements along the mine track in either direction.

A further object of the invention is the provision in a mining machine of the universal type of hydraulic motor mechanism for effecting all of the adjustments of the chain kerf-cutter driven by a motor independently of the hydraulic motor mechanism.

Another object of the invention is the provision of improved and efficient hydraulic motor operated mechanism for effecting swinging feeding movement of a kerf-cutter either on an axis within the boundaries of the kerf-cutter or on an axis spaced therefrom.

It is also the object of the present invention to provide improved mechanism in a track-mounted mining machine, for efficiently cutting a shearing kerf in a working face extending across the space in advance of a curved mine track on which the machine is mounted.

More particularly, it is the object of the present invention to provide in a mining machine of the universal type having an elongated chain kerf-cutter, hydraulic motor mechanism for controlling all of the adjustments and operations of the kerf-cutter for cutting in horizontal and vertical planes, except the driving of the chain cutter which is effected independently of the hydraulic motor mechanism.

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, represent an elevation of the universal mining machine embodying my improvements;

Figs. 3 and 4, placed end to end, represent a plan view of the machine shown in elevation in Figs. 1 and 2;

Fig. 5 is a sectional elevation taken on the

line 5—5 of Fig. 2, looking in the direction of the arrows;

Fig. 6 is a sectional elevation taken on the line 6—6 of Fig. 2, looking in the direction of the arrows;

Figs. 7 and 8, placed end to end, represent a longitudinal section elevation taken through the longitudinal center line of the mining machine shown in plan in Figs. 3 and 4, placed end to end;

Fig. 9 is a sectional view taken on the line 9—9 of Fig. 5, looking in the direction of the arrows;

Fig. 10 is a sectional view taken on the line 10—10 of Fig. 5, looking in the direction of the arrows;

Fig. 11 is a front elevational view of the truck shown at the lower left-hand portion of Fig. 8;

Fig. 12 is a sectional view taken on the line 12—12 of Fig. 11, looking in the direction of the arrows;

Fig. 13 is a transverse sectional elevation taken on the line 13—13 of Fig. 1, looking in the direction of the arrows;

Fig. 14 is a sectional elevation taken on the line 14—14 of Fig. 5, looking in the direction of the arrows;

Fig. 15 is a sectional elevation taken on the line 15—15 of Fig. 17, looking in the direction of the arrows;

Fig. 16 is a sectional elevation taken on the line 16—16 of Fig. 3, looking in the direction of the arrows;

Fig. 17 is a sectional plan view showing the truck and the turntable adjusting mechanism;

Fig. 18 is a sectional view taken on the line 18—18 of Fig. 21, looking in the direction of the arrows;

Fig. 19 is a sectional elevation taken on the line 19—19 of Fig. 1, looking in the direction of the arrows;

Fig. 20 is a section taken on the line 20—20 of Fig. 19, looking in the direction of the arrows;

Fig. 21 is a section taken on the line 21—21 of Fig. 19, looking in the direction of the arrows;

Fig. 22 is a diagrammatic view showing the controlling and operating mechanism for the hydraulic motors including the piping connections thereto;

Figs. 23, 24, 25, 26 and 27 show details of the controlling valve devices shown diagrammatically in Fig. 22;

Fig. 28 shows diagrammatically the range of adjustment in elevation of the chain kerf-cutter when occupying a horizontal plane above all other parts of the machine;

Fig. 29 shows the range of adjustment of the chain kerf-cutter upwardly from a position in a horizontal plane approximately in the plane of the mine bottom;

Fig. 30 represents diagrammatically various adjustments of the kerf-cutter when in a shearing position in a vertical plane parallel to the mine track;

Fig. 31 shows the relative positions of the parts of the machine for making a sumping cut rectilinearly into a working face extending across the space in advance of the mine track;

Fig. 32 represents the relative positions of the elements of the machine for a longwall operation;

Fig. 33 represents the position of the chain kerf-cutter for transportation along a mine track in a low roof mine entry; and

Fig. 34 represents diagrammatically in plan view the relative positions of the parts of the machine for enabling the kerf-cutter to shear a kerf while the mining machine moves along a curved mine track.

Although the mining machine is shown in the accompanying drawings as being wheel-supported for travel along a mine track, it may be supported for sliding movement along the mine bottom in which event rope or cable haulage mechanism may be relied on to transport the machine about the mine or effect certain feeding movement thereof along rectilinear paths parallel to the longitudinal center line of the supporting framework. Or, if desired, the mining machine may be mounted for transportation and for such feeding movements, on crawler treads operated in a well-known manner. I prefer, however, to mount the mining mechanism for tilting movements on longitudinal and transverse intersecting axes as hereinafter fully explained.

By referring to Figs. 7, 8, 11, 12 and 17, it will be seen that the rear portion of the base frame 35 is provided with spaced-apart bearings 36, 36 in which are journaled the trunnions 37, 37 secured to the front and rear sides of the rear axle housing 38 which extends transversely across the bottom of the rear portion of the base frame 35. The rear axle 39 is journaled in bushings at the ends of the axle housing 38. The rear wheels 40, 40 are secured to the ends of the axle 39 to rotate therewith.

The front wheels 41, 41' are secured to the ends of the front axle 42 and the latter is journaled in bushings 43, 44 in the separate transversely extending housings or bearings 45 and 46, as shown in Fig. 17. By means of a collar 47 secured to the axle 42, the bearing 45 moves laterally bodily with the axle 42. At the ends of the bearing 46, however, small clearances are provided at 48 and 49 to permit a slight lateral movement of the bearing 46 relative to the axle 42.

Pivotally mounted on the base frame 35 by means of a king-pin 50 (Fig. 13) is a turntable comprising a circular plate 51 on top of which is secured a platform 52, to the lower side of which is secured a ring 53 concentric with the vertical axis of the king pin 50. Mounted on the base frame 35 is a bracket frame 54 which carries a series of horizontal pins 55, 55 on which are journaled the supporting rollers 56, 56 as shown in Fig. 17. By means of brackets 57, 57 at the inner ends of the pins 55, 55 the rollers 56 are held in their positions shown in Fig. 17, so as to be directly under the ring 53 and engaged thereby. (Fig. 13.) It will thus be seen that when the platform 52 occupies a horizontal plane its support by means of the ring 53 on the rollers 56 is widely distributed by reason of the wide distribution of the rollers as shown in Fig. 17.

Rigidly secured to the rear end of the base frame 35 is a rearwardly extending platform 327 as shown in Figs. 3, 7 and 17. Secured to the upper surface of the platform 327 are the longitudinally extending cylinders 59, 59 of hydraulic motors 60, 60. Within the cylinders are pistons 61, 61 connected to forwardly extending piston rods 62, 62 movable through adjustable stuffing boxes 63, 63 and having their forward ends connected by screws 64 to the rack bars 65, 65.

By referring to Figs. 7, 8 and 13, it will be seen that depending from the peripheral edge of the horizontal plate 51 is a large spur gear 66 concentric with the vertical axis of rotation of the turntable and the mining mechanism mounted thereon. The rack bars 65, 65 are guided along slide bearings 67, 67 in position to mesh with diametrically opposite sides of the spur gear 66

as shown in Fig. 17. The spur gear 66 may be integral with the turntable 51 as shown in Fig. 7, and the latter may be connected to the platform 52 by means of the pins 68, 68 as shown in Figs. 7 and 17. When the pistons 61 of the hydraulic motors 60 are moved in opposite directions under the control of the hydraulic circuits and connections shown in Fig. 22, the spur gear 66 is rotated in one direction or the other to effect rotation of the turntable and the mining mechanism mounted thereon, and, as hereinafter described in connection with Fig. 22, the pistons 61 may be locked in adjusted positions and thereby effect locking of the turntable in adjusted position relative to the base frame 35.

Mounted on the forward end of the base frame 35 are spaced-apart cylindrical supports 69, 69' for the hydraulic motors comprising cylinders 70, 70' in which are movable pistons 71 having depending piston rods 72, 72' movable through stuffing boxes 73 in the lower cylinder heads 74, 74'.

As shown in Fig. 12, the lower end of the piston rod 72 is provided with an enlarged head 75 which fits loosely in a cylindrical recess 76 in the upper portion of the forwardly extending horizontal supporting block 77. At the bottom of the recess 76 is a wear plate 78 and spaced above this plate is a cylindrical plate 79 secured to the top of the supporting block 77 and provided with an opening in its center for loosely receiving the piston rod 72 immediately above its lower enlarged head 75.

Extending rearwardly from the axle housing 45 is an arm 80, the rear end of which is provided with a cylindrical opening 81 for receiving a bushing 82 having an interior surface which diverges from the center to both ends of the bushing. An annular flange 83 at the upper end of the bushing 82 is adapted to engage the ring wear plate 84 which is located on the lower side of the boss 85 on the bottom of the base frame 35. A bearing pin 86 is pinned at 87 in a cylindrical opening in the boss 85, and the lower end of the bearing pin 86 is provided with an enlarged head 88 for engaging the lower side of the rear end of the arm 80. The upper annular surface of the head 88 is spaced sufficiently from the wear plate 84 to permit the axle housing 45 to fulcrum on the bearing 86 when the piston 71 is moved up or down in the cylinder 70. It should also be understood that there is sufficient play of the enlarged head 75 at the lower end of the piston rod 72 to permit the piston rod 72 to move vertically in the stuffing box 73 without binding.

As shown in Fig. 11, a supporting block 77' extends forwardly from the axle housing 46 and this supporting block 77' has a recess therein similar to that shown in Fig. 12, for receiving an enlarged head at the lower end of the piston rod 72' which head is confined by the ring plate 79' as described in connection with Fig. 12.

Extending rearwardly from the axle housing 46 as shown in Fig. 17 is an arm 80' connected to a bearing pin 86' as shown in dotted lines in Fig. 17. The connection between the rear end of the arm 80' and the bottom of the base frame 35 is similar to that shown at the right-hand end of Fig. 12.

Depending from the front end of the base frame 35 is a bracket plate 89 to which is pivoted, as shown at 90 in Figs. 11 and 17, an equalizing link 91, the other end of which is pivoted, as indicated at 92 in Figs. 11 and 17, to the axle housing 45. Inasmuch as it is desired to operate the hydraulic motors 70, 70' individually and independently of each other to secure tilting movements of the platform 52 on the longitudinal axis of the trunnions 37 shown in Fig. 7, as hereinafter described in connection with Fig. 22 showing the hydraulic circuits and connections, the link 91 is relied on to maintain the wheels 41 and 41' on the ends of the axle 42 in their proper relations to the rails of a mine track. The wheel 41 and collar 47 prevent the axle 42 from having an endwise movement in the axle housing 45 and consequently when the axle housing 45 is lifted or lowered by its hydraulic motor 70, relative to the base frame 35, there will be an endwise movement of the axle 42 relative to the base frame 35 as determined by the arcuate movement of the pivot 92 at the outer end of the link 91, but the latter retains the axle housing 45 in a predetermined relation to the base frame 35. Such endwise movement of the axle 42 is relatively small and is not interfered with by the axle housing 46 because of the clearances at the ends thereof, as indicated at 48 and 49 in Fig. 17. The pivotal connections between the rear ends of the arms 80 and 80' and the bottom of the base frame 35 permit vertical as well as lateral movements of the axle housing 45 and 46. When the link 91 compels the arm 80 to move laterally on the vertical axis of the pin 86, the axle 42 may slide endwise in the axle housing 46 as permitted by the clearances at 48 and 49. It is not desired to exert any strains laterally on the lower ends of the piston rods 72, 72' and the recesses 76, and the hole in the plate 79 should therefore be sufficiently large to prevent any binding strain on the piston rods 72, 72'. Inasmuch as the axle 42 is journaled in the bushings 43 and 44, such lateral movement as may be imparted by the link 91 to the arm 80' may be provided for by a loosely fitting connection between the rear end of the arm 80' and the depending bearing 86'.

Inasmuch as the turntable 51 and the platform 52 are mounted on the rollers 56 for rotation on the vertical axis of the king-pin 50, the latter is flexibly connected between the turntable 51 and the base frame 35 by means of the construction shown in Fig. 7 as hereinafter more fully described. The upper end of the king-pin 50 is provided with a head 93 which is located in a recess 94 and rests against an upwardly flaring annular seat 95 so that the king-pin 50 may have a limited lateral movement as permitted by the cylindrical opening 96 in the depending hub 97, in which opening the king pin 50 loosely fits.

Mounted on the outer surface of the hub 97 is the inner race 98 of a ball bearing 99, the outer race 100 of which has its inner surface 101 spherical in shape to permit a limited tilting of the turntable 51 in any direction relative to the cylindrical support 102 which carries the outer race 100. A ball bearing retaining device 103 fits in the ring support 102 and is provided at its lower side with an annular flange 104 which rests against an annular shoulder 105 in the cylindrical support 106 which depends from the bottom of the base frame 35.

The king pin 50 extends loosely through a central opening 107 at the center of the ball bearing retainer 103. At the lower central portion of the retainer 103 is secured a circular bearing block 108' having a central opening through which the king pin 50 loosely extends. The lower surface of the circular bearing block 108' is spherical in shape to receive the upper race 108 of the ball bearing 109, the lower race 110 of which rests on

the ring cup retainer 111 which is mounted in adjustable position on the nut 112 screw-threaded to the lower end of the king pin 50 and locked in adjusted position by the cross-pin 113. It will thus be seen that when the turntable 51 together with the platform 52 are rotated on the axis of the king pin 50, slight universal tilting of the turntable and platform will be permitted by the spherical surfaces at the inner surface of the race 100 and at the outer surface of the race 108 which keep the races of the ball bearings in proper relations to each other. That is to say, the turntable may be rotated in either direction without interfering with the efficiency of the ball bearings, while at the same time permitting the lower ball bearing shown in Fig. 7 to resist upward thrust brought on the king pin 50 whenever there is any tendency for the forwardly overhanging structure of the mining machine to tilt the platform 52 off the rear supporting rollers or those designated 56 in Fig. 17.

It should be particularly understood that the turntable 51 and the platform 52 are so connected to the base frame 35 as to move bodily therewith whenever the base frame is tilted on the horizontal transverse axis of the axle 39 or on the longitudinal horizontal axis of the trunnions 37, 37. It is intended that there shall be only a very slight universal tilting of the turntable 51 relative to the base frame 35 as permitted by the ball bearings shown in Fig. 7 and the mechanism associated therewith and with the king pin 50. In other words, the pivotal connection at the king pin 50 between the turntable 51 and the base frame 35 is such as to permit universal yielding of the turntable relative to the base frame 35 so that the platform 52 may accommodate itself without distortion or undue strain to such irregularities as there may happen to be in the spaced-apart supporting rollers 56 and the mountings therefor.

As shown in Fig. 13, the recess 94 for the head 93 of the king pin 50 may be closed by means of the horizontal plate 114. The platform 52 may be detachably connected to the turntable 51 by means of the bolts 115, 115. Also, as shown in Fig. 13, the frame 54 of Fig. 17 as well as the brackets 57 of Figs. 7 and 17 may be integral with the base frame 35. The bearings for the rollers 56 may each comprise a pin 55 secured to the peripheral frame 54.

By referring to Fig. 15 which is a section taken on the line 15—15 of Fig. 17 looking in the direction of the arrows, it will be seen that the rear axle housing 38 is mounted to slide in the vertical guideways 116, 116 which depend from the bottom of the base frame 35. This rear axle housing guiding structure is located in spaced-apart positions on opposite sides of the trunnions 37, 37 and provides a means for maintaining the axle housing 38 in its proper relation to the base frame 35 when the latter is tilted on the longitudinal axis of the trunnions.

Associated with one of the wheels 40 as shown in dotted lines at 120 in Fig. 17 is manually operated brake mechanism which may be locked in applied position so as to cooperate with the structure shown in Fig. 15 to anchor the supporting framework of the machine relative to the track when the kerf-cutting mechanism, hereinafter described, is operated for effecting the cutting of arcuate kerfs in horizontal planes or vertical planes. A sprocket chain 117 as shown in Fig. 17 meshes with sprockets 118 and 119 connected to the rear and front axles so that when the brake mechanism 120 is applied to one of the wheels 40 to anchor the framework of the machine relative to the mine track, both the rear axle and the front axle could be held by the brake mechanism 120 against rotation. It will also be seen that when the brake 120 is released and the rear axle is driven, power will be transmitted through the chain 117 to the front axle 42 to positively drive the latter at the same time that the rear axle 39 is being driven.

The mechanism for supporting the kerf-cutting apparatus on the platform 52 so as to rotate with the turntable 51 comprises castings 121, 121 which may be welded to the top of the platform 52 as illustrated in Fig. 13, the latter being a view taken on the line 13—13 of Fig. 1, looking in the direction of the arrows. The rear ends of the castings 121, 121 are provided with bearing blocks 122, 122 for the transverse pivot bar 123. (Fig. 3). The hubs 124, 124 and 125, 125 at the rear ends of the arms 126, 126 and 127, 127 are keyed to the pivot bar 123 as illustrated at 128 in Fig. 1. The forwardly extending arms 129, 129 and 130, 130 are provided with hubs 131, 131 and 132, 132 keyed as indicated at 133 in Fig. 1, to the transverse pivot bar 134 shown in Figs. 1, 3 and 8.

The transverse pivot bar 134 is journaled in bearings 135, 135 which extend laterally from the casing 136 as shown in Figs. 3 and 8. The casing 136 is rigidly attached at its rearward end to the forward end of the frame of an electric motor M, the rear end of which is entirely closed by the casing 137 which is provided with screw-threaded hand-hole cover plates 138, 138 which when removed render the brushes and the commutator of the electric motor M accessible for inspection or repair.

To the front end of the casing 136, as shown in Fig. 8, is rigidly welded, as indicated at 139, the cylindrical bearing support 140 in a cylindrical opening 141 in the forward end of the casing 136 so as to occupy a downwardly inclined position when the casing 136 and the motor M are horizontal, as shown in Fig. 8.

To the front end of the motor shaft 142 is secured a bevel pinion 143 which meshes with a horizontal bevel gear 144 keyed to the upper end of the shaft 145, to the lower end of which is keyed the bevel gear 146, as shown in Fig. 8.

The bevel gears 144 and 146 are respectively provided with hubs 147 and 148 which are mounted in upper and lower thrust bearings 149 and 150. The upper thrust bearing 149 is mounted in an annular recess on the underside of the cap plate 151 which is detachably connected by means of cap screws 152 to the cover plate 153 which in turn is detachably connected by means of the cap screws 154 to the upper side of the casing 136. The lower thrust bearing 150 is mounted in an annular recess on the upperside of the bottom cap plate 155 which may be detachably secured to the casing 136 by means of the cap screws 156.

It should be particularly noted that the connections between the peripheral portion of the cover plate 153 and the casing 136 and the connections between the peripheral portions of the cap plate 151 and the cover plate 153 and the peripheral connections between the cap plate 155 and the casing 136 are angular in cross-section as shown in Fig. 8, so as to keep dust and dirt from entering the casing and interfering with the lubrication of the bearings therein. The rear end of the motor is also provided with a flame-proof casing 137 and both the latter and the casing at the front end of the motor M are

rigidly attached to the latter so as to always move bodily therewith as well as with the cylindrical bearing 140 as a single supporting rigid unit.

As shown in Fig. 8, a bevel gear 157 meshes with the bevel gear 146 and is keyed to the rear end of the rotary shaft 158. As shown in Fig. 8, at the outer end of the shaft 158 is keyed a bevel pinion 159 which is adapted to mesh with the bevel gear 160, as shown in Fig. 6. The bevel gear 160 meshes with the bevel gear 161 keyed to the shaft 162, to the outer end of which is keyed the sprocket 163 with which meshes the cutter chain 164 mounted to travel along the guides on the cutter bar 165. It will thus be seen that when the electric motor M is operated, power is transmitted through the bevel gearing shown in Figs. 6 and 8, to the sprocket 163 to drive the chain cutter including the cutting bits 166 which are mounted in the bit-holders 167, as shown in Fig. 4.

By means of cap screws and locking mechanism therefor as shown at 168 and 169 in Fig. 8, the bevel gears 157 and 159 are held against the inner races of the roller thrust bearings 170, 171, as shown in Fig. 8. The roller thrust bearings are mounted on the enlarged portions 172 and 173 of the end portions of the shaft 158, in annular seats at the ends of the tubular bearing 140. Additional annular seats in the ends of the tubular bearing 140 are provided for the packing rings 174 and 175.

A turnover head 176 is provided with a rearwardly extending tubular portion 177 the extremities of which are fitted with bushings 178, 179 secured thereto and journaled on end portions of the cylindrical bearing 140, as shown in Fig. 8. The bushing 179 is provided with a rear annular flange 180 located between the rear end of the tube 177 and the front annular face of the casing 136 where the rear end of the cylindrical bearing 140 fits in the cylindrical opening 141.

The turnover head 176 at its outer end is cylindrical in shape, as shown in Fig. 8, relative to an axis which extends transversely of the axis of the shaft 158. Such cylindrical portion is designated 181 in Fig. 8 and may be integral with the rearwardly extending tubular portion 177. The ends of the cylinder 181 are covered by the spaced-apart bracket plates 183 which are attached by means of the cap screws 182 to an inner cylinder 208 hereinafter described. Fitting into an annular groove 185 at the periphery of the plate 184 is a retaining ring 186 which may be composed of two semi-circular portions secured to the cutter frame 187 by means of cap screws 188, as indicated in Fig. 8. The cutter bar 165 is suitably supported by the cutter frame 187 for adjustment relative thereto by means of the cutter chain slidable adjusting mechanism 189 comprising the head 190 connected to the cutter bar, a screw 191 threaded through a portion of the cutter frame 187, and a collar 192 adapted to receive a turning tool.

Riveted to the upper side of the sprocket 163, as shown in Fig. 8, is a ring plate 193 against which is thrust by means of the springs 194, a ring 195 mounted to slide on spaced pins one of which is shown at 196 in Fig. 8. The ring 195 fits in an annular recess 197 in the bearing block 198 which is secured by means of screws one of which is shown at 199, to the cross-plate 184 of the turnover head 176.

The cutter frame 187 has a circular opening 200 in which fits the bushing 201 which has an annular flange 202 located between the cross-plate 184 and the cutter frame 187. It will thus be seen that when the cutter bar 165 rotates on the axis of the shaft 162, the bushing 200 and its annular flange 202 slide against the relatively stationary surfaces at the outer periphery of the bearing block 198 and the underside of the cross-plate 184, as viewed in Fig. 8. A lubricating packing ring 203 may be located in an annular recess in the outer periphery of the bearing block 198.

Between the sprocket 163 and an annular seat in the bearing block 198 is a roller thrust bearing 204. Extending inwardly from the bearing block 198 is a sleeve 205 to form a cylindrical bearing for the spaced-apart split rings 206 which fit in annular spaced-apart grooves in the enlarged portion 207 of the shaft 162.

The cross-plate 184 may be made in two parts secured together, with each part integral with the bracket plates 183, 183, as shown in Fig. 6. The bracket plates 183, 183 may be secured to the inner cylinder 208 by means of the cap screws 182 as shown in Fig. 6, and the cylinder 208 fitted against the inner sides of the bracket plates 183 and against the guiding shoulders 209, 209. The inner cylinder is journaled within the outer cylinder 181 and the inner peripheral edges of the inner cylinder 208 are guided along the annular shoulders 209, 209 on the inner faces of the bracket plates 183. By means of the ring 186 fitting in the annular groove 185 in the cross-plate 184, the cutter frame 187 together with the chain kerf-cutter mounted thereon is supported by the rigid unit comprising the spaced-apart bracket plates 183 and the connecting inner cylinder 208 between the same. Consequently, when the bracket plates 183 together with inner cylinder 208 are rotated within the cylinder 181, the cutter bar is moved along arcuate lines transversely of itself.

The upper end of the sprocket shaft 162 is provided with a cup shaped cap 210 which is held in place by the cap screw 211. Between the lower edge of the cap 210 and the collar 212 on the shaft 162 is located the inner race of a roller thrust bearing 213, the outer race of which rests on an annular seat 214 of a cylindrical support 215 located intermediate the ends of the transverse axle 216. One end of the axle 216 is journaled in the bearing 217 formed by an inwardly extending hub at the center of the right-hand plate 183 as viewed in Fig. 6. An enlarged head 218 on one end of the axle 216 rests against the outer end of the hub bearing 217. The other end of the axle 216 is provided with a cap 219 which is secured in place by the cap screw 220, and the cap 219 is journaled in the bearing 221 which is in the form of a hub extending outwardly from the left-hand plate 183, as viewed in Fig. 6. The bevel gear 160 is provided with a hub 222 which is journaled by means of the thrust bearings 223 and 224 on that portion of the axle 216 intermediate the cap 219 and the cylindrical support 215.

It should be particularly noted that irrespective of the position of the cutter bar 165, whether in a horizontal plane, a vertical plane or in any other plane, the bearings for the sprocket shaft 162 and for the axle 216 will be maintained in position for efficient operation of the power transmission mechanism between the shaft 158 and the chain driving sprocket 163, since the support for the cutter bar is effected by the cyl-

inder units independently of the power transmission mechanism within the same.

Pivotally connected to the upper portions of the bracket plates 183 by means of the pins 225, 225 as shown in Fig. 6, are rearwardly extending links 226, 226, the rear ends of which are journaled on the ends of the laterally extending bars 227, 227, the intermediate portion 228 of which provides spaced-apart cross-heads or rollers 229, 229 movable along the guides 230, 230 mounted on the forward end of the cylinder bed plate 231, as shown in Fig. 4. The bed plate 231 may be secured by means of the cap screws 232, 232 to the upper side of the rearwardly extending tubular portion 177 of the turnover head 176, as shown in Fig. 2.

Mounted on the bed plate 231 is a hydraulic motor comprising a cylinder 233 and a piston 234 movable therein and provided with a piston rod 235 extending through the stuffing box 236 and secured at its outer end to the cross-head bar 228. When this hydraulic motor is operated to move the piston 234 toward the right, as viewed in Fig. 8, the cutter bar will be swung transversely of its plane on the axis of the axle 216 with the outer end of the cutter bar moving in a downward direction. When the piston 234 is moved toward the left the cutter bar will be swung transversely of its plane with its outer end moving upwardly. The cutter bar may be locked in its adjusted position by locking the piston 234 in the cylinder 233 as hereinafter described in connection with Fig. 22.

The elongated chain kerf-cutter including the cutter bar 165 and the endless chain cutter mounted thereon may be swung either for feeding or adjustment purposes, on the axis of the shaft 162 by means of the hydraulic motors 237 and 238 operated in opposite directions. These hydraulic motors are pivotally connected at 239 239 to supporting plates 240, 240 which are secured to and extend laterally from the bracket plates 183, 183, as shown in Figs. 2 and 4. Extending forwardly from the pistons in the cylinders of the hydraulic motors 237 and 238 are piston rods 241, 241, the forward ends of which are pivoted at 242, 242 to brackets 243, 243 rigidly secured to the cutter frame 187. The axes of the pivots 239, 239 and 242, 242 are parallel to each other and also parallel to the axis of the sprocket shaft 162. By effecting movement of the pistons in the motors 237 and 238 in opposite directions as hereinafter explained in connection with the diagram shown in Fig. 22, the cutter bar may be swung in either direction on the axis of the sprocket shaft 162 and locked in adjusted position by confining the pistons in the cylinders of the motors 237 and 238. Such locking of the cutter bar in adjusted position is desirable when rectilinear feeding of the kerf-cutter is to be effected. When the kerf-cutter is fed arcuately on the axis of the sprocket shaft 162, it is preferred to swing the cutter bar in an anti-clockwise direction, as viewed in Fig. 4, so that the cutter bits emerging from the coal face will sweep the cuttings from the kerf during the operation of the kerf-cutter.

However, if the cutter bits 166 are reversed in the bit-holders 167, the kerf-cutter may be fed arcuately in a clockwise direction, as viewed in Fig. 4. It is therefore desirable to mount the cylinders of the hydraulic motors 237, 238 to resist the rearward thrusts whether the kerf-cutter is fed arcuately in one direction or the other.

In order to permit the sleeve bearing 205, shown in Fig. 8, to extend into the chamber in which the bevel gear 161 is located, a slot 244 is provided in the lower portion of the cylinder 181, this slot having a width equal to the diameter of the sleeve 205. The inner end of the sleeve 205 fits in and extends through a circular opening in the inner cylinder 208. The inner end of the sleeve 205 always moves bodily with the inner cylinder 208. A slot 245 in the inner cylinder 208 is provided for the rear hub portion of the bevel gear 159, and it is desirable to prevent dust and dirt from entering the chamber within the cylinder 208 when the outer end of the cutter bar is moved upwardly from its position shown in Fig. 8. A sealing plate 246 is therefore mounted in a recess 247 in the outer surface of the cylinder 208, as shown in Fig. 8. This plate 246 has the width shown in Fig. 6 and is provided with a slot having a width equal to the diameter of the bearing sleeve 205. A narrow slot 248 in the sealing plate 246 receives the inner end 249 of a screw 250 which may be locked in place by the nut 251, as shown in Fig. 8. The screw 250 is mounted in the outer cylinder 181 and therefore acts as a fixed abutment engageable by the ends of the slot 248. When the inner cylinder 208 is moved in a clockwise direction, it tends to carry with it the sealing plate 246 but when the upper end of the slot 248 engages the fixed abutment 249 the movement of the sealing plate 246 stops while the inner cylinder 208 continues to rotate as permitted by the slots 224 and 245. When the cylinder 208 is moved in an anti-clockwise direction the sealing plate 246 tends to move with it until the lower end of the slot 248 engages the fixed abutment 249 in a position where the left-hand end of the sealing plate 246 will be in overlapping relation with the left-hand end of the slot 244 and the lower end of the slot 245, thus preventing access through the slot 244 to the interior of the cylinder 208. The sliding sealing plate 246 therefore acts automatically when the cutter bar is swung transversely of its plane to always keep the chamber within the cylinder 208 entirely closed from the external atmosphere.

A transverse thrust bar 252 is detachably and rigidly secured to the bracket plates 183, 183 by means of plates 253 and cap screws 254, as shown in Fig. 2. This cross-bar is thus secured to the plates 183, 183 against movement in any direction. The outer ends of the cross-bar 252 are provided with holes for receiving the pins 255 projecting from the lower sides of the cylinders of the hydraulic motors 237 and 238. The upper sides of these cylinders are provided with pins 239, 239 which extend into openings in thrust blocks 256 which are slidable laterally into the guideways 257, 257 on the undersides of the brackets 240, and the slide blocks 256 may be held in place by pins as shown at 258 in Fig. 6. It will thus be seen that forward and rearward thrusts on each cylinder are resisted by the lower pins 255 fitting in openings in the ends of the cross-thrust bar 252 and by the upper pins 239 fitting in openings in the thrust blocks 256 which are fitted in spaced-apart lateral extending guideways in both sides of the lateral extending brackets 240 secured rigidly to the outer sides of the bracket plates 183, 183.

Referring now to the mechanism for turning over the head 176 together with the cutter bar, on the axis of the shaft 158, as shown in Figs. 8, 9 and 10, it will be seen that a worm gear 259 is mounted on the rear end of the tubular portion

177 of the turnover head 176. The front end of the casing 136 is provided with an annular shoulder 260 forming an annular recess 261 for receiving the two halves of a retaining ring 262 which is rigidly secured to the worm gear 259 by means of the cap screws 263. These cap screws extend through an annular flange 264 which may be integral with the tubular support 177, and consequently the worm gear 259 is rigidly connected to the tubular support 177 to rotate therewith while the rear end of the tubular support is journaled in the bushing 179 and the annular flange 180 thereof.

By referring to Fig. 5, it will be seen that the cylindrical bearing 140 is hollow but provided with inwardly extending radial ribs 265 arranged parallel to the shaft 158. The elongation of the cylindrical support 140 reinforced by the spaced ribs 265 on the interior thereof, affords a very rigid support for the mechanism mounted thereon, while the thrust bearings 170 and 171 are kept in proper alinement, and furthermore the elongation of the cylindrical support 140 affords a distribution of the mounting of the tube 177, as indicated by the bushings 178 and 179 in Fig. 8.

As shown in Fig. 5, a worm 266 meshing with the worm gear 259 is connected to a worm shaft 267 the ends of which are mounted in roller thrust bearings 268, 269. These roller thrust bearings are mounted in seats in the casing 270 and the outer races of the thrust bearings are held in place by the cap plates 271, 272 detachably secured by means of the cap screws 273, 274 to the ends of the casing 270, as shown in Fig. 5. A semi-cylindrical cover plate 275 detachably secured to the casing 270 by means of the cap screws 276, 276 serves to cooperate with the casing 270 to entirely enclose the worm gearing 266, 259. The rear edges of the casing 270 and the cover plate 275 fit over arcuate seats 277 and 278 on the front end of the gear casing 136, as shown in Fig. 8. The seats 277 and 278 are concentric and preferably located in adjacent planes extending at right angles to the axis of the shaft 158. The head 176 together with the cutter bar may be rotated to any extent desired without opening the enclosure to the atmosphere. At the outer end of the casing 270 and the cover 275 an annular lubricating packing ring 279 engages the neck portion 177 of the head 176, as shown in Fig. 8.

Keyed to the worm shaft 267, as shown in Figs. 5 and 10, is a worm gear 280 with which meshes a worm 281 connected to a shaft 282 the ends of which are mounted in the ball bearings 283, 283, as shown in Fig. 9. One end of the shaft 282 is connected by the flexible coupling 284 to the rotary cylinder block 285, to the central opening of which is secured a bushing 286 journaled on the bearing 287 secured rigidly by means of mechanism including the nut 288, to the cover 289 which in turn is detachably secured by means of the cap screws 290 to the casing 291.

The rotary hydraulic motor 292 is shown in detail in Fig. 14 which is a section taken on the line 14—14 of Fig. 5, looking in the direction of the arrows. Supply and exhaust ports 293, 294 in the stationary bearing block 287 communicate with the radial cylinders in the rotary block 285 in which cylinders are mounted pistons 295 for reciprocation within the inner race 296 of the ball bearing 297, the outer race 298 of which fits the inner wall of the motor casing. The ball bearing is mounted eccentrically of the axis of rotation of the cylinder block 285 and therefore when the port 293 is used as a supply port and the port 294 is used as an exhaust port, the rotation of the cylinder block will be in an anticlockwise direction as indicated by the arrow 299 in Fig. 14.

It should be noted that while the worm gear 259 is rigidly connected to the rear end of the neck 177 of the turnover head 176 to rotate bodily therewith, the worm shafts 267 and 282 are mounted in casings which are rigidly connected to the gear casing 136. The hydraulic motor 292 and the worm gearing 281, 280 and 266 are mounted on the gear casing 136. The rear edges of the casing 270 and the cover 275 therefore fit on the seats 277 and 278 in stationary position relative to the gear casing 136. The motor casing 291 is secured by means of cap screws as illustrated at 300 in Figs. 4 and 9 to the gear casing 270, and the latter in turn may be secured to the gear casing 136 by means of the cap screws 301, as shown in Fig. 10.

As shown in Figs. 3 and 7, a supporting bracket 302 is rigidly connected to the rear end of the motor casing 137 and is provided with rearwardly extending bearing arms 303, 303 in the rear ends of which are journaled the trunnions 304, 304 which extend laterally from the cylinder 305 of the vertical hydraulic motor 306. A piston 307 is reciprocable vertically in the cylinder 305 and is provided with a piston rod 308 which extends through a stuffing box 309 to a pivotal connection at 310 to the rear end of the platform 52. As hereinafter described in connection with Fig. 22, the cylinder 305 may be locked at various elevations relative to the platform 52 so that when desired the trunnions 304 may be relied on as a fixed pivot for the rear end of the supporting unit comprising the motor rigidly connected to the gear casing 136, shown in Fig. 8, with the latter in turn rigidly connected to the elongated cylindrical bearing 140.

As shown in Fig. 3, the hubs 124 and 125 at the rear ends of the arms 126 and 127 may be pinned to the bearing bar 123 as indicated at 311 and 312. The hubs 131 and 132 at the front ends of the arms 129 and 130 may be pinned to the bearing bar 134 as indicated at 313, 314. Consequently, the pairs of arms at the lateral sides of the motor M may be regarded as link structures 315, 315 connecting the transverse bearing bars 123 and 134, the bearing bar 123 being on a fixed transverse axis relative to the platform 52, while the bearing bar 134 is on a fixed axis relative to the supporting unit comprising the motor M, the gear casing 136 and the elongated cylindrical bearing 140. When the link structures 315, 315 are swung upwardly or downwardly on the rear transverse axis of the bearing bar 123 the rear end of such supporting unit tilts on the axis of the trunnions 304 at the rear end of the bearing arms 303, as shown in Fig. 3 (see also Fig. 28).

For the purpose of swinging the link structures 315 on the transverse axis of the bearing bar 123, hydraulic motors 316, 316 are pivotally connected between the platform 52 and the link structures 315, 315 intermediate the ends of the latter, as shown in Fig. 3. The hydraulic motors 316, 316 include cylinders 317, 317 mounted in rings 318, 318 which are provided with laterally extending trunnions 319 and 320 (Fig. 13). The outer trunnions 319, 319 are mounted in bearings between the adjacent ends of the arms 126 and 129, and the inner trunnions 320 are mounted

in bearings between the arms 127 and 130, as shown in Fig. 3.

Each of the hydraulic motors 316, 316 comprises a piston 321 reciprocable in the cylinders 317, 317 connected to piston rods 322, the lower ends of which are connected to transverse pins 323 mounted in the castings 121, 121 welded to the top of the platform 52, as shown in Fig. 13 which is a sectional view taken on the line 13—13 of Fig. 1, looking in the direction of the arrows. As shown in Figs. 1 and 7, the piston rods 322 are inclined upwardly and forwardly from the upper surface of the platform 52 when the axis of the armature shaft of the motor M is horizontal. Such inclination of the piston rods 322 also occurs when the forward end of the cylindrical support 177 is tilted downwardly as illustrated diagrammatically in Fig. 29. When, however, the cylindrical support 177 is tilted upwardly to the position diagrammatically shown in Fig. 28, the piston rods 322 incline rearwardly.

The great flexibility of adjustments of the chain kerf cutter are illustrated diagrammatically in Figs. 28, 29 and 30. When the pistons in the hydraulic motors 316 are locked against movement in either direction, the transverse axis 319 becomes fixed relative to the platform 52. Then by operating the rear central hydrauic motor to elevate the cylinder 305 the cutter head 176 may be lowered as illustrated in Fig. 29. When the cutter bar 165 is thus tilted downwardly on the transverse axis 134 the pistons in cylinders 237 and 238 may be moved, one forwardly and the other rearwardly, to swing the outer end of the cutter bar on the axis 162.

The two adjustments, one on the axis 134 and the other on the axis 123, will enable the operator to locate the cutter bar 165 in a plane below the level of the mine track rails 324 on which the machine is mounted and along which it is adapted to travel. When the kerf-cutter is in its bottom cutting position in a horizontal plane, as shown in Fig. 29, the cutter head 176 will be held rigidly in adjusted position relative to the supporting framework of the machine because the hydraulic adjusting motors are self-locking and the worm gearing for the turnover head mechanism is self-locking. When the kerf-cutter is in its bottom cutting position, as shown in Fig. 29, it may be fed arcuately about pivot 162 by means of the oppositely acting hydraulic motors 237, 238. In addition, arcuate feeding about the pivot 50 is provided by oppositely acting hydraulic motors 60. When sumping and withdrawal feeding movements are to be made the hydraulic motors 60, 237 and 238 may be relied on to lock the cutter bar at an acute angle relative to the path of travel of the machine along the mine track. Such rectilinear feeding movements may be effected by moving the entire machine along a mine track at a feeding speed as hereinafter described in connection with the illustration at the left-hand portions of Figs. 1 and 3.

By referring to Figs. 29 and 33, it will be seen that the overall height of the machine is relatively low when the supporting unit 325 is in its lowest position. The rear upper surface 326 of the supporting unit 325 is inclined downwardly and rearwardly as indicated in Fig. 33, so that when the kerf-cutter occupies its bottom cutting position shown in Fig. 29 said surface 326 will be approximately horizontal thereby still retaining the overall height of the machine in its relatively low position. Fig. 33 shows the cutter bar inverted relative to its bottom cutting position shown in Fig. 29. Fig. 1 shows that the truck propelling mechanism and other apparatus mounted on the rear platform 327 also occupies a relatively low position so that the entire machine shown in Figs. 1 and 2 may be arranged to have a relatively low overall height for enabling the machine to operate in relatively low roof mine chambers. Figs. 29 and 28 illustrate respectively the positions of the cutter bar for bottom cutting and top cutting in a relatively low roof mine room, and Fig. 33 illustrates the arrangements of parts for transportation along relatively low roof mine entries. While the transverse axis 319 occupies its lowest position the combination of the tilting hydraulic motor 306 and the turnover head mechanism may be relied on to adjust the kerf-cutter to any horizontal plane between the floor and roof of a relatively low roof mine chamber, thereby eliminating any "blind spots" and enabling the machine to cut out dirty bands in a low vein at any elevation between the floor and the roof of such low roof mine chamber.

The kerf-cutter while in its underslung position shown in Fig. 29 may be adjusted to various elevations to have a high reach in a high roof mine chamber. For instance, if the pivot 304 shown in Fig. 29 is adjusted to its lowest position (Fig. 28) and locked there, the hydraulic motors 316 may be operated to swing their link structures on their axis 123. The pivot 134 will then move along an arc having the pivot 123 as its center, and the rear hydraulic motor 306 will simply serve as a link between the rear end of the platform 52 and the rear end of the supporting unit 325. Since the upper ends of the hydraulic motors 316 are connected only to the link structures 315, the supporting unit 325 and the kerf-cutting apparatus mounted thereon, are fulcrumed on the axis 134, and the motor 306 acting as a link between the rear end of the platform 52 and the rear end of the supporting unit 325, cooperates with the transverse supporting bar 134 to retain the kerf-cutter rigidly in adjusted position against movement either up or down, while the pistons in the motors 316 are locked against movement in either direction. That is to say, while the motor 306 is locked and the motors 316 are elevating the forward end of the supporting unit 325, the arcuate movement of the fulcrum 134 on the center 123 will be permitted by the motor 306 acting as a link, and when the motors 316 are locked, the supporting unit 325 will be held rigidly connected to the platform 52 and the turntable 51.

By comparing Figs. 28 and 29, it will be seen that when the kerf-cutter is in its underslung position, it may be adjusted in elevation to occupy any horizontal plane between the bottom plane and plane indicated by the dotted lines 165'. When the kerf-cutter is in top cutting position and occupies a horizontal plane it may be adjusted in elevation between the roof plane and the plane indicated by the dotted lines 165''. The various adjustments therefore enable the kerf-cutter to cut in horizontal planes anywhere between the bottom cutting position, shown in Fig. 29, and the top cutting position shown in Fig. 28. Consequently, in a high roof mine chamber, a dirty band may be cut out from the mine vein at any elevation between the floor and roof of the mine room or mine entry.

Fig. 30 illustrates diagrammatically the adjustments which may be made for the cutting of

shearing kerfs in vertical planes in the working face 328, parallel to the mine track 324 and parallel to the ribs 329 and 330 of the mine room. The shearing kerfs may be cut in any plane between the ribs 329 and 330, and the ribs 329 and 330 may be spaced-apart various distances; so that shearing kerfs may be made anywhere in a working face extending across the space in advance of the mine track, with the ribs 329 and 330 within the reach of the machine, when the supporting unit 325 is swung through its widest angle of adjustment on the vertical axis 50 of the turntable.

When the cutter bar 165 is in a vertical plane, the pivotal axis 216 is vertical and parallel to the vertical turntable axis 50. That this is true may be seen by referring to Figs. 6 and 8 which show that the sprocket shaft 162 is always at right angles to the plane of the cutter bar 165, and the axis of the shaft 216 is always at right angles to the shaft 162 and intersects the same. Consequently, when the cutter bar occupies a vertical plane the axis of the shaft 216 must be vertical since it always occupies a position extending transversely of the cutter bar and spaced therefrom. As shown in Fig. 8, the respective axes of the sprocket shaft 162, the shaft 216 and the shaft 158 intersect each other. The shaft 216 is rotatable in a plane which is at right angles to the axis of the shaft 158, and the shaft 162 is rotatable in a plane which is at right angles to the axis of the shaft 216, and the plane in which the shaft 162 is adjustable also extends through the shaft 158.

The flexibility of adjustment of the cutter bar on the three intersecting axes at the cutter head 176 is such as to cooperate with the turntable axis 50 to secure a wide range of adjustment of the kerf-cutter from rib to rib in planes parallel to the mine track and at right angles to the working face 328 extending across the space in advance of the mine track. The cutter bar may be adjusted from the position shown in full lines in Fig. 30 to its center position indicated by the dotted lines C. Then by operating the turnover head mechanism to invert the kerf-cutter, the latter may be adjusted from a plane adjacent to the rib 330 to the center plane C. It is also evident that the kerf-cutter while in a horizontal plane may be adjusted for operation in any plane between the floor and the roof as illustrated in Figs. 28 and 29. The same machine may also be used for cutting shearing kerfs in any plane between the ribs of the mine room, as illustrated in Fig. 30. In addition to these operations, slanting kerfs may be cut in the working face 328 or in the ribs while the supporting framework remains stationary on the mine track. Under such circumstances feeding may be effected by operating the oppositely acting hydraulic motors 237 and 238 shown in Fig. 4, since the pivotal axis of swinging movement of the cutter bar always remains at right angles to the plane of the cutter bar.

In long-wall operations which are effected by moving the whole machine at a feeding speed along a mine track, the kerfs may be either horizontal or inclined upwardly or downwardly, but when thus inclined the pivotal axis 216 must be horizontal and parallel to the mine track so that both the leading and trailing edges of the cutter bar will move along straight lines parallel to the mine track. When cutting parallel ribbed kerfs in horizontal planes in the working face 328 extending across the space in advance of the mine track, it is preferred to connect sumping and withdrawal rectilinear cuts by an arcuate feeding movement on the vertical axis 50 of the turntable by operating the oppositely acting hydraulic motors 60, 60 shown in Fig. 17, while the kerf-cutter and the supporting structure therefor are rigidly locked to the turntable to move arcuately and bodily therewith.

The apparatus for moving the whole machine along a mine track either at transportation speed or feeding speed, is shown in elevation in Fig. 1 and in plan in Fig. 3, as being mounted on the platform 327 which is rigidly connected to the rear end of the base frame 35. A propelling electric motor P is connected to a pinion 331 which meshes with a large gear 332 connected through the planetary gearing 333 to the pinion 334 which meshes with the large gear 335. The planetary gearing 333 is shown in detail in the sectional views of Figs. 19, 20 and 21, Fig. 19 being a section taken on the line 19—19 of Fig. 1, looking in the direction of the arrows. The large spur gear 335 is mounted on a transverse shaft 336 as shown in Fig. 16, which is a sectional view taken on the line 16—16 of Fig. 3, looking in the direction of the arrows.

The shaft 336 is journaled in bushings 337 and 338 in the bearings 339 and 340 at the upper ends of standards 341 and 342 secured to the supporting frame 367' mounted on the upper surface of the platform 327, as shown in Fig. 16. The clutches associated with the shaft 336 are so arranged that the truck propelling mechanism can be operated while at the same time operating the cable reel 343 to pay out the electric cable 344 when the machine is moved forward and to wind it in when the machine is moved rearwardly. A sprocket 345 is connected by a sprocket chain 346 to a sprocket 347 connected to one end of the shaft which carries the cable reel 343. The other end of the cable reel shaft is connected by the sprocket gearing 348 to rotate the double screw shaft 349 to shift the cable guide 350 laterally in accordance with the convolutions of the cable on the reel 343. In a well-known manner, the cable 344 is connected to a distant source of electric power supply, and the insulated wires of this cable are connected in a well-known manner to the motors M and P and the controllers 351 and 352 therefor.

As shown in Fig. 16, a clutch element 353 is splined to the hub 354 of the spur gear 335. The clutch element 353 is movable by means of the shift lever 355 pivoted at 356, into engagement with the clutch element 357 at one side of the sprocket 345 which is journaled by means of the bushing 358 on the shaft 336.

Extending through a central opening in the shaft 336 is a rod 359 which carries at one end the clutch element 360. To the opposite end of the rod 359 is connected a shifting lever 361 pivoted at 362. The clutch element 360 is movable into engagement with the clutch element 363 on the hub of the sprocket 364 which is connected by means of the sprocket chain 365 to the sprocket 366, as shown in Fig. 1.

Since the spur gear 335 and its hub 354 are keyed to the shaft 336, the latter may be rotated in either direction in accordance with the direction of rotation of the propelling motor P, and such rotation of the shaft 336 may be at varying speeds in accordance with the control of the planetary gearing 333. While the clutches 353 and 360 are independently operable so that the

machine may be moved along the mine track in either direction without rotating the cable reel 343, and the cable reel may be rotated in either direction without moving the machine along the mine track, it is evident that when both the clutches 353 and 360 (Figs. 3 and 16) are applied, the cable reel will wind up the cable 344 when the machine is moved forwardly. The opposing faces of the clutch elements 353 are therefore in ratchet form so as to slip when the pull on the cable 344 reaches a predetermined limit. Since the sprocket chain 117 connects the sprockets 118 and 119 on both the rear axle 39 and the front axle 42, all four wheels of the truck are positively driven (Fig. 17).

The planetary gearing 333 and the controlling mechanism therefor are shown in Figs. 19, 20 and 21. On a standard 367 which is secured to the base plate 367' secured to the platform 327 (Fig. 3), is a bearing 368 lined with bushings 369 in which is journaled the shaft 370 extending concentrically from the cup shaped support 371 which carries an internal annular gear 372. The large gear 332 is keyed to a shaft 373 one end of which is journaled in the frame of the motor P and the other end of which is journaled in the bushing 374 in a central opening at the inner end of the shaft 370. It will thus be seen, by referring to Fig. 19, that the shaft 373 is mounted for rotation on a fixed stationary axis relative to the platform 327.

Keyed to the shaft 373 is the hub 375 of a planetary gear carrier 376 comprising the ring frame member 377 to which at diametrically opposite points are pinned the cylindrical bearings 378, 379 on which are journaled by means of the bushings 380 and 381 the hubs 382 and 383 of the planetary gears 384, 384 and 385, 385. The teeth of the gears 385, 385 are each less in number than the teeth of each of the gears 384, 384. In Figs. 20 and 21, the gears 385 each have fifteen teeth and the gears 384 each have sixteen teeth. The gears 385 mesh with the internal annular gear 372 carried by the cup shaped support 371. The gears 384 mesh with the internal annular gear 386 which is carried by the cylindrical support 387 journaled at 388 on the outer cylindrical surface of the support 371 against the shoulder 389.

Associated with the periphery of the cylindrical support 387 is a brake comprising a brake band 390 lined with friction material 391 and entering the annular groove 392 in the periphery of the cylindrical support 387. To the brake band 390 intermediate its ends is secured a supporting arm 393 having an oval opening 394 transversely therethrough to receive the supporting bar 395, one end of which is secured to the frame of the motor P and the other end of which is mounted in the upper end 396 of the bracket 367.

The brake band lining 391 may be applied to the annular groove 392 to hold the cylindrical support 387 stationary, by operating the hydraulic motor 397, a section of which is shown in Fig. 18.

As shown in Fig. 20, actuating arms 398, 398 are secured to the ends of the brake band 390, and these arms are provided with openings 399, 399, as shown in Fig. 18, for receiving the cup-shaped cylinder 400 of the hydraulic motor 397, the plunger 401 of which is provided with a head 402 which is connected by means of the pins 403 to the spaced-apart members 404, 404 of a frame having abutments 405, 405 for engaging the outer face of one of the arms 398. An annular abutment 406 at the inner end of the cylinder 400 engages the outer face of the other arm 398, as shown in Fig. 18. When the fluid-pressure medium flows through the pipe 408', shown in Fig. 20, and enters the tubular passageway 408 in the center of the plunger 401, pressure will be exerted on the piston cup packing 409 at the left-hand end of the plunger 401, as viewed in Fig. 18. The cylinder 400 and the plunger 401 will then be moved in opposite directions to cause the abutments 405 and 406 to move toward each other and thereby apply the brake band lining 391 to the cylindrical support 387 to hold the latter stationary. Then when the gear 332 is rotated by means of the pinion 331 on the shaft of the motor P, the shaft 373 of Fig. 19 will be rotated, and since the planetary gear carrier 376 is keyed to the shaft 373, such carrier will rotate with the shaft 373 thereby effecting rotation of the planetary gears as the gears 384 travel around the stationary gear 386. By reason of the difference in the number of teeth in the gears 384 and 385, a slow feeding movement will be effected by means of the truck-propelling mechanism and the pinion 334 shown in Fig. 19. Therefore, when the cutter bar is locked in such position as to cut a kerf along lines parallel to the mine track, rectilinear feeding movement may be effected by applying the clutch 360 shown in Fig. 16, operating the hydraulic motor 397 to apply the brake 390 to hold the annular gear 386 stationary, and controlling the motor P to operate in desired direction, the whole machine may be moved along a mine track at a feeding speed. At such time the motor M is controlled to operate in such direction as to drive the chain cutter in cutting direction.

To stop the feeding movement of the machine the pressure in the pipe 408' is relieved, whereupon the spring 410 which is mounted on the cylinder 400, as shown in Fig. 18, will act against the inner faces of the arms 398, 398 to spread them apart and move the plunger 401 in the cylinder 400 back to its initial position, whereupon the brake 390 will be released from the cylindrical support 387 and free the latter for rotation.

The means for effecting a relatively fast or transportation movement of the machine along a mine track will now be described. Journaled on bushings 411 on the shaft 373, as shown in Fig. 19, is a central gear 412, the hub 413 of which is keyed to the hub 414 of the brake drum 415. Associated with the peripheral recess 415' in the brake drum 415 is a brake comprising a brake band 390' lined with friction material 391'. The brake band 390' is connected intermediate its ends to a supporting arm 393' mounted on the supporting bar 395 in a manner similar to that shown in Figs. 20 and 21. The ends of the brake band 390' are connected to a hydraulic motor 397' (Fig. 22) similar to that shown at 397 in Figs. 20 and 21, with its interior structure similar to that shown in Fig. 18. When the brake band 390' is applied after the brake band 390 has been released, the gear 412 will be held stationary, and consequently when the shaft 373 is rotated by means of the motor P, the planetary gears 384, 384 will have to walk around the stationary gear 412 since the carrier 376 is keyed to the shaft 373. If the rotation of the shaft 373 is in a clockwise direction as indicated by the arrow 416 in Fig. 21,

rotation of the gears 384 will each also be in a clockwise direction as they walk around the stationary gear 412. Consequently, the shaft 370 will also be rotated in a clockwise direction to impart a relative rapid rotation to the pinion 334, shown in Fig. 19, and thereby effect a transportation movement to the truck-propelling mechanism. For instance, in the specific illustration shown in Fig. 21, when the shaft 373 makes a complete rotation, the shaft 370 will make approximately 1.285 rotations, or an increase in the speed of rotation of shaft 370 over the speed of rotation of shaft 373, whereas when a slow feeding movement is effected, as aforesaid, shaft 373 must make approximately sixteen rotations for each rotation of shaft 370, or a substantial reduction in speed from shaft 373 to shaft 370.

Under the control of the planetary gear 333 rectilinear sumping and withdrawal cuts may be made either when the kerf-cutter is in a horizontal plane as illustrated in Figs. 28 and 29, or when it is in a shearing plane parallel to the mine track, as illustrated in Fig. 30. Such rectilinear sumping and withdrawal cuts are connected by arcuate feeding movements on the axis 162 and/or the axis 50 (Fig. 31). While the rectilinear feeding movements are being made, the brake mechanism 120 shown in Fig. 17 as associated with one of the wheels 40, is held in released position whereas when the arcuate feeding movements are being made on the axis of the sprocket shaft 162, the brake 120 is held applied to hold the supporting framework stationary on the mine track. Furthermore, during such arcuate feeding movements on the axis of the shaft 162, the anchoring of the supporting framework by means of the brake 120 may be supplemented by means of roof jacks applied to the base frame 35.

When a horizontal kerf is to be cut in a relatively narrow mine entry, the cutter bar 165 may be locked relative to the supporting unit 325 and the turntable may be locked relative to the base frame 35, as shown in Fig. 31. A sumping cut can then be made rectilinearly in the direction of the arrow 417 by moving the whole machine along the mine track at a feeding speed. Then by feeding the kerf cutter arcuately in the direction of the arrow 418 on the turntable axis 50, a horizontal kerf may be cut along the relatively long arc 419, thereby approaching the straight face. That is to say, by feeding the kerf-cutter on a long radius from the turntable axis 50, a new working face is left after the coal is shot down, more nearly approaching parallelism with the approximately straight face 328'. When the kerf-cutter reaches the position illustrated in dotted lines at 420, the turntable rotating mechanism may be locked and, without changing the adjustment of the cutter bar 165 relative to the supporting unit 325, a rectilinear withdrawal cut may be made as indicated by the arrow 421.

When a long-wall operation is to be made the cutter bar 165 is adjusted to the position shown in Fig. 32, and the whole machine moved along the mine track rearwardly in the direction of the arrow 422; and the feeding movement of the kerf-cutter along the long-wall face 423 will be in the direction of the arrow 424.

While long-wall operations may usually be performed by operating the truck-propelling mechanism under the control of the planetary gearing 333, it is sometimes desirable when the coal is unusually hard and the wheels of the truck tend to slip on the track rails, to effect long-wall feeding movement in the direction of the arrow 424 in Fig. 22 by means of rope winding mechanism and a rope connected thereto and wound thereon with its free end anchored extraneous to the machine. In order that the feeding pull may be exerted along lines parallel to the long-wall face 423, it is preferred to extend the feed rope 428 around the pulleys 431 and 445 and anchor the free end thereof as indicated at 446 in Fig. 32. If a long-wall operation is being performed on the face 447, the rope will be extended around the pulleys 430 and 448 and the free end anchored in a similar manner. When the sumping operation indicated by the arrow 417 in Fig. 31 is to be effected by means of the feed rope 428, it may be extended around the pulleys 431 and 445 and the free end of the rope anchored at 449.

By referring to Fig. 3, it will be seen that the rope drum 425 is mounted in bearings 426, 427 secured to the top of the platform 367'. A feed rope 428 connected to and wound on the rope drum 425 is arranged to extend from the latter under a roller 429 pivotally mounted on the platform 327, as shown in Fig. 3. The feed rope 428 extends rearwardly between guide sheaves 430, 430 and the free end of the rope 428 is adapted to be connected to an anchorage in the mine extraneous to the machine.

A casing 432 secured to the top of the platform 327 is adapted to close the rope drum 425 and also the driving gear therefor comprising a large gear connected to the rope drum to rotate therewith and a pinion 433 meshing with such large gear and journaled by means of the bushing 434 as shown in Fig. 16, on the shaft 336. The outer end of the pinion 433 is provided with a clutch element 435 which extends through an opening 436 in the casing 432. Splined to the shaft 336 is a sleeve 437 having a clutch element 438 at its inner end which is adapted to engage the clutch element 435 on the pinion 433. The sleeve 437 is connected to the transverse rod 359, the opposite end of which carries the clutch element 360. The connection of the clutch elements 438 and 360 to the opposite ends of the rod 359 serves as inter-locking mechanism to prevent the rope winding drum 425 from being rotated at the same time that the truck-propelling mechanism is being operated. Only when the truck propelling mechanism is released by releasing the clutch 360 can the clutch elements 435, 438 be connected to effect rotation of the rope drum 425.

By referring to Fig. 3, it will be seen that a handle 439 may be used to actuate gearing 440 to operate the controller 351 from that side of the platform on which the controller 351 is mounted. Or, if desired, a shaft 441 may be extended to the opposite side of the machine and operated from a station where the operator may actuate the lever 442 connected to the controller 352. The controller 351 is connected to the motor M and the controller 352 is connected to the motor P, and both of the motors and both of the controllers are enclosed in flame-proof casings. Screw-threaded covers 443 may be provided for the casing of the motor P to close hand-hole openings near the brushes of the motor.

Connected to that end of the shaft of the motor P opposite the pinion 331 is a rotary hydraulic pump 444. The various hydraulic motor controlling valve structures shown in Figs. 22 to 27, inclusive, may be mounted for operation on that side of the machine from which the controller 352 is operable. If desired, all of the valve

structures and both of the controllers 351 and 352 may be arranged for operation at a single station on the platform 327, and in like manner the clutches shown in Figs. 3 and 16 may have actuating connections extended to the same station.

The system of piping connections for the various hydraulic motors mounted on the universal kerf-cutting machine above described, is diagrammatically illustrated in Fig. 22. The pump 444 may be of the reversible variable delivery type and connected by means of a suction pipe 450 to the supply tank 451. The delivery into the supply line S may be effected by the pump 444 operating in either direction, as indicated by the arrows. If the pump 444 operates to deliver in the direction of the arrow 458, the check valve 453 will open, the check valve 454 will close, the check valve 457 will open, and the check valve 455 will close. The supply will then be from the tank 451 through the pipe 450, check valve 453, pump 444 and check valve 457 to the supply line S. If the delivery of the pump is in the direction of the arrows 452, the check valve 453 will close, the check valve 455 will open, the check valve 457 will close and the check valve 454 will open. The flow will then be through the pipe 450, check valve 454, pump 444, and check valve 455 to the supply line S. When the pressure in the supply line exceeds a predetermined limit such as occurs when the hydraulic motors are locked or their pistons reach the ends of their strokes, a pressure relief valve 459 will automatically open to by-pass the liquid through the exhaust pipe E back to the supply tank 451. It will thus be seen that the pump 444 will be operated by the propelling motor P continuously and whether the electric motor P is rotating in one direction or the other.

There may also be provided a manually controlled by-pass for the pump 444 with a relatively low-pressure relief valve 459' in such by-pass so that when the pump is idling or doing no useful work it need not perform the work necessary to keep open the relatively high pressure relief valve 459. For instance, when rectilinear kerf cuts are being made by movement of the whole machine along the mine track, the various hydraulic motors may have their pistons locked in the cylinders by the closure of their controlling valves including closure of the port 408' by the valve 510 (Fig. 23), and in such event the pump 444 will be continuously driven by the propelling motor P but in order to do so the pump acts against the relatively high pressure relief valve 459 to keep the pump by-pass open in the system shown in Fig. 22. However, by providing another by-pass pipe between the pipe 456 and the exhaust pipe E, shown in Fig. 22, with a manual valve and a low-pressure relief therein in parallel with each other, it is evident that by opening such manual valve the low-pressure relief valve will permit idling of the pump 444 when desired with less consumption of power of the propelling motor P.

The supply pipe S is connected to the central portion of each of eight valve devices each having the construction illustrated in the sectional elevational view of Fig. 25. As shown in Fig. 22, the supply pipe is connected in multiple to the eight valve devices by communicating through the lower side with the central chamber of each valve device. The exhaust pipe E and a branch E' thereof are connected through the underside of each valve device and to end chambers therein.

In order to tilt the base frame 35 on the transverse axis of the horizontal axle 39 shown in Fig. 7 or on the longitudinal axis of the trunnions 37, the hydraulic motors 70 and 70' at the forward end of the truck are controlled by means of the valves 460, 460' one of which is shown in sectional elevation in Fig. 25. The cylinder 70', as shown in Fig. 22, is connected by means of the pipes 461, 462 to the interior of the valve casing 463, as shown in Fig. 25.

Pivotally connected at 464 to a bracket 465 at one end of the valve casing 463 is a lever 466 which is connected to the valve stem 467 which extends into the chamber 468 and has connected to the inner end thereof the valve piston 469. To the latter is connected another valve piston 470. A spring 471 is mounted on the pivot 464 and so associated with the bracket 465 and the lever 466 that when the lever is released it will be automatically moved to neutral position where the valve pistons 469 and 470 rest on the seats 472 and 472' to cut off communication between the chambers 468, 473 and 474. When the lever 466 is moved to its full line position shown in Fig. 25, communication is established between the supply pipe S through the chamber 473 to the pipe 462 thereby exerting hydraulic pressure on the underside of the piston 71' in the left-hand cylinder 70', as viewed in Fig. 22. The liquid on top of the piston 71' will flow through the pipe 461 into the chamber 474 to the exhaust pipe E'. When the lever 466 is moved to its dotted line position shown in Fig. 25, the connections will be such as to move the piston 71' downwardly.

The construction of the valve 460' is the same as that shown in Fig. 25 so that when the lever 466' is moved to the left, liquid will flow into the pipe 475 to move upwardly the piston 71 in the right-hand cylinder 70, as viewed in Fig. 22, the liquid on top of the piston flowing through the pipe 476 to exhaust. It will thus be seen that the hydraulic motors at the forward end of the truck may be individually operated in either direction or simultaneously operated in the same or opposite directions. Consequently the forward end of the base frame 35 may be tilted upwardly or downwardly on the transverse axis of the rear axle, or tilted laterally on the longitudinal axis of the trunnions 37, shown in Fig. 7. Furthermore, since in practice the adjustment of the base frame 35 by means of the hydraulic motors at the forward end of the truck is only occasional, it is preferred to place manually operated valves 477 and 478 in the pipes 461, 462 respectively, and also manual valves 479 and 480 in the pipes 475 and 476 respectively. These manual valves are open when the pistons 71 and 71' are to be moved in either direction, but after they have been moved to adjusted positions and the valves 460 and 460' closed, the valves 477, 478, 479 and 480 may be closed to lock the pistons 71 and 71' in adjusted positions independently of the valves 460 and 460'. The pistons 71 and 71' will thus be locked in adjusted positions by the manually operated valves to avoid the possibility of leakage in the valves 460 and 460' from disturbing the locked adjustment of either piston 71 or 71'.

In order to tilt the supporting unit 325 by means of the spaced-apart hydraulic motors 316, as illustrated diagrammatically in Figs. 28 and 29, a controlling valve 481 similar in con-

struction to that shown in Fig. 25, is connected by means of the pipes 482 and 483 in parallel to the cylinders of the motors 316, 316, as shown in Fig. 22. Movement of the valve pistons, shown in Fig. 25, to the left will effect upward movement of the cylinders simultaneously, and movement of the valve pistons toward the right will effect downward movement of the cylinders to tilt the supporting unit 325 on the pivot 123, as illustrated in Figs. 28 and 29. When the lever of the valve 481 is released the latter will be closed to lock the hydraulic motors 316, 316 against movement of the cylinders either up or down.

The cylinder 305 may be moved up and down by operating the controlling valve 484 which is connected by means of the pipes 485 and 486 to opposite ends of the cylinder 305, as shown in Fig. 22. When the valve 484 is in neutral position, the cylinder 305 will be locked against movement either up or down relative to the piston therein.

After the supporting unit 325, diagrammatically illustrated in Fig. 28, has been tilted to a desired position of adjustment, the valve 487 (shown in section in Fig. 25) may be operated to effect operation of the piston in the cylinder 233, the ends of which are connected by the pipes 488 and 489 to the valve 487. By moving the piston in the cylinder 233, the cutter-bar 165 may be moved on the pivot 216 transversely of itself to adjust the inclination of the kerf-cutter, and when the valve 487 is closed the cutter-bar will be locked against movement in either direction on the pivot 216.

Feeding movement of the kerf-cutter on the pivot 162 (Figs. 4, 6 and 31) may be effected by means of the hydraulic motors 237 and 238 which are controlled by the valve 490, as shown in Fig. 22. Inasmuch as the motors 237 and 238 always operate in opposite directions, they are connected by means of the pipes 491 and 492 as shown at the top of Fig. 22. That is to say, the pipe 492 is connected to the front end of the motor 238 and to the rear end of the motor 237, and the pipe 491 is connected to the rear end of the motor 238 and to the front end of the motor 237. When the pipe 492 is connected to the supply pipe S, the piston of the motor 238 will move rearwardly and the piston of the motor 237 will move forwardly, and when the supply pipe S is connected to the pipe 491 the piston of motor 237 will move rearwardly and the piston of motor 238 will move forwardly. It will thus be seen that the cutter bar by means of the motors 237 and 238 under the control of the valve 490, may be moved in either of opposite directions and then locked in adjusted position when the lever of the valve 490 is released.

In order to control the rotary motor 292 for operation of the turnover head mechanism, a valve 493 similar to that shown in Fig. 25, is connected by means of the pipes 293' and 294' to the hydraulic motor 292. The hydraulic rotary motor 292 shown in Fig. 22 is designated RVS to indicate that it is reversible and of variable speed, in accordance with the pressure exerted in the supply pipe S by means of the pump 444. The hydraulic rotary motor is shown in section in Fig. 14 and its operating connections to the rotary neck 177 of Fig. 8 are shown in detail in Figs. 9 and 10.

A special valve structure 494 shown in section in Fig. 27 is connected by means of the pipes 495, 497 498 and 499 to the turntable hydraulic motors 60, 60 as shown in the lower portion of Fig. 22. The rotary valve element 500 may be set by means of the lever 501 in the position shown in Fig. 27, whereupon the controlling valve 502 may be operated to effect operation of the hydraulic turntable motors 60, 60 in opposite directions. Pipes 503 and 504 are connected to the valve 494, as shown in Figs. 22 and 27. The valve 502 is similar in construction to that shown in Fig. 25 so that either pipe 503 or 504 may be the supply pipe and the other the exhaust. Assuming that the pipe 503 is connected to the supply pipe S, the flow of liquid will be from the pipe 503 into the port 505 which branches in parallel to the pipes 497 and 499. Pressure will therefore be exerted in the left-hand hydraulic motor 60 to move its piston forward and in the right-hand hydraulic motor 60 to move its piston rearwardly. Liquid will flow out of the cylinders through the pipes 495 and 498 into the port 506 of the valve 494 and thence to the pipe 504. When the valve 502 is moved to its opposite position, the motors 60, 60 will be reversed but their operation in opposite directions will be retained so that the turntable will be rotated by means of the mechanism shown in Fig. 17. It will thus be seen that the valve 494 is intended to be set in the position shown in Fig. 27 when the hydraulic motors 60, 60 are to be controlled by the valve 502. When the latter is in closed or neutral position the hydraulic motors 60, 60 will be locked to hold the turntable against movement in either direction.

The valve 494 is positioned as illustrated in Fig. 27 when the turntable is moved at a relatively slow rate to feed the kerf-cutter horizontally. However, there are conditions under which it is desirable to move the turntable at a more rapid rate, for example, when it is desired to adjust said turntable to a position while no cutting operation is being performed. For this purpose the valve element 500 of the valve structure 494 is also provided with additional transverse ports 534, 535 and 536 so that when the valve element 500 is turned 90° from its position shown in Fig. 27, these transverse ports 534, 535, and 536 will connect the pipes 495, 504 and 498, 499 and 503, 497 respectively. With said valve element 500 in this position and with valve 502 operated to supply pressure to the pipe 503, the fluid flow will be as follows: Fluid under pressure in pipe 503 will pass through port 536 and be carried by pipe 497 to the piston pin end of the cylinder of the right-hand motor 60, as viewed in Fig. 22. This fluid pressure will move said piston rearwardly. The fluid on the opposite side of said piston will be forced through pipe 498, through port 535 and pipe 499 to the rearward end of the left-hand motor 60. The fluid adjacent the piston pin end of said cylinder will flow through pipe 495 and port 534 to the exhaust pipe 504. Under these conditions the fluid supplied to pipe 503 is directed to only one of the motors 60 and is directed to the chamber of said motor which is of reduced size due to the presence of the piston pin therein.

Assuming that the pump 444 is operated to supply the same amount of liquid when the turntable is to be rotated freely by means of the fluid-pressure motor mechanism, a more rapid rotation of the turntable may be obtained when one of the motors 60 is operated than when both of them are operated at the same time. When the valve 494 is in the position shown in Fig. 27 and the valve 502 is operated, the motor 60 may be

actuated in opposite directions to rotate the turntable freely while the kerf-cutter is not operated. When the valve element **500** is turned 90° from the position shown in Fig. 27 and the valve **502** is operated to direct liquid through the pipe **497** into the upper end of the right-hand motor **60**, as viewed in Fig. 22, the predetermined rate of flow of liquid from the pump will effect the aforesaid rapid actuation of the single motor **60** so as to produce a more rapid rotation of the turntable. Such greater speed of rotation of the turntable is useful during transportation of the machine along curved portions of the mine track in a mine entry as hereinafter more fully explained.

In order to control the speed of movement of the entire machine along a mine track, the planetary gearing **333** of Fig. 3, shown in detail in Figs. 19, 20 and 21, is under the control of the hydraulic motors **397**, **397'** each of which is constructed as shown in section in Fig. 18. The hydraulic motors **397**, **397'** are connected by means of pipes **408'** and **408''** respectively to the interlocking valve structure **507** shown in sectional plan view in Fig. 23 and in elevation in Fig. 24. The supply pipe S and the exhaust pipe E' are connected as shown in Figs. 22 and 23. By means of the interlocking valve structure **507** neither motor **397** nor **397'** can be operated while the other is being operated, with the result that the brake connected to one motor will be released before the brake connected to the other motor is applied.

By referring to Fig. 23, it will be seen that when the plungers **509** and **510** are in their right-hand positions and the plungers **511** and **512** in their left-hand positions, the supply pipe S is connected to the chamber **513** which is cut off from the exhaust pipe E' and the pipe **408''** but communicates with the pipe **408'**. Consequently, when the parts are in the positions shown in Fig. 23 the motor **397** will receive hydraulic pressure to apply the brake connected thereto.

The actuating lever **508** is secured to a pivot pin **514** mounted in the support **515** for movement longitudinally of itself. The lever **508** is provided with a slot **516** which is adapted to fit over a transverse pin **517** at the rear end of the plunger **509** or a similar pin **518** at the rear end of the plunger **511**, but the slot **516** can fit over only one of the pins **517** or **518** at a time.

An intermediate vertical partition **519** shaped as shown in the sectional elevation in Fig. 26, acts as an abutment to prevent lateral adjustment of the lever **508** while the plunger **509** is in its forward position shown in Fig. 23. Not until the plunger **509** has been moved to its rearward position will the lever **508** clear the intermediate partition **519** so that the slot **516** in the lever **508** can be moved over the inner end of the pin **518** at the rear end of the plunger **511**. When the plunger **509** is moved rearwardly the pipe **408'** is connected to the exhaust pipe E', whereupon the spring **410** will be able to restore the motor **397** to its initial position and to release the brake connected to this motor. It should also be noted that continued movement of the valve **510** toward the left, as viewed in Fig. 23, will effect closure of the port between the chamber **513** and the pipe **408'**. That is to say, the left-hand position of the valve **510** will correspond to the left-hand position of the valve **512**, shown in Fig. 23, when the lever **508** is in position to clear the plate **519**. When both the valves **510** and **512** are in their left-hand positions, both of the brakes connected to the motors **397** and **397'** will be released, and during the interval when the lever **508** is being moved laterally across the rear end of the partition **519**, the pipe S, shown in Fig. 23 will be by-passed through the chamber **513** to the exhaust pipe E'.

After the lever **508** has been moved laterally to connect its slot **516** to the inner end of the pin **518**, the plunger **511** may be moved forward, whereupon the lever **508** will be locked against lateral movement by the partition **519**. Then the plunger **509** will be in its left-hand position and the plunger **511** in its right-hand position. The brake connected to the motor **397** will be released and the pressure supply pipe will be connected through the port **520** to the pipe **408''** to effect operation of the motor **397'** and the application of the brake which is connected thereto. When the plunger **401**, shown in Fig. 18, reaches the limit of its stroke, the liquid will be by-passed through the restricted port controlled by the set screw **521**, shown in Fig. 23. This restricted port connects the supply pipe S to the chamber **513** which is open to the exhaust at this time because the plunger **509** is in its left-hand position. Consequently, the maximum pressure which may be exerted on the brake connected to the motor **397'** may be limited by the control of this restricted port by means of the set-screw **521**. In a similar manner the maximum pressure exerted on the brake connected to the motor **397** may be regulated by the set screw **522**.

Such leakage as may occur in the recesses for the plunger packings **523**, **523** may be connected to the exhaust pipe E' as shown in Fig. 23. The outer ends of the pins **517** and **518** may slide along slots **524**, **524** in the support **515**. Screw plugs **525**, **525** may be located in the right-hand end of the valve casing **526** in alinement with the valves **510** and **512**. It will be seen that when the plunger **511** is moved to its left-hand position the pipe **408''** is connected directly to the exhaust chamber **527**, and therefore the brake connected to the motor **397'** will be released before the brake connected to the motor **397** can again be applied, and vice versa.

By referring to Fig. 34, it will be seen that a shearing kerf, as indicated by the dotted lines **528**, may be cut from a curved mine track **324'** into a working face **529** spaced from the straight portion **324** of the mine track and parallel thereto. The cutting of such kerfs is particularly useful in the mining of break-throughs or openings through pillars in coal mines. The feeding may be effected by traction along the curved track under the control of the planetary gearing **333** of Fig. 3. As shown diagrammatically in Fig. 34, the cutter bar **165** may be maintained in a true vertical plane during the feeding movement of the kerf-cutter along the curved track, and the feeding may be continuous during the sumping feeding movement. To maintain the cutter bar in such vertical plane during the sumping feeding movement, as indicated by the dotted lines **528** in Fig. 34, the vertical pivot **216** will move along a straight line indicated by the dotted line **530** so that when the kerf-cutter reaches its full depth of cut such vertical pivot will occupy approximately the position indicated at **216'** in Fig. 34. The turntable pivot **50**, however, will retain its midway position between the track rails and will therefore move along an arc approximately parallel to the rails, to occupy the point indicated at **50'** in Fig. 34, when the pivot **216** occupies the position indicated at **216'**.

While a shearing cut may be made from a curved mine track by sumping feeding increments under control of the planetary gearing **333**, the valve **487** connected to the motor **233**, and the valve **502** connected to the turntable motors **60, 60**, it is preferred to effect the shearing sumping cut from a curved mine track by one continuous feeding movement. This may be effected by first locking the cutter bar in its full line position shown in Fig. 34 and then after the outer end of the cutter bar is projected a short distance into the mine vein, permitting the cutter bar to float not only on the pivot **216** but also on the pivot **50** so that the pivot **216** will automatically move along the straight line **530** (Fig. 34) while the cutter bar is sumped into the coal vein in a true vertical plane. For this purpose a valve **531** is located in a branch pipe connecting the pipes **488** and **489**, as shown in Fig. 22, and a valve **532** is located in a branch pipe **533** connecting the pipes **503** and **504**.

By permitting the valve **487** to remain in closed position and opening the valve **531**, the ends of the cylinder **233** will be connected by the pipes **488** and **489**, and therefore the liquid may freely circulate to permit the cutter bar to float laterally on the pivot **216**, as illustrated in Fig. **34**.

When the valve **502** is permitted to remain in closed position and the valve **500** is turned 90 degrees from its position shown in Fig. 27, and valve **532** is opened, the pistons in the motors **60, 60** will be free to move in opposite directions, and therefore the turntable will be permitted to float laterally on the turntable axis **50**. As the machine is fed along the curved portion **324'** of the mine track the pivot point **216** will be permitted to move along a straight line **530** to the point **216'** by reason of the floating of the turntable on the axis **50** in an anti-clockwise direction. The circulation to and from the cylinders of the motors **60, 60** will be in the direction of the arrows **537**, shown in Fig. 22. The circuit may be traced from that end of the right-hand motor **60** in advance of the piston therein through the pipe **497**, port **536**, pipe **503**, branch pipe **533**, valve **532**, pipe **504**, port **534**, pipe **495**, into the forward end of the cylinder of the left-hand motor **60**. The liquid back of the piston in the left-hand motor **60** will flow through the pipe **499** into the port **535** and pipe **498** to the cylinder of the right-hand motor back of the piston therein.

After the sumping feeding movement from a curved mine track has been made, to cut the kerf indicated by the dotted lines **528** in Fig. 34, the valves **531** and **532** may be closed to lock the cutter bar against floating laterally either on the pivot **216** or the pivot **50**, and then by operating the valve **490** the hydraulic motors **237** and **238** may be operated to swing the cutter bar downwardly to cut a kerf in a vertical plane on the axis **162** (Fig. 6) which is permanently at right angles to the plane of the cuter bar **165**. After the arcuate kerf has been cut to the desired extent so that the outer lower end of the kerf-cutter is approximately in the plane of the mine bottom, the valves **531** and **532** are again opened and the valve **500** adjusted to permit floating of the cutter bar laterally on the pivots **216** and **50**, whereupon under the control of the planetary gearing **333** and the controller **352** for the propelling motor P of Fig. 3, the withdrawal cut is made in the same vertical plane as that in which the sumping feeding cut was made near the roof. It will thus be seen that a parallel ribbed shearing kerf may be made in a vertical plane from a curved mine track, with the ribs of the kerf in the planes of the roof and the mine bottom respectively, and both the sumping and withdrawal rectilinear feeding movements of the kerf-cutter may be made without interrupting the traction feeding movement of the entire machine along the curved mine track.

A review of the constructional and practical advantages of the universally flexible kerf-cutting machine shown in the accompanying drawings, will make it evident that notwithstanding the many adjustments that may be made for operation of the kerf-cutter under many different conditions, the dimensions of the machine may be reduced to a minimum to enable the machine to operate in mines where the available space is very limited. This is particularly true as to the overall height of the machine which enables it to operate in relatively low roof mine entries and rooms and to self-propel itself at a transportation speed along low roof mine entries. For instance, the plane of the roof may be as low as thirty inches from the level of the mine track rails when the truck wheels are ten inches in diameter. During transportation along curved mine tracks in narrow entries the supporting unit **325** may be rotated rapidly on the turntable axis **50** by means of one of the hydraulic motors **60, 60** (Fig. 17). At the same time, the cutter bar may be swung rapidly on its pivot **162** by means of the hydraulic motors **237, 238** (Fig. 4). By referring to Fig. 33, which shows the arrangement of parts for transportation, it will become evident that notwithstanding the elongation of the entire mining machine it is provided with two flexible joints on vertical axes, one axis being located forwardly of the platform **327** between the axles of the truck and the other axis being located between the rear end of the cutter bar **165** and the forward end of the supporting unit **325**.

It should be particularly noted that when the kerf-cutter is given a swinging feeding movement on the turntable axis **50** by means of the hydraulic motors **60, 60** (Fig. 17) or a swinging feeding movement on the cutter bar pivot **162** by means of the hydraulic motors **237, 238** (Fig. 4), the feeding pressure may be limited by the setting of the relief valve **459** (Fig. 22). The driving of the chain cutter is effected by the electric motor M under the control of the controller **351** (Fig. 3) entirely independently of the feed of the cutter bar. This is true not only with respect to swinging or arcuate feed of the kerf-cutter but also with respect to rectilinear feed thereof along the mine track by means of the propelling motor P under the control of the planetary gearing **333** (Fig. 3).

Since the arcuate feeding pressure is limited by the relief valve **459** (Fig. 22), the rate of feed will automatically accommodate itself to the hardness of the material to be cut. When the material is relatively soft the feed will be more rapid than when the material is relatively hard, even though the chain cutter is continuously driven at the same rate of speed. During transportation (Fig. 33) along curved portions of a mine track in narrow entries in a mine, the swinging of the supporting unit relatively to the truck and the swinging of the cutter bar on its pivot, may be effected under the control of the operator, at a relatively rapid rate of speed since

the chain cutter is then free from any resistance.

Since all of the controlling levers and valves are located at the rear end of the machine, the operator may at all times during kerf-cutting proceed with safety and confidence with the efficient and economic operation of the machine. That is to say, since the operator is always away from possible danger arising from roof falls, abnormal cutter-bar movements and so on which may occur at the working face, he can with safety increase the speed of operations of the cutting cycles.

Reverting to the rectilinear feeding movements independently of the driving of the cutter chain, under the control of the planetary gearing **333**, it should be noted by reference to the valve structure **507** shown in Figs. 22 and 23, that the pressure which may be exerted in the hydraulic motor **397** may be limited and regulated by the restricted port controlled by the needle set screw valve **522**. Therefore, when the rectilinear feeding pressure reaches a predetermined limit, the cylinder **387** (Fig. 19) will slip under the brake **391** to discontinue the traction feed. Consequently the rate of rectilinear feed will be automatically regulated in accordance with the hardness of material encountered by the kerf-cutter, while the chain cutter continues to be driven at its independently controlled speed.

In a similar manner the truck propelling mechanism for transportation purposes is controlled by the brake **391'** (Fig. 19) and the set screw needle valve **521**, so that such propelling mechanism will be protected if the machine meets an obstruction in the mine during transportation or if the brake **120** (Fig. 17) is left applied when an attempt is made to transport the machine.

Inasmuch as the kerf-cutter may be swung through an angle of more than 180° on the turntable axis **50** and through an angle of more than 180° on its pivotal axis **162**, and is mounted for adjustments on the axis **216** transversely of its plane and for inversion on the turnover head axis, the various connections between the hydraulic motors and the controlling valve may be made by means of flexible hose capable of withstanding the operating pressures, and coiled sufficiently to permit freedom of the various adjustments pointed out.

All of the different duties of the machine are capable of being performed as the result of simple and fool-proof manipulations and adjustments, and the latter may be performed quickly and efficiently with minimum skill and labor. Not only can the kerf-cutter be adjusted to cut in a horizontal plane beneath the level of the mine track rails or at the level of the mine bottom, or in any horizontal plane between the mine bottom and the level of the mine roof in mine rooms of various heights, or in vertical planes anywhere between the ribs of the mine entry or room within the reach of the machine, or in intersecting planes along rectilinear lines parallel to the mine track in longwall operations, but also in intersecting planes in a working face in advance of the mine track parallel to the axis of the turnover head when the latter is adjusted to a horizontal position parallel to the mine track. Furthermore, when the kerf-cutter is at the mine bottom with the parts arranged as shown in full lines in Fig. 31, the mine track may extend to the working face **328'** with the assurance that the rear end of the cutter bar may be disposed in a narrow entry at the mine bottom between the mine track and the adjacent rib **329'** preparatory to making the sumping rectilinear feeding movement indicated by the arrow **417**. In such event the withdrawal cut in the direction of the arrow **421** may be made after the pivot **162** has been adjusted for withdrawal movement along a line between the mine track and the rib **330'**.

While the tilting adjustments of the base frame **35** on the axes **37** and **39** (Fig. 7) are mainly for the purpose of placing the turntable **51**, **52** (Fig. 7) in a horizontal plane when the mine track is not level, such tilting adjustments may also be made to enable the machine to accommodate itself to any slight variations of the coal veins or dirt strata to be arcwall cut. While all individual adjustments of the kerf-cutter transversely of its plane are arcuate, nevertheless such adjustments may be combined to move the kerf-cutter to various elevations in parallelism from the floor to the roof or from one rib to the other. When cutting from a curved mine track as shown in Fig. 34, the kerf-cutter remains in the predetermined vertical plane at **528**, and the hand-operated valves **531**, **532** (Fig. 22) may be placed in partially opened position to restrict the floating effect on the axes **50** and **162** when it is desired to regulate the rectilinear sumping and withdrawal feeding movements.

Shearing operations, particularly in high roof mine chambers, may also be carried out with the assistance of the tilting mechanism connected to the supporting unit **325**. By referring to Figs. 29 and 30, it will be seen that when the supporting unit **325** is in its dotted line position the cutter bar may be adjusted to a vertical plane. Then while the supporting unit **325** is held rigidly connected to the base frame the whole machine may be moved along the mine track at a feeding speed to effect a rectilinear sumping cut in a vertical plane. The downward arcuate feeding movement may then be performed by means of the hydraulic motors **316**, **316** on the tiltable axis **304**. The withdrawal cut may be performed by reverse feeding movement effected by rearward movement of the mining machine along a mine track at a feeding speed. When the supporting unit **325** is in a position parallel to the mine track and the cutter bar is in a vertical plane parallel to the mine track such use of the tilting mechanism will result in the cutting of a shearing kerf in a true vertical plane. However, shearing kerfs may also be cut by use of the tilting mechanism when the parts are arranged as shown in full lines in Fig. 30 because the cutter bits extend laterally from the surfaces of the cutter bar sufficiently to afford ample clearance to prevent binding of the kerf-cutter in the coal vein.

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 front wheels and rear wheels adapted to travel on a mine track, mechanism for supporting the rear portion of said base frame

on the rear wheels for adjustment on transverse and longitudinal axes relative to the horizontal, an axle for the front wheels, separate axle housings serving as separate journal bearings for end portions of said axle, rearwardly extending arms from said axle housings each pivotally connected to said base frame, a link pivotally connected to said base frame and one of said axle housings, arms extending forwardly from said axle housing, independently operable motors between said base frame and said forwardly extending arms, and means for controlling said motors to effect tilting of said base frame relatively to the horizontal on said transverse and longitudinal axes.

2. In a mining machine, the combination with a wheeled frame adapted to move along a curved mine track, of a turntable mounted thereon for movement relatively thereto on a vertical axis, means providing for free swinging movement of said turntable, an elongated shearing kerf-cutter, mechanism for supporting said shearing kerf-cutter on said turntable for freely swinging pivotal movement relatively thereto on a vertical axis spaced horizontally from said turntable axis, means for driving said kerf-cutter, and means for moving the whole machine along such curved mine track at a feeding speed to sump the kerf-cutter into a working face in advance of the mine track while the aforesaid free relative movements on said spaced vertical axes enable the kerf-cutter to cut a kerf while maintained in a vertical shearing plane.

3. In a track mounted mining machine, the combination with a wheeled frame adapted to move along a curved mine track, of a turntable mounted thereon for movement relatively thereto on a vertical axis, an elongated chain kerf-cutter comprising a cutter bar, mechanism for pivotally connecting said cutter bar to said turntable for movement relatively thereto on rectangularly related axes one of which is at right angles to said cutter bar and the other of which is vertical and spaced horizontally from the vertical axis of said turntable, and mechanism for operating said kerf-cutter by first moving the whole machine along a curved mine track at a feeding speed to effect a rectilinear sumping shearing cut in a vertical plane, then feeding the kerf-cutter on such right angle axis in the same vertical plane and finally effecting a withdrawal rectilinear cut by rearward movement of the machine along such curved mine track, said turntable during the rectilinear sumping and withdrawal feeding movements being free to float on said spaced vertical axes relatively to said cutter bar moving in a vertical plane and relatively to said wheeled truck moving along the curved mine track.

4. A mining machine comprising a cutter bar, an endless chain cutter, a driving sprocket therefor, a support for the cutter bar, a driving shaft connected to said sprocket, an anti-friction bearing between said sprocket and a seat in said support, a cylindrical bearing extending from said support on one side of said anti-friction bearing, a plurality of spaced split rings in said cylindrical bearing and fitting in annular grooves in said shaft, a ring plate secured to said sprocket on the other side of said anti-friction bearing, and a spring-pressed ring between said support and the said ring plate, said interengaging ring and ring plate co-operating with said spaced split rings in said cylindrical bearing to completely enclose said anti-friction bearing and thereby prevent leakage of lubricant from said anti-friction bearing.

5. A mining machine comprising a support, an elongated chain kerf-cutter comprising a cutter bar, a drum journaled on said support and having end plates connected to said cutter bar to move bodily therewith, a transverse bearing journaled at its ends in said end plates, a sprocket driving shaft having its inner end portion journaled to said transverse bearing intermediate the ends of the latter, intermeshing bevel gears one keyed to said sprocket shaft and the other journaled on said transverse bearing, and means for driving said bevel gearing to transmit power to said kerf-cutter to drive the same.

6. In a low roof mining machine, the combination with a main supporting frame, of a supplemental frame mounting thereon for tilting adjustment relative thereto on spaced-apart transverse axes, a kerf-cutter carried on the forward end of said supplemental frame, the upper surface of the rear end of said supplemental frame being sloped downwardly towards the rear end of said supplemental frame so that when said kerf-cutter is in bottom cutting position the rear sloping surface will be horizontal and so that when the kerf-cutter is elevated for transportation the forward surface will be horizontal thereby adapting the machine for operation and transportation in low roof mine rooms and low roof mine entries, and means for operating said kerf-cutter when in its bottom cutting position.

7. In a mining machine, the combination with a main frame, of a supplemental frame mounted thereon for tilting movements on either of two spaced-apart horizontal transverse axes above said main frame, of an elongated chain kerf-cutter pivoted to said supplemental frame for movement relatively thereto on a horizontal transverse axis in advance of said main frame, mechanism for driving said chain kerf-cutter, and means for feeding said kerf-cutter in a vertical plane on any one of said horizontal transverse axes.

8. A mining machine comprising a cylindrical support, a drum journaled therein and comprising end enclosures, a chain kerf-cutter comprising a cutter bar, mechanism for supporting said cutter bar on said drum to move bodily therewith on the axis of said drum, power transmission mechanism extending through said drum to said kerf-cutter to drive the same, and an automatic sealing gate having the shape of a segment of a cylinder and mounted between said drum and said cylindrical support for limited sliding movement relatively thereto to maintain the gearing within said enclosure sealed from the atmosphere when said cutter bar is adjusted on the aforesaid axis.

9. In a mining machine, the combination with a main support, of a turntable mounted thereon for swinging movement about an upright axis, a supplemental support mounted on said turntable, a head mounted on said supplemental support for rotation relatively thereto on a longitudinally extending axis, a flat kerf-cutter mounted on said head for adjustment relative thereto on an axis extending transversely of said longitudinal axis and parallel to the plane of said kerf-cutter, means for rotating said head on said longitudinal axis, means for adjusting said kerf-cutter on said transverse axis, means for tilting said supplemental support successively on spaced-apart transverse axes relatively to said turntable to vary the inclination of said longitudinally extending axis relative to the horizontal and thereby adjust the elevation of the kerf-cutter, the

adjustments on the aforesaid axes enabling said kerf-cutter to be supported in parallelism at various elevations, and means for operating said kerf-cutter in the positions to which adjusted.

10. In a mining machine, the combination with a main support, of a turntable mounted thereon for swinging movement about an upright axis, a supplemental support mounted on said turntable, a turnover head mounted on said supplemental support for adjustment relative thereto on a longitudinally extending axis, mechanism for turning over said head on said longitudinally extending axis, an elongated flat chain kerf-cutter comprising a cutter bar, mechanism for supporting said cutter bar on said head for adjustment relative thereto on an axis extending transversely of said longitudinally extending axis and parallel with the plane of said kerf-cutter, means for tilting said supplemental support relatively to said turntable on spaced-apart transverse axes to vary the inclination of the longitudinally extending axis relative to the horizontal, means for adjusting the cutter bar transversely of its plane on said first-named transverse axis relative to said turnover head, the adjustments on the aforesaid axes being in cooperation to secure horizontal positions of the cutter bar in parallelism anywhere between the floor and roof of a mine chamber, and means for operating the kerf-cutter in any of its adjusted positions.

11. In a mining machine, the combination with a main support, of a supplemental support, kerf-cutting mechanism mounted on said supplemental support and comprising an elongated cutter bar with an endless chain cutter traveling around the periphery thereof, a pair of links one on one side of said supplemental support and the other on the other side thereof and each pivotally connected to said main support and to said supplemental support, a pair of fluid pressure motors each pivotally connected to said main support and to one of said links, a pivotal connection between said main support and said supplemental support, means for controlling said motors to effect tilting of said supplemental support on its pivotal connection to said main support to vary the elevation of the chain kerf-cutter for presentation edgewise to an upright coal face, and means for operating said kerf-cutter at adjusted elevation including feed thereof in its own plane to cut a plane kerf in such upright coal face.

12. In a mining machine, the combination with a main support, of a supplemental support pivotally connected at its rear end to said main support, kerf-cutting mechanism mounted on the forward end of said supplemental support, a U-shaped support pivoted at its rear end to said main support on a transverse axis, trunnion connections between the arms of said U-shaped support and the sides of said supplemental support intermediate the ends of the latter, a pair of fluid pressure motors pivotally connected to said main support and to said arms to effect adjustment in elevation of said kerf-cutting mechanism, and means for effecting operation of said kerf-cutting mechanism at its adjusted elevation.

13. In a mining machine, the combination with a supporting frame, of a bearing extending outwardly therefrom, a neck mounted on said bearing for rotation thereon on an outwardly extending axis, a reciprocating hydraulic motor mounted on said neck and movable bodily therewith, an elongated chain kerf-cutter comprising a cutter bar, a head supporting said cutter bar and mounted on said neck for rotary movement relatively thereto on an axis extending transversely of the plane of the cutter bar and spaced therefrom, a link structure connecting said hydraulic motor to said head, means for rotating said neck on said bearing to adjust the plane of operation of said kerf-cutter, and means for controlling said hydraulic motor to swing said cutter bar transversely of its plane on said transverse spaced axis.

14. In a mining machine, the combination with a portable frame including means to transport it, of a turntable mounted on said frame for oscillation relatively thereto on an upright axis, a supplemental frame carried by said turntable, cutting mechanism pivoted to said supplemental frame for pivotal movement about an upright axis and constructed and arranged to cut a vertical kerf, hydraulic piston motor mechanism for adjusting said cutting mechanism relative to said supplemental frame, additional hydraulic piston motor mechanism for adjusting said turntable relative to said first-named frame, and a hydraulic system for controlling said hydraulic motors including means permitting said cutting mechanism to float freely on its pivot and permitting said turntable to float freely on its pivot.

15. In a mining machine, the combination with a portable supporting frame including means to transport it, of a turntable pivoted to said frame for oscillation about an upright axis, a supplemental frame mounted on said turntable, cutting mechanism pivoted to said supplemental frame for movement relatively thereto on an upright axis while positioned to cut a vertical kerf, hydraulic piston motor mechanism for adjusting said cutting mechanism on its pivot relative to said supplemental frame, additional hydraulic piston motor mechanism for adjusting said turntable relative to said first-named frame, and a hydraulic system for controlling said hydraulic motors including means permitting said cutting mechanism to float freely on its pivot.

16. In a mining machine, the combination with a portable supporting frame including means to transport it, of a turntable carried by said frame and pivoted thereto for oscillation about an upright axis, a supplemental frame mounted on said turntable, cutting mechanism pivoted to said supplemental frame for pivotal movement about an upright axis while positioned to cut a vertical kerf, hydraulic piston motor mechanism for adjusting said cutting mechanism relative to said supplemental frame, additional hydraulic piston motor mechanism for adjusting said turntable relatively to said first-named frame, and a hydraulic system for controlling said hydraulic motors including means permitting said turntable to float freely on its pivot.

17. In a mining machine, the combination with a portable supporting frame including means to transport it, of a turntable mounted on said frame for oscillation relatively thereto on an upright axis, a supplemental frame mounted on said turntable, cutting mechanism pivoted to said supplemental frame for pivotal movement about an upright axis while positioned to cut a vertical kerf, means for adjusting said cutting mechanism relative to said supplemental frame and for adjusting said turntable relative to said first-named frame, said means being so constructed and arranged that operation thereof will permit free swinging movement of both said turntable and said cutting mechanism about their respective

upright axes when the machine is used for cutting a vertical kerf from a curved track.

18. A mining machine comprising kerf-cutting mechanism, a support having a cylindrical bearing, a drum journaled to the inner walls of said cylindrical bearing, mechanism for supporting said kerf-cutting mechanism on said drum for bodily movement therewith, and power-transmission means for said kerf-cutting mechanism and comprising a rock shaft journaled at its ends to said drum at the axis of rotation thereof, said shaft being concentric with said drum but spaced from the journal bearing surfaces between said drum and said cylindrical bearing.

19. A mining machine comprising a support, an elongated kerf-cutter, mechanism comprising an elongated neck on an elongated bearing for mounting said kerf-cutter on said support for bodily rotary adjustment relative thereto, a worm gear secured to the inner end of said neck to rotate therewith, annular thrust bearings between said support and the inner end of said neck and comprising an annular collar fitting into an annular groove to maintain connection between said neck and said bearing during operation of said kerf-cutter in a mine vein, a rotary hydraulic motor on said support, worm gear driving connections between said motor and said worm gear, driving connections between said motor and said worm gear to effect rotation of said neck on said bearing upon operation of said motor to vary the plane of said kerf-cutter, said worm gearing being self-locking to hold the kerf-cutter in adjusted position, and a casing for completely enclosing all of said worm gearing.

20. In a mining machine, the combination with a main frame, of a supplemental frame, a reciprocating hydraulic motor pivotally connected at its ends to said main frame and the rear end of said supplemental frame, means to control said motor to lock the same in adjusted position, a tilting support pivoted to said main frame and to said supplemental frame forwardly of the rear end thereof, a kerf-cutter mounted on the forward end of said supplemental frame, means for driving said kerf-cutter, and hydraulic motor mechanism connected between said main frame and said tilting support to effect tilting of said supplemental frame on its rear pivot at said first-named hydraulic motor to secure variation in elevation of said kerf-cutter along an upright face of a mine vein.

21. In a mining machine, the combination with a base frame, of a turntable mounted thereon for rotation relatively thereto on an upright axis, hydraulic motor mechanism for effecting adjustment of said turntable on said upright axis, a supplemental frame mounted on said turntable for adjustment relative thereto on spaced-apart transverse axes, hydraulic motor operated mechanism for adjusting said supplemental frame relative to said base frame on said spaced-apart transverse axes, a kerf-cutter, mechanism for supporting said kerf-cutter on said supplemental frame for adjustment relative thereto on angularly related axes, hydraulic motor operated mechanism for adjusting said kerf-cutter on such angularly related axes, motor operated mechanism for operating said kerf-cutter in the position to which adjusted, and a hydraulic controlling system for said hydraulic motors to effect locking thereof in adjusted positions to hold the kerf-cutter in the position to which adjusted and to limit the hydraulic pressure in the making of each of the aforesaid adjustments.

22. A mining machine comprising a cutting tool and motor operated power-transmission mechanism connected to said cutting tool to drive the same and comprising a motor, a pinion on the shaft of said motor, a countershaft at right angles to said motor shaft, bevel gears at the ends of said countershaft, one of said gears meshing with said pinion, an inclined driven shaft making an acute angle with said countershaft, and a bevel gear at one end of said inclined shaft in position to mesh with the other bevel gear on said countershaft the axes of all of said shafts lying in a single plane.

23. In a mining machine, the combination with a main support, of a kerf-cutter, a kerf-cutter support, link mechanism pivotally attached at one end to said main support and at the other end to said kerf-cutter support, and means connected to said link mechanism at a position between the pivotal connections and to said main support for swinging said link mechanism about one of its pivots.

24. In a mining machine, the combination with a main frame, of a supplementary frame, a flat cutter mechanism, a turn-over head, means attaching said cutter mechanism to said head for adjustment about two axes, one of which is parallel with the plane of said cutter mechanism and the other perpendicular thereto, an elongated fixed neck permanently sloping downwardly relative to the plane of said supplementary frame, a head supporting bearing telescoping said neck and having engagement therewith at spaced areas, means for rotating said head on the axis of said neck, and drive means for said cutter mechanism.

25. In a mining machine, the combination with a main support, of a supplemental support extending over said main support and pivotally attached thereto at the rear end of said supplemental support, kerf-cutting mechanism mounted on said supplemental support, link mechanism pivotally connecting said supports, mechanism connected between said main support and said link mechanism for tilting said supplemental support to vary the elevation of said kerf-cutting mechanism, and means for operating said kerf-cutting mechanism in adjusted position to cut a plane kerf.

26. In a mining machine, the combination with a main frame, of a normally horizontally disposed supplemental frame mounted thereon, an elongated cylindrical non-rotatable bearing rigidly connected to said supplemental frame and sloping downwardly relative to the plane thereof, a cutter head having an elongated neck journaled on said elongated cylinder, kerf-cutting mechanism mounted on said head, means for rotating said neck thereby adjusting said head and kerf-cutter, and drive means for said kerf-cutter including a motor on said supplemental frame and connections therefrom to said kerf-cutter including a shaft extending through said elongated cylindrical bearing.

27. In a mining machine, the combination with a track mounted truck having forward and rearward wheel means, of a turntable mounted on said truck for pivotal movement about an upright axis between said forward and said rearward wheel means, a supplemental frame mounted on said turntable for pivotal movement about an axis to the rear of said upright axis, said supplemental frame having a rigidly attached longitudinally extending neck which permanently slopes downwardly with respect to the plane of said supplemental frame, a head journaled on

said neck for rotary movement along the axis thereof, a flat kerf-cutter pivotally mounted on said head on an axis parallel with the plane of said kerf-cutter and at right angles to the longitudinal axis thereof, and power means operable from a single station for swinging said turntable, pivoting said supplemental frame, turning over said head, and pivoting said cutter bar relative to said head, whereby said cutter bar may be adjusted by an operator at a central control station to any position between its extreme positions and maintain substantially horizontal and there operated to cut a horizontal kerf without the operator leaving his control station.

28. In a mining machine, the combination with a main frame, of a supplemental frame mounted thereon for pivotal movement on a horizontal axis at the rear end of said supplemental frame, a kerf-cutter carried by said supplemental frame, arms on said supplemental frame, one on each side thereon, extending forwardly from said horizontal axis and attached at their forward ends to said supplemental frame, hydraulic piston motors pivotally attached to said arms and to said main frame and positioned between the arms and supplemental frame, and a control system for said piston motors operative to adjust said supplemental frame about said horizontal axis.

29. In a truck mounted mining machine, the combination with a truck adapted to travel on a mine track, of kerf-cutting apparatus on said truck, a motor for driving said truck, a hydraulic fluid pressure system on said truck, a clutch between said motor and a driving wheel of said truck, and means for actuating said clutch and said kerf-cutting apparatus, said means including said pressure system.

30. In a mining machine, the combination with a frame, of a kerf cutting mechanism on said frame, a driving motor on said frame, traction means for moving said mining machine, and mechanism including a hydraulic control system having control valves for adjusting said kerf cutting mechanism relative to said frame and for effecting a drive between said motor and said traction means.

31. In a mining machine, the combination with a frame, of an electric motor on said frame, a hydraulic control system on said frame including a pump driven from said electric motor, kerf cutting mechanism mounted on said frame, hydraulic motor means for adjusting said kerf cutting mechanism, control means in said hydraulic system for operating said hydraulic motor means at high and low speeds by operating them selectively in series and in parallel, respectively, traction means for said mining machine, and mechanism including said hydraulic system for driving said traction means from said electric motor at high and low speeds.

32. In a truck mounted kerf-cutting apparatus, the combination with a kerf-cutting machine comprising a truck adapted to travel in a mine, of apparatus carried by said machine for performing a mining operation while the machine is stationary, a hydraulic fluid pressure system on said truck driven from said motor and cooperating with said apparatus to perform said mining operation as aforesaid, driving means between said motor and a driving member of said truck adapted to effect a driving connection between said motor and said member or to disengage said motor from said member, and actuating means for said driving means, said actuating means including said pressure system, whereby said pressure system has utility for moving said apparatus within said mine and during the performance of a mining operation while said apparatus is stationary.

33. In a truck mounted mining machine, the combination with a truck adapted to travel in a mine, of kerf-cutting apparatus on said truck, a motor for driving said truck, a fluid pressure system on said truck, a clutch between said motor and a driving member of said truck, and means for actuating said clutch and said kerf-cutting apparatus, said means including said pressure system.

34. In a truck mounted kerf-cutting apparatus, the combination with a kerf-cutting machine comprising a truck adapted to travel in a mine, of apparatus carried by said machine for performing a mining operation while the machine is stationary, a fluid pressure system on said truck driven from said motor and cooperating with said apparatus to perform said mining operation as aforesaid, driving means between said motor and a driving member of said truck adapted to effect a driving connection between said motor and said member or to disengage said motor from said member, and actuating means for said driving means, said actuating means including said pressure system, whereby said pressure system has utility for moving said apparatus within said mine and during the performance of a mining operation while said apparatus is stationary.

35. In a truck mounted mining apparatus, the combination with a kerf-cutting machine comprising a truck adapted to travel in a mine, of apparatus carried by said machine for performing a mining operation while the mining machine is stationary, a driving motor carried by said truck, a fluid pressure system on said truck, and mechanism constructed and arranged to employ said fluid pressure system to effect a driving connection between said motor and a driving member of said truck to propel it through a mine and to cooperate with said apparatus to perform a mining operation when the machine is stationary, as aforesaid.

36. In a mining machine, the combination with a truck adapted to travel in a mine, a kerf-cutter carried on said truck and adapted to be sumped into a mine face to cut a kerf, driving means for said kerf-cutter, and means for driving a member of said truck to move said truck at a sumping speed while said kerf-cutter cuts a kerf, said means including a fluid pressure system.

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