

April 28, 1942.

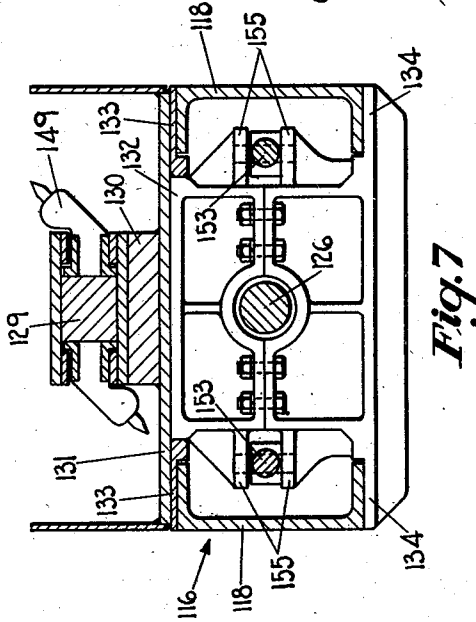
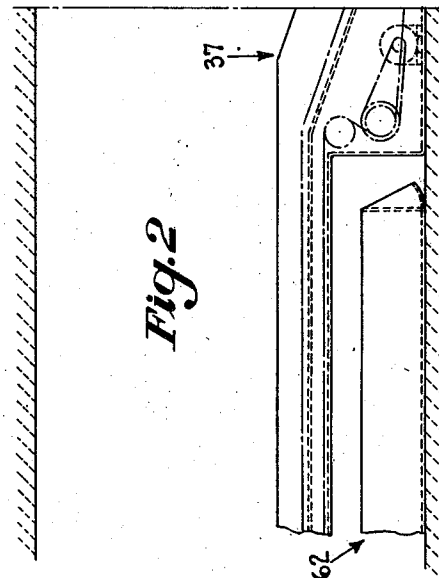
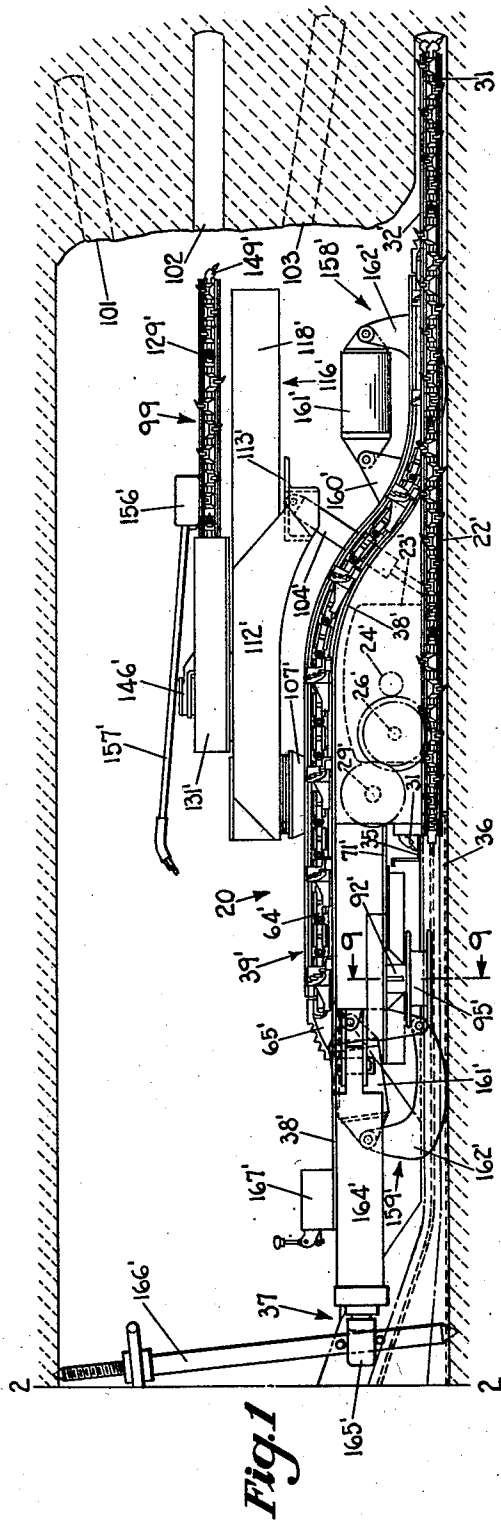
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2,281,503

APPARATUS FOR MINING COAL

Filed Aug. 15, 1938

8 Sheets-Sheet 1



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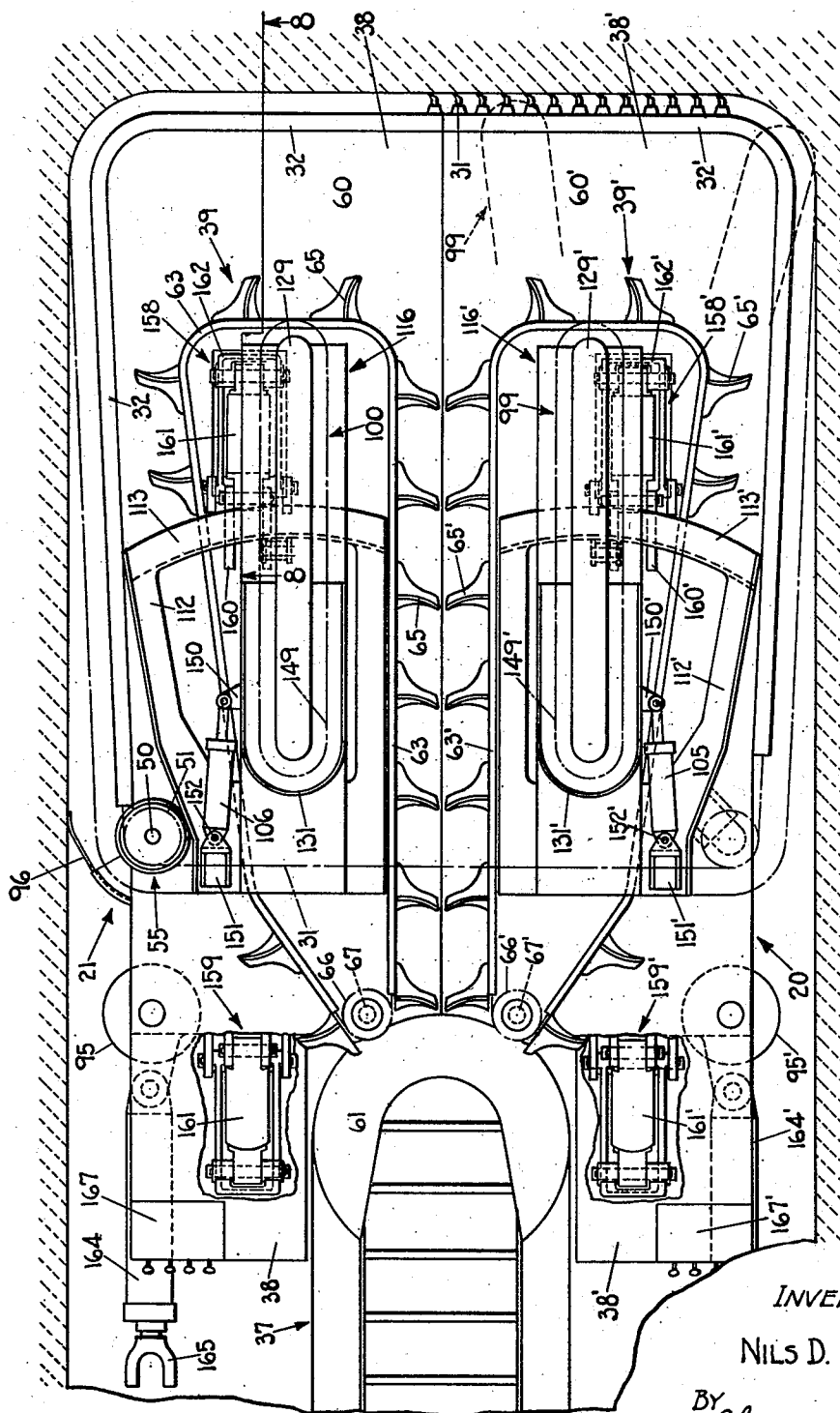


Fig. 3

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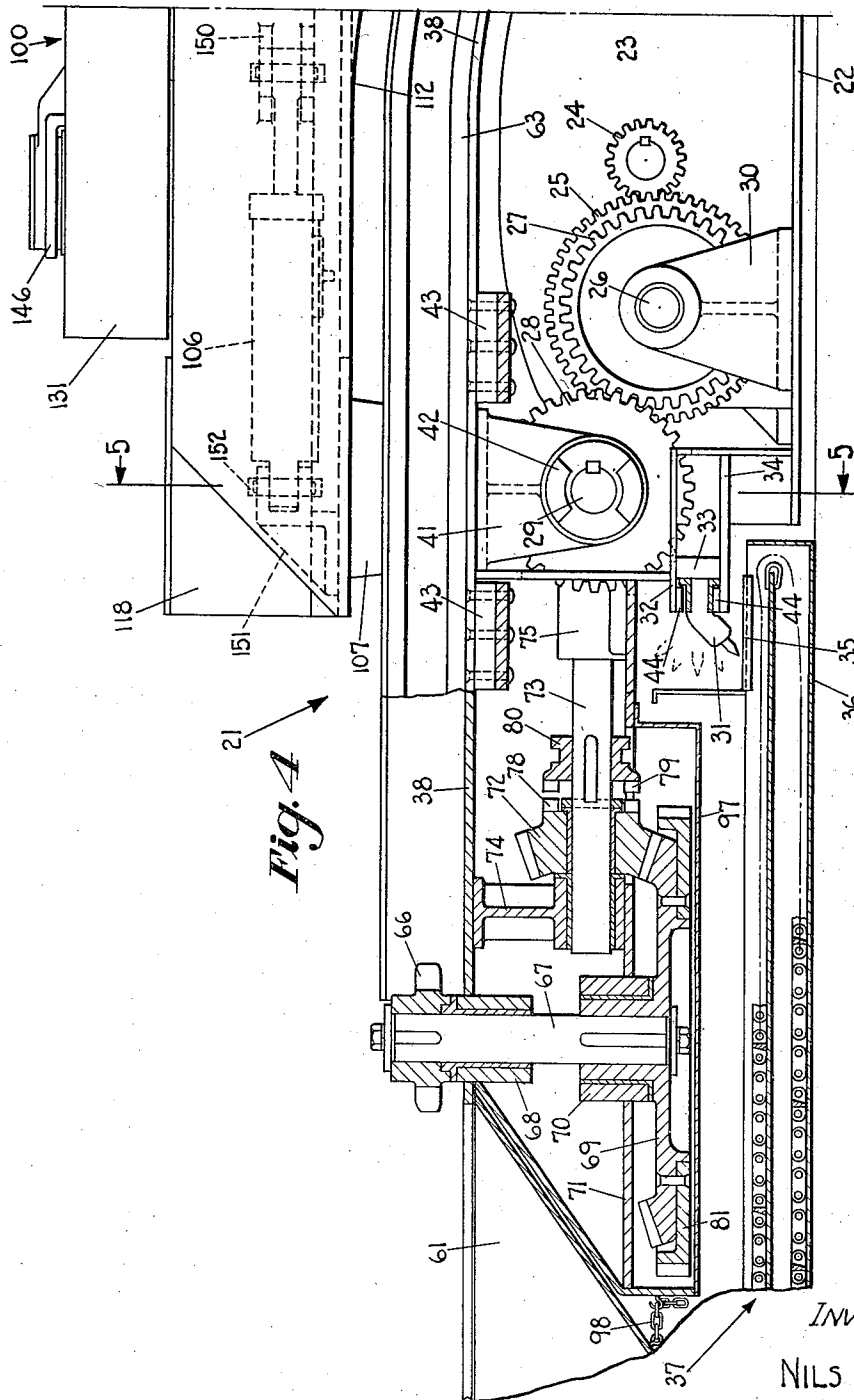
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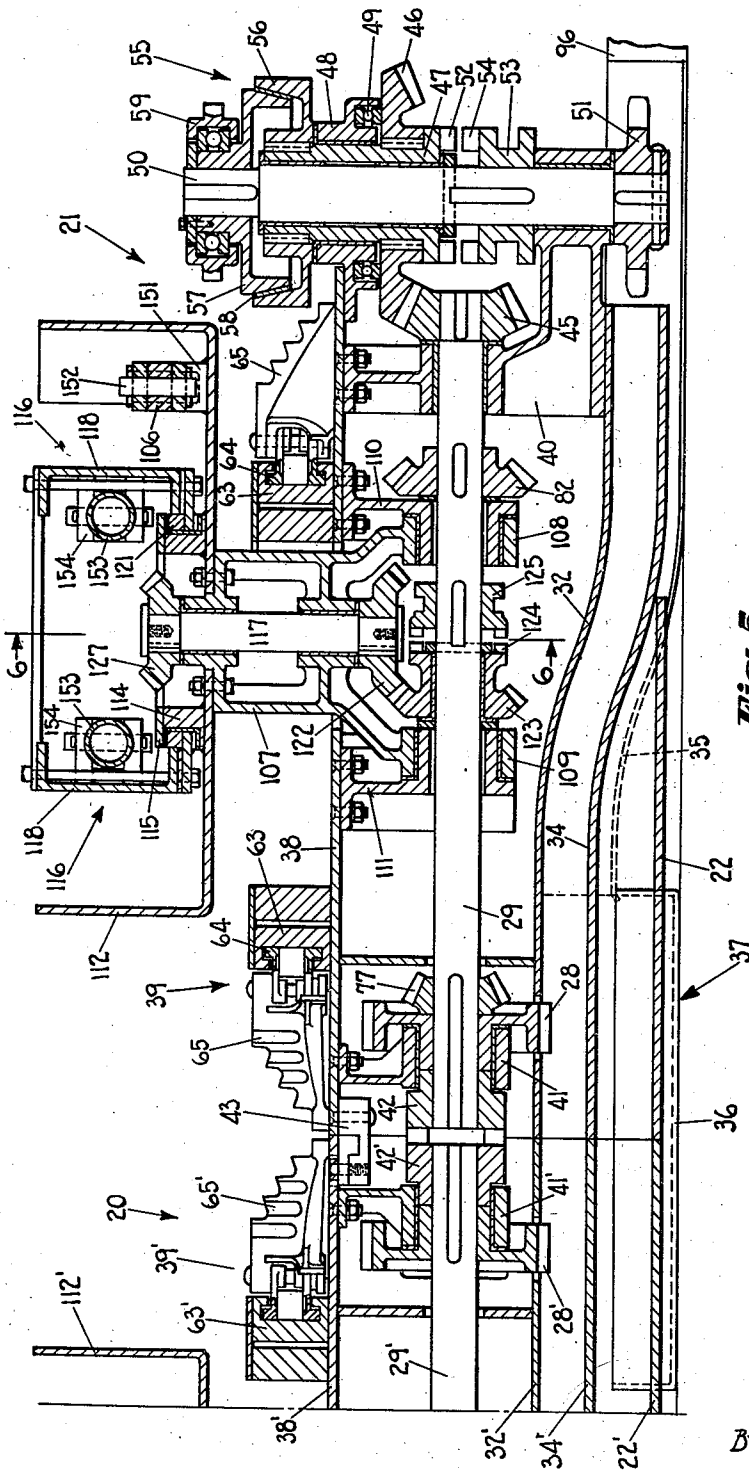


Fig. 5

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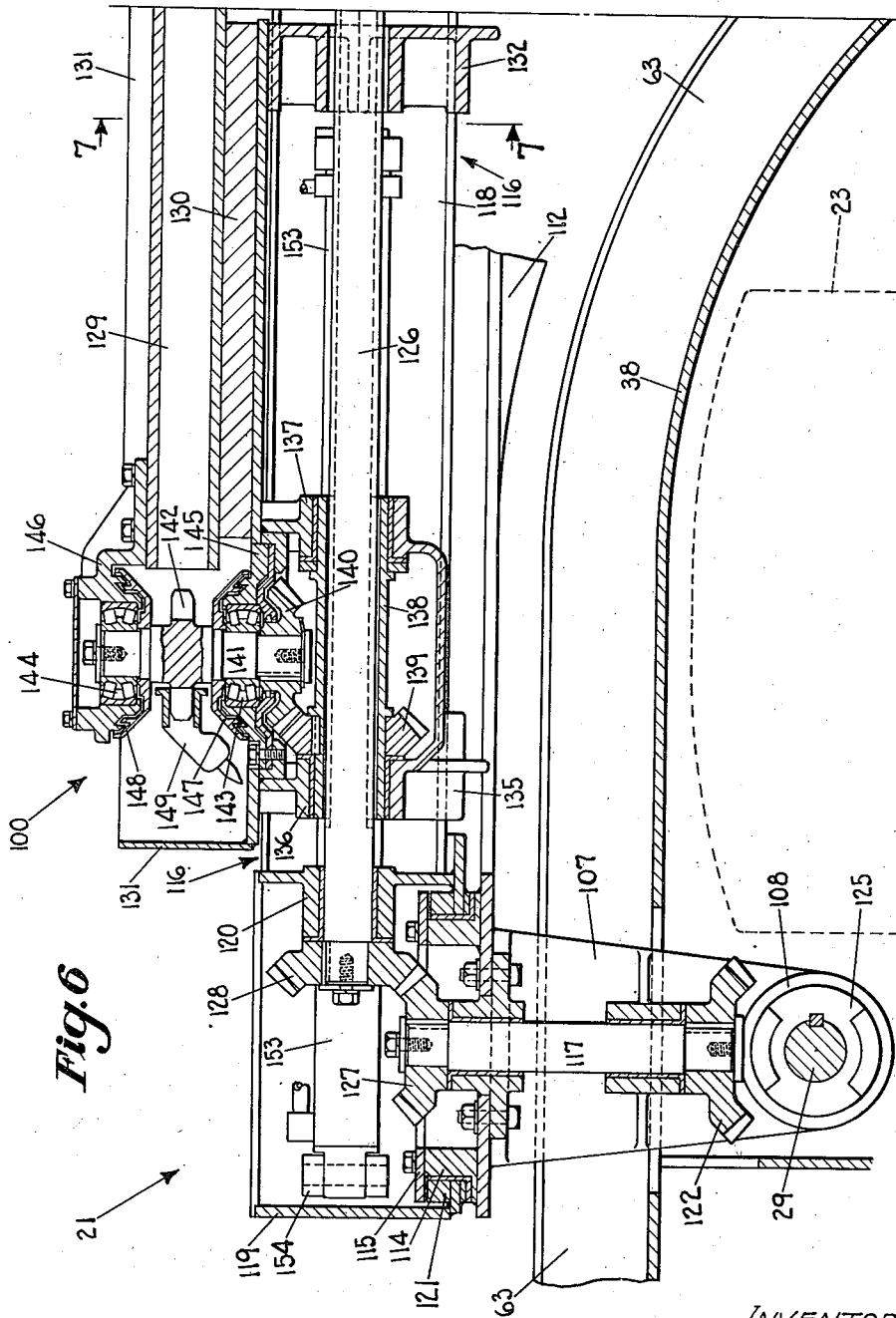


Fig. 6

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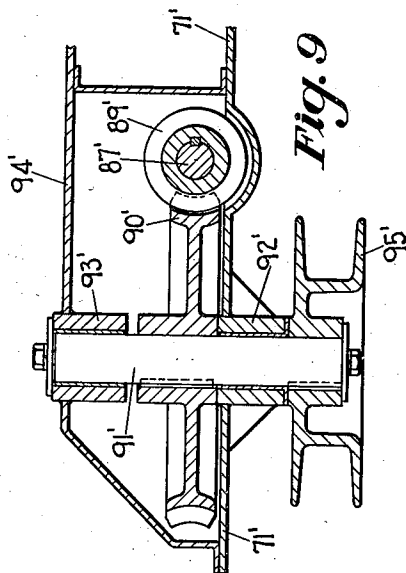
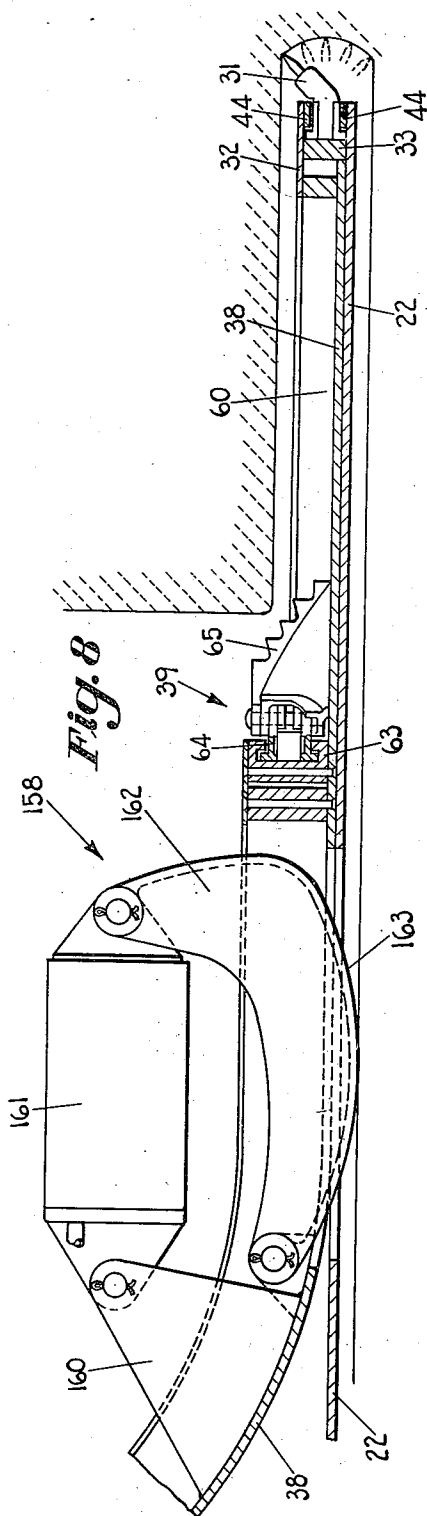
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8 Sheets-Sheet 6



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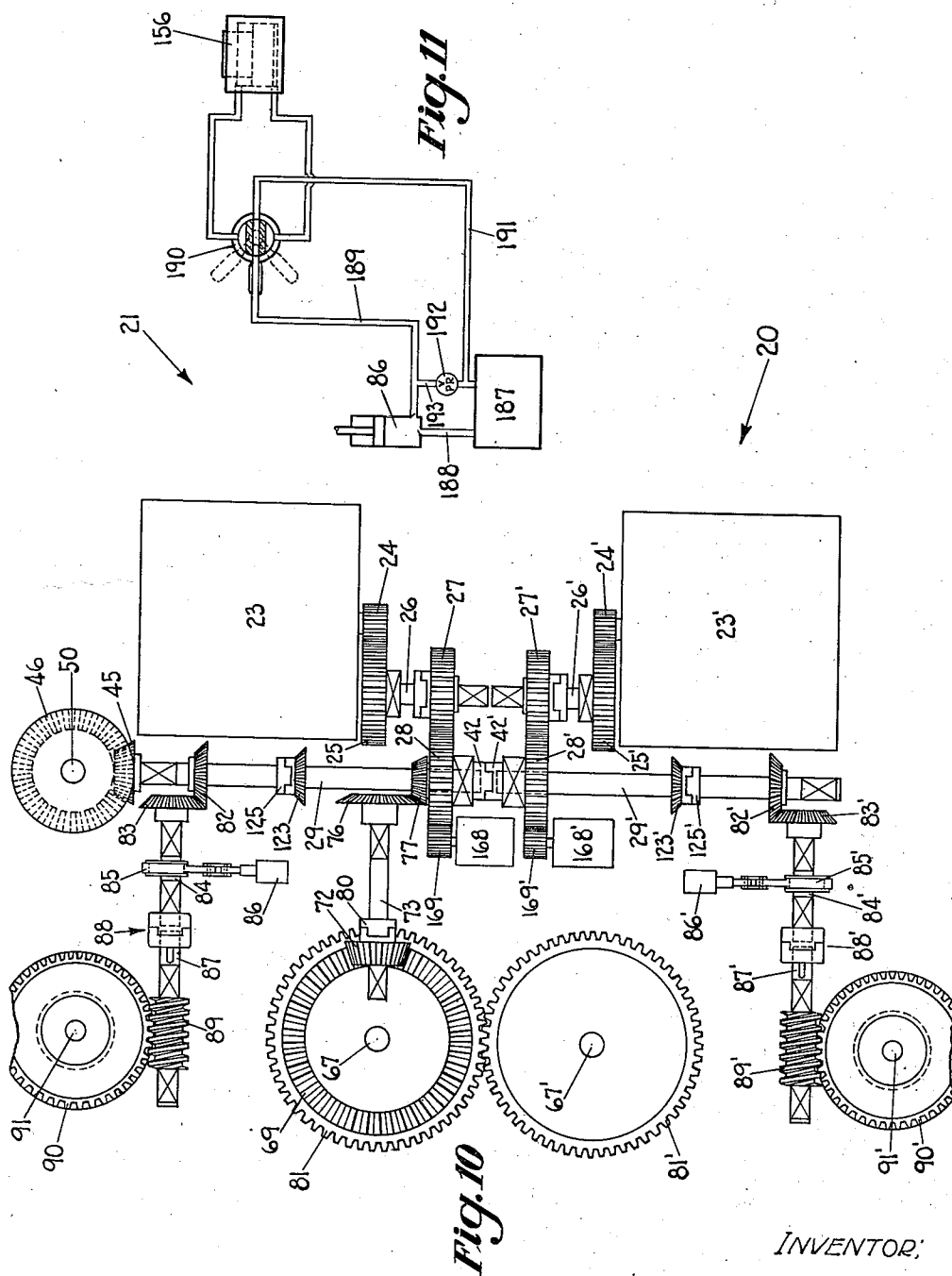
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APPARATUS FOR MINING COAL

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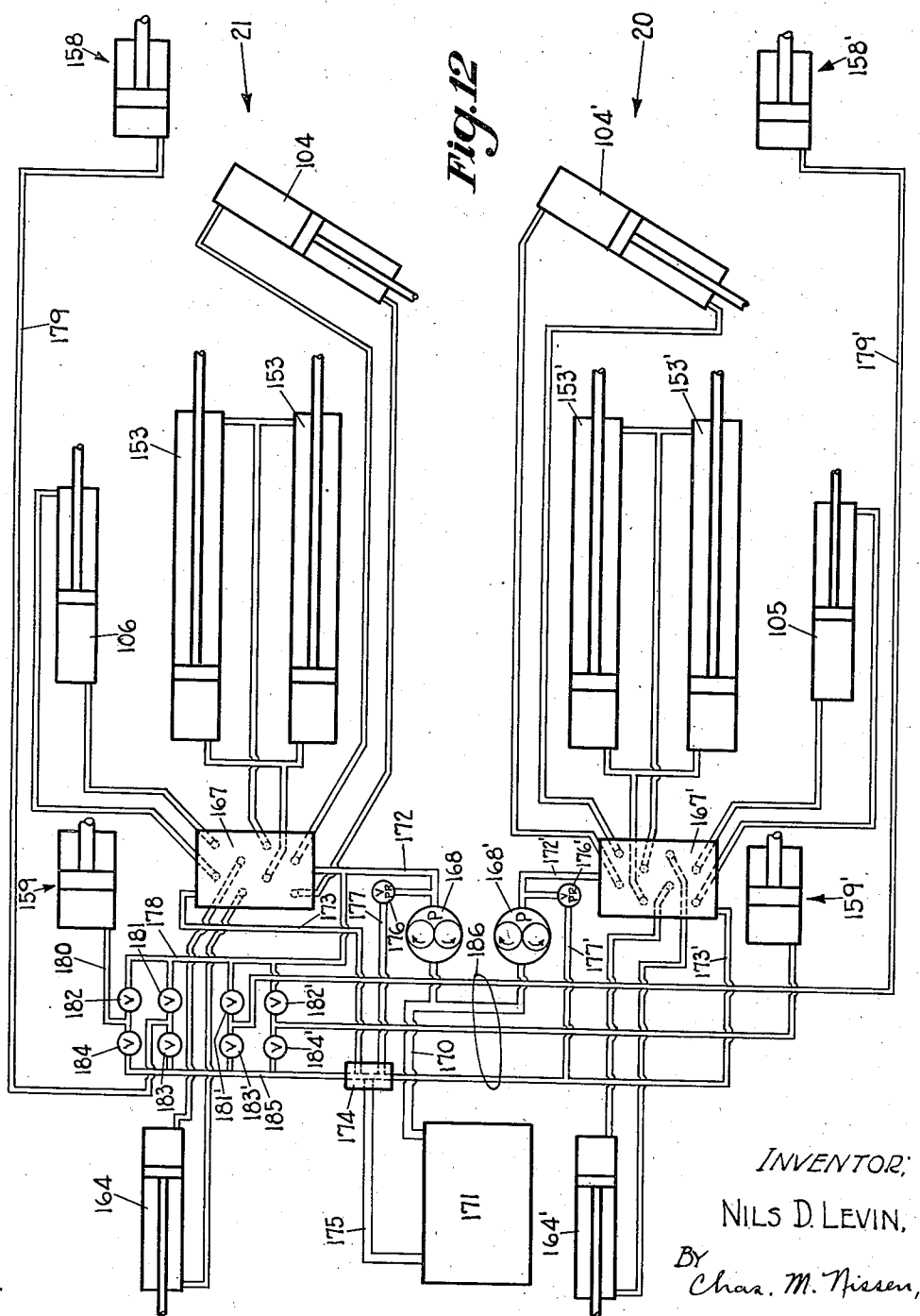
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APPARATUS FOR MINING COAL

2,281,503

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8 Sheets-Sheet 8



UNITED STATES PATENT OFFICE

2,281,503

APPARATUS FOR MINING COAL

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Application August 15, 1938, Serial No. 224,845

13 Claims. (Cl. 262—28)

This invention relates to a mining machine such as a coal mining machine and more specifically to a combination kerf cutting and loading machine.

An object of the invention is to provide a machine of the above type which is extremely flexible in operation and which has a relatively low overall height and one which can be separated into two parts each of which has its own power operating mechanism to remove it from a mine room.

Another object of the invention is to provide an efficient combination of parts for the cutting of a wide bottom kerf and intermediate or top horizontal kerfs in a plurality of positions to receive a hydraulic break-down jack.

A further object of the invention is to provide a balanced combination kerf cutting and conveying machine which will operate very efficiently to mine and remove coal.

A further object of the invention is to provide means to remove slack by the back run of the bottom kerf cutter.

Still another object of the invention is to provide means for inching the cutter chain of a kerf cutter particularly for setting the cutter bits.

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 side elevational view of a mining machine comprising my invention shown after having cut a bottom kerf in a mine room;

Fig. 2 is an extension of Fig. 1 along the line 2—2 of said Fig. 1;

Fig. 3 is a plan view of the front end of the combined mining and loading machine with parts only shown diagrammatically in the interest of clearness;

Fig. 4 is a sectional elevational view taken substantially along the center line of the mining machine except for the drive gear train of one of the gathering conveyors which is shown in complete section;

Fig. 5 is a transverse sectional elevational view taken along the line 5—5 of Fig. 4 looking in the direction of the arrows;

Fig. 6 is a sectional elevational view taken along the line 6—6 of Fig. 5 looking in the direction of the arrows;

Fig. 7 is a transverse sectional elevational view taken along the line 7—7 of Fig. 6 looking in the direction of the arrows;

Fig. 8 is a sectional elevational view taken

along the line 8—8 of Fig. 3 looking in the direction of the arrows;

Fig. 9 is a sectional elevational view taken along the line 9—9 of Fig. 1 looking in the direction of the arrows;

Fig. 10 is a schematic plan view showing the various gear trains and drives;

Fig. 11 is a piping diagram for one of the coal break-down hydraulic jacks and the control system therefor; and

Fig. 12 is a piping diagram of the hydraulic control system of the mining machine.

The mining machine comprising my invention is formed of two similar parts 20, 21 which are to be understood as identical except for a reversal of parts and except for differences specifically pointed out, which two parts are complementary and go together to form the complete unit. That is, the two parts 20 and 21 are similar, but one may be called a right hand part and the other a left hand part, and the two parts cooperate to provide the entire machine. It will therefore be understood that except for obvious differences and differences specifically mentioned, the description of the part 20 will also apply to the part 21, and vice versa, taking into account that one is a right hand structure and the other a left hand structure, similar parts carrying similar reference characters, except those associated with part 20 will be primed.

By reference to Figs. 1, 3, 4, 5 and 8 it will be seen that the part 21 comprises a frame in the form of a bottom plate 22 upon which is mounted a reversible electric driving motor 23, the drive shaft of which is provided with a pinion 24 (Figs. 4 and 10) which meshes with a large gear 25 keyed to a shaft 26 to which is keyed another gear 27 which, in turn, meshes with and drives a gear 28 keyed to the main rear jack shaft 29 (see Fig. 5). The shaft 26 is supported from the bottom plate 22 by appropriate spaced brackets one of which is seen at 30 (Fig. 4) and the other of which is located between the two gears 25 and 27. Adjacent its outer edge the bottom plate 22 is constructed to form a cutter bar comprising guide means for a bit carrying kerf cutter chain 31. Said guideway is formed by a peripheral plate 32 (see Figs. 5 and 8), which is spaced from and rigidly attached to the bottom plate 22 by a bottom guideway forming spacer plate 33.

At its rear end the bottom plate 22 is provided with a false bottom plate 34 (see Fig. 5 of the drawings), which is effective to guide the rear run of the cutter chain 31 to an elevated posi-

tion above the bottom of the mine floor which is effective to scrape cuttings up an inclined ramp 35 and discharge it into the receiving end 36 of a receiving conveyor or feeder 37, as hereinafter described more completely. The plate 32 is also elevated to follow the contour of the false bottom 34 at the rear end, as clearly illustrated in Fig. 5 of the drawings. Spaced above the bottom plate 22 at said rear end and supported therefrom is a top plate 38 which gradually slopes downwardly toward the front where it joins the bottom plate 22, as clearly illustrated in Fig. 8 of the drawings. This top plate 38 forms the pan or bottom of the scraper gathering conveyor 39, as hereinafter described in complete detail.

The afore-described jack shaft 29 is supported in an appropriate journal bearing at one end in a bracket 40 (see Fig. 5), which extends between the plates 32 and 38 and at the other end in a bracket 41 suspended from the said top plate 38, the latter bracket being journaled upon the hub of aforementioned gear 28 and of a coupling member 42 keyed to said shaft 29, which coupling member 42 cooperates with a similar coupling member 42' of the part 20 keyed to shaft 29' of said part 20 which is generally similar to shaft 29. It may be stated that the two parts 20 and 21 are removably attached together by removably attached cooperating interlocking means 43, clearly illustrated in Fig. 5 of the drawings.

The cutter chain 31 is retained in the aforementioned guideway by retaining flanges 44 which cooperate with appropriate retaining gibs on said cutter chain 31 in a manner well understood in this art. It is thus manifest that when the two parts 20 and 21 are attached together the bottom plates thereof will form an effective cutter bar of appreciable width at the bottom of the mining machine about which the continuous cutter chain 31 runs, which cutter chain will cut a bottom kerf as the mining machine is fed along the mine floor by being slid thereover, as hereinafter described in complete detail. At the same time, the rear run of the cutter chain 31 will scrape cuttings along the inclined ramp 35 and discharge it into the end 36 of the feeder 37.

Power to drive the cutter chain 31 is derived from the jack shaft 29 by way of beveled pinion 45 (see Fig. 5) keyed to one end of said shaft 29 which meshes with beveled gear 46 which, in turn, is keyed to sleeve 47 journaled in bracket 48 rigidly attached to top plate 38. An anti-friction thrust bearing 49 is also provided between the beveled gear 46 and the bracket 48. Journaled within the sleeve 47 is an upright shaft 50 the bottom of which is journaled to the afore-described bracket 40, which shaft 50 carries a drive sprocket 51 which meshes with and drives the cutter chain 31.

To effect a normal driving relation between the beveled gear 46 and the shaft 50 to drive the cutter chain 31 said beveled gear 46 is provided with bottom jaws 52 adapted to receive a sliding clutch element 53 provided with cooperating jaws 54 and which is feathered to the shaft 50. Appropriate operating mechanism is provided to shift the jaws 54 of clutch element 53 into and out of engaging relation with the jaws 52 and to maintain it in either position. It is desirable, however, to provide for relatively small movement of the cutter chain 31 or to provide for inching movement thereof for the purpose of setting the cutter bits in said cutter chain 31, and to this end I also provide a friction clutch

55 to effect a driving relation between the shaft 50 and the sleeve 47. Said friction clutch 55 comprises a clutch element 56 which is keyed to the sleeve 47 and a cooperating movable clutch element 57 preferably provided with a friction clutch band 58 and shiftable into and out of engaging relation by appropriate ball bearing shipper mechanism 59 controlled by an appropriate operating handle. The clutch element 57 is feathered on the shaft 50 for free vertical adjustment with respect thereto.

It may be mentioned that there is only one drive sprocket 51 associated with the cutter chain 31 and consequently the shaft 29' does not have associated with it any gear similar to the beveled pinion 45 or any of the mechanism driven from said beveled pinion 45. This is evident by reference to Fig. 10 of the drawings.

By reference particularly to Figs. 1, 3 and 8 of the drawings, it will be seen that the bottom plate 22 of the part 20 and the similar bottom plate of the part 21, as well as the horizontal forward portion of the top plate 38 which joins the bottom plate 22 at the forward portion of the machine, cooperate to provide a material receiving pan or area 60 for the coal which is cut and broken loose.

The previously mentioned gathering conveyor mechanism 39 is provided to convey material received by said pan or area 60 rearwardly and to discharge it into a hopper 61 (see Figs. 3 and 4), of the receiving conveyor or feeder 37 by which it is conveyed to a receptacle such as a room conveyor 62, as illustrated in Fig. 2 of the drawings.

The gathering conveyor 39 for the part 21 has as its bottom the top plate 38 over which the coal is conveyed. Mounted upon said plate 38 is an endless chain guideway 63 adapted to receive and maintain therein an endless chain 64 to which is attached a plurality of gathering flights 65 which, as illustrated in the drawings, have top serrated edges which will bite into the coal and are particularly effective to remove coal when in the form of a semi-compact mass. By reference to Fig. 3 of the drawings, it will be evident that the flights 65 of the gathering conveyor 39 associated with part 21 cooperate with similar flights associated with a similar gathering conveyor 39' on the part 20 to convey material along a central longitudinal axis of the complete mining machine and to discharge it into said hopper 61 of the receiving conveyor or feeder 37.

To drive the endless chain 64 of the conveyor 39 I provide a drive sprocket 66 (Fig. 4) which meshes therewith and which is keyed to an upright shaft 67 journaled at its top in a cup 68 carried at the rear end of the top plate 38, the bottom of which shaft 67 is keyed to a large beveled gear 69 which is journaled in a cup 70 carried by a rearwardly extending plate 71 rigidly attached to the top plate 38, which beveled gear 69 meshes with a drive pinion 72 loosely journaled on a shaft 73, which shaft 73 is journaled to brackets 74 and 75, the former of which is rigidly attached to and extends between top plate 38 and plate 71, and the latter of which is supported by said plate 71.

The shaft 73 carries at its forward end a beveled pinion 76 (see Fig. 10), which meshes with a beveled pinion 77 keyed to the shaft 29 (see Figs. 5 and 10).

To effect a selective driving relation for the sprocket 66 and consequently for the endless conveyor chain 64 the pinion 72 is provided with jaws

78 adapted to be selectively engaged with jaws 79 of shiftable clutch element 80 feathered to the shaft 73. Appropriate operating means is provided for shifting the clutch element 80 into and out of clutch engaging relation and maintaining it in either desired position.

To drive the conveyor mechanism 39' associated with the part 20, similar to the conveyor 39, the beveled gear 69 has rigidly attached to it a ring gear 81 which meshes with a similar ring gear 81' associated with shaft 67' which carries a drive sprocket 66' for driving said gathering conveyor mechanism 39' of the part 20. It will, of course, be understood that there is no structure associated with the part 20 similar to the pinion 77 and all those parts driven thereby illustrated particularly in Fig. 4 of the drawings, as is manifest from a consideration of Fig. 10 of the drawings.

As was previously mentioned, each of the parts 20 and 21 is provided with an individual handling drum which is particularly useful to remove said part individually from the mine room after the machine has completed the operation in any room, which drum may also be employed to aid the feeding of the mining machine whenever hard material is encountered or may be employed to move the mining machine away from the working face in case a hard material is encountered and it is desired to back the machine off and adjust its elevation, by means hereinafter described in full detail, to present a new attack. The handling drum associated with the part 20 is illustrated in detail, particularly by reference to Figs. 1, 9 and 10 of the drawings, and it will be understood that a similar construction is associated with the part 21.

Mounted upon the shaft 29' and keyed thereto is a beveled pinion 82', the equivalent of which for the part 21 is seen at 82 in Fig. 5 of the drawings, which pinion 82' meshes with another beveled pinion 83' keyed to a shaft 84' mounted upon appropriate journal bearings and carrying an eccentric 85' which drives a piston type hydraulic pump 86' employed to supply hydraulic fluid pressure to a hydraulic system hereinafter described and disclosed in Fig. 11 of the drawings, for controlling a hydraulic coal break-down jack, as hereinafter described in full detail.

The shaft 84' is coupled to another shaft 87', which is in alignment therewith, by a jaw clutch 88' provided with appropriate operating mechanism to move it to engaging or non-engaging position, which shaft 87' carries a worm 89'. The two shafts 84' and 87' are supported upon appropriate journal bearings, as illustrated diagrammatically in Fig. 10 of the drawings, which journal bearings are supported by appropriate brackets from the plate 71'. The worm 89' meshes with a worm gear 90' keyed rigidly to upright shaft 91' which is journaled in appropriate journal bearings carried by cups 92' and 93' the former of which is rigidly attached to plate 71' and the latter to cover plate 94' rigidly attached to said plate 71'. At its bottom the shaft 91' carries a handling drum 95' which is rigidly keyed to said shaft 91', said drum 95' being adapted to receive a flexible steel cable for moving the complete mining machine or the part 20, as above described.

It may be mentioned that in cooperation with ramp 35 by which slack is conveyed by the rear run of the cutter chain 31 to the end 36 of the receiving conveyor or feeder 37, I provide a spring

guide 96 (see Figs. 3 and 5), the outer end of which is adapted to press against the side wall or rib of the mine room and thereby guide the cuttings onto said ramp 35. It may further be mentioned that a bottom enclosing and protecting plate 97 (see Fig. 4), is provided to enclose the gears 69 and 81. It is also to be noted by reference to Fig. 4 of the drawings that the rear end of the receiving conveyor or feeder 37 is attached to the combined mining and loading machine by means of hook and chain means 98, there being two such means, one associated with each of the parts 20 and 21. This results in movement of the feeder 37 with the mining and loading machine as the latter is fed forwardly and rearwardly, as hereinafter described in more complete detail.

In cooperation with the kerf cutting mechanism afforded particularly by the cutter chain 31 each of the parts 20 and 21 is provided with a top generally horizontally positioned kerf cutter mechanism the one associated with part 20 being seen at 99 and the one associated with part 21 being seen at 100. It is to be understood that these mechanisms 99 and 100 are similar, though one is right hand and the other left hand, and thus a description of the mechanism 100 will suffice for an understanding of the construction of both.

It may be stated that the two kerf cutting mechanisms 99 and 100 are mounted for pivotal movement about a horizontal axis defined by the shafts 29 and 29', as a consequence of which kerfs may be cut in a plurality of vertical positions as illustrated by the kerfs 101, 102, 103 illustrated in Fig. 1 of the drawings. Furthermore, swinging movement of each of said kerf cutting mechanisms 99 and 100 about a vertical axis is provided so that kerfs such as kerfs 101, 102 and 103 may be cut at substantially any position in the face of the mine room. By reference to Fig. 1 of the drawings, it is to be seen that hydraulic jack or piston motor 104' is provided for adjusting the mechanism 99 about the aforementioned horizontal axis. It will, of course, be understood that a similar motor 104 is provided for similarly adjusting the kerf cutter mechanism 100. By reference to Fig. 3 of the drawings it will be seen that hydraulic jacks or piston motors 105 and 106 are provided for swinging the kerf cutting mechanisms 99 and 100, respectively, about the aforementioned upright axes. These hydraulic jacks 105 and 106 will be described more in detail hereinafter.

By reference particularly to Figs. 4, 5 and 6 of the drawings, it will be seen that the kerf cutting mechanism 100 comprises a bracket 107 provided with spaced bottom journal bearings 108, 109 which are journaled on brackets 110 and 111, respectively, which depend from top plate 38 to which they are rigidly attached. To the upper end of the bracket 107 is attached a supplemental or supporting frame 112 the forward extent of which is seen by reference to Figs. 1 and 3 of the drawings. It is also to be noted by reference to Fig. 3 of the drawings that said supporting frame 112 is provided with a forward arcuate cross-piece 113 which receives a hydraulic jack similar to the afore-described adjusting hydraulic jack 104' of part 20. Stated in another way, by reference to Fig. 1 of the drawings, it will be seen that the hydraulic jack 104' supports the forward end of supporting frame 112' with which cross-piece 113' is associated, which frame 112' in turn supports the guide frame 116' of kerf cutter mechanism 99.

As best seen by reference to Figs. 5 and 6 of the drawings, the supporting frame 112 is provided with a large journal bearing 114 provided with a removable hold-down plate 115 above the bracket 107 to which is journaled for pivotal movement about the upright axis of shaft 117 a guide frame 116. The guide frame 116 extends forwardly to the extent indicated in Fig. 3 of the drawings and to the extent indicated by the similar guide frame 116' in Fig. 1 of the drawings.

By reference to Figs. 5, 6 and 7 of the drawings it will be seen that said guide frame 116 comprises a pair spaced channel members 118 connected at their rear ends by cross-piece 119 (see Fig. 6), and cross-bearing casting 120. At said rear end the guide frame 116 is provided with a wide faced built-up bearing 121 which is journaled to the afore-described journal bearing 114 and there retained by the afore-described hold-down plate 115, thus providing for free pivotal movement of the guide frame 116 about the axis of the normally upright shaft 117.

It may be stated that the shaft 117 is driven from the jack shaft 29 by a pair of intermeshing beveled pinions 122 and 123, the former of which is keyed to the bottom of said shaft 117 and the latter of which is journaled loosely on said shaft 29 while being held against axial movement with respect thereto. A selective driving relation between the jack shaft 29 and said shaft 117 is effected by jaw clutch 124 which includes shiftable member 125 feathered on said jack shaft 29 for axial movement. Appropriate operating means is provided to shift the member 125 into engaging and non-engaging relation and to hold it in either position.

Extending longitudinally through the guide frame 116 is a splined drive shaft 126 which is driven from shaft 117 by intermeshing beveled gears 127, 128 keyed respectively to shafts 117 and 126, which shaft 126 is supported at one end in a journal bearing in bearing casting 120 and at the opposite end in a similar member carried between channels 118, not shown in the drawings.

Positioned above the guide frame 116 is a kerf cutter bar 129 lying in a generally horizontal plane the rear end of which is mounted upon a supporting block 130 carried on the bottom of a rear protecting trough 131 which trough 131 is, in turn, attached to a forward casting 132 and is supported upon slide bearings 133 (see Fig. 7) which ride upon the top flanges of the channel members 118 of the guide frame 116. The casting 132 is made in two separable parts and the lower portion thereof is provided with bearing flanges 134 which cooperate with the bottom flanges of said channel members 118 to prevent upward movement of the cutter bar 129 with respect to the guide frame 116 while permitting free longitudinal movement of said cutter bar 129 along said guide frame 116.

At its rear end the trough 131 is also slidably supported upon the upper flanges of the channel members 118 and has attached thereto a casting 135 which has bottom flanges cooperating with the bottom flanges of channel members 118 to restrict upward movement between said casting 135 and the guide frame 116 while permitting the aforementioned longitudinal movement. The casting 135 is extended forwardly and is provided with a pair of spaced journal bearings 136 and 137 between which is journaled a splined sleeve 138 which is driven by the splines on said shaft 126, said sleeve 138 surrounding said shaft 126, as clearly illustrated in Fig. 6 of the drawings.

The sleeve 138 has keyed thereto a beveled pinion 139 which meshes with another beveled pinion 140 keyed to the bottom of upright shaft 141 which has a kerf cutting chain drive sprocket 142 formed integral therewith, the shaft 141 being mounted near opposite ends in anti-friction roller bearings 143 and 144, the former of which is carried in a casting 145 attached to the bottom of said protecting trough 131 and the latter of which is carried by a bracket 146 attached at the rear upper end of the cutter bar 129. Protecting labyrinth forming plates 147 and 148 are provided for the bearings 143 and 144, respectively. Extending around the periphery of the cutter bar 129 is a continuous bit carrying cutter chain 149 which is driven by the sprocket 142. The extent of the cutter bar 129 will be evident by reference to Fig. 1 of the drawings where the similar cutter bar 129' of kerf cutter mechanism 99 associated with part 20 is illustrated.

From the above description it is manifest that the cutter chain 149 may be driven from the jack shaft 29 under the control of the jaw clutch 124 whenever it is desired to cut a kerf with said kerf cutter mechanism 100. It is also evident that the kerf cutter mechanism 99 may be controlled in a similar manner to cut a kerf. It is furthermore manifest that by controlling the hydraulic jack 104' and the similar jack 104 associated with the part 21 that the position of the cutter bar 129 may be adjusted about the axis of the jack shaft 29 or 29' whereby kerfs may be cut at substantially any position between the top and the bottom of the mine face though it is, of course, impossible to make a cut by said kerf cutter mechanism 99 or 100 directly on the bottom, this being performed by the previously described cutter chain 31 of the mining machine.

Furthermore, as is evident by reference to Fig. 3 of the drawings, and as previously described, the hydraulic jacks 105 and 106 may be employed to swing the kerf cutter mechanisms 99 and 100, respectively, about the axes of the shafts one of which is seen at 117. It may be stated that the piston of the jack 106 is pivotally attached to a bracket 150 (see Fig. 3), which, in turn, is attached to one of the channel members 118 of guide frame 116 and the rear end of the cylinder thereof is pivotally attached to a bracket 151 (see Figs. 3 and 5), by a pivot pin 152, which is carried by the supporting frame 112.

As was previously suggested, the cutter bar 129 and the protecting trough 131 are mounted for longitudinal adjustment along the axis of the shaft 126 and this provides for the rectilinear feeding of said cutter bar 129 to cut a kerf while the main body of the mining machine is stationary. To effect this rectilinear feeding movement I provide a pair of hydraulic jacks or piston motors 153 which are connected in parallel, the rear ends of which are pivotally attached to brackets 154 at the rear of the guide frame 116 one bracket 154 being carried by each channel member 118 (see Fig. 5 of the drawings). The piston rods of the jacks 153 are pivotally attached at their forward ends to brackets 155 (Fig. 7) formed integral with the previously described casting 132. It is thus manifest that upon expansion or contraction of the hydraulic jacks 153 the kerf cutter 129 will be slid rectilinearly along the axis of the shaft 126 all the while a drive connection is effected to rotate the cutter chain 149.

It is thus manifest that by virtue of the two

kerf cutting mechanisms 99 and 100 rectilinear kerfs may be cut over a wide area of the mine room face and that it is possible not only to cut rectilinear kerfs but arcuate kerfs may be cut, after one or both of the kerf cutters 99 and 100 have been fed into the mine face, by swinging said kerf cutter about the axis of the shafts, one of which is seen at 117, by means of the hydraulic jacks 105 and 106. In this connection it may be stated that by feeding the two kerf cutting mechanisms, 99 and 100 at the same time there will be a balance upon the unit both during rectilinear feeding and during arcuate feeding, particularly where the latter is effected by moving the cutter bars 129 and 129' simultaneously toward or away from each other.

To provide for the breaking down of the coal after the desired kerfs have been cut, I provide a pair of hydraulic break-down jacks one for each of the parts 20 and 21, one of which is seen (Fig. 1), at 156' which is carried on the end of a long handle 157' and which is controlled by a hydraulic control system illustrated in Fig. 11 of the drawings, hereinafter described in complete detail.

The mining machine of my invention is adapted to slide over the mine floor as previously indicated, and to provide a sliding and supporting surface therefor while at the same time providing for the adjustment of the machine vertically and angularly with respect to a horizontal plane or to the plane of the mine floor I provide four adjustable shoes upon which the machine rests on said mine floor, there being a forward and rearward shoe of similar construction associated with each of the parts 20 and 21. The forward shoe mechanism for part 21 is seen at 158 and the rearward shoe mechanism therefor is seen at 159 in Fig. 3 of the drawings, similar shoe mechanisms for the parts 20 being seen at 158' and 159' in said Fig. 3.

The shoe mechanism 158 is illustrated in detail in Fig. 8 of the drawings and comprises a bracket 160 extending upwardly from the plate 38 to which it is rigidly attached, to the upper end of which bracket 160 is pivotally attached a hydraulic jack 161, the piston of which is attached to an arcuate shoe 162 having a relatively wide mine floor engaging face 163. The shoe 162 extends through bottom openings in the plates 22 and 38 whereby it may directly engage the mine floor. It is manifest that by expanding and contracting the jack 161 as hereinafter described in full detail, that portion of the mining machine may be raised and lowered with respect to the mine floor. As hereinafter described, each of the shoe mechanisms 158, 159, 158' and 159' is individually controllable whereby the mining machine may be raised or lowered or tilted in a universal manner to adjust the plane of the bottom thereof with respect to a horizontal plane. After any adjustment of the shoe mechanisms is effected the hydraulic jack thereof may be locked in position to maintain the adjustment. The slightly different structure of the shoe mechanisms 159 and 159' is obvious from a reference to Fig. 1 of the drawings.

To provide for forward feeding movement of the combined mining and loading machine each of the parts 20 and 21 is provided with a hydraulic jack, that associated with the part 21 being seen at 164 in Fig. 3 of the drawings and that associated with part 20 being seen at 164' in Fig. 1 of the drawings. Said jacks 164 and 164' are similar in structure and as seen by refer-

ence to Fig. 1 of the drawings, jack 164' is pivotally attached to a bracket at the rear end of the part 20 and has a bifurcated head 165' on the piston with a mine jack 166'. The hydraulic jack 164 is likewise provided with a bifurcated head 165 which is associated with a mine jack similar to the mine jack 166' during feeding of the mining machine.

Also at the rear end of each of the parts 20 and 21 is a hydraulic control valve assembly that associated with the part 21 being seen at 167 and that associated with the part 20 being seen at 167'.

It may be stated that when the combined mining and loading machine is in operation two operators are employed to control it, one of which is positioned adjacent the control valve assembly 167 and the other adjacent the control valve assembly 167', the two operators working in unison to control the parts 20 and 21 and thereby control the entire combined mining and loading machine.

Attention is now directed to Fig. 12 of the drawings which illustrates the piping diagram for the hydraulic control systems controlling the hydraulic piston motors or jacks associated with the parts 20 and 21 of the mining machine. It is to be understood that similar elements of the parts 20 and 21 are given similar reference characters except for the fact that in general those applied to the part 20 will carry a prime, and it may be stated that throughout the specification wherever an element is designated by a reference character which is a prime that it refers to an element of the part 20 corresponding to a similar element of the part 21 having a similar reference character except for the omission of the prime.

The individual systems for the parts 20 and 21 are essentially similar except for differences hereinafter specifically pointed out, so the system associated with part 21 will be described, it being understood that a similar description will apply to that associated with part 20. Said system comprises a hydraulic pump such as a gear pump 168 which, by reference to Fig. 10 of the drawings, is seen to be driven by a pinion 169 which meshes with gear 28 keyed to shaft 29, as previously described, as a consequence of which gear pump 168 will operate whenever jack shaft 29 rotates. Feed pipe 170 leads from a hydraulic fluid tank or reservoir 171, of which there is only one for the entire machine, to the in-pipe of the pumps 168 and 168'. The output of the pump 168 delivers to a pressure pipe 172 which leads to the control valve assembly 167 at which there are four control valves, one individual to the hydraulic piston motor or jack 104, one individual to the two hydraulic piston motors or jacks 153, one individual to the hydraulic piston motor or jack 164, and another individual to the hydraulic piston motor or jack 106.

It may be stated that the structure of the control valve assembly 167 preferably follows the structure of the control valve disclosed in the application of Robert K. Jeffrey and Lewis E. Mitchell for a Mining machine, Serial No. 206,448 filed May 6, 1938, now Patent No. 2,263,779, dated November 25, 1941. It may be stated that this control valve assembly is such that hydraulic fluid may be applied so as to expand or contract any hydraulic jack 104, 106, 153 or 164 positively and lock any of them in any position to which they are adjusted. Furthermore, the arrangement is such that there is normally a no-load by-pass provided for the pump 168, by way

of the return pipe 173 leading from control valve assembly 167 to a distribution block 174 which is connected by a return pipe 175 to the tank 171, whenever all of the four control valves associated with control valve assembly 167 are in their normal positions. The moving of any of said control valves from its normal position automatically cuts off this no-load by-pass and directs the fluid to the proper conduit to control one of the jacks 104, 106, 153 or 164. Furthermore, any two or more of said jacks 104, 106, 153 or 164 may be operated at the same time and when so operated they are connected in series, that is, the out-put of one of said jacks is fed to the other, thus insuring that both will move whenever two control valves are operated. Likewise, in case three of said control valves are operated in unison, three of said jacks will be connected in series and all will operate at the same time.

To protect the pump 168 a high pressure relief valve 176 is provided in a relief conduit or pipe 177 which communicates between the pressure pipe 172 and the distribution block 174. It is evident that the relief valve 176 will provide a high pressure relief for the pump 168 should anything whatever cause an undesirable high pressure in the pressure pipe 172. An example of this may be the expansion of any jack to its limit with the control valve therefor retained in its open position or any attempt to move a portion of the mining machine by one of the hydraulic jacks which movement is obstructed by any strong obstruction.

To provide for the adjustment of the hydraulic jacks associated with the shoe mechanisms 158 and 159 I provide a by-pass pressure pipe 178 to which the jacks associated with said shoe mechanisms 158 and 159 are connected by conduits 179 and 180, respectively, through in-put control valves 181 and 182, respectively. These jacks are only positively moved in one direction, namely, to elevate the mining machine since the weight of the mining machine is effective to move them in the reverse direction whenever their discharge control valves 183 and 184, respectively, are open, connecting the conduits 179 and 180, respectively, to the return pipe 185 leading to distribution block 174. It may be stated that since the parts 20 and 21 are separable, the four pipes or conduits enclosed by the circle 186 are of flexible construction and are provided with removable couplings, the ends of which may be plugged whereby they may be connected together and disconnected when said parts 20 and 21 are attached or detached, respectively.

In Fig. 11 of the drawings there is disclosed the hydraulic control system for the hydraulic break-down jack 156, it being understood that there will be two such systems for the two similar jacks associated with the parts 20 and 21. Said system comprises the pump 86 which receives hydraulic fluid from a tank 187 by way of feed pipe 188 and delivers it to pressure pipe 189 leading to three-way control valve 190 which, in its normal position of adjustment, provides a no-load by-pass for said pump 86 by way of return pipe 191. A high pressure by-pass valve 192 is provided in a high pressure by-pass conduit 193 to protect the pump 86 in case excessive pressure appears in the pressure pipe 189. The hydraulic jack 156 is of the double acting type being provided with two feed pipes whereby it may be positively expanded and contracted. It is manifest that by moving the control valve 190 to one of the dotted line positions the jack 156 will be

expanded and by moving it to the other dotted line position it will be contracted. It is to be understood that this coal break-down jack is adapted to be slid into one of the kerfs such as illustrated at 101, 102 and 103 in Fig. 1 of the drawings and expanded thereby to break down the coal which will fall into the pan or area 60 of the combined mining and loading machine.

In the operation of the machine comprising my invention the two parts 20 and 21 will be attached together in the manner illustrated in Figs. 1, 3 and 5 of the drawings and the shoe mechanisms 158, 159, 158' and 159' will be adjusted by means of the control valves 181, 182, 183, 184 and 181', 182', 183' and 184' to adjust the mining machine in a generally horizontal position at any desired elevation above the mine floor and with the jacks 164 and 164' positioned against the jacks 166, 166'. With one or both of the driving motors 23 and 23' in operation the shafts 29 and 29' will rotate and the cutter chain 31 will be placed in operation by engaging the clutch including jaws 52 and 54.

It may be stated that if relatively soft coal is being cut only one of the motors 23, 23' need be operated and as an example of the manner in which they may be operated alternate shifts of workmen may use alternate motors 23, 23'. It is manifest that by employing the two motors 23 and 23' the overall height of the mining machine may be maintained at a minimum which is particularly desirable as the mining machine may have to work in a low seam mine where height is a controlling factor. In case very hard coal is encountered it is manifest that increased power may be applied to the cutter chain 31 by operating both of the motors 23, 23' in unison. With the cutter chain 31 rotating about the bottom of the combined mining and loading machine a bottom kerf will be cut, as illustrated in Fig. 1 of the drawings, by feeding the entire mining machine forward which is accomplished by expanding the hydraulic jacks 164, 164' controlled by the two operators, one positioned at a control valve assembly 167 and the other at control valve assembly 167'. After the bottom horizontal kerf has been cut the cutter bars 129, 129' will be fed into the mine face to cut a plurality of kerfs over the face of the mine room, such as the kerfs 101, 102 and 103.

As was above mentioned, if desired, cutter bars 129 and 129' may also be swung about the axis of the shafts 117 and 117' to cut arcuate kerfs though in general only a rectilinear movement of the cutter bars 129, 129' along various adjusted angles of the shafts 126 and 126' will be made. As was previously suggested, these kerfs are preferably distributed over the room face both vertically and horizontally.

After the desired number of kerfs have been cut the hydraulic break-down jacks 156 and 156' will be inserted in the kerfs which are above the bottom kerf moving progressively from the bottom-most of them, similar to the kerf 103, progressively upward and in each instance the hydraulic break-down jacks 156 and 156' upon expansion will break off the coal which is below said jack which will fall into the pan or area 60. The resulting face slopes forwardly from the bottom upwardly due to the positions of the forward ends of kerfs 101, 102 and 103, as illustrated in Fig. 1 of the drawings, which is due to the fact that the pivotal axis of mining mechanisms 99 and 100 is appreciably below the planes of rectilinear movement thereof which pivotal axis is

along the axis of shafts 29, 29'. During the time that this break-down of the coal is being accomplished the endless gathering conveyors 39, 39' will be placed in operation to convey the material towards the central axis of the machine and to the rear thereof along a trough defined by the guideways 63 and 63', as clearly seen by reference to Figs. 3 and 5 of the drawings, the coal being discharged by said endless gathering conveyors into the hopper 61 of the feeder 37 by which it is, in turn, delivered to the room conveyor 62 and thereby conveyed to any desired receptacle such as an empty conveyor or mine car.

As was previously pointed out, any slack formed by the cutter chain 31 will be conveyed by the rear run thereof up the ramp 35 and discharged into the end 36 of the feeder 37 by which it will be removed with the coal received in hopper 61 thereof. If during the operation of the machine it is found that the cutter chain 31 is striking a stone or a hard seam which requires that the position of attack thereof be adjusted, cables associated with the drums 95 and 95' and attached to mine jacks in the mine room may be employed to reverse or back the machine away from the room face after which the shoe mechanisms 158, 159, 158' and 159' may be adjusted to position the attack of the cutter chain 31 to avoid the obstruction and to follow the desired path.

It is manifest that by virtue of the hydraulic controls of the mining and loading machine that the entire machine may be very easily controlled to effect the cutting, breaking down and rearward conveying of the coal. After the machine has reached the end of its travel in any mine room and it is desired to remove it to another place, the machine may be broken up into two similar parts comprising the parts 20 and 21 and individually removed from the mine room. This is of considerable importance because the mine room has a width only slightly greater than the rear end of the combined mining and loading machine and substantially equal to the front end thereof and it would be very difficult to remove the entire mining machine due to these crowded conditions. However, since each of the parts 20 and 21 has its own operating motor by which power can be applied to its own drum 95 or 95' it is manifest that the individual parts 20 and 21 can be separately handled within the mine room, thus making for their easy removal.

As was above pointed out, the hydraulic conduits of the hydraulic control system of Fig. 12 which extend between the two parts 20 and 21 are removably attached and may be plugged up to prevent any loss of hydraulic fluid or oil from the hydraulic control system.

Furthermore, as was above pointed out, the friction clutch 55 disclosed in Fig. 5 of the drawings is particularly valuable to inch the cutter chain 31 thereby providing for the ready setting of the cutter bits while the driving motor, such as the motor 23, is in continuous operation.

It is furthermore to be pointed out that if desired, the cutter chain 31 may operate simultaneously with the cutter chains 149 and 149' during which time a single bottom horizontal kerf the full width of the room and two intermediate or top kerfs may be cut simultaneously. Furthermore, the cutter bars 129 and 130 may be swung simultaneously either toward or from each other either during the time the bottom kerf is being cut or independently thereof, there-

by balancing the lateral forces acting on the machine.

It is thus manifest that a very flexible mining and loading machine of high capacity has been provided which will perform a complete mining and loading operation simultaneously.

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

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

1. A mining machine comprising a pair of complementary parts, each part having a kerf-cutter and driving motor, said parts when joined providing a single bottom cutter bar, and a continuous bottom bit carrying cutter chain mounted on said bar.

2. A combination kerf-cutting and loading machine comprising a pair of similar parts each including a bottom plate which bottom plates combine to form a bottom cutter bar, of an endless bit carrying cutter chain on said bar for cutting a bottom horizontal kerf, each part also including an individual top cutter bar having an endless cutter chain thereon and means for feeding it on its longitudinal axis relative to said bottom plate, each part also having an endless flight carrying conveyor chain which chains cooperate to gather material received by said bottom plate and convey it centrally of the combination machine to a rearward discharge position, and means for driving all of said chains and for feeding said cutter bars as aforesaid.

3. A combination kerf-cutting and loading machine comprising a pair of similar parts each including a bottom plate which bottom plates combine to form a bottom cutter bar, of an endless bit carrying cutter chain on said bar for cutting a bottom horizontal kerf, each part also including an individual top cutter bar having an endless cutter chain thereon and means for feeding it on its longitudinal axis relative to said bottom plate, each part also having an endless flight carrying conveyor chain which chains cooperate to gather material received by said bottom plate and convey it centrally of the combination machine to a rearward discharge position, and means for driving all of said chains and for feeding said cutter bars as aforesaid, said top cutter bars being swingable about both horizontal and upright axes.

4. In a mining machine, the combination with a frame adapted to slide over a mine floor, of a bottom kerf-cutter formed as an integral part of said frame and movable in unison therewith, said frame providing a material receiving pan at its forward end surrounded by said kerf-cutter, gathering mechanism on said frame constructed and arranged to gather material on said pan and to elevate it and convey it rearwardly and there discharge it into a receptacle, a material receiving receptacle attached to the rear end of said machine for movement therewith, adjustable mining mechanism positioned above said pan which cooperates with said kerf-cutter to break down coal onto said pan, hydraulic jack means for feeding said mining machine forward while cutting a bottom kerf, cable drum means for moving said mining machine rearwardly, and

adjustable shoes for raising, lowering or tilting said frame relative to a mine floor.

5. In a mining machine, the combination with a main frame, of a supplemental frame pivoted thereto for adjustment relative thereto on a transverse axis, a motor on said main frame, a pair of kerf-cutters mounted on said supplemental frame for pivotal movement relatively thereto on an upright axis and for bodily rectilinear movements relatively to the supplemental frame forwardly and rearwardly along the same, means for tilting the supplemental frame on said transverse axis to effect tilting of said kerf-cutters relative to an upright face of a mine vein, means for feeding said kerf-cutters rectilinearly along said supplemental frame into the said face at the adjusted inclination, means for feeding said kerf-cutters arcuately in opposite directions while in the mine vein, and power-transmission mechanism extending from the motor on the main frame to said kerf-cutters to drive the same in its various positions of adjustment and feeding as aforesaid.

6. In a mining machine, the combination with a main frame, of a supplemental frame pivotally mounted thereon on a transverse axis, a kerf-cutter guided rectilinearly along said supplemental frame, said kerf-cutter being also mounted on said supplemental frame for pivotal movement relatively thereto, a motor on the main frame, power-transmission mechanism extending from said motor to said kerf-cutter to drive the same in its various positions of adjustment relative to said supplemental frame, fluid-pressure motor means between said main and supplemental frames for adjusting said supplemental frame on said transverse axis, fluid-pressure motor means for arcuately feeding said kerf-cutter relatively to said supplemental frame, and fluid-pressure motor means for feeding said kerf-cutter rectilinearly relatively to said supplemental frame.

7. A combined mining and loading machine comprising two separable complementary sections which when attached together provide a bottom cutter bar and a material receiving pan, two endless conveyors one on each section guided along the joining edges back of the receiving pan, the adjacent runs of the conveyors on the adjacent sections co-operating to move material from the pan along a common trough between the conveyors, an endless chain kerf-cutter carried by said cutter bar and adapted to travel along the forward edge of the receiving pan transversely of the direction of travel of the adjacent runs of the conveyor, and means for driving said kerf-cutter and said conveyors.

8. In a mining machine, the combination with a supporting frame having two complementary sections one detachably connected to the other, of an endless chain kerf-cutter extending around both sections, two motors one mounted on each section, mechanism connecting said motors to said kerf-cutter to enable either motor alone to effect driving of the kerf-cutter or to enable both motors operating in unison to drive said kerf-cutter, two handling drums one on one of said sections and the other on the other section, and driving means on each section between the motor thereon and its associated handling drum, to enable the handling of each section independently of the other when detached from each other.

9. A combined mining and loading machine comprising a pair of complementary frames adapted to be connected together to form a ma-

terial receiving pan and a cutter bar, an endless chain kerf-cutter mounted on such cutter bar in advance of the said receiving pan, two gathering conveyors one on each of said frames and each comprising spaced flights connected to endless draft elements, adjacent flight runs adapted to travel along the rearward extension of the receiving pan where the frames are joined together, two handling drums one on each frame, mechanism on each frame for operating the associated handling drum, means for driving said kerf-cutter and said conveyors, and two motors one on each frame connected to said kerf-cutter and conveyor driving means, the motor on each frame being adapted to be connected to the mechanism for operating the associated handling drum on that frame.

10. A combined mining and loading machine comprising the combination with supporting framework in two complementary sections which when connected are adapted to form a material receiving pan at the forward end of the framework with a conveyor trough extending rearwardly from such receiving pan, an endless chain kerf-cutter extending along the front edge of said receiving pan and around both sections of the framework, two endless conveyors one on each of said sections, each conveyor comprising spaced flights adapted to travel in the same direction rearwardly from said receiving pan along said trough, mechanism for driving said kerf-cutter and said conveyors comprising a separable coupling adapted to be uncoupled when said sections are separated, two motors one on each section and each connected to said driving mechanism to operate the same, one motor being adapted to operate the kerf-cutter and the conveyors when coal to be cut is relatively soft and both motors being adapted to operate in unison when the coal to be cut is relatively hard, two handling drums, and driving mechanism between each motor and its associated handling drum to effect handling of each of said sections separately when detached from each other.

11. In a mining machine, the combination with a cutter bar, of a bit-carrying chain kerf-cutter guided along said cutter bar, a driving sprocket connected to said chain kerf-cutter, a main power shaft, an auxiliary shaft connected to said sprocket, power transmission mechanism between said shafts comprising two separate clutches one between a jaw clutch for normal operation of the kerf-cutter and the other being a friction clutch for driving the chain kerf-cutter by increments while the jaw clutch is released to enable the cutting bits to be removed or replaced on the kerf-cutter chain.

12. In a mining machine, the combination with a main frame, of a bottom kerf-cutter mounted thereon, a supplemental frame, a pair of top chain kerf-cutters mounted on said supplemental frame for rectilinear and arcuate feeding movements relative thereto, mechanism pivotally mounting said supplemental frame on said main frame on a transverse axis between the planes of feeding movements of said bottom kerf-cutter and said top kerf-cutters but nearer the plane of the bottom kerf-cutter to enable adjustment of said top kerf-cutters into a position for rectilinear feed to the plane of the roof of the mine entry and to enable adjustment of said top kerf-cutters into positions for rectilinear feed in spaced-apart planes with the inner ends of the kerfs spaced above the bottom kerf in an upwardly extending

arcuate series, and means for operating said kerf-cutters including the feed thereof.

13. In a mining machine, the combination with a main frame adapted to rest on and slide over the mine bottom, of a chain kerf-cutter on said main frame in position to cut a bottom kerf in continuation of the floor of the mine chamber, a supplemental frame pivotally mounted on said main frame on a transverse axis, a pair of chain kerf-cutters mounted on said supplemental frame for feeding movements relatively thereto rectilinearly and arcuately, means for adjusting said supplemental frame on said transverse axis to

5 adjust said pair of chain kerf-cutters for the cutting of a series of kerfs extending from the lower portion of the mine vein to the roof limit thereof, and means for operating said pair of kerf-cutters to cut such series of kerfs with their inner ends in an upright arcuate series and each kerf arcuate transversely of the mine vein so that upon dislodgement of the mineral between the kerfs cut by all of the kerf-cutters the new working face will be arcuate transversely and also arcuate from the floor to the roof of the mine chamber.

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