

Nov. 25, 1941.

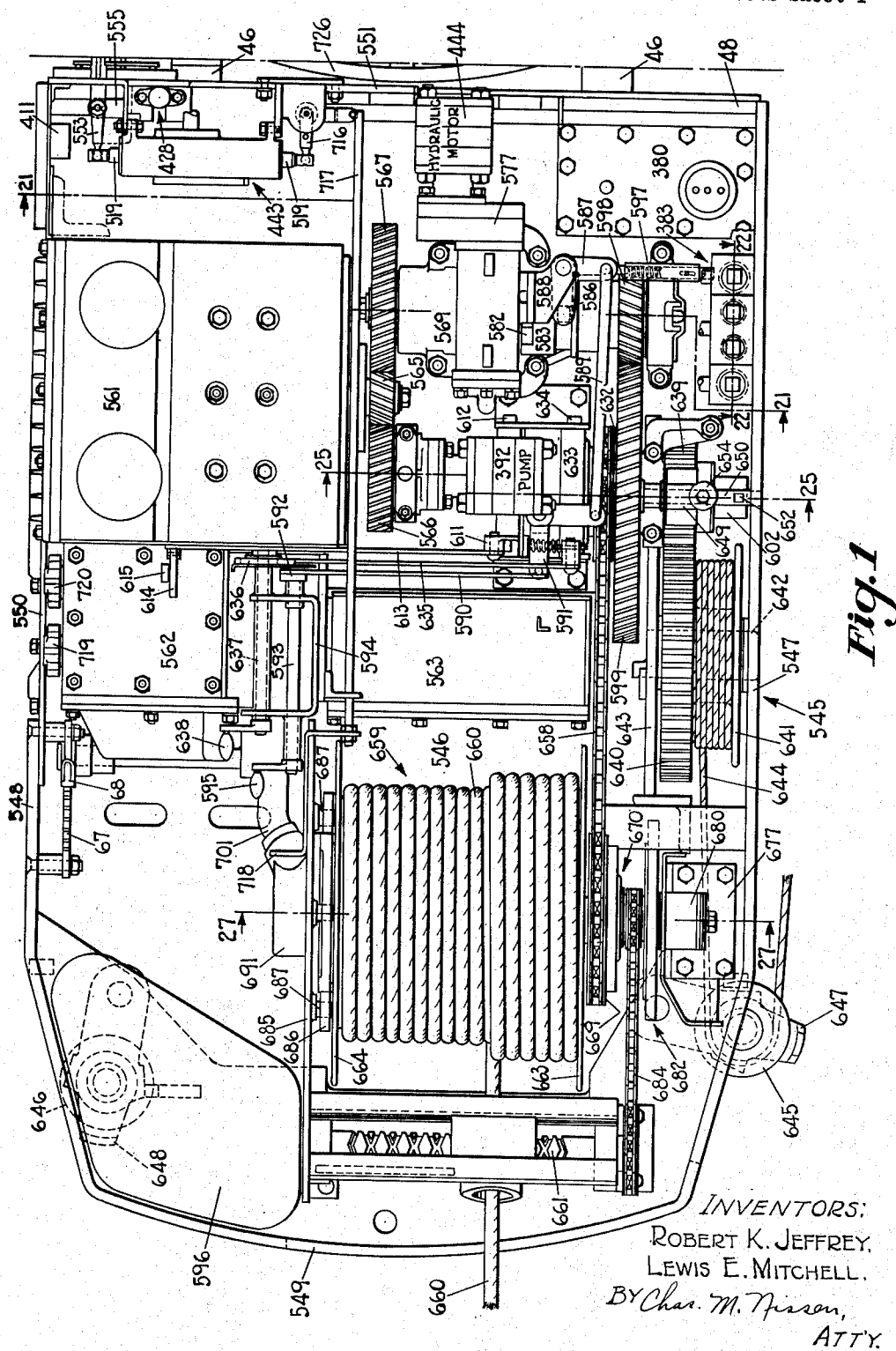
R. K. JEFFREY ET AL

2,263,779

MINING MACHINE

Filed May 6, 1938

18 Sheets-Sheet 1



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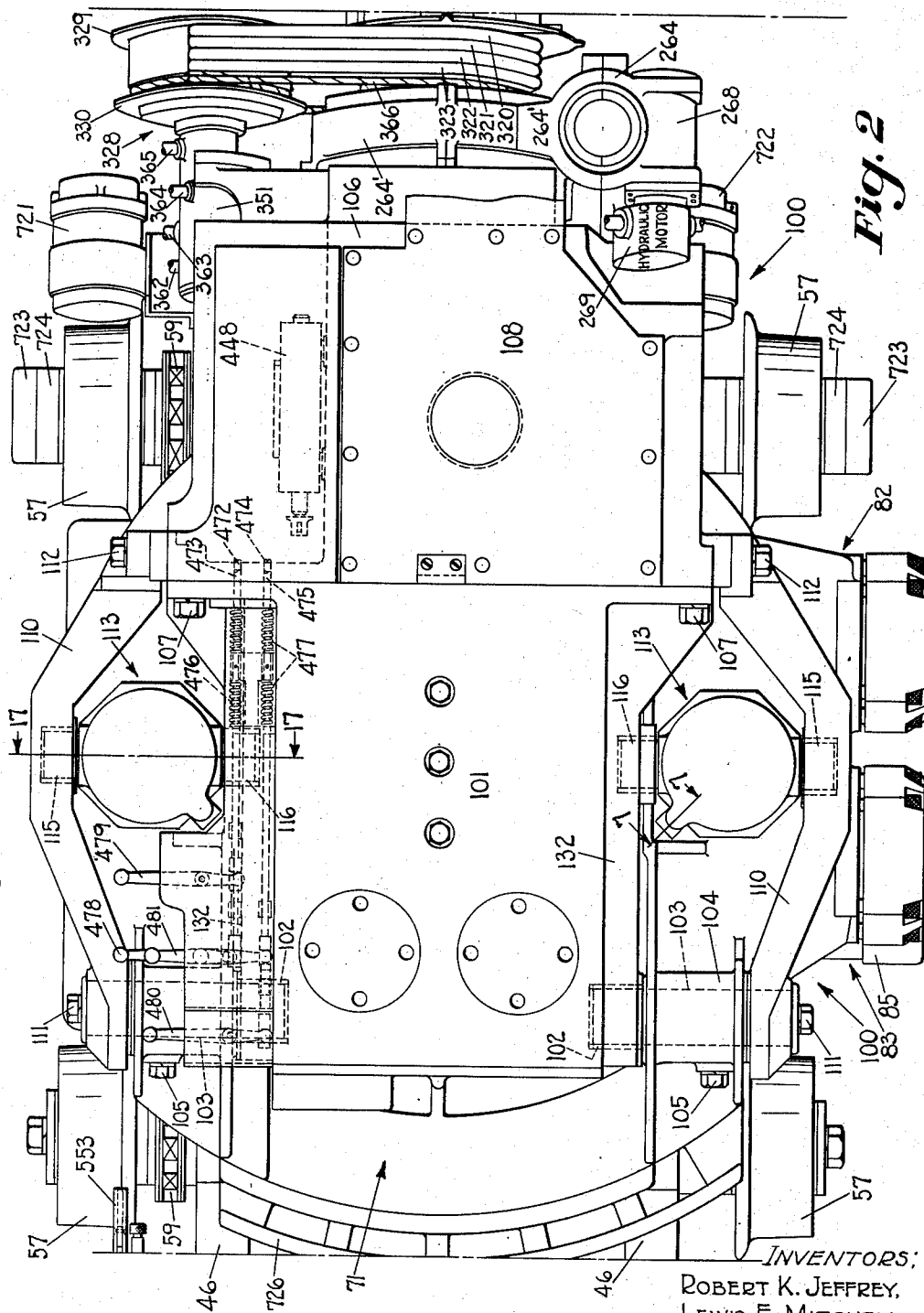
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MINING MACHINE

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18 Sheets-Sheet 2



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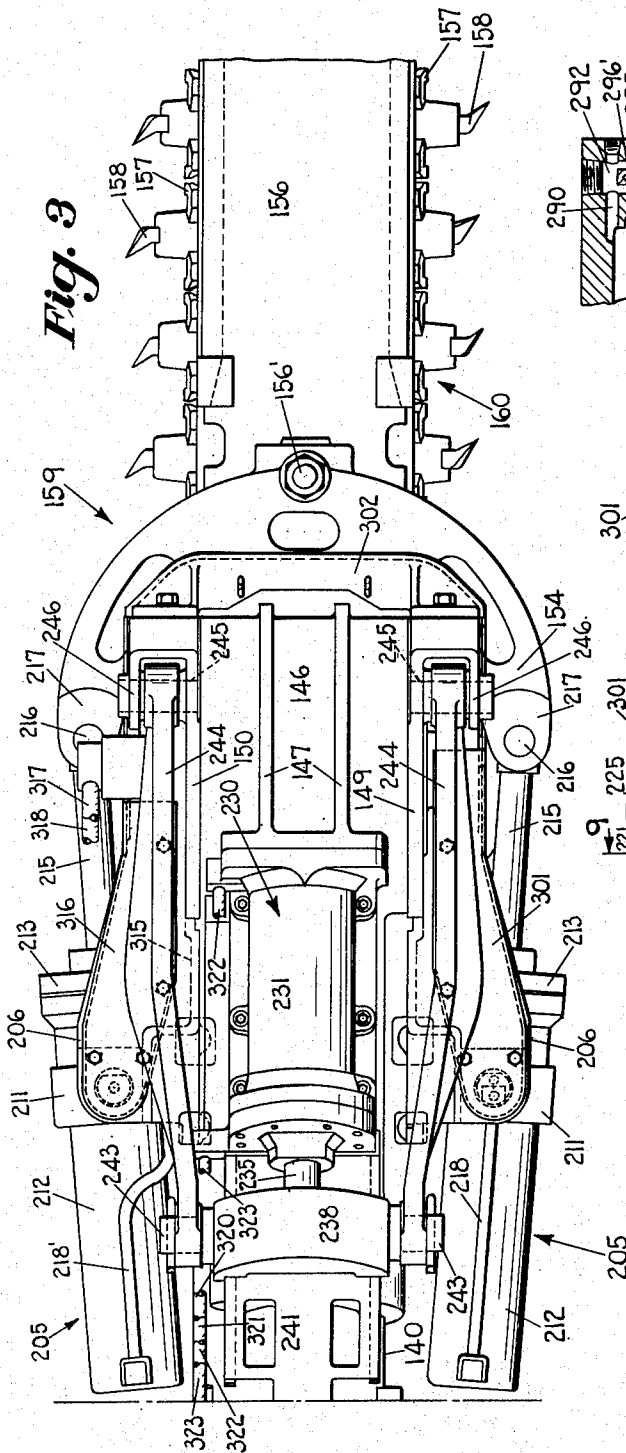


Fig. 3

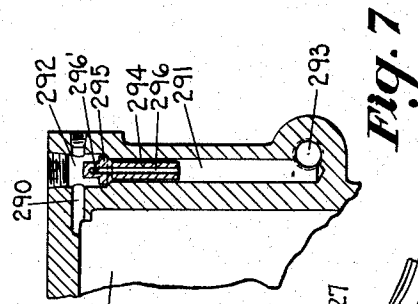


Fig. 7

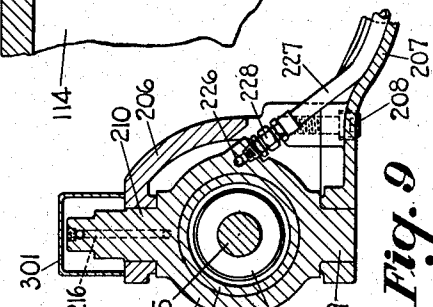


Fig. 9

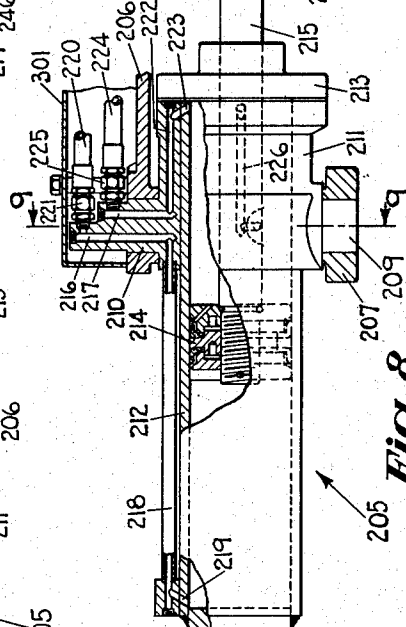


Fig. 8

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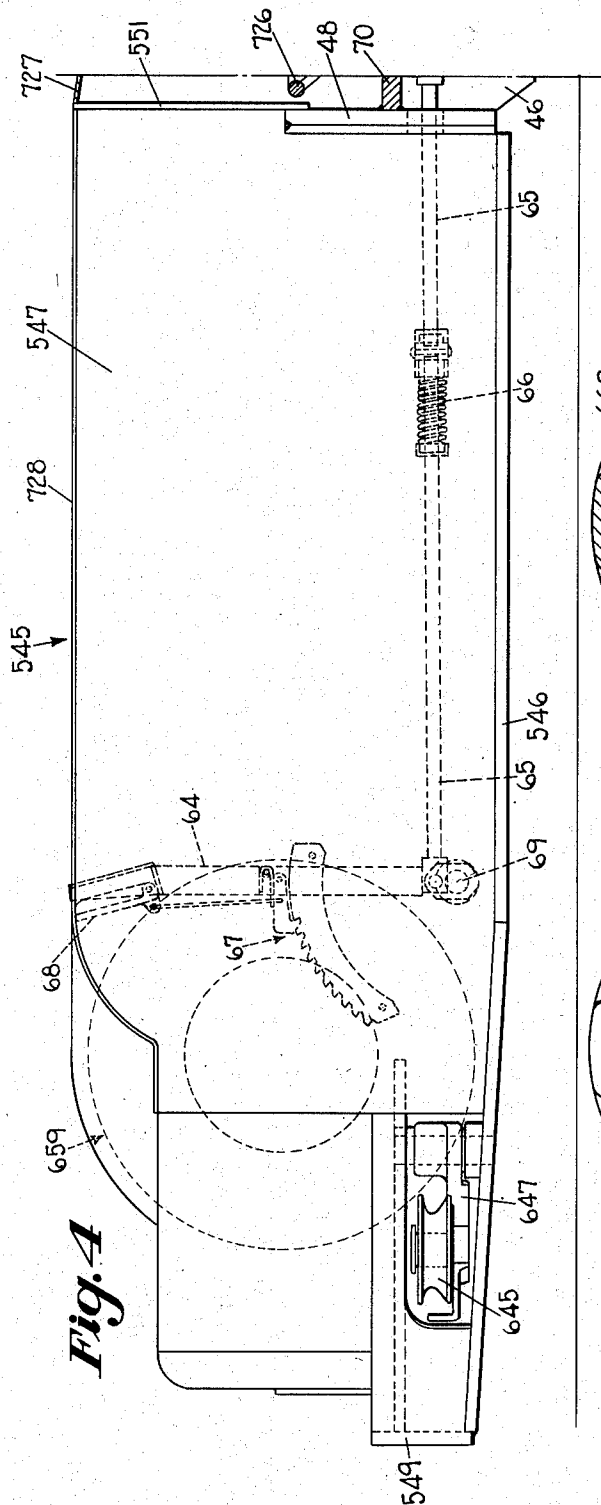


Fig. 4

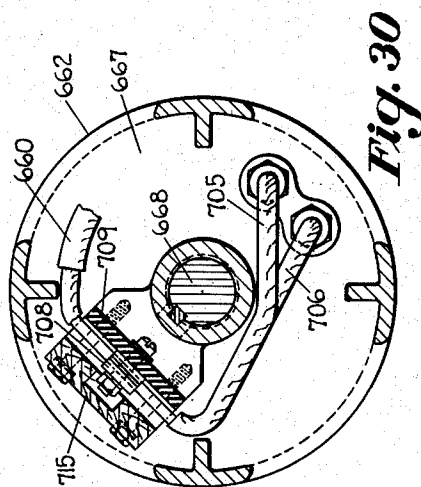


Fig. 30

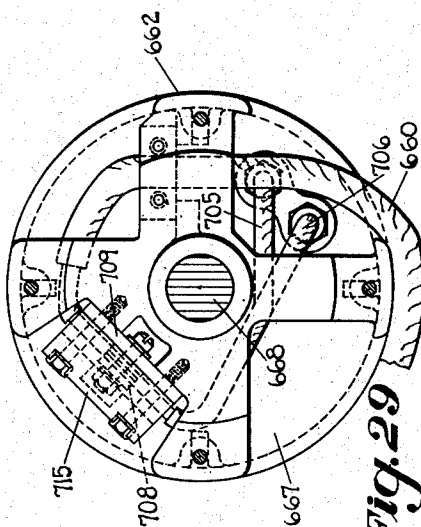


Fig. 29

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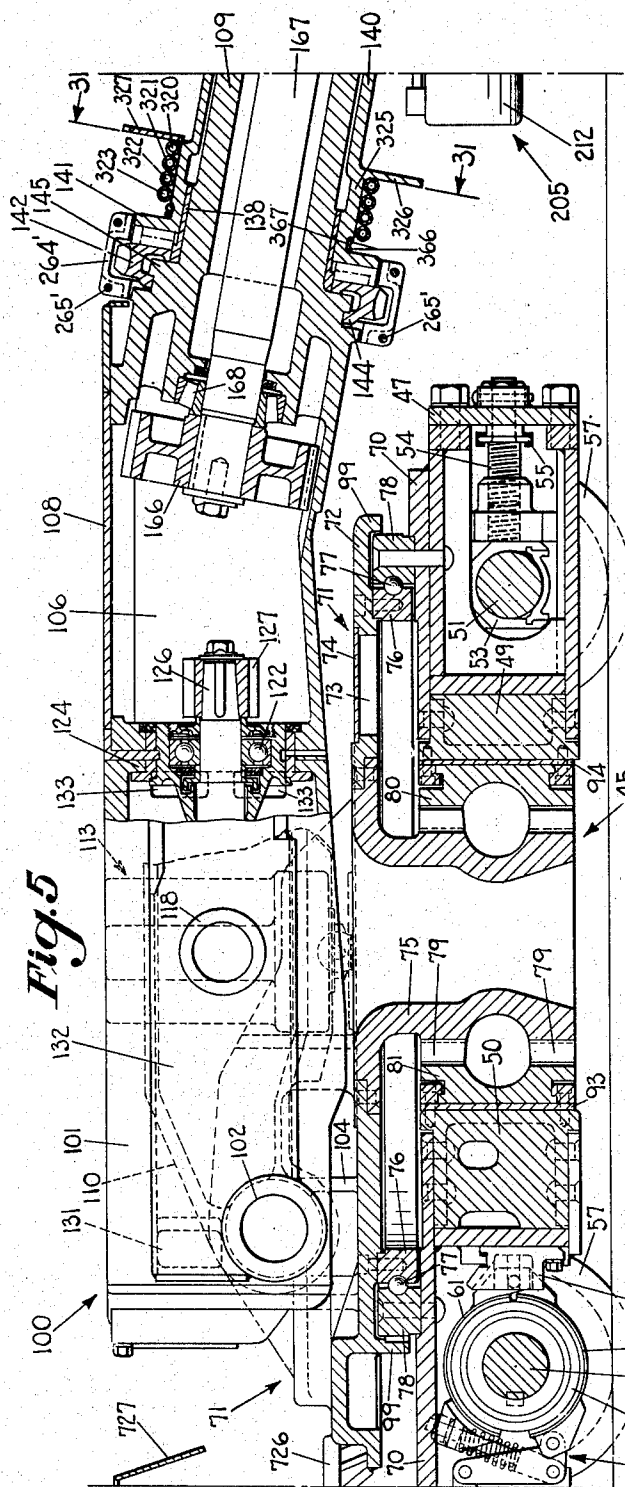


Fig. 5

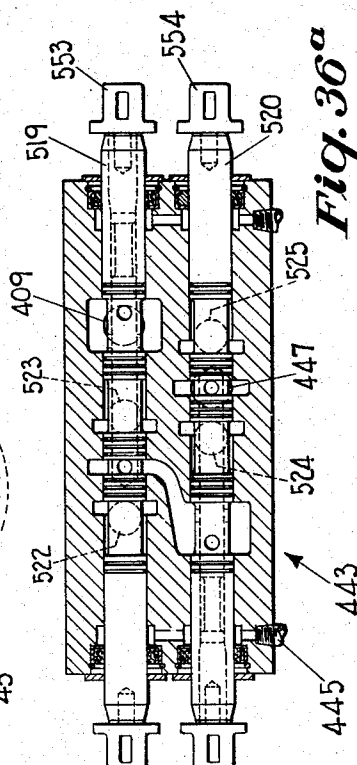
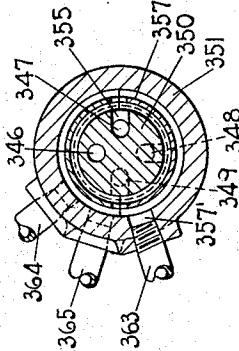


Fig. 36a



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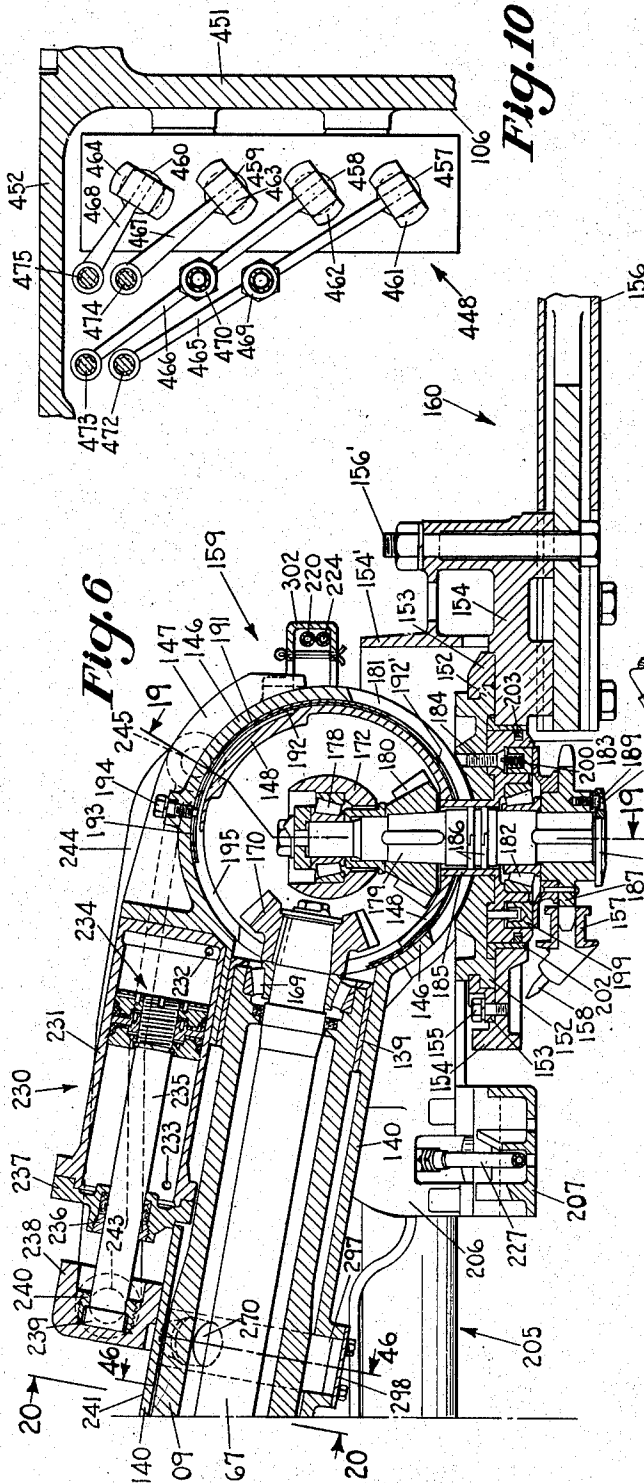


Fig. 6

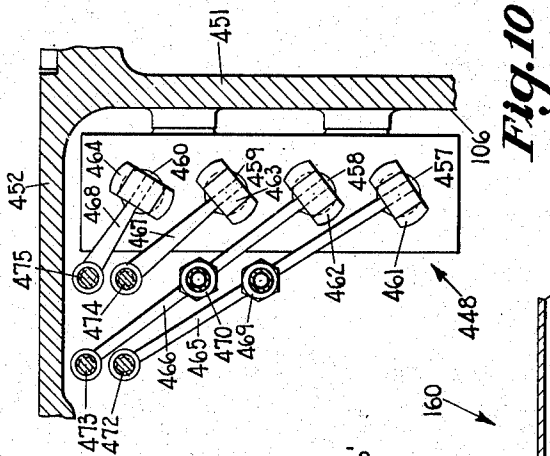


Fig. 10

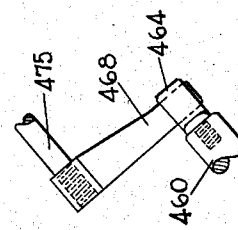


Fig. 12

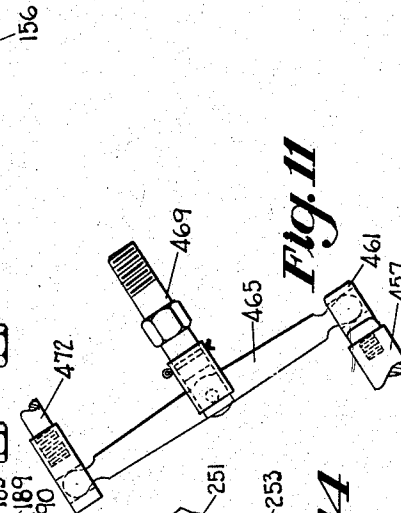
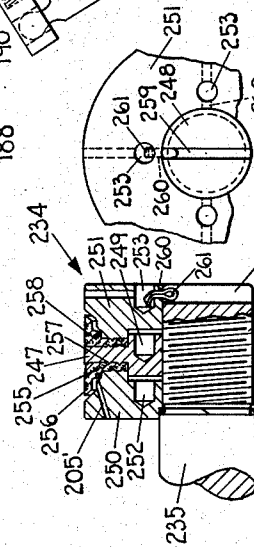


Fig. 11



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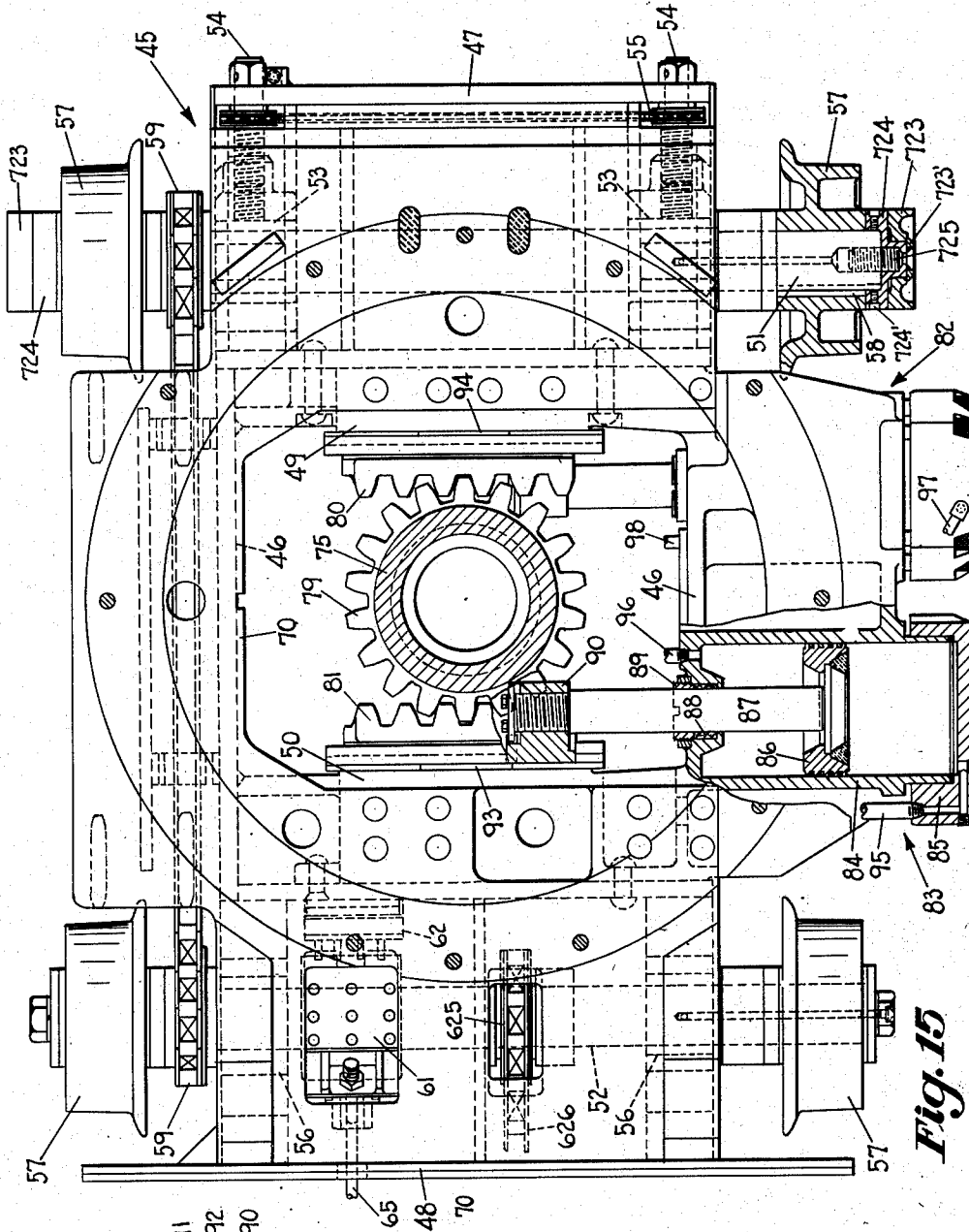


Fig. 15

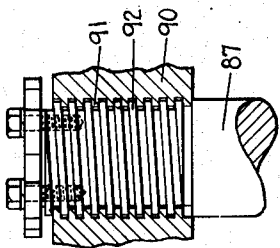


Fig. 16

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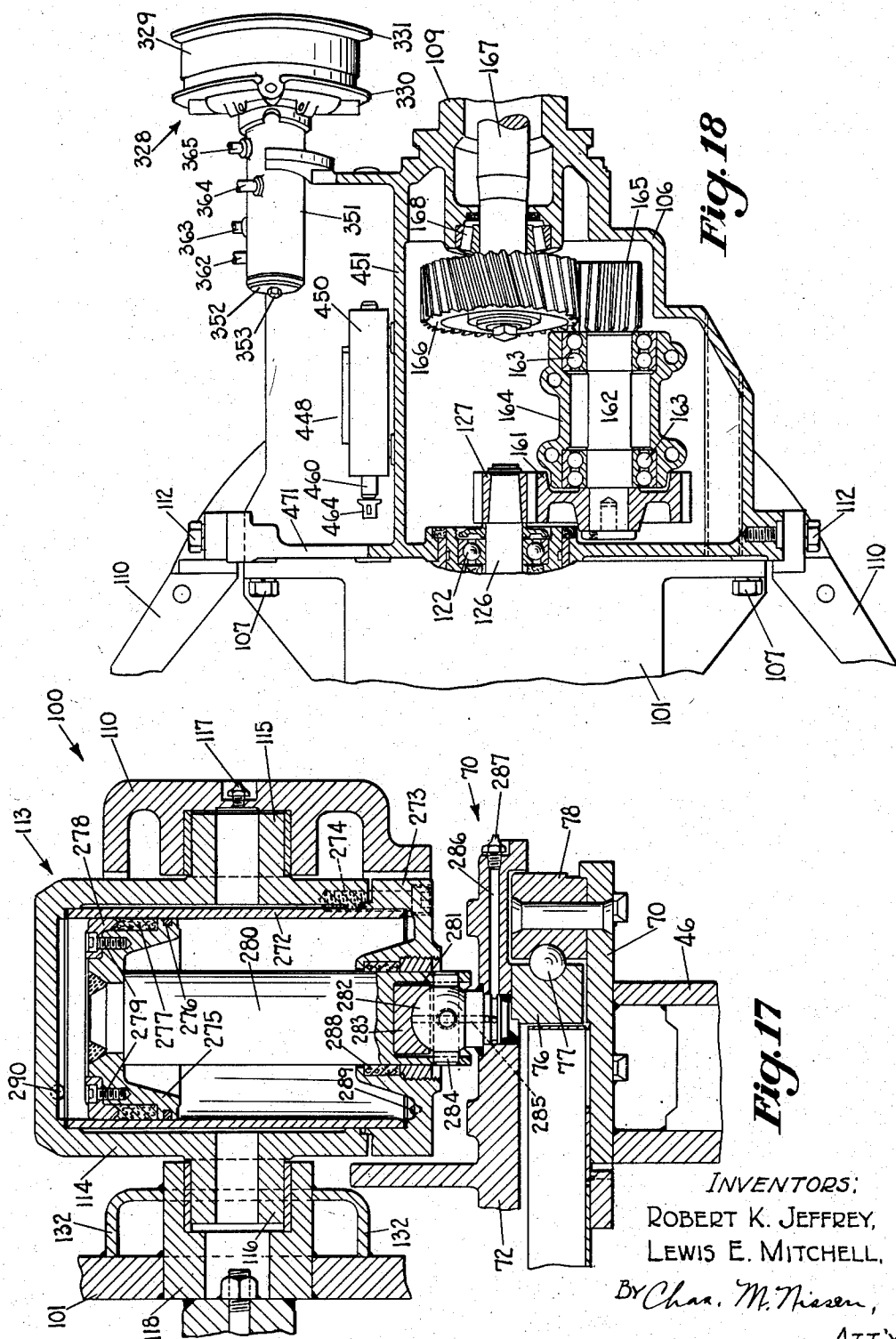
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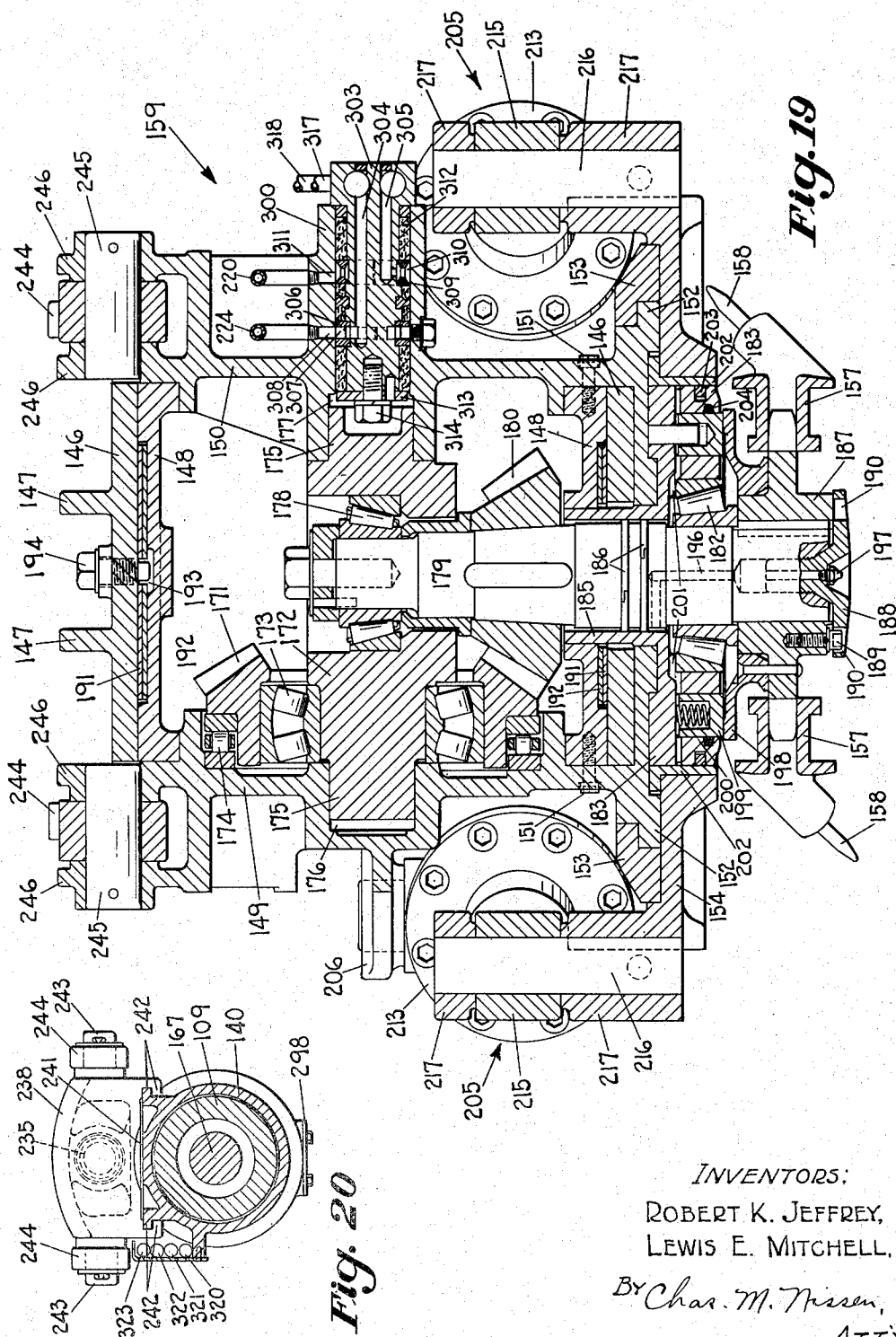
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Fig. 21

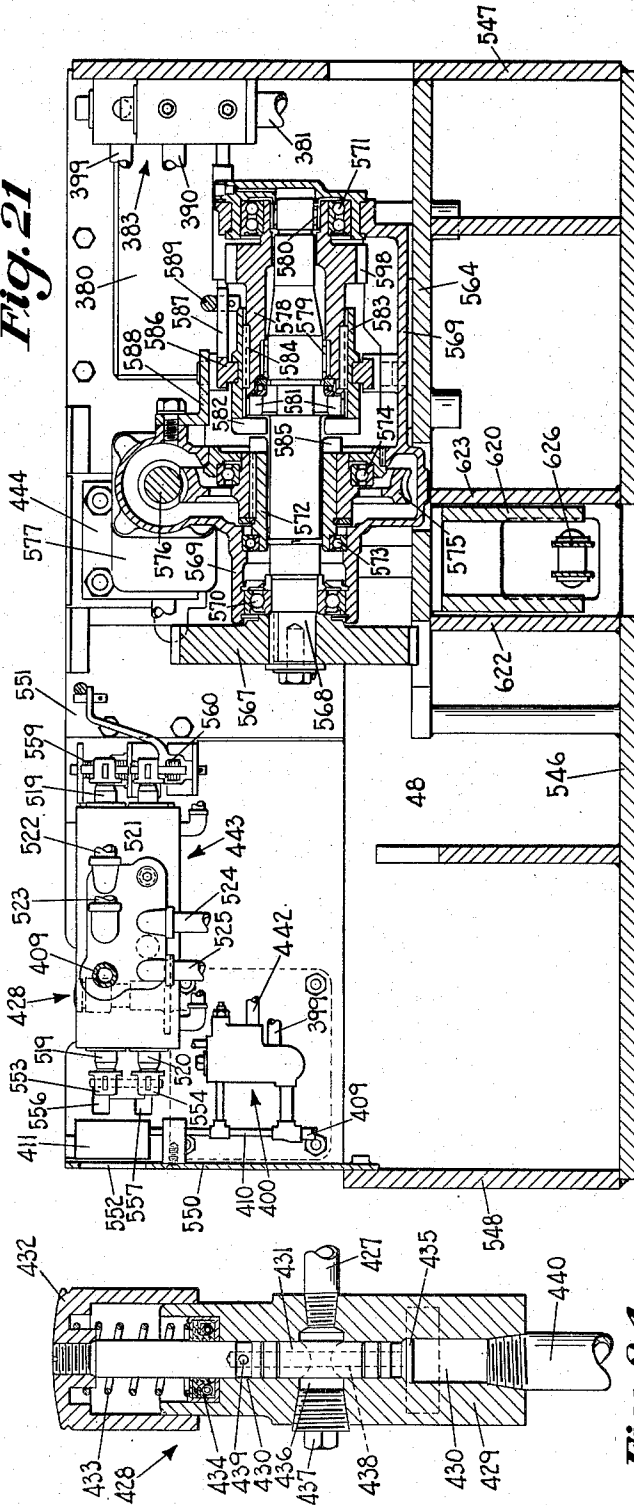


Fig. 24

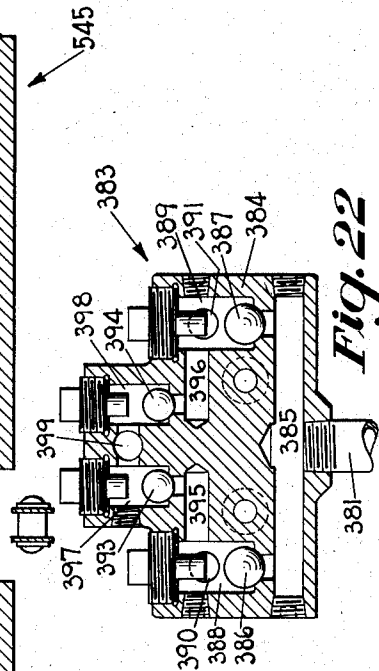


Fig. 22

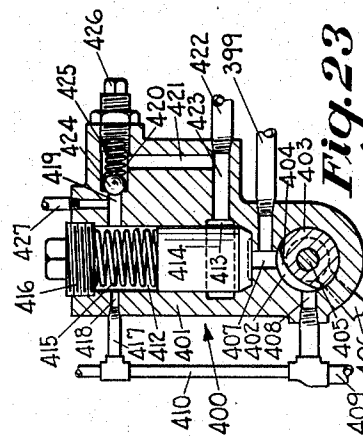


Fig. 23

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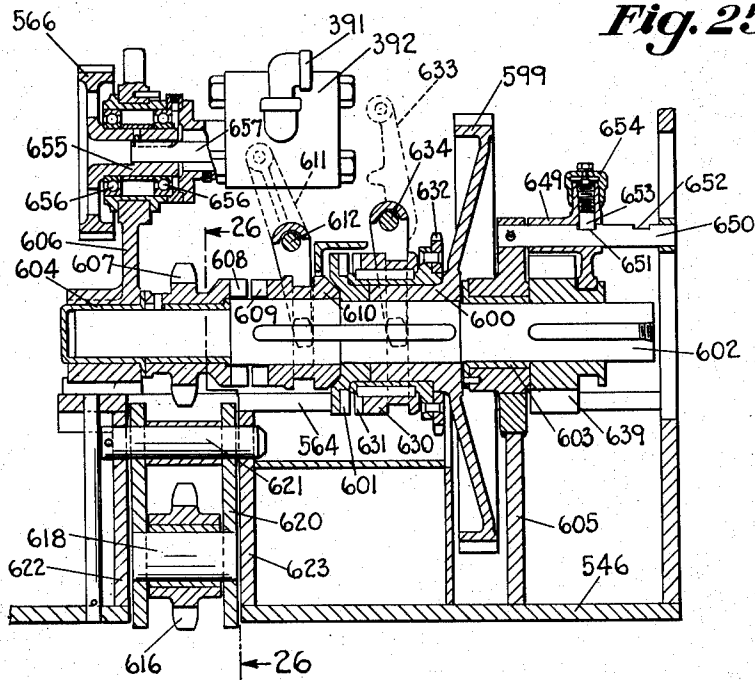


Fig. 25

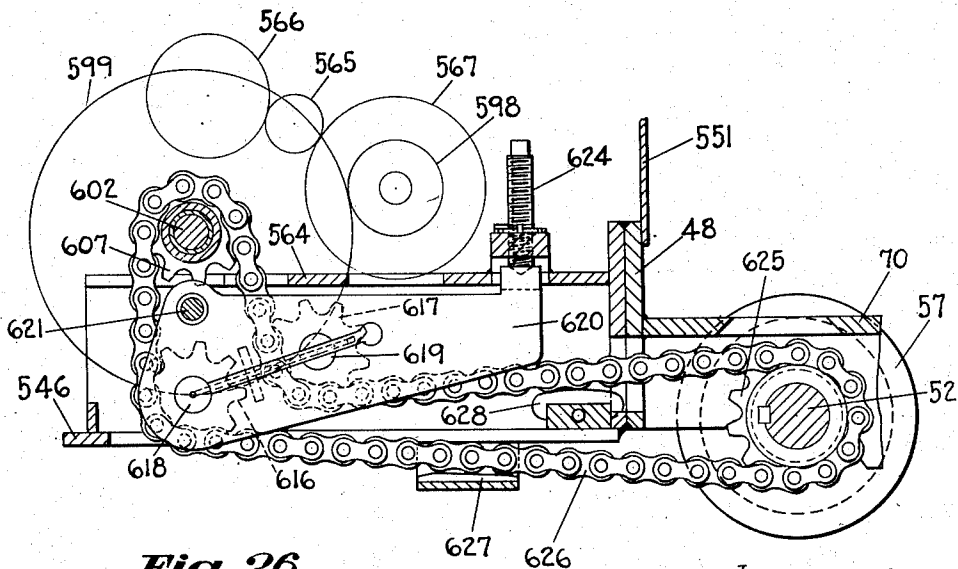


Fig. 26

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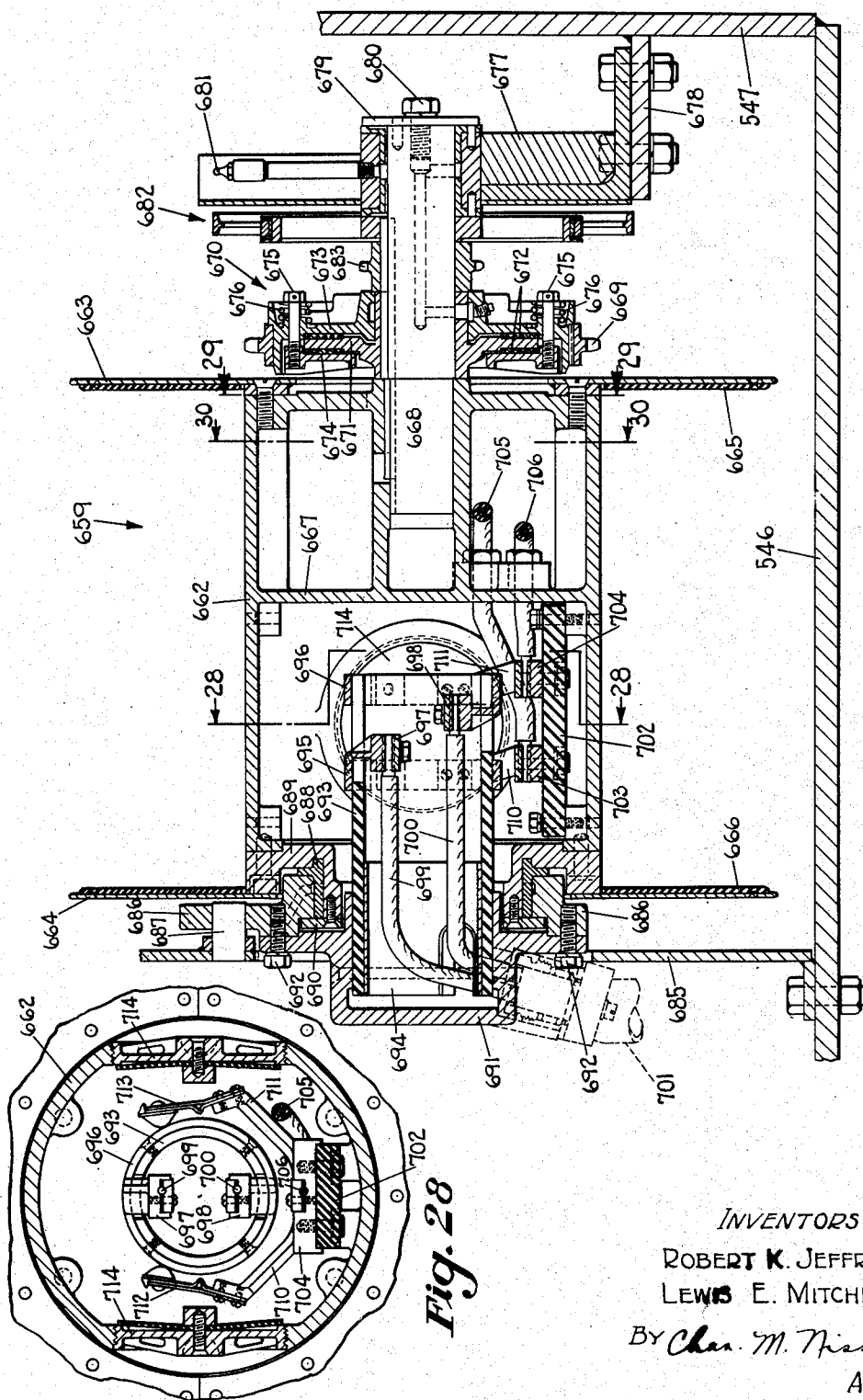


Fig. 27

Fig. 28

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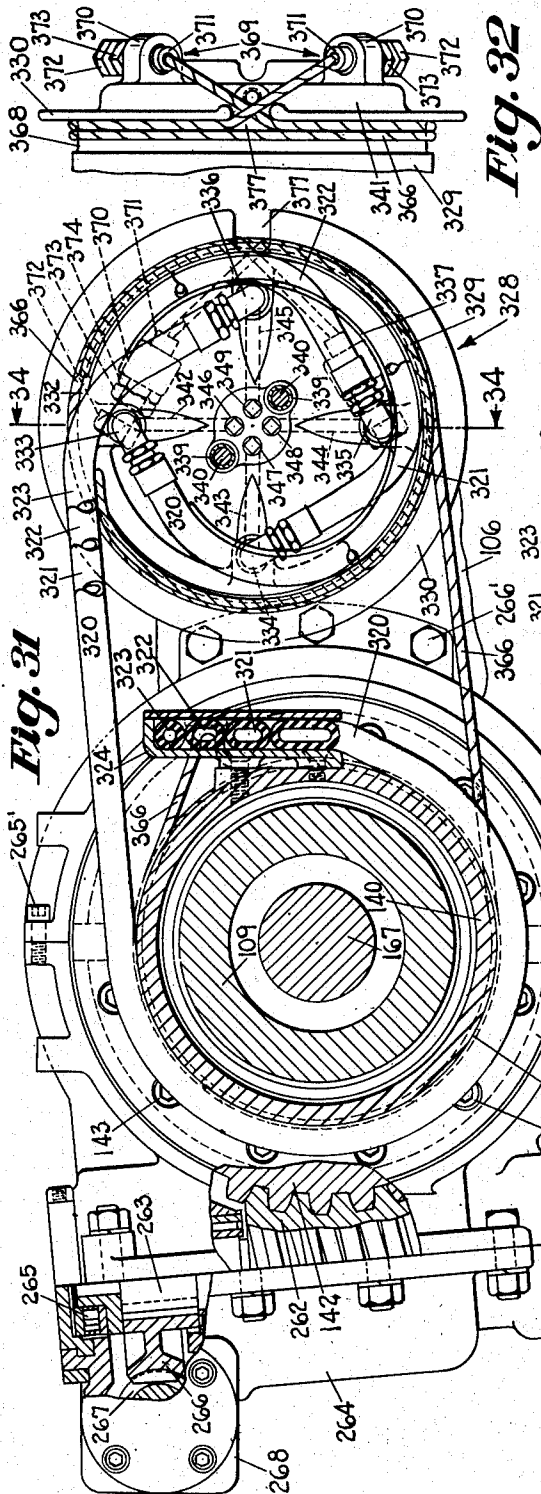


Fig. 31

Fig. 32

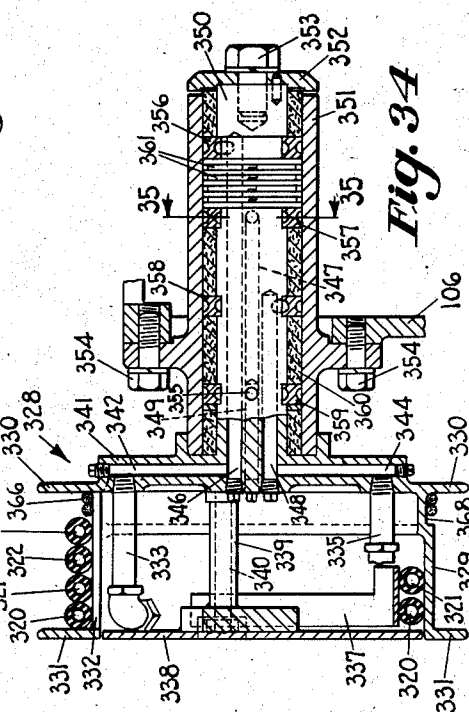


Fig. 34

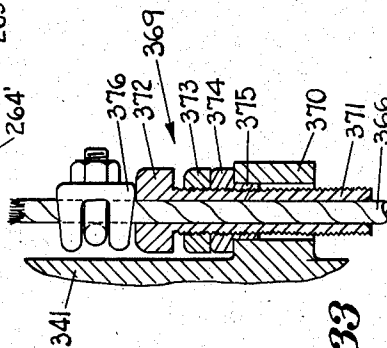


Fig. 33

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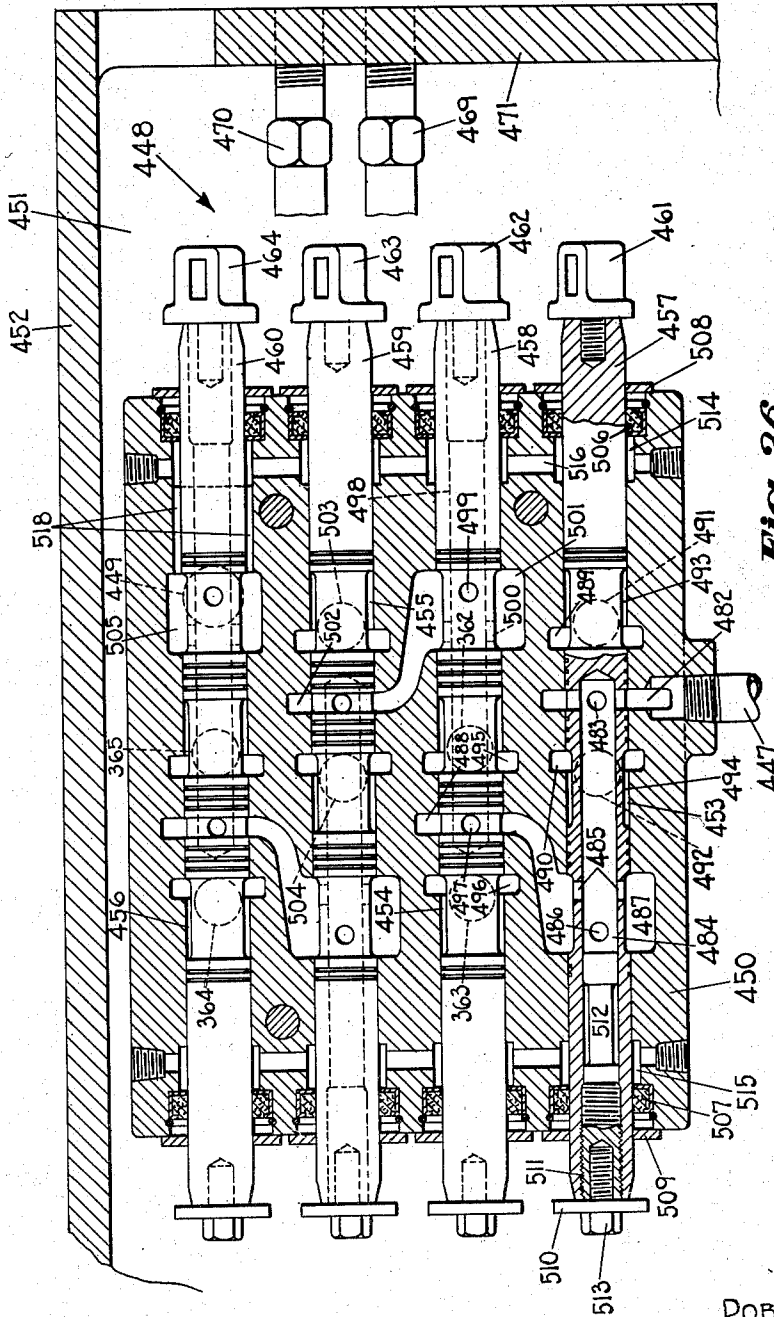


Fig. 36

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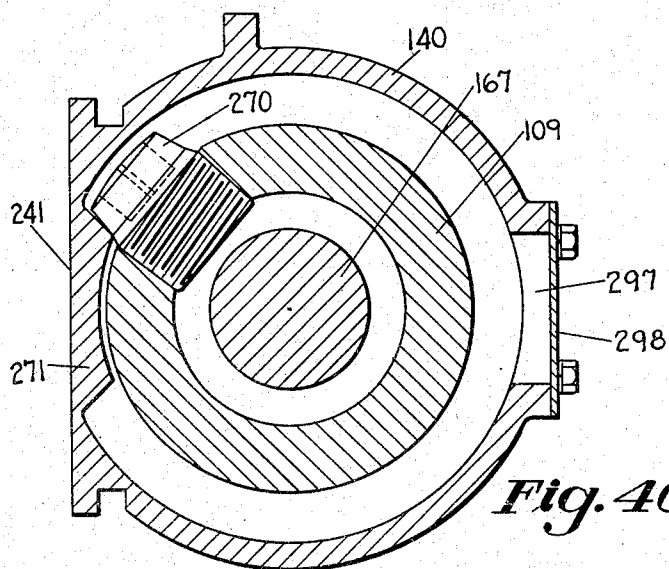
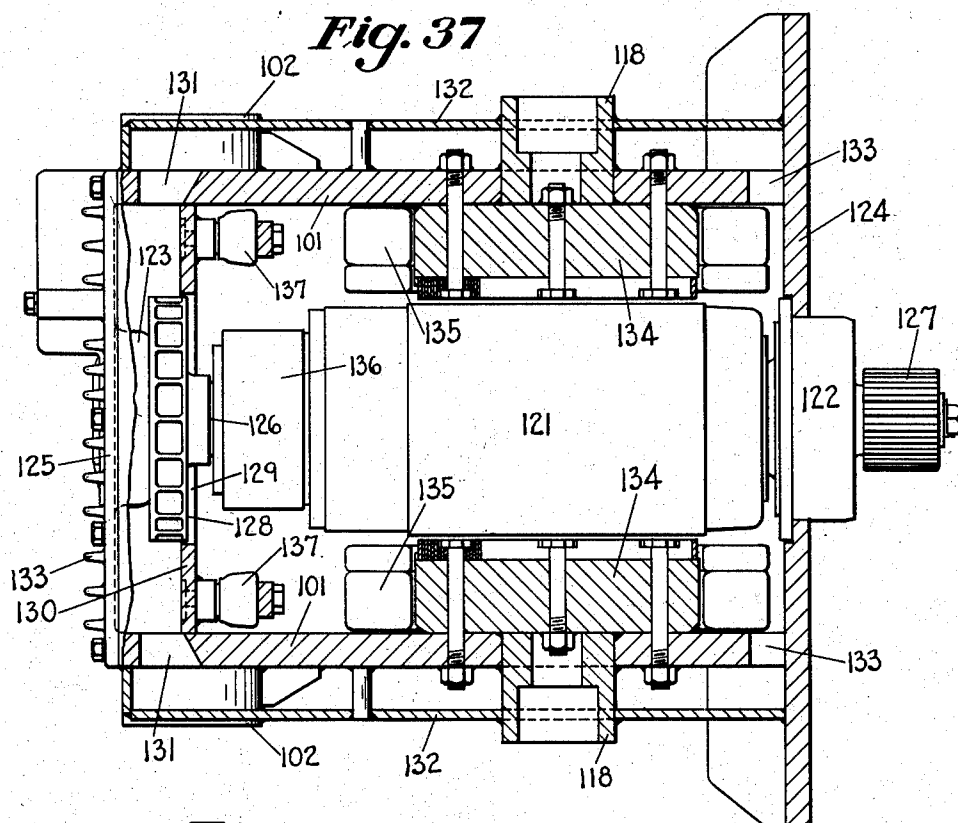
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MINING MACHINE

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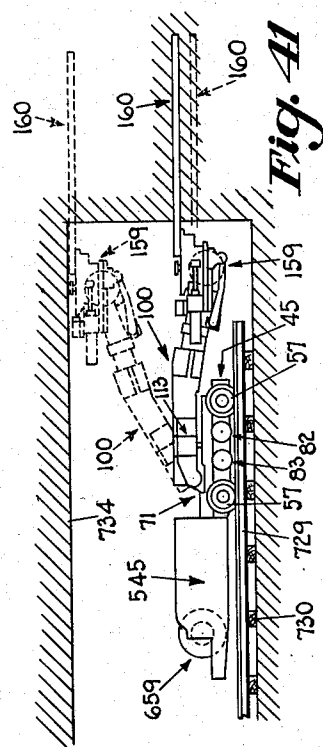


Fig. 41

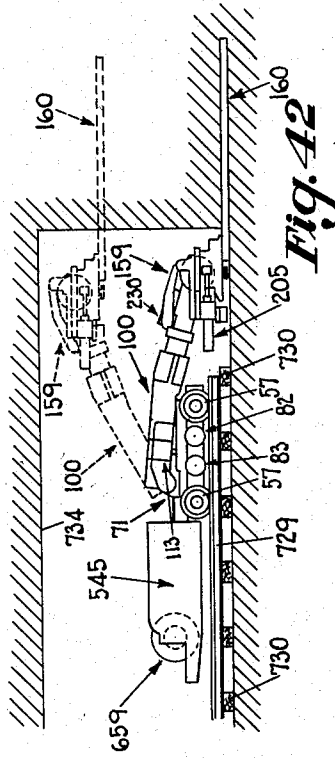


Fig. 42

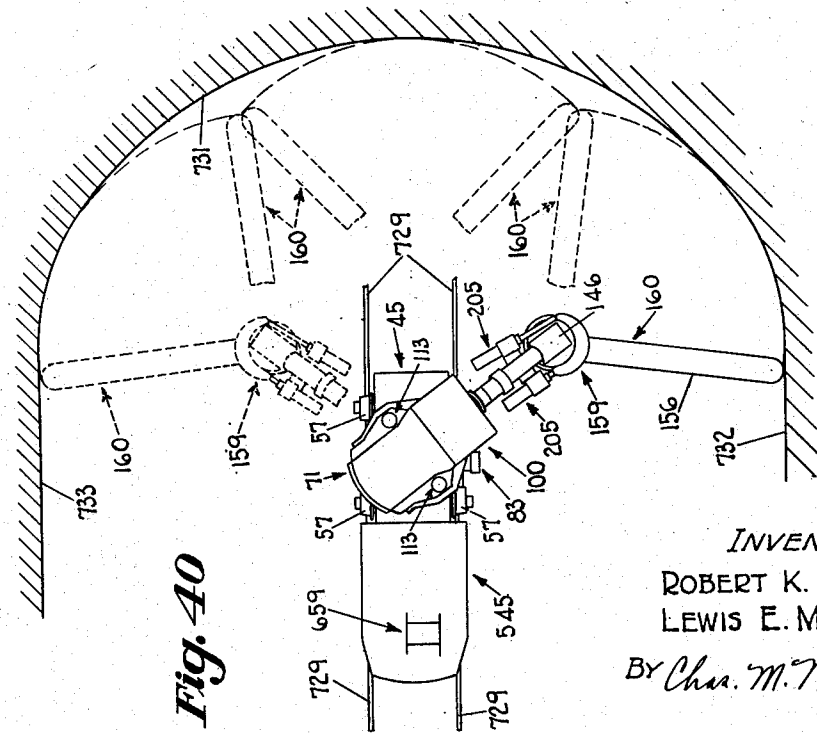


Fig. 40

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MINING MACHINE

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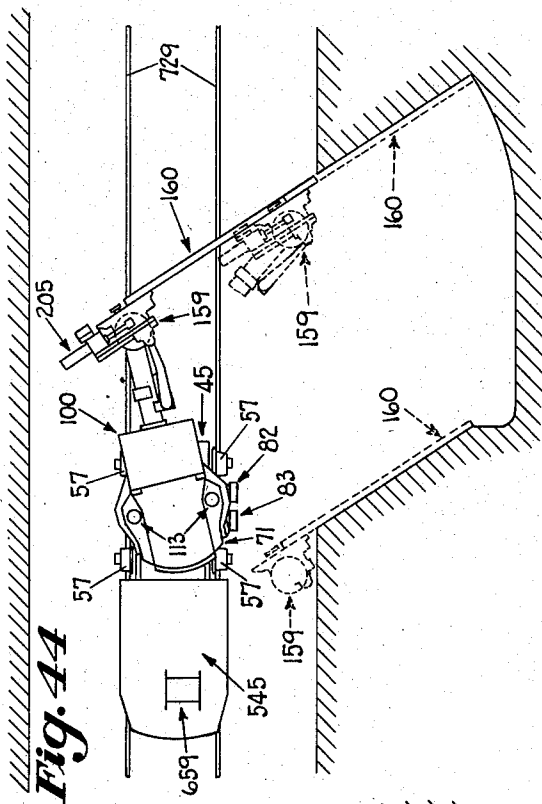


Fig. 44

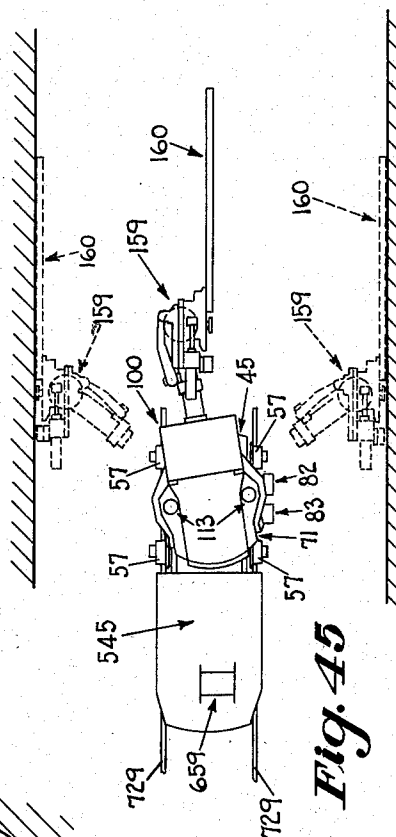


Fig. 45

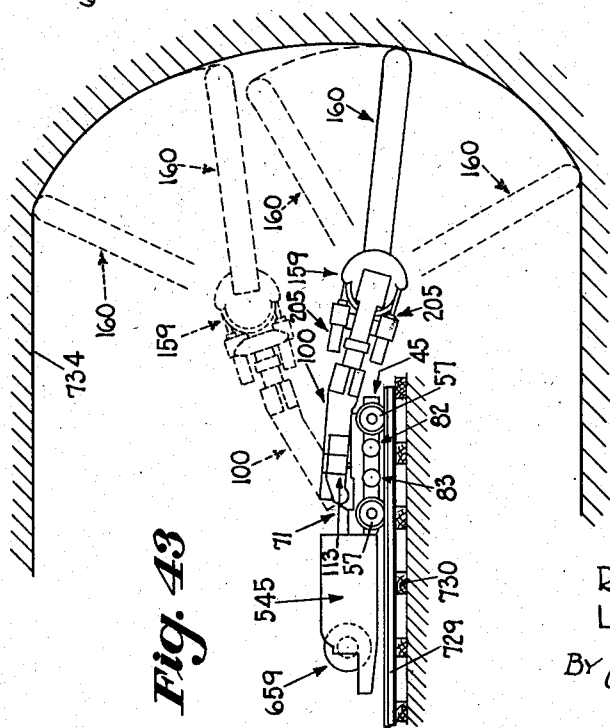


Fig. 43

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UNITED STATES PATENT OFFICE

2,263,779

MINING MACHINE

Robert K. Jeffrey and Lewis E. Mitchell, Columbus, Ohio, assignors to The Jeffrey Manufacturing Company, a corporation of Ohio

Application May 6, 1938, Serial No. 206,448

20 Claims. (Cl. 262—28)

This invention relates to a mining machine of the universal type and one of the objects of the invention is to provide an improved and efficient device of the type capable of cutting kerfs in any one of a plurality of intersecting or parallel planes including horizontal planes at any elevation between a relatively high roof and the floor of a mine room and also including vertical or shearing kerfs in any vertical plane between relatively widely spaced apart ribs or side walls of a mine room.

Another object of the invention is to provide a mining machine of the universal type which has a wide range of operation and which can be operated with safety, a high degree of efficiency and economy in mines where the available space is relatively small or where the available space is relatively large.

Another object of the invention is to provide a mining machine of the universal type which can be operated to cut kerfs in any plane between the extreme limits and which can be quickly and easily handled and adjusted with a minimum of manual effort.

Another object of the invention is to provide a mining machine in which cutting mechanism is adapted to be fed in a vertical plane by means of a hydraulic system which includes an equalizing relief valve mechanism which compensates for the unequal displacement in the hydraulic system thereby permitting the cutter bar to float while cutting on a curved portion of the track.

Another object of the invention is to provide a mining machine in which the mining mechanism is fed through the material to be mined at a predetermined maintained speed by means of an hydraulic system which speed can be adjusted to any one of a plurality of values.

Another object of the invention is to provide a mining machine in which an adjustable kerf cutter support includes a cylindrical bearing through which the drive for a kerf cutter extends in which the cylindrical bearing has sleeves which maintain the drive gearing enclosed irrespective of adjustment of the kerf cutter.

Still another object of the invention is to provide a mining machine with a hydraulic motor in which the flow of hydraulic fluid to the motor is relatively free while the flow of hydraulic fluid from the motor is restricted.

Another object of the invention is to provide an improved construction for conduits leading to a pivotally mounted hydraulic piston type motor.

Another object of the invention is to provide an improved control mechanism for a hydraulic control system of a mining machine.

Another object of the invention is to provide improved means for effecting continuous hydraulic connections between relatively movable parts of a mining machine.

Another object of the invention is to provide an improved hydraulic control system particularly useful in connection with mining machines.

Another object of the invention is to provide an improved construction for effecting the connection of a plurality of flexible hydraulic conduits to a rotating element of a hydraulically controlled mining machine.

A further object of the invention is to provide a hydraulic control system with pressure equalizing means whereby the piston of the hydraulic piston type motor will not lock.

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

In the accompanying drawings:

Fig. 1 is a plan view of the rear end of the mining machine comprising our invention;

Fig. 2 is a continuation of Fig. 1 showing the central portion of the mining machine of our invention;

Fig. 3 is a continuation of Fig. 2 showing the forward end of the mining machine with the kerf cutting mechanism cut short;

Fig. 4 is a side elevational view of the rear portion of our mining machine;

Fig. 5 is a combined side elevational and sectional view of the central portion of our device;

Fig. 6 is a longitudinal sectional view of the forward portion of our device with the kerf cutting mechanism again shown cut short;

Fig. 7 is an enlarged sectional detail taken on the line 7—7 of Fig. 2, looking in the direction of the arrows;

Fig. 8 is a combined side and sectional elevational view showing the construction of a hydraulic piston motor;

Fig. 9 is a transverse sectional view taken on the line 9—9 of Fig. 8;

Fig. 10 is a transverse sectional and elevational view showing a plurality of control valves and operating means therefor;

Fig. 11 is a side view of one of the control devices of Fig. 10;

Fig. 12 is a side view of another of the control devices of Fig. 10;

Fig. 13 is an enlarged segmental sectional view of the improved piston construction of a hy-

draulic piston motor comprising our invention;

Fig. 14 is an end elevational view of the structure illustrated in Fig. 13;

Fig. 15 is a plan view of the truck of the mining machine of our invention showing portions in section;

Fig. 16 is an enlarged sectional view of an actuating element of one of the piston motors comprising a feature of our invention;

Fig. 17 is a transverse sectional elevational view of an elevating hydraulic piston motor taken on the line 17—17 of Fig. 2 looking in the direction of the arrows;

Fig. 18 is a combined sectional and plan view of a portion of our device;

Fig. 19 is a transverse sectional view through the head of the mining machine of our invention taken approximately on the line 19—19 of Fig. 6, looking in the direction of the arrows;

Fig. 20 is a transverse sectional view taken on the line 20—20 of Fig. 6, looking in the direction of the arrows;

Fig. 21 is a transverse sectional elevational view taken on the line 21—21 of Fig. 1 of the drawings, looking in the direction of the arrows;

Fig. 22 is a sectional elevational view taken on the line 22—22 of Fig. 1, looking in the direction of the arrows;

Fig. 23 is a sectional elevational view of the volume control of our invention;

Fig. 24 is a sectional elevational view of a volume relief pilot valve of our invention;

Fig. 25 is a transverse sectional elevational view taken on the line 25—25 of Fig. 1, looking in the direction of the arrows;

Fig. 26 is a longitudinal sectional elevational view showing the drive for the truck and taken on line 26—26 of Fig. 25 looking in the direction of the arrows;

Fig. 27 is a transverse sectional view taken on the line 27—27 of Fig. 1, looking in the direction of the arrows;

Fig. 28 is a sectional elevational view taken on the line 28—28 of Fig. 27, looking in the direction of the arrows;

Figs. 29 and 30 are sectional elevational views taken on the lines 29—29 and 30—30, respectively, of Fig. 27, looking in the direction of the arrows;

Fig. 31 is a transverse sectional elevational view taken on the line 31—31 of Fig. 5, looking in the direction of the arrows;

Fig. 32 is a side elevational view of a detail of the apparatus shown in Fig. 31;

Fig. 33 is a sectional view showing in detail the rope anchorage and tension means of Fig. 32;

Fig. 34 is a longitudinal elevational sectional view taken on the line 34—34 of Fig. 31, looking in the direction of the arrows;

Fig. 35 is a transverse sectional view taken on the line 35—35 of Fig. 34, looking in the direction of the arrows;

Fig. 36 is a sectional view showing the construction of the control valves for the hydraulic motors;

Fig. 36* is a sectional view similar to Fig. 36;

Fig. 37 is a sectional plan view through the electric motor for driving the kerf-cutting mechanism;

Fig. 38 is a sectional elevational view of the equalizing relief valve comprising a feature of our invention;

Fig. 39 is a diagrammatic illustration of the hydraulic control system;

Fig. 40 is a plan view showing diagrammatically our mining machine cutting a horizontal kerf;

Figs. 41 and 42 are side elevational diagrammatic views showing various positions of adjustment of our mining machine;

Fig. 43 is a diagrammatic elevational view illustrating our mining machine cutting shearing kerfs and performing a strip mining operation;

Fig. 44 is a diagrammatic plan view showing our mining machine making an angle shear cut from a straight track;

Fig. 45 is a diagrammatic plan view showing the range of vertical kerfs which may be cut by our mining machine; and

Fig. 46 is a sectional view taken on the line 46—46 of Fig. 6, looking in the direction of the arrows.

The mining machine comprising our invention is mounted upon a truck 45 best seen in Figs. 5 and 15 of the drawings comprising a main frame formed by spaced apart longitudinally extending frame members 46, 46 which are laterally spaced apart and between which extend transversely extending forward plate 47 and transversely extending rearward plate 48 (Fig. 4) and intermediate transversely extending bolster members 49 and 50 (Fig. 5). All of said main frame members 46 to 50, inclusive, are rigidly attached together to form a strong main frame for the truck 45. Said main frame is supported upon a forward axle 51 and a rear axle 52 which axle 51 is slidably journaled in adjustable journal boxes 53, 53 which may be longitudinally adjusted by adjusting screws 54, 54 to adjust the tension of the driving chain, as hereinafter described. To assure movement of the axle 51 in parallelism the adjusting screws 54, 54 are connected to rotate together by chain and sprocket mechanism 55.

The journal boxes 53, 53 are held in the main frame against longitudinal movement but provide for limited vertical movement thereby to permit the shaft 51 to move relative to the longitudinal axis of the truck 45 to provide a modified three point suspension for said truck 45 so it may readily accommodate itself to the unevenness of the mine tracks over which the mining machine travels.

The rear end axle 52 is rigidly journaled to the main frame of the truck 45 by appropriate journal bearings 56, 56 (Fig. 15). The axles 51 and 52 are provided with appropriate driving and supporting track engaging flanged wheels 57 all of which are keyed to the respective axles 51 and 52 by keys 58. The axles 51, 52 are connected to rotate in unison by chain and sprocket mechanism 59. It is thus evident that any driving force supplied to axle 52, as hereinafter described, will be transmitted to all four of the wheels 57 thereby insuring a maximum of traction for propelling the mining machine which is particularly desirable during sumping operations. It is, of course, evident that the afore-described adjusting screws 54 (Fig. 5) provide for the tensioning of the chain and sprocket mechanism 59 by the forward and rearward adjustment of the axle 51.

Associated with the rear axle 52 is a brake mechanism (Fig. 5) comprising a brake drum 60 keyed to shaft 52 with which is associated a pair of brake shoes 61 pivoted to a casting 62 carried by bolster 50, to the rearward free ends of which is associated a clamping mechanism 63 operable by a brake lever 64 (Fig. 4) pivoted adjacent the rear end of the mining machine on pivot 65 and

connected to said clamping mechanism 63 through an operating rod 65 having a tensioning spring 66 connected intermediate its ends. Brake lever 64 has associated with it a retaining pawl and rack 67 and a pawl releasing handle 68. It is evident that the brake lever 64 may be operated to effect braking action on the rear axle 52 which will be transmitted to all four of the wheels 57 by virtue of their previously described connection together.

It is, of course, evident that the flanged wheels 57 are adapted to ride upon rails in a mine either for transporting the mining machine from one place to another or for supporting said mining machine while performing a mining operation. While we prefer this track mounted type of truck said truck may be mounted in any other desired manner as upon endless treads to operate in a trackless mine room.

In addition to those elements above described the truck 45 also includes a top plate 70 which is rigidly attached to the frame members 46, 47 and 48 (Fig. 15).

Mounted upon the truck 45 for swinging movement in a horizontal plane or about an upright axis is a turntable 71 (see Fig. 5). The turntable 71 is formed by a top plate 72 provided with an inspection opening 73 covered by a plate 74. Said top plate 72 has attached at its center a casting or pedestal 75 and carries at its periphery a large race 76 which cooperates with a plurality of balls 77 and an outside large race 78 carried by the top plate 70 of the truck 45 to form an anti-friction mounting for said turntable 71 upon said truck 45. The outer peripheral edge of the top plate 72 is provided with a downwardly extending flange 99 adapted to protect the bearing members and to prevent entrance of dirt to the bearing surfaces.

It is to be noted that the balls 77 are held in shearing relation between the races 76 and 78 and thus prevent both upward and downward movement of the turntable 71 with respect to the truck 45 while providing an anti-friction pivotal connection between them for relative movement about a vertical or upright axis. The bearing area provided by the large number of balls 77 is sufficient to provide for this particular type of mounting.

To provide for the swinging movement of the turntable 71 about its upright axis with respect to the truck 45, the lower portion of the casting 75 is provided with a pair of spaced integral gears 79 (Figs. 5 and 15) with which cooperate a pair of racks 80 and 81 having spaced top and bottom teeth. This construction provides for a very large amount of bearing area between the gears 79 and racks 80 and 81 which is particularly useful to transmit turning movement to the turntable 71 when the mining machine is making a horizontal arcuate cut.

To apply turning movement to said turntable 71 through the racks 80 and 81 said racks 80 and 81 are connected to hydraulic piston motors 82 and 83, respectively, (Fig. 15) the structures of which are similar and thus a description of motor 83 will apply to both. Said motor 83 comprises a cylinder 84 formed as an integral part of one of the frame members 46 and supplied with a removable cylinder head 85. Within the cylinder 84 is a piston 86 provided with appropriate piston rings and rigidly attached to a piston rod 87 which extends through the bottom of the cylinder 84 and is provided with a fluid tight packing gland 88 which includes an externally threaded

bushing 89. By having both motors 82, 83 on the same side of the machine a single casting serves a plurality of functions in that such casting has a frame portion 46 and the cylinders are reinforced by being connected together and to the frame member 46.

In order to effect a connection between the piston rod 87 and the rack 81 to transmit the force of the motor 83 to move said rack 81 and yet to prevent the lateral thrusts on the rack 81 being transmitted to the rod 87, bushing 88, and the piston 86 of the motor 83, we provide a novel connection illustrated particularly in Figs. 15 and 16 of the drawings. As here illustrated, the rack 81 is provided with a boss 90 which is internally threaded with square threads at 91. The free end of the piston rod 87 is provided with cooperating square threads 92 which mesh with said threads 91. The threads 91 and 92 insure axial movement of the piston rod 87 and boss 90 together without lost motion but a restricted amount of lateral movement is permitted between the boss 90 and the piston rod 87. Therefore, any lateral thrust on the rack 81 must be taken by a bearing plate 93 (see Fig. 5), which is carried by the bolster 50. The bolster 49 carries a similar bearing plate 94 for the rack 80.

As clearly illustrated in Fig. 15 of the drawings, a pipe 95 leads to the head end of the piston motor 83 and a pipe 96 leads to the piston rod end thereof. Similarly associated with the motor 82 is a pipe 97 leading to the head end and a pipe 98 leading to the piston rod end.

As will be hereinafter described in more detail, the two hydraulic piston motors 82 and 83 are always operated together and in reverse directions so that a very powerful and equalizing force will be transmitted to the turntable 71 to swing it.

As best seen in Figs. 2, 5, 17 and 37 of the drawings, there is mounted upon the turntable 71 for movement about a horizontal axis a supplementary frame 100 formed by a rigid motor casing 101 within which is housed an electric motor for driving the kerf cutting mechanism, as hereinafter described in full detail. Adjacent its rear bottom portion the motor casing 101 is provided with side journal bearings 102, 102 which pivotally support said supplementary frame 100 upon a pair of horizontally positioned stub shafts 103, 103 (see Fig. 2), which are rigidly supported upon brackets 104, 104 and removably attached thereto by clamp screws 105, 105; brackets 104, 104 being formed integral with the top plate 72 (Fig. 5) of turntable 71. As shown in Fig. 37 the casing 101 may be an enclosing field frame of a flame proof motor with the journal bearings 102, 102 at the rear end sides of the motor itself.

As clearly seen by reference to Figs. 2, 5 and 18 of the drawings, the supplementary frame 100 also includes a gear casing 106, the rear end of which is bolted to the front end of the motor casing 101 by bolts or screws 107. The gear casing 106 is also provided with a removable cover plate 108. Said supplementary frame 100 further includes a downwardly sloping elongated neck 109, best seen in Figs. 5 and 6 of the drawings, which is formed integral with the gear casing 106.

To provide for the adjustment of the supplementary frame 100 with respect to the turntable 71 about the horizontal axis provided by the stub shafts 103, 103 there is provided adjacent each side thereof an arm 110, one end of which is journaled to the outer end of the stub shaft 103,

as clearly seen in Fig. 2 of the drawings, and is pivotally attached to said stub shaft 103 by bolt and washer means 111. The forward end of each arm 110 is bolted to the gear casing 106 by bolts or screws 112.

Positioned between each of the arms 110 and the motor casing 101 is a pivotal hydraulic piston type motor 113. Said motors 113 are substantially of identical construction and one of them is shown in detail in Fig. 17 of the drawings to which attention is now directed. Said motor 113 comprises a cylinder 114 provided with pivot trunnions 115 and 116. The trunnion 115 is journaled in an appropriate journal bearing in arm 110 which journal bearing is provided with a grease fitting 117 and trunnion 116 is journaled in an appropriate journal bearing carried by stub cylinder 118 formed rigid with a vertical side wall of the motor casing 101, best seen in Figs. 17 and 37.

Within the cylinder 114 is a sleeve 272 which is held rigidly in place between end gaskets by removable head 273 attached to cylinder 114 by screws 274. Within the sleeve 272 is a piston 275 provided with a piston ring 276 and a felt packing gland 277 held in place by a removable bronze cap 278 which is attached to the piston 275 by screws 279. Rigidly attached to the piston 275 is a piston rod 280 the lower end of which is recessed at 281 to receive a pivotally attached bearing knuckle 282 which rides on a bearing cup 283. Knuckle 282 and cup 283 have contacting spherical bearing surfaces and said knuckle is pivotally attached to the lower recessed end of piston rod 280 by transversely extending pin 284. The knuckle 282 is permanently attached to the top plate 72 of turntable 71, as by welding, or it may be screw threadedly attached thereto.

To provide for lubrication of the spherical bearing surfaces between knuckle 282 and bearing cup 283 said knuckle 282 is provided with a bore 285 which communicates with a bore 286 in top plate 72 with which is associated a grease fitting 287.

The head 273 is provided with a packing gland 288 which cooperates with the piston rod 280 to provide an oil-tight sliding seal.

The piston motors 113 are of the double acting type and thus inlet ports 289 and 290 are provided adjacent the piston rod end and the head end, respectively, of the cylinder 114 so that the supplementary frame 100 can be moved positively about the horizontal pivotal axes provided by stub shafts 103 in either direction.

It is manifest that when hydraulic fluid is applied to the piston motors 113 through inlet ports 290 said piston motors will be expanded to raise the supplementary frame 100 against the action of gravity. On the other hand, when fluid under pressure is admitted to the port 289 to contract the hydraulic piston motors 113 the weight of the supplementary frame 100 will aid the hydraulic fluid and thus there will be a tendency for the piston motors 113 to contract at a relatively rapid rate unless some means is provided to prevent this.

In order to prevent an undesirable rapid downward movement of the supplementary frame 100 when the piston motors 113 are contracted, we provide a valve mechanism, as illustrated in Fig. 7, in association with the port 290, which valve mechanism is adapted to allow a relatively free passage of hydraulic fluid to the cylinder 114 through port 290, but to restrict the passage of

hydraulic fluid through port 290 from cylinder 114. Said valve mechanism is formed by an upright bore 291 the top of which is expanded into a chamber 292 in communication with port 290. The bore 291 communicates with a bore 293 which is connected to the source of hydraulic fluid, as hereinafter described.

Within the bore 291 and chamber 292 is a piston 294 having an enlarged head 295 and a central bore 296 communicating with ports 296' of restricted size. The piston 294 is free to move up and down and thus when fluid is flowing upwardly through the bore 291 said piston will be lifted so that the head 295 no longer seats on the bottom of the chamber 292. The outside diameter of the piston 294 is appreciably less than the diameter of the bore 291 and thus when in its lifted position oil can flow freely past the piston 294 into the bore 290 as well as through the bore 296 and ports 296'. This provides for free passage of the hydraulic fluid or oil to expand the piston motor 113. During contraction of the piston motor 113 the piston 294 will move downwardly and seat its head 295 on the bottom of chamber 292 and thus all of the oil must pass through the restricted ports 296' and bore 296 which limits the rate of downward movement of the supplementary frame 100. This prevents the supplementary frame 100 from moving downwardly at too rapid a speed, which might damage the mining machine.

Attention is now directed to Figs. 5, 17 and 37 and to the structure of the electric motor carried by the supplementary frame 100 and particularly to the cooling means for said electric motor. Within the motor casing or housing 101 there is provided an armature 121 mounted for rotation in spaced bearings 122 and 123, the former of which is carried by the front wall 124 of said casing 101 and the latter of which is carried by the rear wall 125 thereof. The armature 121 also includes a shaft 126 (see Fig. 5) to which is keyed a drive pinion 127.

Adjacent its rear end the armature shaft 126 carries a centrifugal fan rotor 128 which rotates in an opening 129 in a partition wall 130. The opening 129 provides an inlet for the fan rotor 128 the outlet for which is provided by a pair of spaced ports 131 in the upright side walls of the casing 101. The ports 131 lead to cooling passageways outside the motor casing 101 provided by longitudinally extending U-shaped plates 132 which provide air cooling passageways from the rear end of the motor casing 101 to the front end thereof.

Adjacent the front end of said motor casing 101 there is provided a plurality of inlet ports 133 which provide a return path for the cooled air from the cooling passageways to the interior of the motor casing 101. It is thus evident that the fan rotor 128 will operate to circulate air over two continuous paths, drawing the air from within the motor casing 101 and circulating it through cooling passageways outside said motor casing 101 as provided by the plates 132 and then returning the cooled air to said motor casing 101.

It is additionally to be noted that the rear wall 125 is provided with a plurality of cooling vanes or ribs 133 which aid in dissipating the heat of the motor.

It is also to be noted by particular reference to Fig. 17 of the drawings, that the plates 132 perform the additional function of acting as bracing supports for the stub cylinders 118.

In addition to those elements previously described, it may be mentioned that the electric driving motor within the casing 101 also includes field structure 134, field coils 135 and commutator 136 which has associated with it the usual brushes, which are not illustrated in the interest of clearness but which are supported by brush supports 137. In this connection it is also to be noted that the partition wall 130 not only acts to direct the inner air to the fan rotor 128 but also acts as a support or base for the brush supports 137.

Attention is now directed particularly to Figs. 3, 5, 6 and 19 and to the structure of the turnover head mechanism, the kerf cutting mechanism, and the operating means therefor which are adjustably supported with respect to the supplementary frame 100. As clearly seen in Figs. 5 and 6 of the drawings, the previously mentioned elongated neck 109 is provided at opposite ends with spaced apart journal bearings 138 and 139 upon which is journaled a cylinder 140. The cylinder 140 is provided at its upper end with an integral flange 141 which is attached to a split worm gear 142 by screws 143 (see Fig. 31) said worm gear 142 having a circumferential flange 144 which interlocks with a flange 145 formed integral with the elongated neck 109 thereby to lock the cylinder 140 against longitudinal movement with respect to the neck 109 while permitting free rotary movement between them along the longitudinal axis of said neck 109 and cylinder 140. It is thus obvious that the cylinder 140 will be mounted upon widely spaced journal bearings for free rotation along its longitudinal axis.

As clearly illustrated in Figs. 3, 6 and 19 of the drawings, the forward and lower end of the cylinder 140 is provided with an integral drum 146 having integral top reinforcing ribs 147 within which drum is rotatably mounted a cylindrical shell 148. The shell 148 is provided with a pair of end plates 149 and 150 which are rigidly but removably attached to said shell 148 as by machine screws 151. It is thus to be seen that the shell 148 provides an enlarged bearing contact with the interior of the drum 146 and is mounted for rotation with respect to said drum 146 about the longitudinal axis of said shell 148 and drum 146.

Adjacent their bottoms the end plates 149 and 150 are provided with semi-cylindrical flanges 152 which cooperate with a flanged split ring 153 rigidly attached to a supporting plate or casting 154 as by screws 155 (see Fig. 6) which plate 154 carries a cutter bar 156 with which is associated a cutter chain 157 provided with cutter bits 158. The cutter bar 156 is removably attached to the casting 154 by means including elongated bolt 156'. It is also to be noted that the casting 154 is provided with a protecting skirt 154' which extends adjacent the front and sides of the turnover head mechanism 159. It is thus evident that the drum 146, shell 148 and end plates 149 and 150 form a turnover head mechanism 159 which is pivotally adjustable with respect to the longitudinal axis of the neck 109, and that the head mechanism 159 swingably supports a kerf cutting mechanism 160 comprising the plate 154, cutter bar 156, cutter chain 157 and bits 158, which kerf cutting mechanism 160 is pivotally adjustable with respect to the head mechanism 159 about a generally upright or vertical axis.

Before describing the mechanism for effecting the various adjustments of the head mechanism 159 and the kerf cutting mechanism 160, atten-

tion is directed to Figs. 5, 6, 18 and 19 of the drawings and to the gear train for driving the kerf cutting mechanism 160 from the electric motor within the casing 101. Said gear train extends from the pinion 127 which meshes with a gear 161 (see Fig. 18) carried upon shaft 162 mounted in anti-friction bearings 163 carried by bracket 164 in gear casing 106. Shaft 162 has formed integral with one end thereof a helical pinion gear 165 which meshes with a helical drive gear 166 carried on the end of an elongated shaft 167 which extends through the neck 109 and is supported at opposite ends upon anti-friction roller bearings 168 and 169 (Figs. 5 and 18).

At its lower end the elongated shaft 167 has keyed thereto a bevel pinion 170 which meshes with bevel gear 171 (see Fig. 19) mounted upon yoke 172 by anti-friction bearing means 173. Lateral thrust to insure meshing of the bevel gears 170 and 171 is taken by anti-friction roller bearing 174 which is positioned between gear 171 and end plate 149. The yoke 172 is provided with end trunnions 175 pivotally mounted in bearing pockets 176 and 177 in end plates 149 and 150, respectively, thereby providing free pivotal movement between the yoke 172 and the end plates 149 and 150.

Supported by anti-friction roller bearing 178 in the yoke 172 is a normally vertical shaft 179 to which is keyed a bevel gear 180 meshing with bevel gear 171. The shaft 179 extends downwardly through a cylindrical opening in the shell 148 and through an elongated opening 181 (see Fig. 6) in the bottom portion of the drum 146, and is mounted at its bottom upon an anti-friction roller bearing 182 carried by a plate or casting 183 which, as clearly illustrated in Fig. 6 of the drawings, is rigidly attached to the bottoms of the side plates 149 and 150 (Fig. 19) which carry the flanges 152, as by screws 184 (Fig. 6).

The casting 183 is provided with an integral neck or sleeve 185 which extends through the elongated opening or slot 181 in the bottom of drum 146 and forms a tight fit with the cylindrical opening in the bottom of shell 148. The shaft 179 carries a pair of piston rings 186 which cooperate with the interior of the neck or sleeve 185 to prevent loss of lubricating oil from the interior of the head mechanism 159.

Adjacent its bottom, the shaft 179 has keyed thereto a drive sprocket 187 which meshes with and drives the cutter chain 157 and is removably held in place by a threaded cap 188 locked by a screw 189, the head of which extends into a selected one of a plurality of openings 190 in said cap 188.

It will be evident that the above described gear train provides for the driving of the cutter chain 157 from the driving electric motor while providing for adjustment of the turnover head mechanism 159 about the longitudinal axis of the neck 109, the adjustment of the turnover head mechanism 159 and the kerf cutting mechanism 160 about the axis of the yoke 172 and the adjustment of the kerf cutting mechanism 160 about the axis of the shaft 179. This, of course, provides for a very flexible adjustment of the kerf cutting mechanism 160 with respect to the supplementary frame 100.

To provide for the relative adjustment between the shell 148 and the drum 146 while preventing a loss of lubricating oil from the gear housing provided by the head mechanism 159, a pair of sliding cylindrically segmental seal plates 191, 192 are provided between the shell 148 and drum

146 and are arranged so that at all times they provide an overlap between the shell 148 and drum 146 particularly adjacent the opening 181 as the kerf cutting mechanism is adjusted by swinging it on the axis of the yoke 172. To this end the seal plates 191 and 192 (Figs. 6 and 19) are provided with elongated grooves 193 with which cooperates a stop screw 194 threaded in drum 146. The stop screw 194 permits a restricted amount of free movement of the seal plates 191 and 192 but prevents the lower edge thereof moving beyond the left hand extremity of the opening 181, as viewed in Fig. 6 of the drawings.

It is also, of course, evident that due to the fact that there must be relative movement between the shell 148 and the drum 146, said shell 148 is provided with an elongated opening 195 through which the elongated drive shaft 167 and the hub of pinion 170 extend. It will be evident that the seal plates 191 and 192 permit the openings 181 and 195 in the drum 146 and the shell 148, respectively, to allow the aforesaid pivotal movement between them while preventing any loss of lubricating grease from the interior of head mechanism 159. It is also evident that the piston rings 186 prevent any loss of lubricating grease from said compartment through the neck or sleeve 185.

It should be particularly understood that the use of two concentric inter-engaging seal plates 191, 192, each having the shape of a segment of a cylinder and arranged as shown in Figs. 6 and 19, provides for the sealing of the lubricant within the drum 146 and shell 148, while a relatively wide angle of adjustment of the kerf-cutter transversely of the plane thereof is effected by operation of the motor 230. As shown in Fig. 6, the relation of the parts is such that the kerf-cutter may be swung downwardly from its position in Fig. 6 through an angle of over twenty degrees and upwardly from its position in Fig. 6 through an angle of over sixty degrees, the total range of adjustment being through an angle of nearly ninety degrees.

When the shaft 179 is swung clockwise as viewed in Fig. 6, the stop screw 194 extending into the grooves 193, limits the seal plates in their movements in a clockwise direction so as to secure the desired overlapping relation at their lower left-hand ends in association with the adjacent portion of the drum 146 at the left-hand end of the opening 181.

When the shaft 179 is swung in an anti-clockwise direction, the shell 148 moves with it but the seal plates remain stationary until the sleeve 185 strikes the abutment 192' on the inner seal plate 192 whereupon the latter will move with the shaft 179 relatively to the outer seal plate 191 which remains stationary. When the upper end of the opening in the plate 191 is reached the latter will be moved until the limit of adjustment of the kerf-cutter is reached.

It will thus be seen by referring to Fig. 6 that when the kerf-cutter is adjusted transversely of its plane in an anti-clockwise direction, the lower left-hand end of the inner seal plate 192 will first be slid relatively to the outer seal plate 191 in an anti-clockwise direction and then both seal plates will be moved as a unit relatively to the drum 146 but at the limit of movement of the kerf-cutter the lower left-hand end of outer seal plate 191 will remain in overlapping and sealing relation to the drum 146 at the left-hand end of the opening 181 and the lower left-hand end of

the inner seal plate 192 will remain in overlapping and sealing relation with the outer seal plate 191. Therefore, notwithstanding the wide angle of adjustment of the kerf-cutter transversely of its plane, the seal plates 191, 192 act automatically to maintain the lubricant confined within the drum 149 and the shell 148, without interfering with the power transmission mechanism extending to the kerf-cutter and without interfering with adjustment of the kerf-cutter transversely of its plane through an angle of nearly ninety degrees.

To provide for lubrication of the roller bearing 182 we provide a grease conduit 196 leading to a discharge position above said roller bearing 182 and below the piston rings 186, which grease conduit 196 is provided with a grease fitting 197, as shown in Fig. 19.

To provide a sealing enclosure for the roller bearing 182 the sprocket 187 is provided with a removable ring 198 having sliding frictional contact with a bearing ring 199 carried by the casting 183 and urged downwardly by spring means 200. Lubrication conduits 201 are provided in the casting 183 leading to the ring 199 and to a journal bearing 202 between the casting 183 and the plate or casting 154, the journal bearing 202 being carried by said casting 154 which swings with respect to the casting 183. A piston ring 203 is provided in the casting 183 to bear against the journal bearing 202 to prevent loss of grease. Also to prevent loss of grease adjacent the ring 199 we provide packing means 204 carried by the casting 183 adjacent said ring 199.

To provide for the adjustment of the kerf cutter mechanism 160 with respect to the turnover head mechanism 159 about the axis of the shaft 179, we provide a pair of hydraulic piston motors 205, best seen by reference to Figs. 3, 6, 8, 9 and 19 of the drawings. The two piston motors 205 are mounted upon opposite sides of the turnover head mechanism 159 and are carried by rearwardly extending arms 206 formed integral with the end plates 149 and 150 of the turnover head mechanism 159. Extending between the two spaced arms 206 and cooperating therewith to support the piston motors 205 is a bracket 207 (see Figs. 6 and 9) which is rigidly attached thereto as by screws 208. As clearly seen by reference to Figs. 8 and 9 of the drawings, each of the arms 206 cooperates with one end of the bracket 207 to provide a pair of spaced journal bearings adapted to receive trunnions 209 and 210 formed integral with a cylindrical casting 211 of a piston motor 205. It is thus evident that each of the piston motors 205 is mounted for pivotal movement with respect to the turnover head mechanism 159 about a normally upright axis.

Each of the piston motors 205 also includes a cylinder 212 rigidly attached to the casting 211 and a removable piston rod head 213. Within the cylinder 212 we provide a piston 214 which is similar in structure to the piston 234 herein-after described in full detail. The piston 214 is carried on a piston rod 215. The forward ends of the piston rods 215 of the piston motors 205 are pivotally attached by pins 216 to bifurcated portions 217 of casting 154 forming a part of the kerf cutting mechanism 160, as previously described and as shown in Fig. 6.

It will be evident that by operating the hydraulic piston motors 205 in opposite directions the kerf cutting mechanism 160 may be swung about the axis of the shaft 179.

Attention is now directed particularly to Figs. 8 and 9 and to the construction of the hydraulic conduits leading to the opposite ends of one of the hydraulic piston motors 205. It may be mentioned that each of said hydraulic piston motors 205 is of the double acting type so that hydraulic fluid may be fed under pressure to either end thereof. To provide a conduit leading to the cylinder 212 which will permit pivotal movement thereof about the trunnions 209, 210, trunnion 210 is provided with two drilled passageways 216' and 217', the former of which communicates with a pipe 218 leading to a port 219 in the head end of the cylinder 212. Associated with the passageway 216' is a flexible rubber hose 220 provided with an appropriate fitting 221. Passageway 217' communicates with a longitudinal extending passageway 222 in casting 211 which, in turn, communicates with a port 223 providing communication to the piston rod end of the cylinder 212. A rubber hose 224 is provided with a fitting 225 and communicates with the passageway 217'.

Also within the casting 211 and communicating with the piston rod end of cylinder 212 is a passageway 226 leading to an outlet hose 227 provided with an appropriate fitting 228. It is to be noted that the fitting 228 is attached to the casting 211 at a position adjacent the pivotal axis of the cylinder 212.

It may be stated that the two piston motors 205 are of similar but not identical construction and the upper piston motor 205, as viewed in Fig. 3, differs from the piston motor illustrated in Figs. 8 and 9 of the drawings in the following respects. Said upper piston motor 205 is not provided with any passageway similar to passageway 216'. It is also provided with a pipe 218' similar to pipe 218 except that said pipe 218' leads to a passageway in the casting 211 which receives a fitting on the opposite end of hose 227 similar to fitting 228. In other words, hose 227 has a fitting at its opposite end from that illustrated in Fig. 9 which is threaded in casting 211 of the upper piston motor 205 which communicates with pipe 218' leading to the head end of the cylinder 212 of said piston motor. The piston rod end of the upper piston motor 205 is connected to a flexible hose similar to hose 224 through passageways similar to passageways 217' and 222 and port 223. The various connections by which hydraulic fluid is supplied to the piston motors 205 are described in full detail hereinafter.

To provide for the pivotal movement of the kerf cutting mechanism 160 on the transverse axis of the yoke 172 a hydraulic piston motor 230 (Fig. 6) comprising a cylinder 231 is bolted to the top of cylinder 140 carried on neck 109. The piston motor 230 is of the double acting type and thus the cylinder 231 is provided with inlet ports 232 and 233 adjacent its head and piston rod end, respectively.

Within the cylinder 231 is a piston indicated generally by the reference character 234 the structure of which is illustrated in full detail in Figs. 13 and 14 of the drawings and is described hereinafter. The piston 234 is mounted upon a piston rod 235 which extends through a packing gland 236 in the head 237 and is connected to a sliding cross-piece 238 by virtue of an enlarged head 239 cooperating with a threaded socket 240 which is threaded in said cross-piece 238. The cross-piece 238, as clearly illustrated in Fig. 20, is adapted to slide upon a horizontal

slideway 241 formed on the top of cylinder 140, said slideway 241 and cross-piece 238 having cooperating locking flange means 242 which provides for free sliding movement between them while holding the cross-piece 238 onto said slideway 241. The cross-piece 238 is provided with trunnions 243 which cooperate with a pair of arms 244 which are pivotally attached by pins 245 (see Fig. 3) to integral bifurcated brackets 246 (Fig. 19) carried adjacent the tops of end plates 149 and 150 of the turnover head mechanism 159. It will thus be evident that by controlling the supply of hydraulic pressure to the piston motor 230 the cross-piece 238 may be slid forwardly and rearwardly or locked in any desired position with a consequent pivotal movement of the kerf cutting mechanism 160 about the axis of the yoke 172.

Attention is now directed particularly to Figs. 6, 13 and 14 and to the detailed construction of the composite piston 234 which has been found very effective to provide a high efficient seal so that the kerf cutting mechanism may be locked in any desired position where it will be held substantially indefinitely due to the fact that there is no leakage of fluid past piston 234.

Said piston 234 is formed by a central plate 247 which is threaded onto the threaded portion 248 of piston rod 235 and is provided with wrench receiving notches 249 to provide for its adjustment. On opposite sides of the plate 247 are plates 250 and 251 which are also threaded upon the threaded portion 248 and are provided with wrench receiving notches 252 and 253, respectively.

To prevent any leakage of hydraulic fluid by the threads between plate 250 and piston rod 235, we provide a copper wire gasket 254 between them which will be compressed when plate 250 is screwed as far as possible against a shoulder provided by virtue of the reduced size of threaded portion 248 with respect to piston rod 235.

Between the plates 247 and 250 we provide a ring-shaped washer or packing cup 255 of composition material having an enlarged peripheral flange 256 which turns in a left-hand direction, as viewed in Fig. 13 of the drawings. The flange 256 is spaced slightly from the plate 250 so that pressure oil extending through the passageway 205' will find its way between said plate 250 and the flange 256 to force said flange 256 outwardly in intimate sliding contact with the interior surface of the cylinder 231. The portion of the cup 255 which is parallel with the plates 247 and 250 is rigidly clamped between them and may be held in place by integral circular projections 257 on said plates 250 and 247. Between the plates 247 and 251 there is provided another ring-shaped washer or packing cup 258 similar in construction to cup 255 except that its peripheral flange is turned in the opposite direction.

In the assembling of the construction the copper wire gasket 254 is placed over the reduced threaded portion 248 of piston rod 235 and the plate 250 is screwed down tightly against it. Cup 255 is then placed on plate 250 and plate 247 is then screwed tightly in place. Cup 258 is then put in place and plate 251 is screwed tightly against it.

To insure the maintenance of the parts in their positions the end of the threaded portion 248 is provided with a diametrical groove 259 and a hole 260 is drilled parallel therewith extending into each of the notches 253 of plate 251. Extending through one of the holes 260 we place a

cotter key 261 the head of which extends into the groove 259 and the ends of which are bent over, as clearly illustrated in Fig. 13 of the drawings. This cotter key 261 will, of course, prevent relative movement between the plate 251 and the piston rod 235.

As previously stated, the construction of the piston 214 associated with each of the piston motors 205 is similar in construction to that of the piston 234.

Referring to Fig. 31 of the drawings, there is illustrated the drive means for turning over the turnover head mechanism 159 and the kerf cutting mechanism 160 about the longitudinal axis of the downwardly sloping neck 109.

Meshing with the previously described worm gear 142 is a worm 262 mounted upon shaft 263 which is supported in a split housing 264 upon anti-friction bearings, one of which is seen at 265. Keyed to the shaft 263 is a worm gear 266 which is driven from a worm 267 mounted in housing 268 and driven from a hydraulic rotary type motor 269, best seen in Fig. 2 of the drawings.

It may be noted by reference to Figs. 5 and 31 that the right hand portion of housing 264 is in the form of a split casting 264' which also provides a housing for the worm gear 142, the two parts of said split casting 264' being held together by screws 265', and being attached to casting 106 by screws 266'.

It is evident that due to the double worm gear drive between motor 269 and cylinder 140, said drive will be self-locking to hold the cutter bar 156 in any adjusted position.

It will be evident that rotary motion applied to the worm 267 by rotary hydraulic motor 269 will drive the worm gear 142 through worm 262, shaft 263 and worm gear 266. Since said worm gear 142 is rigidly attached to cylinder 140, said cylinder 140 and all elements rigidly attached thereto, including the turnover head mechanism 159 and the kerf cutting mechanism 160, will be pivotally adjusted about the longitudinal axis of the neck 109 in response to operation of said rotary hydraulic motor 269.

In order to limit the amount of pivotal movement possible between the cylinder 140 and the neck 109 to prevent a breaking of the hydraulic feed pipes hereinafter described, yet to permit sufficient rotation of the turnover head mechanism 159 to adjust the cutter bar of the cutter mechanism 160 to cut top and bottom kerfs and to cut vertical kerfs either to the right or left-hand side of the axis of neck 109, said neck 109 is provided with an enlarged stop screw 270 (see Figs. 6 and 46), which cooperates with a stop lug 271 formed integral with the cylinder 140. The stop lug 271 and stop screw 270 are so formed that the cylinder 140 may rotate through an angle of approximately 282 degrees, one extreme position being with the cutter bar 156 making an angle of approximately 11 degrees beyond a horizontal position and the other extreme position being with the cutter bar 156 one degree beyond a vertical position. In other words, it is possible to adjust the cutter bar 156 into either top or bottom horizontal positions and to a position 11 degrees beyond the horizontal in the bottom position, thereby providing several degrees of reserve at the bottom.

It is also possible to adjust the cutter bar 156 to vertical positions to either side of the axis of rotation of cylinder 140 and to adjust it one degree beyond the vertical position at one side. At

the other side the cutter bar can, of course, be adjusted in either direction from the vertical position to either a top or a bottom horizontal position. This obviously provides for the cutting of kerfs on four right angularly related planes including both horizontal top and bottom planes and vertical right and left-hand planes. For purposes of illustration, the stop 270 is shown in Fig. 46 in engagement with one end of the abutment 271, the cutter bar then being 11° beyond the horizontal position shown in Fig. 6. The true position of the stop 270 when the cutter bar is in its lower horizontal position is 11° clockwise from the position shown in Fig. 46 or as shown in Fig. 6.

To provide for the removal of the stop screw 270 an opening 297 is provided in cylinder 140 which is normally covered by a removable cover plate 298.

It is evident that the hydraulic piston motor 230 for adjusting the kerf cutting mechanism 160 about the axis of yoke 172 and the hydraulic piston motors 205 for swinging said kerf cutting mechanism 160 about the axis of shaft 179 are both mounted to partake of the rotary motion of the cylinder 140 about the neck 109. Furthermore, there is a pivotal motion between the hydraulic piston motors 205 and the cylinder 140 about the axis of yoke 172. As a consequence, provision must be made for connecting the hydraulic hoses or conduits to the hydraulic piston motors 205 and 230 while providing for these free pivotal movements. To this end the hoses 220 and 224 lead from the lower piston motor 205, as viewed in Figs. 3 and 39, to a swivel cylinder 300 (see Figs. 19 and 39), formed in end plate 150, the axis of which is along the axis of the yoke 172.

It may be stated that the hoses 220 and 224 are protected by housing 301 mounted on arm 206 and by housing 302 (see Figs. 3, 6 and 8), carried on the forward portion of brackets 246.

Within the cylinder 300 is a piston or post 303 provided with longitudinally extending bores 304 and 305. Bore 304 (Fig. 19) communicates with a circumferential piston ring 306 provided with a circumferential groove 307 in communication with a bore 308 in cylinder 300 which communicates with hose 224. In a similar manner bore 305 communicates with piston ring 309 provided with circumferential groove 310 communicating with bore 311 in cylinder 300 which communicates with hose 220.

Oil sealing packing 312 surrounds the piston 303 and provides an oil tight seal between it and the cylinder 300. The packing 312 is removably held in place on the piston 303 by a removable cap 313 attached thereto by machine screw 314, Fig. 19.

It will be evident that the piston or post 303 may be rotated with respect to the cylinder 300 and yet insure continuous communication between the bores or ports 304 and 308 and between the bores or passageways 305 and 311.

It may also be mentioned that connected to the bore or port 311 is a flexible rubber hose 315 (Fig. 39) which connects to the piston rod end of the top piston motor 205. This hose 315 is protected by housing 316 mounted upon top arm 206, as viewed in Fig. 3 of the drawings. It is thus to be noted that all of the flexible rubber hoses 220, 224 and 315 are fully protected. It may also be mentioned that the rubber hose 227 is protected by the bracket 207, as clearly illustrated in Fig. 6 of the drawings.

Leading from the bores 304 and 305, respectively, and rigidly attached to the cylinder or post 303 is a pair of rigid metal hydraulic pipes 317 and 318, the other ends of which are rigidly connected to a block 319 mounted on the cylinder 140, as illustrated in Fig. 39 of the drawings. It is thus evident that a flexible fluid-tight connection is provided between the rigid hydraulic pipes 317 and 318 which are carried by the cylinder 140 and the ports 308 and 311 in the cylinder 300 which is pivotally mounted with respect to said cylinder 140 and which pivots with the kerf cutting mechanism 160 about the axis of yoke 172.

Extending along one side of the cylinder 140 (Fig. 31), to rotate therewith are four hydraulic flexible rubber hoses comprising hoses 320, 321, 322 and 323 of which hoses 320 and 321 are connected to rigid pipes 317 and 318, respectively, by virtue of being connected to block 319, as clearly illustrated in Fig. 39 of the drawings, and of which hoses 322 and 323 lead to the head and piston rod end ports 232 and 233, respectively, of the piston motor 230, Fig. 6.

As clearly illustrated in Fig. 31 of the drawings, the four hoses 320, 321, 322 and 323 are rigidly connected to the cylinder 140 by bracket means 324 and, as clearly illustrated in Fig. 5 of the drawings, are wrapped around a drum 325 formed as an integral portion of the upper end of the cylinder 140 by integral flanges 326 and 141.

The flange 326 does not form a continuous disc but where it terminates continuing flange 327 begins so that flanges 326 and 327 together do form a substantially continuous disc.

The hoses 320, 321, 322 and 323 extend to hose reel 328 comprising a drum 329 having integral side flanges 330 and 331. The drum 329 is provided with an opening 332 through which the four hoses 320, 321, 322 and 323 extend to the interior of said drum 329 where they are attached by appropriate fittings to pipes 333, 334, 335 and 336, respectively.

Within the drum 329 is a progressively stepped curved guide plate 337 which guides the hoses 320, 321, 322 in a smooth curve to their respective pipes 333, 334 and 335 and keeps them taut at all times.

The drum 329 is provided with a removable cover plate 338 carrying a pair of spacers 339 through which a pair of elongated bolts 340 extend and thread into a base 341 of drum 329. It is thus evident that the cover plate 338 is readily removable to grant access to the interior of drum 329 of the hose reel 328.

Within the base 341 there are provided four radial bores 342, 343, 344 and 345 which communicate with pipes 333, 334, 335 and 336, respectively, and which, in turn, communicate with four longitudinally extending bores 346, 347, 348 and 349, respectively (see Figs. 31, 34 and 35), in shaft 350 formed integral with the base 341 and providing a pivotal support for the hose reel 328. The shaft 350 is supported in a cylindrical housing 351 and held therein for free rotation by an end plate 352 removably attached to the shaft 350 by a screw 353. As clearly seen by reference to Fig. 18 of the drawings, the housing 351 is rigidly and removably attached to the gear housing 106 of the supplementary frame 100, as by screws 354 (Fig. 34).

Communicating with each of the bores 346, 347, 348 and 349 are radial bores, one of which is seen at 355 in Fig. 35 of the drawings, which

bores lead to radially bored and circumferentially grooved rings designated in Fig. 34 as 356, 357, 358 and 359, respectively.

Aligned with each of the rings 356, 357, 358 and 359 is a port one of which is seen at Fig. 35 of the drawings at 357' which is in alignment with ring 357. It is thus evident that fluid under pressure will be communicated from pipe 363 associated with bore 357' for any position of the reel 328 by way of grooved and bored piston ring 357. This provides for free rotation of the hose reel 328 while at the same time providing continuous communication between the hoses 320, 321, 322 and 323 and the pipes 362, 363, 364 and 365, respectively.

The rings 356, 357, 358 and 359 are separated by synthetic rubber packing 360 which completely surrounds the shaft 350 and rings 356 and 357 are separated by a plurality of piston rings 361 on said shaft 350. The piston rings 361 are used at this place because the pressure which flows through rings 356 and 357 is not as great as that which flows through rings 358 and 359, and while the piston rings 361 do not make as effective a seal as the packing 360, it is adequate for this purpose and it reduces the necessary spacing between said rings 356 and 357, thus reducing the over-all length of the shaft 350.

As clearly illustrated in Figs. 2, 18, 35 and 39 of the drawings, the housing 351 is provided with four longitudinally and angularly spaced bored bosses aligned respectively with the rings 356, 357, 358 and 359 providing the above mentioned ports, one of which is seen at 357' in Fig. 35 of the drawings, and to which are connected pipes 362, 363, 364 and 365, respectively.

It is to be noted particularly by reference to Fig. 31 of the drawings, that the drums 325 and 329 have the same diameter and that the lengths of the hoses 320, 321, 322 and 323 are such that they readily permit of substantially a complete rotation of the drum 325. As was previously pointed out, rotation of said drum 325 and the cylinder 140 of which it is a part, is restricted to approximately 282 degrees by the stop means 270, 271, illustrated in detail in Fig. 46 of the drawings.

In order to insure rotation of the drums 325 and 329 in unison, we provide drive means between them, illustrated in detail in Figs. 5, 31, 32, 33 and 34 of the drawings. It is, of course, evident that the initial drive will be on the drum 325 carried by cylinder 140 and that drum 329 of the hose reel 328 will be driven from said drum 325. The drive means is in the form of a small metal cable 366 which is wound around the drums 325 and 329 and rides in a groove 367 (Fig. 5) in the former and a groove 368 (Fig. 32) in the latter, and clamped to the former by bracket 324.

The free ends of the cable 366 are held in duplicate anchor and tension means 369 on the rear of base 341 of hose reel 328. The structure of said anchor and tension means 369 is disclosed in detail in Fig. 33 of the drawings. Each of said anchor means comprises a bored lug 370 integral with base 341 through which an end of the cable 366 extends, upon which end is provided an elongated threaded sleeve 371 provided with a square wrench receiving head 372.

Threaded on the sleeve 371 is a pair of threaded nuts 373 and 374, the latter of which has a sleeve 375 which extends loosely into the bore of lug 370. A clamp 376 is provided on the extreme end of cable 366 and abuts the head 372

of sleeve 371 preventing sliding movement of the cable 366 with respect to said sleeve 371.

It will be evident that by adjusting the nuts 373 and 374 the cable 366 may be tensioned and when any desired tension is reached the nuts 373 and 374 may be screwed tightly together to lock each other in adjusted position.

By reference to Fig. 32 of the drawings, it is to be noted that the flange 330 is broken away at 377 to permit the ends of cable 366 to pass from the groove 368 to the anchor and tension means 369. It is thus evident that the cable 366 may be maintained taut at all times and the two strands thereof will act as a driving belt to insure rotation of the hose reel 328 with the cylinder 140 and drum 325. It is thus evident that flexible conduits have been provided to supply hydraulic fluid under pressure to the hydraulic piston motors 230 and 205 while permitting free pivotal movement of said hydraulic piston motors as required by their positions on the mining machine.

Attention is now directed particularly to Fig. 39 of the drawings which illustrates diagrammatically the hydraulic control system for operating the mining machine including the various hydraulic motors which have been found to impart great flexibility and ease of operation to said mining machine. Said hydraulic system includes a supply tank 380 for the hydraulic fluid, preferably oil, from which extends a feed pipe 381 associated with a filter 382 in the bottom of said supply tank 380. The feed pipe 381 leads to a pressure control valve 383 disclosed in detail in Fig. 22 of the drawings, to which attention is now directed.

Said pressure control valve 383 comprises a block 384 provided with a passageway 385 in communication with feed pipe 381. Associated at opposite ends of the passageway 385 are ball check valves 386 and 387 leading to chambers 388 and 389, respectively. Communicating with the chambers 388 and 389 are pipes 390 and 391, respectively, which form the feed pipe and out-put pipe, respectively, of a high pressure pump 392 which, for example, may be of the gear type and capable of producing a pressure of approximately 1500 pounds per square inch. The pressure control valve 383 also includes ball check valves 393 and 394 which communicate with chambers 388 and 389, respectively, by passageways 395 and 396, respectively. Associated with the ball check valves 393 and 394 are chambers 397 and 398, respectively, both of which communicate with pressure pipe 399 which is the main pressure pipe for the hydraulic system.

The function of the pressure control valve 383 is to insure that the pipe 381 will act as a feed pipe and that it will be under suction at all times and that the pipe 399 will act as a pressure pipe and be under pressure at all times, regardless of the direction of rotation of the gear pump 392. For example, if the gear pump 392 is operated in its normal direction to draw in oil through pipe 390 and discharge oil through pipe 391, check valve 386 will be open to provide communication between pipe 381 and pipe 390 and due to the pressure in pipe 391 check valve 387 will be maintained closed. At the same time, due to the pressure in chamber 389 check valve 394 will be open to supply oil under pressure pipe 399 and check valve 393 will be held closed by the pressure in chamber 397.

Should the pump 392 reverse its direction of rotation and draw in oil from pipe 391 and de-

liver oil under pressure to pipe 390, check valve 387 will open to supply oil from pipe 381 to said pipe 391 and check valve 386 will be held closed by the pressure in chamber 388. Also check valve 393 will be open due to the pressure in chamber 388 to provide communication between pipe 390 and pressure pipe 399. Furthermore, due to the pressure in chamber 398 check valve 394 will be maintained closed. It is thus evident that pressure pipe 399 will always be the main pressure line of the hydraulic system and that pipe 381 will always be the main feed line of the hydraulic system without regard to the direction of rotation of pump 392.

The pressure pipe 399 leads to a volume control and pressure relief valve 400 which, as its name indicates, acts to control the volume of fluid delivered to the hydraulic system by the pump 392 and to relieve the pump 392 in case a predetermined high pressure is reached. During normal operation when the pressure in the line is not sufficient to open the hereinafter described pressure relief valve, the volume control valve 400 operates automatically to maintain a substantially constant or predetermined rate of fluid flow to the hydraulic motor being operated, such as motors 82 and 83, when control valve 443 is in full open position, and thus produce a substantially uniform or predetermined feed rate or speed of the mining mechanism for each position of operating handle 406. Said handle 406 being adjustable, it is possible to adjust this predetermined maintained speed or feed rate at any one of a large plurality of values including the maximum and minimum values and any value between them. Any feed rate thus predetermined is maintained substantially constant regardless of pressure variations in the hydraulic system, provided the high-pressure relief valve does not operate. The feed rate is, of course, determined as the rate of movement of the cutter bar with respect to the main frame of the mining machine, or, in the case of sumping, the rate of movement of the wheels relative to zero.

An unusual condition, such as a hard spot, might cause the main frame to give temporarily with respect to the track, or in the case of sumping cause temporary slipping, but these are very unusual occurrences. Normally a very wide range of cutting conditions will not produce substantial variations in the selected feed rate, nor will wide variations of fluid pressure below that which opens the high-pressure relief valve. The structure of this volume control and pressure relief valve 400 is illustrated in detail in Fig. 23 of the drawings, to which attention is now directed.

Said valve comprises a main block 401 provided at its bottom with a cylindrical chamber 402 with which the pressure pipe 399 communicates and within which is a rotary control cylinder 403 having a removed portion 404 and carried on a shaft 405 with which is associated an operating lever 406 to adjust the position of the control cylinder 403 in the chamber 402. By adjusting the cylinder 403 the size of the opening afforded between inlet port 407 and outlet port 408 of the chamber 402 may be regulated thereby controlling the volume of fluid which flows from the pressure pipe 399 to the pressure pipe 409 leading from the volume control and pressure relief valve 400 which pressure pipe 409 is in communication with the outlet port 408. It is thus evident that the operating lever 406

may be adjusted to control the normal volume of hydraulic fluid to be supplied to the pressure pipe 409.

Associated with the pressure pipe 409 is a pipe 410 which leads to a pressure gauge 411 which will, of course, indicate the pressure in the pressure pipe 409 at all times.

To provide for the high pressure relief feature of the valve 400 the block 401 is provided with a cylindrical chamber 412 the bottom of which is in communication with the inlet port 407 and above which port 407 is a circumferential chamber 413. Within the chamber 412 is a piston 414 urged to bottom seating position by a coil spring 415, the top of which rests against a plug 416 threaded in the top of block 401. A connecting pipe 417 leads from the pipe 410 to a bore 418 of restricted size which communicates with the chamber 412 at a position above the piston 414. Also communicating with the chamber 412 at a position above piston 414 is a larger bore 419 leading to a chamber 420 which is connected by a vertical bore 421 to a drain pipe 422 which also communicates by a bore 423 with the chamber 413. Within the chamber 420 is a ball relief valve 424 provided with a compression spring 425, the compression of which may be adjusted by adjusting screw 426.

In normal operation the piston 414 automatically assumes a floating position in chamber 412 to by-pass just enough hydraulic fluid to maintain a fluid flow from pipe 399 to pipe 409 through the adjustable orifice, provided by remove portion 404, to maintain said piston 414 in a condition of equilibrium, whereby it will operate to by-pass an amount of hydraulic fluid as determined by the adjustable position of handle 406 to insure delivery of a variable predetermined amount of hydraulic fluid at all times, under the control of the operator, to the said pipe 409, the remaining portion of the hydraulic fluid delivered by the pump 392 to the pipe 399 being by-passed by way of chamber 407, chamber 413 and bore 423 to drain pipe 422. The delivery rate to pipe 409 is therefore determined solely by the position of handle 406.

The adjustable pressure drop across the adjustable orifice provided by remove portion 404 is of course the controlling factor in maintaining this condition of equilibrium because this pressure drop is supplied to the floating piston 414. Any decrease in fluid flow to pipe 409 from that required by the setting of arm 406 will cause the piston 414 to move downwardly thereby reducing the amount of liquid by-pass from pipe 399 to drain pipe 422 which will immediately correct this condition. Conversely, any increase in fluid flow to pipe 409 from that required by the setting of arm 406 will cause the piston 414 to move upwardly thereby increasing the amount of liquid by-pass from pipe 399 to drain pipe 422 which will correct this condition.

The valve 400 has a high pressure relief function by virtue of ball relief valve 424. For example, should the pressure in the pipe 409 exceed 12,000 pounds per square inch, or any other valve 424, said relief valve 424 will open to permit fluid under pressure in the chamber 412 to flow through bores 419 and 421 to drain pipe 422.

The opening of check valve 424 may be due to a gradual increase in pressure communicated through bore 418 or to a sudden increase which will move piston 414 upwardly since the pressure above it will not be equalized immediately due to the drop through said bore 418.

When ball valve 424 opens, reduced pressure is provided above piston 414. The higher pressure below piston 414 then lifts it. As a consequence of any of the above conditions the piston 414 will be lifted above its normal position to permit more or all of the fluid under pressure in port 407 to flow to the chamber 413 and thence to drain pipe 422 by way of bore 423.

It is evident that after a high pressure condition is relieved, the relief valve 424 will operate to close the bore 419 thereby to restore said piston 414 to its normal condition.

As a safety feature we also provide a by-pass around the relief valve 424 which may be manually operated in case said relief valve becomes inoperative for any purpose. This by-pass is formed by a pipe 427 communicating with bore 419 and extending to manually operated relief pilot valve 428 the structure of which is disclosed in full detail in Fig. 24 of the drawings to which attention is now directed.

Said relief pilot valve 428 comprises a main block 429 provided with a central bore 430 within which extends a piston 431, the top of which carries an operating knob or handle 432. A coil spring 433 has its upper end against the handle 432 and its lower end against a packing gland 434 providing a seal for the piston 431 and urging the piston 431 to the top position, as illustrated in Fig. 24. Upward movement of the piston 431 is limited by an enlarged integral head 435 thereof cooperating with a ledge in the bore 430. Adjacent its central bore the block 429 is provided with a chamber 436 closed at one side by a plug 437 and communicating with the pipe 427. The piston 431 is provided with a longitudinally extending bore 438 and with a communicating diametrically extending bore 439. Communicating with the bore 430 adjacent the bottom thereof is a pipe 440 which, as clearly illustrated in Fig. 39 of the drawings, leads to a junction block 441 which communicates with the drain pipe 422.

It is evident that in the positions of the parts illustrated in Fig. 24 of the drawings, communication between the pipes 427 and 440 will be shut off which is the normal operating position of the apparatus. However, should the knob or handle 432 be pushed down, port 439 will be in communication with chamber 436 and will provide a free passage for oil from pipe 427 through chamber 436, port 439, bore 438 and bore 430 to pipe 440. This operation will, of course, have the same effect as the opening of the relief valve 424 which will provide a pressure relief for high pressure in the pipe 409 as previously described in connection with the volume control and pressure relief valve 400. Thus should any emergency arise in which the automatic pressure relief function of the valve 400 is not performed, it may be relieved by the manual operation of the relief pilot valve 428.

It may also be noted at this point, by reference to Fig. 39 of the drawings, that a drain pipe 442 extends between the pump 392 and the junction box 441 to provide for the return of any oil which does not flow in the proper path, particularly such oil as leaks past bearings or bushings.

From that portion of the hydraulic control system above described it is manifest that hydraulic fluid under regulated pressure and volume is supplied to the pressure pipe 409 which, as clearly illustrated in Fig. 39 of the drawings, leads to a two unit control valve 443 which has

two control pistons the structure of which is similar to that of the four unit control valve 448 hereinafter described in full detail. It may be stated, however, that the two unit control valve 443 (Fig. 36^a) has one slide piston 520 which is operative to control the hydraulic piston motors 82 and 83 for swinging the turntable 71 about its upright axis; and another slide piston 519 which is operative to control a rotary type of hydraulic motor 444 to effect slow speed or sumping travel of the mining machine, as hereinafter described in complete detail.

It may also be stated that excess fluid drain pipes 445 and 446 are provided for the control valve 443 and hydraulic motor 444, respectively, which lead to the junction box 441 and, in turn, to the drain pipe 422.

It may also be stated that without regard to the positions of the slide pistons 519, 520, Fig. 36^a, of the two unit control valve 443, pressure will always be available to pressure pipe 447 which extends therefrom and leads to the four unit control valve 448 the structure of which is illustrated in detail in Figs. 2, 10, 11, 12, 18 and 36 of the drawings, to which attention is now directed. As hereinafter described, the pressure pipe 447 is a flexible rubber hose as it extends from a stationary part of the mining machine to the adjustable supplementary frame 100. It may also be noted that a return or drain pipe 449 also formed of a flexible rubber hose extends from the four unit control valve 448 to the junction box 441.

Said four unit control valve 448 comprises a main block or manifold 450 supported from an upright wall 451 of the gear casing 106 (see Fig. 18) over which extends an integral protecting plate 452 (see Fig. 10). The block 450 is provided with four longitudinally extending bores 453, 454, 455 and 456 (Fig. 36) within which are slide pistons 457, 458, 459 and 460, respectively. The pistons 457, 458, 459 and 460 are provided with rigidly attached operating heads 461, 462, 463 and 464 with which are associated operating arms 465, 466, 467 and 468, respectively, (see Fig. 10).

The arms 465 and 466 are pivoted intermediate their ends to bosses 469 and 470 which are threaded in an upstanding plate 471 (Fig. 18) of the gear housing 106 and have one end pivotally attached to the operating heads 461 and 462, respectively, and the other end pivotally attached to operating rods 472 and 473, respectively. The arms 467 and 468 are not pivotally mounted but are rigidly and directly connected to operating rods 474 and 475, respectively.

As clearly illustrated in Fig. 10 of the drawings, the operating rods 472, 473, 474 and 475 are formed at the corners of a rectangle or quadrangle while the four slide pistons 457, 458, 459 and 460 are mounted in a single vertical plane. By reference to Fig. 2 of the drawings, it is to be noted that the operating rods 472, 473, 474 and 475 extend rearwardly from a position adjacent the gear casing 106 through the plate 471 to positions along one side of the motor casing 101. Each of the operating rods 472, 473, 474 and 475 has associated with it spring centering means, two of which are seen at 476 and 477 in Fig. 2 of the drawings, which tend to maintain the rods 472, 473, 474 and 475 in their central positions in which the slide pistons 457, 458, 459 and 460 are also in their central positions, as illustrated in Fig. 36 of the drawings.

Adjacent their rear ends the operating rods 75

472, 473, 474 and 475 are provided with pivoted operating levers or handles 478, 479, 480 and 481, respectively, which are positioned adjacent the rear portion of the supplementary frame 100 where they can be readily reached and operated by an operator who can watch the operation of the kerf cutting mechanism at all times.

As clearly seen by reference to Fig. 36 of the drawings, the block or manifold 450 is provided with a chamber 482 which is constantly in communication with the hydraulic fluid under pressure which is delivered by the pressure pipe 447. In the position of the slide piston 457 illustrated in said Fig. 36, the fluid under pressure will flow through a diametrical bore 483 in piston 457 which communicates with a longitudinal bore 484 therein with which communicate diametrical bores 485 and 486 in communication with a large chamber 487 which is constantly in communication with chamber 488 associated with slide piston 458.

Also associated with slide piston 457 are chambers 489 and 490 to which are connected the previously described pipes 491 and 492 by which hydraulic fluid is conducted to the piston motors 113. By moving the slide piston 457 in opposite directions the hydraulic fluid under pressure received in chamber 482 may be selectively directed to pipe 491 or 492, the former of which branches and leads to the ports 289 (Fig. 17) at the piston rod ends of the two elevating piston motors 113 in parallel, and the latter of which branches and leads to the ports 290 (Fig. 17) at the opposite or head ends of said two elevating piston motors 113 in parallel, as clearly illustrated in Fig. 39 of the drawings. This is effected by virtue of the reduced necks 493 and 494 on the slide piston 457, which are so constructed that when said slide piston is moved to the right, as viewed in Fig. 36, communication will be established between chamber 482 and chamber 490 so that said fluid under pressure will flow from said chamber 482 to said chamber 490, and by way of feed pipe 492 to the head ends of the elevating piston motors 113. The opposite or piston rod ends of the motors 113 will be connected by pipe 491 to bore 484 of slide piston 457 by way of bore 483 which is then aligned with chamber 489, whereby the return fluid from the elevating piston motors 113 is conducted to chamber 488 associated with slide piston 458 by way of longitudinal bore 484, diametrical bores 485 and 486 and chamber 487. This will expand piston motors 113.

If the slide piston 457 is moved to the left, as viewed in Fig. 36, chamber 482 is placed in communication with chamber 489 by way of neck 493 to supply fluid under pressure to pipe 491 to cause a reverse movement or contraction of the elevating hydraulic piston motors 113, the return path from said piston motors 113 being by way of pipe 492, chamber 490, diametrical bore 483 now in alignment therewith, longitudinal bore 484, diametrical bores 485 and 486, chamber 487 to chamber 488 associated with slide piston 458.

It is thus to be noted that regardless of the direction of movement of slide piston 457 to operate the hydraulic piston motors 113 either to expand or to contract them, the out-put fluid of said piston motors 113 will be delivered to chamber 488 associated with slide valve 458. As a consequence, there will always be fluid available to the slide valve 458 regardless of the position of slide valve 457 and in a similar manner

there will always be fluid under pressure available at the main feed chambers of the valves, including slide pistons 459 and 460.

In addition to the chamber 488 the slide piston 458 has associated therewith chambers 495 and 496 in communication respectively with pipes 362 and 363 which, as previously described in connection with Fig. 39, lead to piston motors 205. The slide piston 458 also has a diametrical bore 497 leading to a longitudinal bore 498 therein with which cooperate a pair of diametrical bores 499 and 500 which, in the normal position of slide piston 458, communicate with chamber 501 which leads to a chamber 502 associated with slide piston 459.

From the above discussion of the operation of the slide piston 457 it is manifest that when slide piston 458 is in its normal position, as illustrated in Fig. 36, the hydraulic fluid which reaches chamber 488 will flow through bores 497, 498, 499 and 500 in parallel to chamber 501 by which it is communicated to chamber 502.

It is also evident from the description of the operation of the slide piston 457 that reverse movements of slide piston 458 will direct the hydraulic fluid alternately to pipes 362 and 363 and when fluid is directed to pipe 362 the return of hydraulic fluid from motors 205 will be by way of pipe 363 and when hydraulic fluid is fed to pipe 363 the return of hydraulic fluid from motors 205 will be by way of pipe 362. It may be noted from reference to Fig. 39 of the drawings, that the hydraulic motors 205 are connected in parallel in a reverse fashion; that is, the fluid under pressure is fed to the head end of one of said motors and the piston rod end of the other whenever fluid is applied to them.

It is also to be noted from reference to Fig. 36 of the drawings, that when the slide valves 457 and 458 are in their normal or central positions, the hydraulic piston motors associated with them are locked in position as the hydraulic fluid in the pipes leading to said motors is trapped by the slide valves 457 and 458. A similar condition is realized in connection with the hydraulic motors associated with the slide pistons 459 and 460.

It may be stated that the valve mechanism associated with slide piston 459 is substantially the same as that associated with slide piston 457, and that the valve mechanism associated with slide piston 460 is substantially the same as that associated with slide piston 458. It thus appears that no further description of the valve mechanism associated with the slide pistons 459 and 460 is required.

It is to be noted, however, that associated with slide piston 459 and controlled thereby are pipes 503 and 504 which control the rotary hydraulic motor 269 for turning the cylinder 140 to adjust the turnover head mechanism 159 about the longitudinal axis of the elongated neck 109. It is also to be noted that previously described pipes 364 and 365 are associated with slide piston 460 and thus said slide piston 460 is operative to control the piston motor 230 to adjust the kerf cutting mechanism 160 about the axis of the yoke 172.

It is furthermore to be noted that associated with the slide piston 460 is chamber 505 which communicates with the previously mentioned drain pipe 449. It is thus to be noted that hydraulic fluid under pressure delivered to the pressure pipe 447 may be diverted by any of the slide pistons 457, 458, 459 or 460 either singly or in any combination, and in each instance the fluid

will flow successively to the slide pistons 457, 458, 459 and 460 either directly or after having been directed to a hydraulic motor, finally returning to the drain pipe 449. As a consequence, should any two or more of the slide pistons 457, 458, 459 or 460 be operated in unison, both of the hydraulic motors associated with an operating valve will receive fluid under pressure, and one of said hydraulic motors will receive fluid which is returned from the other. In other words, the two hydraulic motors will be connected in series and as a consequence, operation of both of them at the same time is assured, whereas should the motor be connected in parallel the motor which is easiest to operate will be operated first, only after which the motor which is the most difficult to operate would do so.

Attention is now directed to other mechanism associated with the slide piston 457, it being understood that each of the slide pistons 458, 459 and 460 are provided with similar elements. Adjacent opposite ends of the slide piston 457 are packing glands 506 and 507 provided with cover plates 508 and 509. Movement of the slide piston 457 in one direction is controlled by head 461 and movement thereof in the opposite direction is controlled by washer 510 attached to a threaded sleeve 511 which threads into a threaded end of bore 484 in slide piston 457 and carries a filler 512 to fill the non-working end of the bore 484. As originally formed, the sleeve 511 is provided with a head which is sawed off after it is screwed tightly into the slide valve 457. The sleeve 511 is then tapped and threaded to receive a machine screw 513 which holds the washer 510 in place.

The slide piston 457 is provided with numerous oil grooves to prevent leakage of oil along the surface thereof but since all leakage cannot be prevented there is provided a seepage pocket 514 at one end and a seepage pocket 515 at the other end thereof adapted to receive seepage oil. The seepage pockets similar to 514 associated with the slide pistons 458, 459 and 460 are all in communication by means of vertical bores, the one between slide pistons 457 and 458 being indicated at 516. Likewise, vertical bores connect the pockets associated with the opposite ends of slide pistons 458, 459 and 460 similar to pocket 515.

As clearly illustrated in Fig. 39 of the drawings, a seepage drain pipe 517 connects the pockets 514 and 515 and also is connected to collect the seepage from the rotary hydraulic motor 269. It is also to be noted that the upper right hand pocket associated with slide piston 460, as seen in Fig. 36, communicates with chamber 505, with which the drain pipe 449 is connected, by way of opposite horizontal slots 518. It is thus evident that all seepage oil or hydraulic fluid which reaches the pockets 514 and 515 and the similar pockets associated with slide pistons 458, 459 and 460 will ultimately be returned to the drain pipe 449 and to the supply tank 380. It is to be noted that since the bore 518 and the chamber 505 are adjacent the top of block or manifold 450, they will remain filled with oil at all times after once becoming filled, whereby only the excess oil will flow to the drain pipe 449.

It will be evident from reference to Figs. 2, 10, 36 and 39 that the operating lever 478 controls the slide piston 457 and controls the operation of the elevating hydraulic piston motors 113 whereby the adjustment of the supplementary frame 100 about its rear horizontal pivotal axis provided by the stub shafts 103 is effected. It is also evident that the lever 479 controls the

slide piston 458 and controls the operation of the reversely acting hydraulic piston motors 205 to control the swinging motion of the kerf cutting mechanism 160 about the axis of the shaft 179. The operating lever 480 controls the slide piston 459 and controls the rotary hydraulic motor 269 for adjusting the cylinder 140 about the longitudinal axis of the downwardly sloping neck 109 thereby to adjust the turnover head mechanism 159. The operating lever 481 controls the slide piston 460 and controls the hydraulic piston motor 230 to adjust the plane of the cutter bar 156 of the kerf cutting mechanism 160 about the axis of the yoke 172. It is thus evident that a very flexible control is provided to adjust the position of the cutter bar 156 either to cut horizontal kerfs adjacent the mine floor or the mine roof at a great height or at any horizontal plane between them or on planes which are inclined to the horizontal an amount which may reach the vertical.

It is also evident that the cutter bar 156 may be adjusted to cut vertical kerfs on either side of the longitudinal axis of the mining machine a very appreciable distance and to a very great height. The mining machine is therefore truly universal in that there are no blind spots whatever between the extreme positions within which it can operate. Furthermore, the operation of the hydraulic piston motors 82 and 83 to swing the entire supplementary frame 100 on the turntable 71 provides for even increased distances between the vertical kerfs which can be cut as well as the maximum sweep of the cutter bar 156. This is explained in more detail hereinafter.

Reverting briefly to the construction of the above mentioned two unit control valve 443, it may be stated that said control valve includes two slide pistons 519 and 520 (see Fig. 21), associated with a block 521. The structure of the control units associated with the slide pistons 519 and 520 is generally similar to that associated with any two adjacent units of the four unit control valve 448. Slide piston 519 controls the flow of hydraulic fluid under pressure from pressure pipe 409 by way of pipe 522 or 523 to rotary pumping hydraulic motor 444 for driving the mining machine at a slow sumping or kerf cutting speed, as hereinafter described, and slide piston 520 controls the flow of fluid under pressure from pressure pipe 409 from the after-described control unit by way of pipe 524 and 525 to the hydraulic piston motors 82 and 83 which are reversely connected in parallel to swing the turntable 71. It is to be understood that reverse operations of the slide pistons 519 and 520 will produce a reverse operation of the motor 444 in the one instance and of the motors 82 and 83 in the other instance. It is also to be understood that when in their normal positions the slide pistons 519 and 520 will lock the motor 444 and the motors 82, respectively, and 83 in their adjusted positions.

One of the features of our invention is that the mining machine is capable of cutting a vertical kerf while travelling along a curved track and in the performance of this kerf cutting operation the cutter bar 156 is, of course, adjusted to a vertical position and then is allowed to float on the vertical axis of the yoke 172 after the kerf has been started which is provided by allowing the piston 234 of the piston motor 230 to float. This is effected by providing a hand operated by-pass valve 526 (see Fig. 39) connecting the pipes 364 and 365, providing free communication be-

tween the opposite sides of the piston 234. It is to be noted, however, that this alone will not provide for the free floating of said piston 234 due to the fact that the presence of piston rod 235 causes a greater fluid displacement on the head side of the piston 234 than on the piston rod side thereof when it moves. In other words, as clearly seen by reference to Fig. 6 of the drawings, if the piston 234 moves to the left the amount of fluid necessary to maintain the cylinder on the head side filled will be greater than the amount of fluid which is forced out of the piston rod side thereof.

Reverse motion of the piston 234 will cause a reverse condition. This will cause differential pressures between the pipes 364 and 365 and to compensate for these pressure differences and to provide for this floating action without breakage to the apparatus there is provided an equalizing relief valve 527 connected between the pipes 364 and 365 by pipes 528 and 529. The equalizing relief valve 527 also provides for the relief of high pressure differentials between the pipes 364 and 365 or abnormal, high or low pressures in either of them, which may be otherwise caused as, for example, where an excessive load is placed upon the hydraulic piston motor 230 which may happen if the mining machine is adjusted while a kerf is being cut.

The structure of said equalizing relief valve 527 is disclosed in detail in Fig. 38 of the drawings. It comprises a block 527' having chambers 530 and 531 fed by pipes 528 and 529, respectively. The chambers 530 and 531 are connected to bore 532 by bores 533 and 534, respectively, and communication between said chambers 530 and 531 and said bore 532 is controlled by relatively weak ball check valves 535 and 536, respectively. The block 527' is also provided with a bore 537 which communicates with bore 532 by vertical bore 538 and communicates with chambers 530 and 531 by vertical bores 539 and 540, respectively, controlled by relatively strong relief valves 541 and 542, respectively, which, for example, may be set for 1500 pounds per square inch. Bore 532 is connected by pipe 543 to the previously described drain pipe 517 which is generally filled with oil.

The operation of the equalizing relief valve 527 is such that should an excessive high pressure appear in pipe 529 above that required to operate relief valve 542, said relief valve 542 will open to allow the hydraulic fluid under pressure to flow by way of bores 537, 538 and 532 to the drain pipe 543. On the other hand, should an excessively low pressure or vacuum be created in pipe 529, check valve 536 will open whereby the vacuum will draw hydraulic fluid or oil from the pipe 543 by way of bores 532 and 534 to relieve the vacuum. Likewise, should an undesirable high pressure appear in pipe 528, for example, above the seating of relief valve 541, said check valve 541 will relieve this pressure by affording a passage to drain pipe 543 by way of bores 537, 538 and 532. On the other hand, should a vacuum appear in pipe 528, check valve 535 will relieve the condition by replenishing oil therein from drain pipe 543 by way of bores 532 and 533. It is thus evident that the equalizing relief valve 527 not only permits floating of the kerf cutting mechanism 160 about the axis of yoke 172 when by-pass valve 526 is open, but also operates to relieve any abnormal pressures or vacuum in lines 364 and 365, and to compensate for any pressure differentials between them.

As seen by reference to Figs. 1, 4 and 21 of the drawings, rigidly attached to the truck 45 and extending rearwardly therefrom is a platform 545 comprising a bottom plate 546 to which is rigidly attached side plates 547 and 548 which merge into end plate 549. Said bottom, side and end plates are all rigidly attached together and are rigidly attached to the rearward plate 48 (Fig. 1) of the truck 45 by virtue of which the platform 545 is supported from said truck 45. It may be stated that the platform 545 and the elements carried thereby aid to balance the overhanging weight of the supplementary frame 100 and the structure carried thereby which overhangs the truck 45. It will be noted by reference to Fig. 21 of the drawings, that the side plate 548 and the rear plate 48 do not extend to the height of the side plate 547. We therefore provide supplementary side plate 550 as an extension of side plate 548 and supplementary rearward plate 551 as an extension of rearward plate 48, the tops of the plates 550 and 551 being substantially level with the top of side plate 547.

As clearly seen by reference to Figs. 1 and 21 of the drawings, the previously described pressure control valve 383 is carried adjacent the forward and top portion of the side plate 547. In the corner provided by the side plate 547 and the supplementary rearward plate 551, the hydraulic fluid supply tank 380 is supported. Adjacent the opposite forward corner of the platform 545 and supported upon the supplementary rearward plate 551 is the two unit control valve 443. The volume control and pressure relief valve 400 (Fig. 21) and the relief pilot valve 428 are likewise carried on the supplementary rearward plate 551 near the two unit control valve 443. The pressure gauge 411 is supported by the supplementary side plate 550 which is provided with a window 552 (see Fig. 21), so that said gauge may be easily read.

It is to be noted by reference to Figs. 1, 2 and 21 that a pair of operating means 553 and 554 are associated with the slide pistons 519 and 520 of the two unit control valve 443 each of which comprises a pivoted lever pivoted to a bracket 555 and extending respectively through slots 556 and 557 in the plate 551 whereby they will be readily accessible at a position near the previously described operating levers 478, 479, 480 and 481. As a consequence, the mining machine operator will have the control levers for both the four unit control valve 443, which is carried by the upright wall 451 (Fig. 36) and the two unit control valve 443, which is carried by the platform 545, close at hand so that they can be easily controlled. In this connection it may be stated that as seen in Fig. 39 of the drawings, all of the hydraulic system which is to the right and above the line 558 is carried by and moved with the supplementary frame 100 and all of the apparatus which is to the left and below the said line 558 is carried by and moves with the platform 545. It is for this purpose that the pressure pipe 447 and the drain pipe 449 are both made of rubber hose since there is, of course, appreciable movement of the supplementary frame both about a horizontal axis and a vertical axis with respect to the platform 545. It is to be noted, however, that only two hoses extend between these relatively movable parts.

Returning to Fig. 21 of the drawings, it is to be noted that at their right hand ends each of the slide pistons 519 and 520 is provided with automatic spring controlled centering mechanisms

559 and 560, respectively, which operate automatically to center said slide pistons 519 and 520 whenever they are released.

Supported from the bottom plate 546 of the platform 545 is an electric motor 561 (Fig. 1) with which is associated control mechanisms in control box 562 and starting resistors in resistor box 563. The electric motor 561 is for driving the mining machine both at transportation and sumping speeds through the mine and for operating the oil pump 392 to provide hydraulic fluid, such as oil, under pressure to the previously described hydraulic control system. The electric motor 561 drives gear mechanism supported upon platform 564 (see Fig. 21) supported from the bottom plate 546 and comprising a pinion 565 keyed to the armature shaft of said electric motor 561. Pinion 565 meshes with two gears 566 and 567, the latter of which is keyed to a counter-shaft 568 (see Fig. 21) which is journaled in housing 569 by spaced ball bearings 570 and 571. Surrounding the counter-shaft 568 and mounted for free rotation with respect thereto is a sleeve 572 mounted in housing 569 upon ball bearings 573 and 574. Keyed to said sleeve 572 is a worm gear 575 meshing with a worm 576 which is driven through gear reduction mechanism 577 from the rotary type hydraulic motor 444, previously described.

It will be noted by reference to Fig. 1 of the drawings, that the gear housing 569 and the housing of gear reduction mechanism 577 are rigidly connected together and are rigidly connected to the housing of rotary hydraulic motor 444 whereby they will all be supported from the platform 564.

Also surrounding the counter-shaft 568 is a sleeve 578 mounted on said shaft 568 by roller bearings 579 and 580. Intermediate its ends the counter-shaft 568 is provided with a plurality of dogs or jaws 581, for the purpose of effecting a driving relation with the sleeve 578 by way of cooperating jaws 582 formed on slide sleeve 583 which is feathered to the outer portion of sleeve 578 by cooperating key-ways and keys 584. The jaws 582 are also adapted to cooperate selectively with jaws 585 on sleeve 572 to effect a driving relation between sleeves 572 and 578. It is evident that in the central position of the jaws 582, as illustrated in Fig. 21 of the drawings, neither the sleeves 572 and 578 nor the shaft 568 and the sleeve 578 are connected together. This, of course, represents a neutral position.

Operating means for the sleeve 583 takes the form of a shipper 586 operable by a pivoted bell crank 587 (see Fig. 1), pivoted to a bracket 588 and operable from a rod 589 which, in turn, is operated from rod 590 through pivoted bell crank 591, which rod 590 is controlled by crank 592 on the end of rod 593 supported in appropriate journals in bracket 594 and operable by handle 595 which is adjacent operator's seat 596 at the rear left-hand corner of the platform 545. It is thus evident that by controlling the handle 595 a driving connection may be made to the sleeve 578 from the electric motor 561 through the gears 565 and 567 and the shaft 568 or from the rotary hydraulic motor 444 through the gear reduction mechanism 577, worm 576 and worm gear 575 (Fig. 21). The former drive is employed as a high speed drive for the mining machine for transportation purposes and the latter drive is employed for a low speed or sumping drive when the mining machine is cutting a kerf.

It may be stated that in normal operation, the jaws 582 will engage either jaws 581 or 585 so that either a high speed or a low speed connection will be effected at this point. To maintain either of the mentioned driving relations the bell crank lever 587 has associated with it spring compression mechanism 597 operative to urge the slide sleeve 583 either to the right or to the left as the arm of the bell crank lever 587 passes to either side of the vertical alignment with spring compression mechanism 597, as will be evident from reference to Fig. 1 of the drawings. This spring compression mechanism will not only maintain the jaws in locked relation but will aid their movement into interlocking relation under the controlling influence of operating handle 595.

Adjacent its outer end the sleeve 578 is provided with an integral gear 598 which meshes with a large gear 599 (see Figs. 1 and 25), provided with a large hub 600 having spiral jaws 601 and keyed to a second counter-shaft 602 journaled in bearings 603 and 604 carried by upright plates 605 and 606, respectively, the former of which is supported from bottom plate 546 and the latter of which is supported from platform 564.

Loosely journaled on the counter-shaft 602 is a drive sprocket 607 provided with jaws 608 adapted to be engaged with and disengaged from jaws 609 of clutch sleeve 610 keyed to and slidable on counter-shaft 602 by a pivoted shipper 611 pivoted on shaft 612 and operable by rod 613 (see Fig. 1) which may be adjusted longitudinally of itself by handle 614 which may be placed on either side of stop lug 615 carried on the top of control box 562. It will be evident that by moving handle 614 to one side of stop lug 615 the jaws 608 and 609 will be engaged and by moving it to the other side they will become disengaged. It is by virtue of this clutch that the operating or non-operating connection is determined for driving the mining machine either at a sumping or transportation speed.

Below the drive sprocket 607 is a pair of guide and tensioning sprockets 616 and 617 mounted on shafts 618 and 619, respectively, both of which are carried by a pivoted chain adjusting arm 620 pivotally mounted by pin 621 on a pair of upright plates 622 and 623 supported from bottom plate 546, the free end of which arm 620 has co-operating therewith a chain adjusting set screw 624 which may be adjusted to swing said arm 620 about the axis of pin 621.

Reeved about the sprockets 607, 616 and 617 and about a sprocket 625, keyed to the rearward axle 52 of the truck 45, is a drive chain 626, the lower run of which is supported intermediate the sprockets 616 and 625 by a bearing pad 627 and the upper run of which is supported intermediate the sprockets 617 and 625 by bearing pad 628. It is evident that by swinging the arm 620 about the pin 621 under the influence of the set screw 624 the tension of drive chain 626 may be adjusted. It is to be particularly noted that the drive chain does not extend in a straight line between the sprocket 607 and the sprocket 625 but is generally L-shaped. This provides for a relatively large amount of adjustment in the length of the chain 626 so that the distance between the axle 52 and the shaft 602 need not be determined with extreme accuracy. It all provides for a relatively large take-up which may be caused by stretching of the chain 626 so that a complete link of the chain 626 may be removed

without extending beyond the limits of adjustment thereof afforded by the arm 620.

Also associated with the previously described hub 600 of the gear 599 and feathered to the outside thereof is a clutch sleeve 630 having spiral jaws 631 adapted to be selectively placed in engagement with or disengaged from the jaws 601 of said hub 600 to effect a driving connection between said hub 600 and a chain sprocket 632 and for driving an electric cable reel mechanism. Shifting movement of the clutch 630 is effected by a pivoted spring pressed shipper 633 holding jaws 601 and 631 normally engaged and pivoted to shaft 634 and operable by rod 635 and crank 636 carried at the end of shaft 637 appropriately journaled in bracket 594 and having an operating handle 638 associated therewith which is adjacent the previously described operating handle 595 for controlling the slide sleeve 582.

Before describing the cable reel and the operating means therefor, attention is directed to gear 639 which meshes with a large gear 640 (see Fig. 1) formed integral with steel cable drum 641 journaled on shaft 642 carried by side plate 547 and an upright plate 643. The drum 641 carries a steel cable 644 which is particularly useful in case the mining machine is operated in very hard coal in which case it is employed to supplement the drive effected by wheels 57 (Fig. 2) or, in case the mining operation is being carried on up a slope. The cable 644 is adapted to be reeved about guide pulleys 645 or 646 at opposite sides of the platform 545 which are preferably journaled on pivoted brackets 647 and 648, respectively.

It will be noted by reference to Fig. 25 of the drawings, that the gear 639 is feathered on the end of shaft 602 for sliding movement along the axis thereof to be brought into mesh with gear 640 or brought out of mesh therewith. To effect this sliding movement of gear 639 we provide a shipper 649 adapted to slide upon rod 650 provided with retaining notches 651 and 652 with which a spring pressed detent 653 is adapted to be selectively inserted. An operating handle 654 is provided for the detent 653. It will be evident that when detent 653 is in notch 651 there will be a driving relation between gears 639 and 640 and when detent 653 is in notch 652 this driving relation will no longer exist.

It is furthermore to be noted by reference to Fig. 25 of the drawings, that the gear 566 which is driven from pinion 565 has an integral shaft 655 mounted in anti-friction bearings 656 in upright plate 606 and is keyed to a drive shaft 657 of the hydraulic gear pump 392 of the previously described hydraulic control system. It is thus to be noted that whenever the electric motor 561 is in operation the hydraulic pump 392 will be in operation to supply hydraulic fluid, such as oil under pressure, to the hydraulic control system. It is furthermore to be noted that this is entirely independent of the operation of the electric motor in casing 101 which drives the kerf cutting mechanism 160. In other words, the drive for moving the mining machine along the mine track is entirely independent of the drive of the kerf cutting mechanism.

Attention is now directed particularly to Figs. 1, 25, 27, 28, 29 and 30 and to the construction of the electric cable reel and mechanism associated therewith. The previously mentioned sprocket 632 (Fig. 25) drives a chain 658 (see Fig. 1) which, in turn, drives a sprocket 659 (see Fig. 27) which drives a cable reel 659 upon which

is reeled an electric cable 660 guided by compound screw reeling mechanism 661 (see Fig. 1). The cable reel 659 comprises a drum 662 having removable end walls 663 and 664 provided with insulating discs 665 and 666, respectively, the drum 662 having a dividing web 667 (Figs. 29, 30) and provided with a supporting and operating shaft 668 driven from the sprocket 669 by a friction slip clutch 670 (Fig. 27) which is so adjusted that when a predetermined pull is exerted by electric cable 660 on reel 659 said clutch 670 will slip. The clutch 670 comprises a central disc 671 keyed to shaft 668 and carrying on opposite faces clutch lining rings 672 compressed against disc 671 by outer discs 673 and 674 which are attached together by elongated bolts 675 and are urged toward each other and against clutch lining rings 672 and disc 671 by coil springs 676. The sprocket 669 is keyed to a flange of the disc 673. It is thus evident that movement of the sprocket 669 will be transmitted to shaft 668 through the clutch 670 but will permit slippage between the two.

It may be noted that the shaft 668 is journaled in a bracket 677 removably attached to plate 678, welded to side plate 547 and is retained in place by disc 679 attached to shaft 668 by screws 680. Lubricating fitting 681 is provided for the bearing end of shaft 668.

The shaft 668 also has cooperating therewith a brake mechanism 682 which prevents over-running of the cable reel 659 when the cable 660 is being pulled therefrom, which takes place without any driving connection to the cable reel 659 from the shaft 602 (Fig. 25). That is, the cable 660 is fed out while the mining machine moves forward, under which conditions the jaws 601 and 631 (Fig. 25) ratched over each other. It may further be stated in this connection that the driving relation between the shaft 602 and the reel 659 is only effected to haul in the cable 660.

It is further to be noted that the compound screw reeling mechanism 661 is driven from the shaft 668 by a sprocket 683 (Fig. 27) and a chain 684 (Fig. 1) which cooperates with a drive sprocket of the compound screw reeling mechanism 661.

At its other end the drum 662 of cable reel 659 is supported upon an upright plate 685 attached to bottom plate 546 and which carries a stationary bearing ring 686 supported from plate 685 by a plurality of spaced stub shaft 687 welded to the plate 685. The ring 686 is provided with a journal bearing 688 which receives a cooperating ring 689 rigidly attached to and forming part of the drum 662. A retaining ring 690 is attached to ring 689 and forms an interlocking relation with ring 686 thereby preventing axial movement of the cable reel 659 relative to ring 686 while providing for free rotation thereof. The stationary ring 686 also has rigidly but removably attached thereto a cap 691 attached by machine screws 692 and carrying at its interior surface an elongated cylinder 693 of insulating material and a shorter clamping cylinder 694, preferably formed of metal.

Mounted upon the cylinder 693 is a pair of spaced slip rings 695 and 696 which are rigidly attached thereto as by screws and which are provided with terminal blocks 697 and 698, respectively, adapted to receive the ends of electric cable conductors 699 and 700, respectively, by which power is supplied to the electrical mechanisms of the mining machine including

electric motors 561 and electric motor in housing 101. The cable conductors 699 and 700 are extended from cap 691 through conduit 701. It is, of course, evident that the cable conductors 699 and 700, the slip rings 695 and 696 and the cylinder 693 of insulating material are all stationary while the cable reel 659 rotates whenever electric cable 660 is drawn out or pulled in, and it is necessary to provide electric conductors between the conductors in cable 660 and cable conductors 699 and 700. Therefore, within the drum 662 there is mounted a base 702 of insulating material upon which is supported a pair of terminal blocks 703 and 704 which receive conductors 705 and 706, respectively, the other ends of which are attached to similar terminals one of which is seen at 708 and mounted upon insulating base 709 carried by web 667, as best illustrated in Figs. 29 and 30 of the drawings.

As best seen in Figs. 27 and 28 of the drawings, it is to be noted that the terminal blocks 703 and 704 are provided with arms 710 and 711, respectively, which carry removable contacting fingers 712 and 713, respectively, which have sliding contact with the slip rings 695 and 696, respectively. It will be noted by reference to Figs. 27 and 28 of the drawings that contacting fingers 712 and 713 and the slip rings 695, 696 are in a totally enclosed housing whereby they are fully protected and that access to said housing is gained by a pair of removable threaded doors 714 formed in opposite sides of the drum 662.

Reverting to Figs. 29 and 30 of the drawings, it is to be noted that the terminals for the conductors 705 and 706, one of which is seen at 708, are protected by a removable cover 715. It is also to be noted that this portion of the drum 662 is of generally open construction (Fig. 27) providing ready access of the electric cable 660 to the terminals one of which is seen at 708 (Fig. 30). It will thus be seen that any pull on the cable 660 which is transmitted to the reel 659 will be received by friction between the contacting convolutions of the cable 660 or will be received by the base 709 (Figs. 29, 30) which is rigidly attached to the web 667 of cable reel 659 and no pulling force will be transmitted to the conductors 705 and 706 or to the terminal block 703 and 704.

As was previously pointed out, rotation of the turntable 71 about an upright axis with respect to the truck 45 is effected by the piston motors 82 and 83 which are controlled by the two unit control valves 443 and particularly by slide piston 520 thereof controlled by an operating means 554 (Fig. 21) which is adjacent the forward left-hand end of platform 545 and close at hand to the operating levers 478, 479, 480 and 481 (Fig. 2).

It is also desirable to be able to control said hydraulic motors to swing the turntable 71 from the operator's seat 596 as the mining machine is transported along the mine tracks through the mine, particularly to adjust the supplemental frame 100 and the kerf cutting mechanism 160 to round curves in the mine. Therefore, we provide at the opposite end of slide valve 520 a pivoted operating bell crank 716 (see Figs. 1 and 21) operable by rod 717 which is controlled by handle 718 positioned near the handles 595 and 638, all of which are readily operable by an operator on seat 596 where the operator will ride when the mining machine is be-

ing transported through the mine. It may additionally be pointed out that control handles 719 and 720 are provided within reach of the operator on seat 596 for controlling the motor 561 and the motor in housing 101.

When a kerf cutting mining machine is employed to perform a sumping and swinging kerf cutting operation it is usual to support the mining machine against lateral movement by a plurality of elongated jacks one end of each of which bears against the mine roof and the other against a portion of the mining machine. Generally there is one jack on one side of the forward portion of the mining machine and another on the opposite rear side thereof, the jacks being inclined outwardly and laterally in opposite directions from opposite sides of the machine. These jacks are thus employed for the double purpose of preventing the mining machine from becoming derailed and for preventing lateral feed of the kerf-cutter of the mining machine sliding the mine track laterally over the mine bottom or spreading the rails apart. It is evident that the turntable 71 and the supplementary frame 100 must swing to cut an arcuate kerf and frequently may be adjusted while a sumping cut is being performed. It is therefore not expedient to rest a jack upon the supplementary frame 100.

When a wheeled truck of a track-mounted mining machine remains stationary on a mine track during cutting operations, a roof jack may be anchored on the periphery of a selected wheel, but when sumping operations are to be performed by moving the whole machine along the mine track, the roof jack will be displaced and drop off after a relatively short distance of travel.

To provide for a greatly extended distance of travel during such sumping operations without throwing off the roof jack, we provide jack anchoring collars 723 (Fig. 15) at the ends of the front axle 51 of the truck 45, so as to be free to swing or rotate relatively to the truck frame independently of the rotation of such front axle. Stub screws 725 are threaded into the outer ends of the axles and the circular caps 724 threaded onto such stub screws to provide for the outer thrust bearings for the hub of the wheels 57. The outer central portions of the caps 724 are provided with outwardly projecting bearings on which the jack anchoring collars 723 are journaled for free rotation of the axle 51 relatively thereto. Retaining rings 723' are welded to the outer ends of the journal bearings to keep the collars in close fitting contact with the caps 724, as shown in Fig. 15. Set screws 724' lock the caps 724 against turning relatively to the axle shaft 51.

Now upon placing roof jacks with their lower ends on the collars 723 and with their upper ends leaning forwardly, outwardly and laterally from the machine toward the working face, the jacks will remain effectively anchored at both their upper and lower ends during an appreciable distance of forward feeding travel of the machine along the mine track. This distance of travel may be as much as three or four feet. Such rotatable collars 725 serve as pivoted anchorages for the lower ends of the roof jacks which enables the use of simple and inexpensive roof jacks in that each may comprise a pipe or rod pointed at its upper end with an arcuate shoe at its lower end to fit the contour of the collar 725. If desired the roof jacks may be adjustable in length so as to be extensible for the various positions

of the mining machine during rectilinear sumping and withdrawal feeding movements parallel to the mine track.

It may also be noted by reference to Fig. 2 of the drawings that the supplementary frame 100 carries a pair of electric lights 721 and 722 at opposite sides thereof to illuminate the work ahead of the mining machine or to illuminate the entry, room or tunnel in which the mining machine is travelling.

It may further be mentioned that adjacent its rear end the turntable 72 is provided with a basket rim 726 (see Figs. 4 and 5) which co-operates with the top plate 72 of turntable 71 to provide a holder or receptacle which is found useful to receive tools or other loose objects which a mine operator may care to keep ready at hand.

It is also to be noted that a guide plate 727 (Figs. 4 and 5) extends forwardly from the supplementary rearward plate 551 to guide any material to the receptacle formed by the basket rim 726 and to prevent it falling below the turntable top plate 72 and onto the top plate 70 of the truck 45.

It may further be stated that while Figs. 1 and 21 of the drawings, show most of the mechanism carried by the platform 545 as exposed, said mechanism will, in fact, be covered by cover plate means 728 seen in Fig. 4 of the drawings, which cover plate means covers substantially the entire platform 545 except that it will not cover the motor 561, control box 562 or the space immediately to the rear of said control box 562 which, of course, provides a space for the operator who rides on seat 596. Adjacent said seat 596 the cover plate 728 terminates at the extremity of upright plate 685.

In the operation of the mining machine comprising our invention for transportation through the mine, it is evident that the wheels 57 of the truck 45 will be driven from the electric motor 561 through a relatively high speed drive which is effected by virtue of the engagement of jaws 608 and 609 (Fig. 25) and by the engagement of jaws 581 and 582 (Fig. 21). During this transportation operation the operator will ride on the seat 569 where he will have ready control of operating handles 595 and 638. The operator can also control the motor 561 from this position through the control handles 719 and 720. It is manifest that whenever the motor 561 is in operation the pump 392 of the hydraulic control system will also be in operation to supply hydraulic fluid under pressure for any desired purpose. It may be stated that when the pump 392 is doing no useful work, the hydraulic fluid delivered thereby will flow through a low resistance path through the two unit control valve 443 and the four unit control valve 448 back to the supply tank 380 by way of drain pipe 449.

Should it be necessary to adjust the turntable 71 for any purpose during transportation of the mining machine as, for example, when travelling around a curve, the operator on seat 596 can readily operate handle 718 to control slide piston 519 of the two unit control valve 443 which controls the piston motors 82 and 83 for adjusting the turntable 71 about its vertical axis. It is, of course, evident that movement of the handle 718 in opposite directions will cause rotation of the turntable 71 in opposite directions and that when handle 718 is in its normal position to which it automatically returns, the piston

motors 82 and 83 will be locked in their adjusted positions thereby to lock the turntable 71.

After the mining machine has reached a place or position where it is desired to cut a kerf of any type, the operator will control said mining machine from a position adjacent the left side thereof and at the rear of the supplementary frame 100 where the operating levers 478, 479, 480, 481, 553 and 554 are located.

In the performance of a kerf cutting operation it is to be noted that the electric motor in casing 101 has for its sole purpose the driving of the cutter chain 157 of the kerf cutting mechanism 160; as a consequence, all the power of said electric motor may be applied to the kerf cutting operation.

All of the various adjustments to the mining machine are effected from power derived from the electric motor 561, most of which adjustments are effected by the hydraulic control system supplied with hydraulic fluid, such as oil, under pressure from the pump 392, in a manner previously described. In this connection it is to be noted that the low speed sumping of the mining machine is effected by driving the wheels 57 of the truck 45 from the electric motor 561 through a hydraulic gear train or coupling unit including the pump 392 and the rotary hydraulic motor 444 which motor 444 is under the control of the slide piston 519 of two unit control valve 443. By virtue of this hydraulic drive it is manifest that the rate of feed during sumping is not only independent of the rate of travel of the cutter chain, but is also responsive to the hardness of the coal or the resistance of the coal to the entrance of the kerf cutting mechanism 160. In other words, a hydraulic coupling provides for flexibility in the drive of the mining machine at sumping speeds and also greatly reduces the amount of gearing which would otherwise be necessary to effect the low speed drive required for sumping. It is furthermore to be noted that this driving connection will be effected when jaws 582 (Fig. 21) are in engagement with jaws 585 which are controlled by handle 595.

Attention is now directed particularly to Figs. 40, 41, 42, 43, 44 and 45 which illustrate some, but not all, of the kerf cutting operations which can be performed by the mining machine comprising our invention. As clearly illustrated in these figures of the drawings, the wheels 57 of the truck 45 are adapted to travel on the rails 729 of a mine track which are supported on cross-ties 730.

In Fig. 40 of the drawings there is illustrated the flexibility of the mining machine in cutting a horizontal kerf or kerf which may be inclined slightly to the horizontal. As here illustrated an arcuate cut 731 is made between the side walls or ribs 732, 733 of the room or place where the mining operation is being conducted. This kerf may be cut by a combined action of swinging of the kerf cutting mechanism 160 about the vertical axis of the drive shaft 179 and the swinging movement of the turntable 71 about its upright axis. It is, of course, evident that both swinging motions are controlled by hydraulic piston motors, the first by hydraulic piston motors 205 and the second by hydraulic piston motors 82 and 83.

In Fig. 41 of the drawings, there is illustrated the cutting of horizontal arcuate kerfs with the kerf cutting mechanism 160 in the top cutting position which, of course, is effected by turning over the cylinder 140 by operation of rotary hy-

draulic motor 269. The level at which this horizontal kerf is cut is adjusted by the vertical adjustment of supplementary frame 100 about the axis of stud shafts 103 at the rear end of turntable 71 and may be anywhere between the two dotted line positions of the kerf cutting mechanism 160 illustrated in Fig. 41 of the drawings. This provides for the cutting of a horizontal kerf adjacent the roof 734 of the mine room and in planes below said roof anywhere to the position below the top of the mining machine represented by the lower dotted lines 160.

In Fig. 42 the kerf cutting mechanism 160 is illustrated in bottom cutting positions and this figure illustrates the range of horizontal kerfs which can be cut thereby when in said bottom position which extend from the mine floor at which the kerf cutting mechanism is shown in full lines to a relatively high position where it is illustrated in dotted lines. It is obvious by a comparison of Figs. 41 and 42 that there are no vertical blind spots whatever and that the mining machine can cut a horizontal kerf anywhere between the roof of the mine room and the floor thereof. It is, of course, evident that kerfs which are inclined any amount to the horizontal may also be cut between wide limits.

Figs. 43, 44 and 45 illustrate vertical kerf cutting positions of the kerf cutting mechanism 160 and the extreme range through which they may be cut by the combined adjustment of the supplementary frame 100 and the kerf cutting mechanism 160. It is to be particularly noted from reference to Fig. 43 that vertical kerfs cannot only be cut from the mine floor of the mine roof 734 but in case the mining machine is desired for use in strip mining, vertical kerfs may be cut along the sides of the rails 729 to depths appreciably below said rails.

As illustrated in Fig. 45 of the drawings, the vertical kerfs may be cut anywhere between the ribs of the mine room as determined by the length of the supplementary frame 100 measured from the pivot point of the turntable 71 to the kerf cutting mechanism 160 when said turntable 71 is swung either to the right or to the left the greatest permissible amount, and the kerf cutting mechanism 160 is vertical and parallel with the track 729. Between these two extreme conditions, which are illustrated in dotted lines in Fig. 45 of the drawings, there are no blind spots whatever because the kerf cutting mechanism 160 can be moved to the longitudinal axis of the mining machine when on either side of the longitudinal axis of neck 109 and still lie in a plane parallel with said longitudinal axis of the mining machine.

In Fig. 44 of the drawings, the mining machine is shown cutting an angle shear from a straight track, though the same cut may be made from a curved track through one of the ribs of the room or to make an entry into a new mine room. This operation is effected by first adjusting the kerf cutting mechanism 160, as illustrated in full lines in Fig. 44, and starting the cut by swinging the turntable 71 about its vertical axis. After the kerf is started the kerf cutting mechanism 160 is allowed to float on the vertical axis provided by the yoke 172 by opening the hand valve 526 of the hydraulic control system disclosed in Fig. 39 of the drawings. The kerf cutting mechanism 160 is continued to be fed along a straight line in its own plane by continuous rotation of the turntable about its upright axis with the kerf cutting mechanism 160

floating as aforesaid and with a slow forward feeding of the mining machine along the rails 729 toward the right as viewed in Fig. 44, until the kerf cutting mechanism 160 has been imbedded in the coal vein its full effective length. Thereafter the cutting mechanism 160 is fed in a vertical plane by swinging the same on the axis 179 (Fig. 6) of the cutter bar by means of the hydraulic motors 205. Finally a withdrawal cut is made by reversing the sumping operation, to complete the cutting of a parallel ribbed kerf in a vertical plane extending at an acute angle with the face of the rib.

It should be understood that such vertical kerfs are spaced apart along the rib and the coal thus shot down between the kerfs and removed leaving the opening illustrated in Fig. 44 between the dotted line positions 160, 160. These mining operations are intended to be preliminary to the formation of a break-through in a pillar, and are followed by the laying of a curved mine track into such opening so that the mining machine may be operated from the curved mine track to produce additional spaced-apart vertical kerfs in the pillar to facilitate dislodgement of the coal between such vertical kerfs. Such mining operations are carried on until the break-through is completed.

It is evident that the hydraulic control system affords a compact and rugged mining machine with such flexibility of adjustments as to secure very speedy operations in the cutting of horizontal and upright kerfs in a coal face in advance of the mine track with no blind spots whatever and in the cutting of spaced upright kerfs from either side of a straight track or a curved track.

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 we therefore wish not to be restricted to the precise construction herein disclosed.

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

1. In a mining machine, the combination with a support, of a supplemental frame pivotally connected at its rear end to said support for adjustment of the elevation of the forward end of said supplemental frame on a horizontal axis, arms rigidly connected at their forward ends to the sides of said supplemental frame and branching rearwardly in spaced-apart relation to the sides of the supplemental frame, hydraulic reciprocating cylinder and piston motors, means for pivotally connecting the pistons of the motors to said supports, mechanism for journaling the cylinders of the motors between said arms and the sides of said supplemental frame, kerf-cutting mechanism mounted on said supplemental frame, and means for effecting the operation of said motors to adjust the elevation of said kerf-cutting mechanism on said horizontal axis.

2. In a mining machine, the combination with a support, of a chain kerf-cutter comprising a cutter bar, a cylindrical bearing at the outer end of said support, a cutter head journaled in said cylindrical bearing, power-transmission mechanism extending from said support through said cutter head to said kerf-cutter to drive the same and comprising a shaft at right angles to said cutter bar projecting through an arcuate slot in said cylindrical bearing, a pair of arcuately slotted segmental sleeves with said cylindrical bear-

ing in position to maintain closed said arcuate slot in the cylindrical bearing, a limit stop in position on the cylindrical bearing to co-operate with the slots in said segmental sleeves, and motor-operated means connected to said cutter head to swing the same on its pivot to effect swinging of the cutter bar through a wide angle while said sleeves maintain closed the said arcuate slot in said cylindrical bearing.

3. In a mining machine, the combination with a support, of a cylindrical bearing at the outer end of said support, a chain kerf-cutter comprising a cutter bar, a cutter head comprising an enclosing cylindrical drum journaled in said cylindrical bearing, power-transmission mechanism extending from said support and through a slot in said drum to said kerf-cutter to drive the same, said power-transmission mechanism comprising a shaft extending at right angles to the axis of said drum and through an arcuate slot in said cylindrical bearing to said cutter bar at right angles to the latter, a pair of overlapping segmental sleeves fitting between said drum and said cylindrical bearing and having slots of different lengths for the projection of said shaft therethrough, limit stop mechanism associated with said sleeves to prevent the same from moving at any time to positions opening the arcuate slot in said cylindrical bearing, and means for adjusting the cutter bar transversely of itself by moving said cutter head on the axis of said drum while said shaft slides said sleeves successively relatively to said cylindrical bearing to maintain enclosed the power-transmission elements within the said drum and thereby prevent lubricant from escaping therefrom.

4. In a mining machine, the combination with a supporting frame, of a supplemental frame mounted thereon for rotary adjustment relative thereto, mining mechanism carried by said supplemental frame, a motor mounted on said supplemental frame and connected to said mining mechanism to adjust the same, a reel mounted on said supplemental frame on the axis of rotation thereof relative to said supporting frame, means for supplying power to said motor including a flexible conductor coiled about said reel and connected to said motor, and means for effecting rotary adjustment of said supplemental frame relative to said supporting frame while maintaining taut said flexible conductor.

5. In a mining machine, the combination with a supporting frame, of a supplemental frame mounted thereon for rotary adjustment relative thereto, mining mechanism carried by said supplemental frame, means comprising a motor carried by said supplemental frame for adjusting said mining mechanism relative to said supplemental frame, a reel mounted on said supplemental frame to rotate therewith relatively to said supporting frame on the same axis of rotation, another reel mounted on the supporting frame on a parallel spaced-apart axis and in the plane of the first-named reel, a flexible power conductor extending from the supporting frame to said motor and associated with said reels, means for rotating said supplemental frame relatively to said supporting frame to effect rotary adjustment of the mining mechanism bodily, and means operatively connected between the supplemental frame and the reel on the supporting frame to effect rotation of the last-named reel in unison with the rotation of the reel on the supplemental frame and thereby take up the flexible conductor on one reel while paying it out from the other.

6. In a mining machine, the combination with a supporting frame, of a supplemental frame mounted thereon for adjustment relative thereto on a predetermined axis, kerf-cutting mechanism mounted on said supplemental frame for adjustment relative thereto, means for adjusting said kerf-cutting mechanism relative to said supplemental frame comprising a fluid-pressure motor mounted on said supplemental frame to rotate bodily therewith, a hose reel mounted on said supplemental frame to rotate with said supplemental frame on said axis, a hose wound on said reel and connecting a source of power on said supporting frame to said fluid-pressure motor, means operatively connected to said supplemental frame for taking up and paying out said hose during rotation of said reel to maintain the hose taut for the various positions of rotary adjustment of said supplemental frame on said axis, and means for rotating said supplemental frame on said axis to adjust the kerf-cutting mechanism bodily.

7. In a mining machine, the combination with a support, of a pump thereon, a supplemental frame mounted thereon for rotary adjustment relative thereto on a predetermined axis, a hose reel mounted to rotate on said axis, fluid-pressure operating means on said supplemental frame, a hose wound on said reel and adapted to connect said pump to said fluid-pressure operating means, and means for effecting the paying out or winding up of said hose on said reel when said supplemental frame is rotarily adjusted on said axis.

8. In a mining machine, the combination with a support, of a cylinder mounted thereon for rotary adjustment relative thereto, a reel on said cylinder to rotate therewith, a flexible power conductor wound on said reel, and means for receiving the conductor when paid out from said reel upon rotation of the latter in one direction and for paying out the conductor to said reel upon rotation of the latter in the opposite direction and thereby maintain taut said flexible conductor during the various positions of rotary adjustment of said cylinder on said support.

9. In a mining machine, the combination with a frame, of a rotatable cylinder thereon, a reel, a flexible conductor attached at one end to said cylinder and at the other end to said reel and having sufficient length to coil about said cylinder and said reel to permit rotation of said cylinder through an arc not less than 270 degrees, means for limiting the rotation of said cylinder, and means for rotating said cylinder and reel together while maintaining said conductor taut.

10. In a mining machine, the combination with a support, of a shaft journaled to said support, a reel on said shaft, a supplemental frame mounted on said support for rotary adjustment relative thereto on a predetermined axis, mining mechanism mounted on said supplemental frame, fluid-pressure motor mechanism on said supplemental frame and connected to said mining mechanism to adjust the same relative to said supplemental frame, a hose wound on said reel and connected to said fluid-pressure motor mechanism to conduct the fluid-pressure medium thereto, and means affording passageways from said hose through said shaft to a source of fluid pressure on said support.

11. In a mining machine, the combination with a support, of a reel mounted thereon to rotate relatively thereto, a supplemental frame mounted on said support for rotary adjustment

relative thereto, mining mechanism mounted on said supplemental frame, means comprising a fluid-pressure motor for adjusting said mining mechanism relative to said supplemental frame, a hose wound on said reel and connected to said motor, means comprising a flexible cable for rotating said reel when said supplemental frame is rotarily adjusted relative to said support, and means affording passageways to said hose from a source of power on said support during the various positions of said reel.

12. In a mining machine, the combination with a main frame, of a supplemental frame mounted thereon for rotary adjustment relative thereto, mining mechanism mounted on said supplemental frame, means comprising a fluid-pressure motor for adjusting said mining mechanism, reeling mechanism, a hose associated with said reeling mechanism and connected between a source of power on said main frame to said motor, and means comprising a flexible cable and anchoring and tensioning means therefor to effect the driving of said reeling mechanism to maintain the hose taut during rotary adjustment of said supplemental frame relative to said main frame.

13. In a mining machine, the combination with a supporting frame having a horizontal rear portion and a downwardly inclined forward portion, of a motor on the rear portion of said frame, kerf-cutting mechanism on the outer end of said downwardly inclined forward portion of said frame, a downwardly inclined driven shaft extending along said downwardly inclined forward portion of said frame, and power transmission mechanism gearing between said motor and said driven shaft and comprising a countershaft parallel to the motor axis with spur gearing connected between one end thereof and the motor and spiral gearing connected between the other end of said countershaft and the said downwardly inclined driven shaft.

14. In a mining machine, the combination with a supporting frame, of a plane kerf-cutter mounted thereon in position to cut a kerf in an upright plane, fluid-pressure motor mechanism for swinging said kerf-cutter on an upright pivot relatively to said supporting frame, means comprising a pair of conduits for controlling said fluid-pressure motor mechanism, a valve between said conduits for freeing said kerf-cutter to float on its pivotal connection to said supporting frame, and equalizing relief valve mechanism between said conduits and adapted to co-operate with said fluid-pressure motor mechanism.

15. In a mining machine, the combination with a supporting frame, of a plane kerf-cutter mounted thereon in position to cut a kerf in an upright plane, a reciprocating double acting fluid-pressure motor comprising a piston in a cylinder with a piston rod projecting from one end of the cylinder, mechanism connecting said piston rod to said kerf-cutter to effect swinging of the latter on an upright pivot when the motor is operated, means comprising a pair of conduits for controlling said motor, a valve between said conduits to permit the kerf-cutter to float relatively to said supporting frame, and equalizing relief valve mechanism between said conduits and adapted to act automatically to compensate for the unequal displacement of fluid-pressure medium on opposite sides of said piston and thus maintain freedom of floating of said kerf-cutter.

16. In a mining machine, the combination with

track-mounted supporting framework, of a kerf-cutter mounted thereon for adjustment to an upright plane, a piston and cylinder double acting hydraulic motor connected to said kerf-cutter to swing the same on a vertical pivot while the kerf-cutter is in upright or shearing position, a hydraulic system comprising a pair of conduits for controlling said motor and locking the motor in adjusted position, a valve between said conduits for freeing the kerf-cutter for floating the latter for feed along a curved mine track, means for moving the whole machine along such curved track to effect feeding of the kerf-cutter while in shearing position, and automatic equalizing relief valve mechanism between said conduits for preventing interference with the free floating of the kerf-cutter as the machine moves along the curved mine track and the swinging of the kerf-cutter on its vertical pivot alters the position of the piston in said cylinder.

17. In a mining machine, the combination with a supporting framework, of mining mechanism mounted thereon, means for driving said mining mechanism, hydraulic mechanism for feeding said mining mechanism including a source of hydraulic fluid under pressure, a control valve, a hydraulic motor, and means for variably adjusting the feed rate of said mining mechanism to any one of a plurality of predetermined maintained speeds when said control valve is in its normal open position, said last named means including an adjustable member, there being a predetermined maintained speed for each position of adjustment of said adjustable member.

18. In a mining machine, the combination with a supporting framework, of mining mechanism mounted thereon, means for driving said mining mechanism, hydraulic mechanism for feeding said mining mechanism including a source of hydraulic fluid under pressure, a control valve, a hydraulic motor, and a volume control

valve for variably adjusting the feed rate of said mining mechanism to any one of a plurality of predetermined maintained speeds when said control valve is in its normal open position, said volume control valve including an adjustable member, there being a predetermined maintained speed for each position of adjustment of said adjustable member.

19. In a mining machine, the combination with a supporting framework, of a kerf-cutter having an endless bit carrying cutter chain and mounted for swinging movement on said framework, a motor for driving said cutter chain, hydraulic mechanism for feeding said kerf-cutter by swinging movement including a source of hydraulic fluid under pressure, a control valve, a hydraulic motor, and means for variably adjusting the feed rate of said kerf-cutter to any one of a plurality of predetermined maintained speeds when said control valve is in its normal open position, said last named means including an adjustable member, there being a predetermined maintained speed for each position of adjustment of said adjustable member.

20. In a mining machine, the combination with a supporting framework, of a kerf-cutter having an endless bit carrying cutter chain and mounted for swinging movement on said framework, a motor for driving said cutter chain, hydraulic mechanism for feeding said kerf-cutter by swinging movement including a source of hydraulic fluid under pressure, a control valve, a hydraulic motor, and a volume control valve for variably adjusting the feed rate of said kerf-cutter to any one of a plurality of predetermined maintained speeds when said control valve is in its normal open position, said volume control valve including an adjustable member, there being a predetermined maintained speed for each position of adjustment of said adjustable member.

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