June 12, 1956 R. A. McCALLUM 2,750,178

PICKING TYPE MINING APPARATUS

Filed March 6, 1952 5 Sheets-Sheet 1

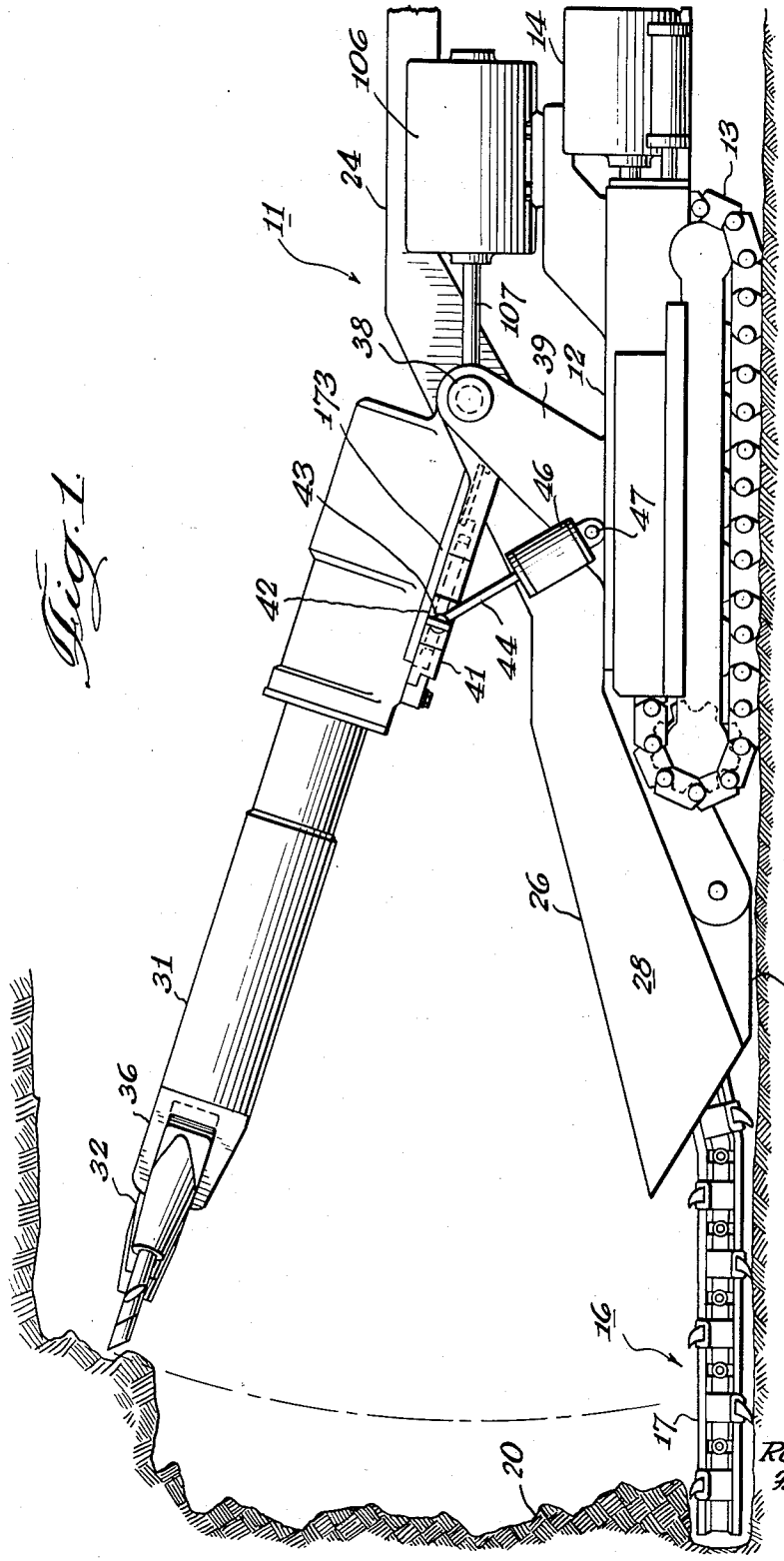


Fig. 1.

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PICKING TYPE MINING APPARATUS

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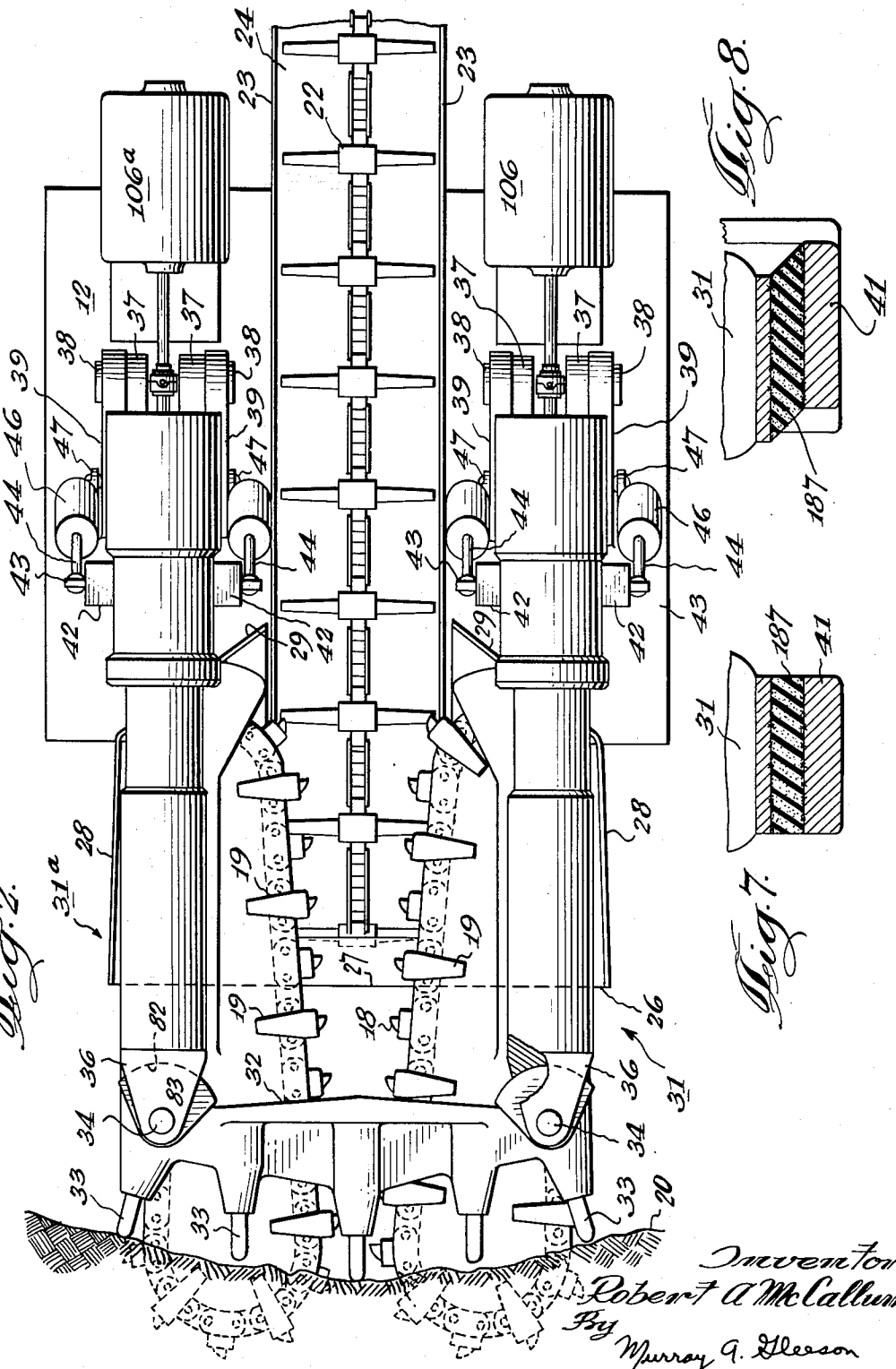


Fig. 2.

Fig. 8.

Fig. 7.

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PICKING TYPE MINING APPARATUS

Filed March 6, 1952 5 Sheets-Sheet 3

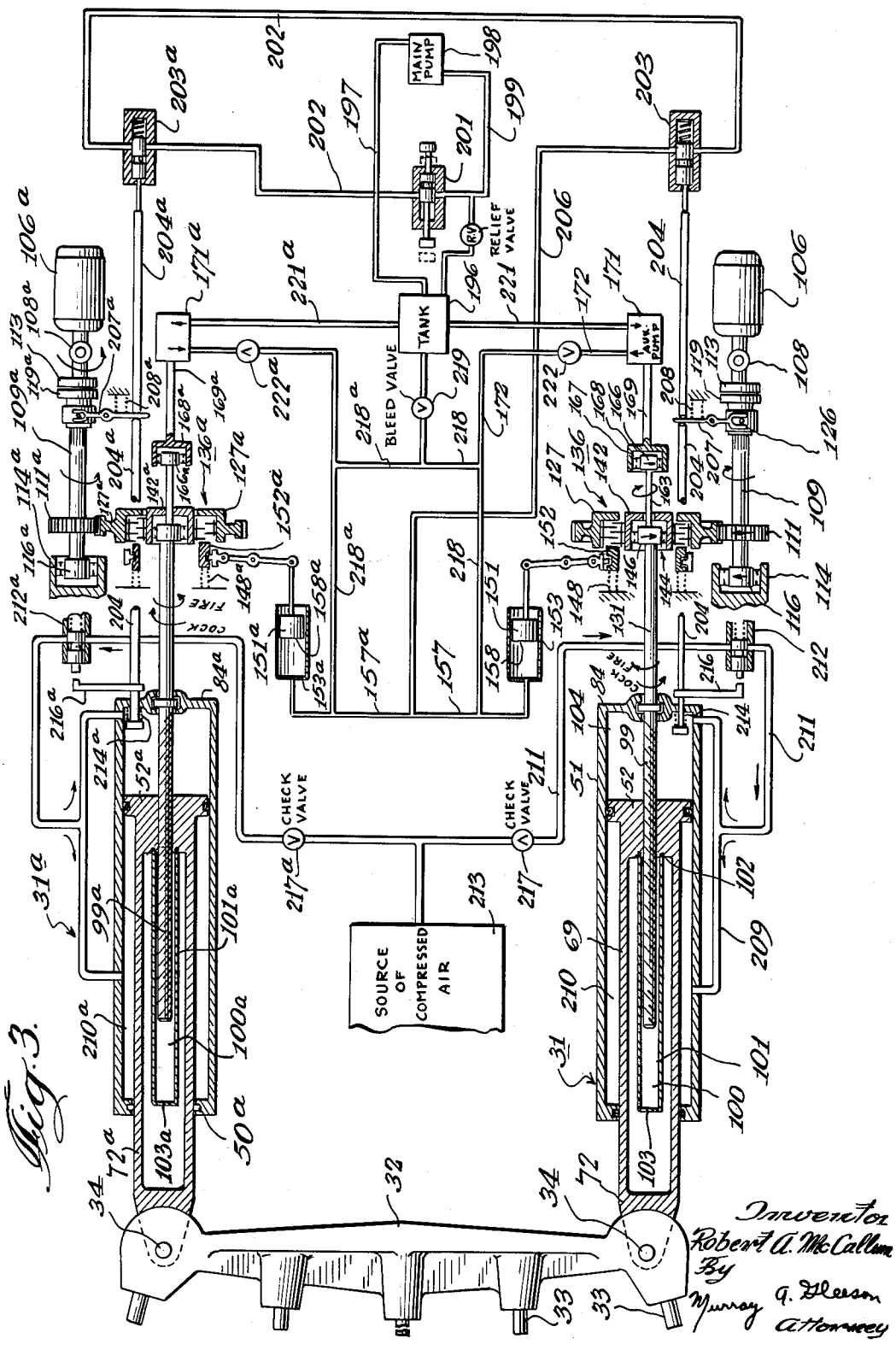


Fig. 3.

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June 12, 1956 R. A. McCALLUM 2,750,178

PICKING TYPE MINING APPARATUS

Filed March 6, 1952 5 Sheets-Sheet 4

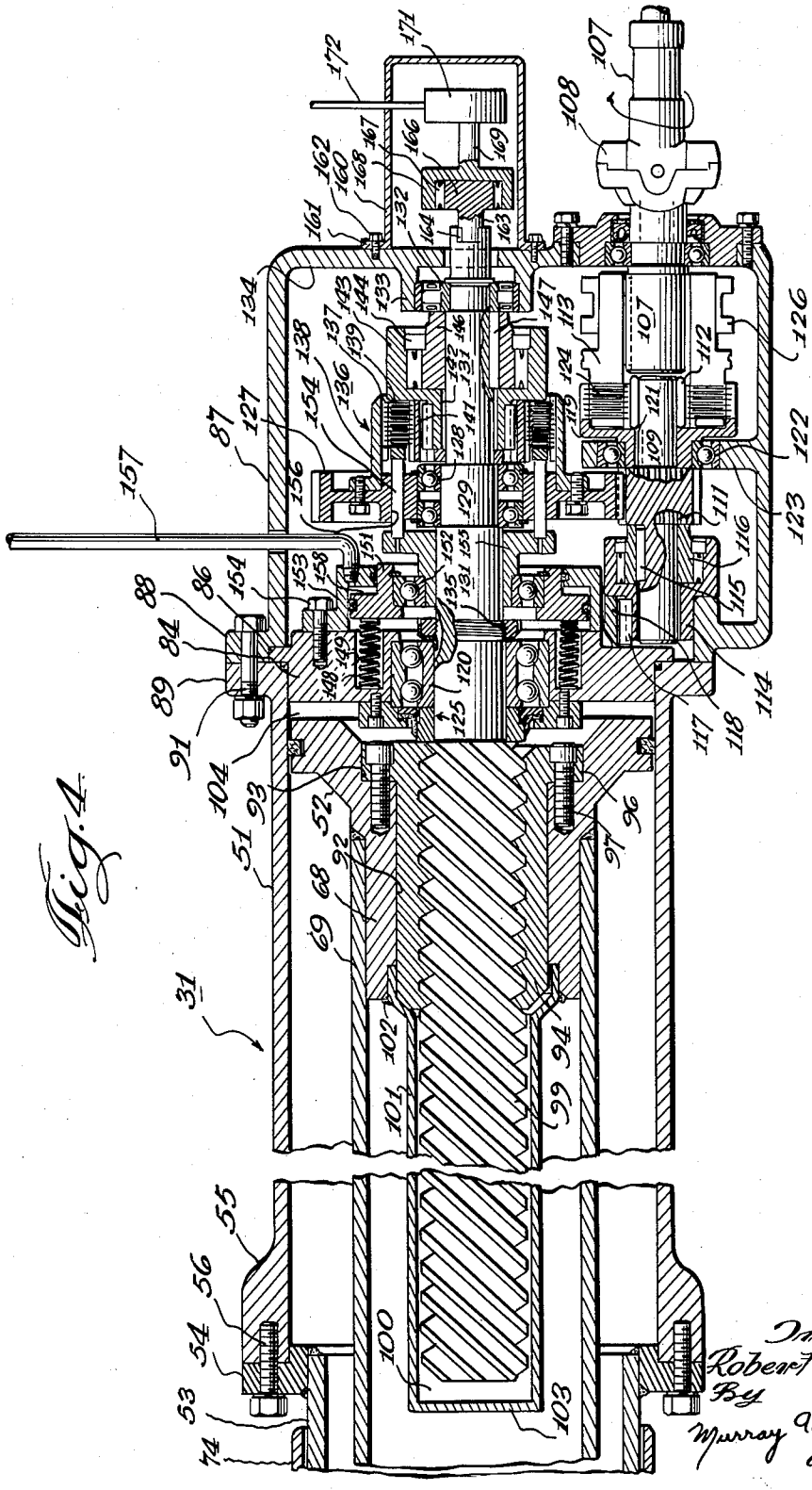


Fig. 4.

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PICKING TYPE MINING APPARATUS

Filed March 6, 1952 5 Sheets-Sheet 5

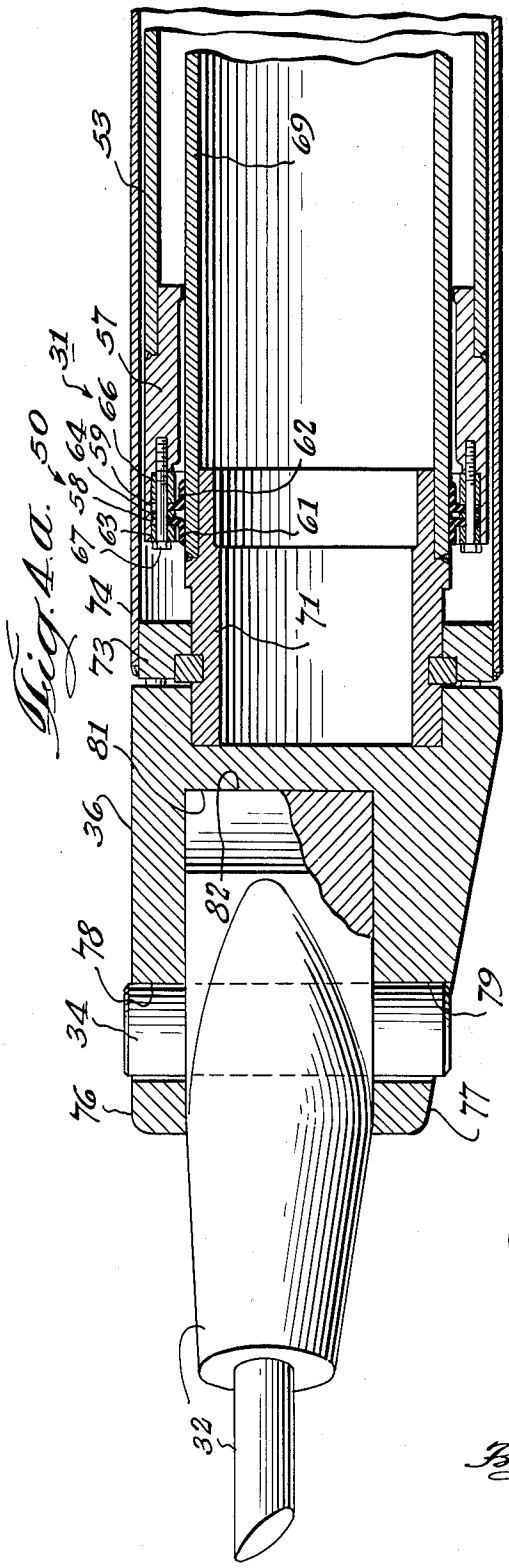


Fig. 4A.

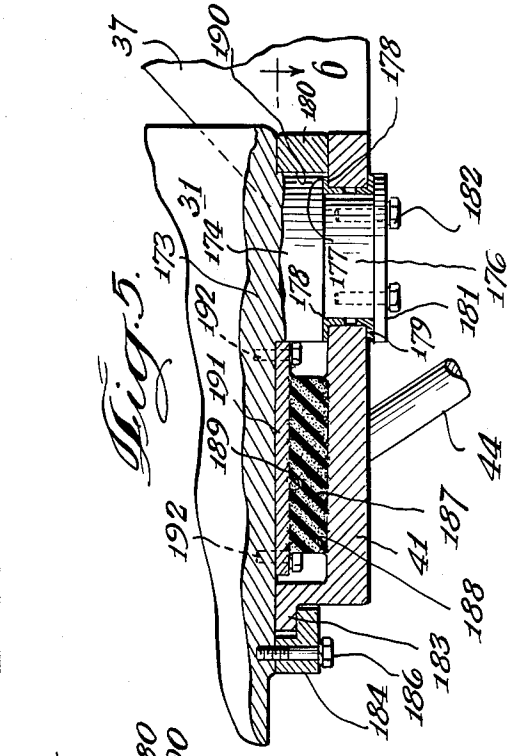


Fig. 5.

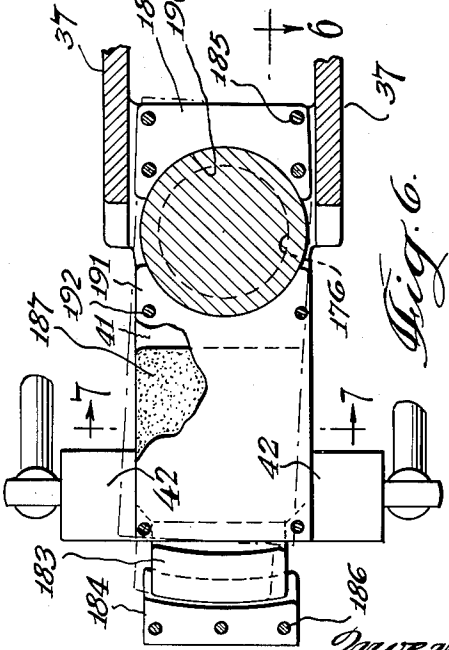


Fig. 6.

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United States Patent Office

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PICKING TYPE MINING APPARATUS

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Application March 6, 1952, Serial No. 275,102

15 Claims. (Cl. 262—15)

This invention relates generally to continuous mining machines and more particularly to a machine for fragmenting coal from a seam thereof by a picking action.

The machine according to the present invention may broadly be considered as a combined undercutting and gathering and loading machine together with automatically operated picking mechanism cooperating with the gathering and loading mechanism, all of which combine effectively to mine material without the necessity of blasting. More particularly, the machine is effective for mining coal continuously but with the production of coal of larger sizes having greater commercial value than may be possible with the use of cutter chains and cutter bits moving in side by side relationship about a moving cutter head.

The invention is characterized by a pair of reciprocating rams connected by a crosshead having pick elements carried thereon. The crosshead is pivoted at its ends so that the rams may move in accordance with the resistance encountered by the pick elements. Each ram thus includes a piston movable in a cylinder supplied with air under pressure from an external source, and mechanism is provided to retract the ram and piston rapidly for the compression of a charge of air to advance the piston and ram rapidly against the seam in a power stroke.

According to the invention, the rams and pistons are retracted by power means to a cocked position, such retraction placing each piston in a cocked position for subsequent release in a power stroke. In order to prevent a power stroke of one of the rams taking place before the other has reached cocking position both of the rams must reach cocked position before each can be released simultaneously for a power stroke.

In a preferred form of the invention, each cylinder and ram assembly is mounted on a resilient pad which is bonded on its upper side to the ram assembly and on its lower side to a support therefor, the resilient pads affording individual and partly limited swinging movement of each individual ram assembly in order to accommodate skewing of the crosshead in encountering material of varying resistance throughout the length thereof. By such an arrangement the ram assemblies may adopt positions of non-parallelism with respect to each other.

With the foregoing considerations in mind it is a principal object of the invention to provide a picking type of continuous mining apparatus which will mine coal or other fragmentable material in an extremely efficient manner.

Another object of the invention is to afford a pair of piston and ram assemblies for a picker crosshead, the assemblies being operated to a "cocked" position for conjoint and simultaneous release in a power stroke, control means being effective to prevent a premature power stroke of one of the ram and piston assemblies.

Other objects and important features of the invention will be apparent from a study of the description hereinafter taken with the drawings which together illustrate and describe a preferred embodiment of the invention and

what is now considered to be the best mode of practicing the principles thereof. Other embodiments of the invention may be suggested to those having the benefit of the teachings herein and it is therefore contemplated that the scope of the invention not be limited by the precise embodiment herein shown, and only by the terms of the claims appended to this specification.

In the drawings:

Fig. 1 is a side view of a mining machine having embodied therein the improvements according to the present invention;

Fig. 2 is a plan view thereof;

Fig. 3 is a schematic view of certain control mechanism employed in the operation of the machine shown in Figs. 1 and 2;

Fig. 4 is a longitudinal sectional view through part of a moving piston and ram assembly shown in elevation in Figs. 1 and 2, certain of the parts being shown in elevation;

Fig. 4A is a longitudinal sectional view through the forward part of the piston and ram assembly shown in Fig. 4, showing the manner in which a crosshead is affixed to the ram;

Fig. 5 is a detailed partly sectional and partly elevation view of a support for the piston and ram assembly shown in Figs. 4 and 4A, the support being so arranged as to provide limited horizontal swinging movement of the piston and ram assembly in accordance with the resistance encountered by the cross head and piston and ram assembly;

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

Fig. 7 is a transverse section taken along the line 7—7 of Fig. 6 looking in the direction of the arrows, showing details of a resilient pad forming part of the support assembly for the piston and ram assembly; and

Fig. 8 is a view similar to Fig. 7 but showing the deformation of the resilient pad, the amount of such deformation being exaggerated for the purposes of clarity.

Referring now to Fig. 1 of the drawings, there is shown a mining machine, indicated generally by the reference numeral **11**, having embodied therein the improvements according to the present invention. The machine **11** includes a frame **12** mounted on crawler treads **13**, and power to drive the crawler treads **13** is furnished by a drive motor **14** situated on the main frame **12**.

The machine **11** also includes a gathering head, indicated generally by the reference numeral **16**, and comprising a pair of gathering frames **17** forming a support for cutter chains, not shown, having cutter bits **18** moving thereon and traveling orbitally around the frame **17**. The chain also has moving therewith gathering arms **19** which travel orbitally with the chain to gather coal which is cut by the cutter bits **18** as they move orbitally around the gathering frames **17**. The cutter bits **18** thus provide a means for cutting a kerf in a vein or seam of coal **20** or the like, and the gathering head **16** may thus be sumped into the working face in the manner shown more particularly in Fig. 1.

The precise form of such a gathering and cutting head forms no part of the present invention except as it may be disclosed or claimed in connection with the improved picking means according to the present invention, and other gathering and cutting means may be employed without departing from the invention herein.

A conveyor **22** of the chain flight type is guided within vertical walls **23** of a conveyor trough section **24**. The receiving end of the conveyor **22** is disposed beneath the gathering arms **19** and gathering frames **17** so as to receive the discharge therefrom. A receiving trough **26** is designed to prevent spillage from the gathering head **16** and the flight conveyor **22** and as seen in Figs.

1 and 2 consists of a plate 27 formed to underlie the gathering head 16 and the receiving end of the flight conveyor 22. The receiving trough 26 has vertical sides 28 which fair inward as at 29 toward the vertical walls 23 of the conveyor trough 24.

As seen in Fig. 1 the flight conveyor 22 conveys material gathered by the gathering head 16 upwardly over the frame 12 and towards the rear thereof. The machine 11 may be provided with a discharge boom, not shown, which may be articulated with respect to conveyor trough 24 so that the material may be discharged off to the rear and one side or another of the machine 11 into a shuttle car, belt conveyor or the like.

A pair of piston and ram assemblies 31 are joined at their ramming end adjacent the seam 20 by a cross head 32 having spaced picking members 33 thereon which engage the working face of the seam 20. Each end of the crosshead 32 is pin connected as at 34 to a ram member 36 which is a part of the ram and piston assembly 31, the details of which assembly will be described in more detail as this specification proceeds.

Each ram piston assembly 31 is provided with a pair of rearwardly extending trunnion members 37 having trunnion stub shafts 38 which extend laterally and outwardly therefrom. Said shafts extend through laterally spaced trunnion supports 39 which extend upward from the frame 12 and flank the ram and piston assemblies 31.

Each piston and ram assembly 31 is adapted to swivel in a vertical plane on the stub shafts 38, and means for raising and lowering the piston and ram assemblies in such manner will now be described. Each piston and ram assembly 31 is mounted on a support plate 41 having lateral extensions 42 on each side of the piston and ram assembly 31. Each end of such extension 42 is provided with a free swivelling connection 43 to a piston rod 44 of a hydraulic cylinder 46 also having a swivel connection 47 to the top of the main frame.

Referring now particularly to Figs. 4 and 4A, each ram and piston assembly 31 comprises a cylinder sleeve 51 having a piston 52 movable therein. The cylinder sleeve 51 has an extended skirt 53 welded to an annular ring 54 which in turn is held by cap screws 56 to a thickened rib 55 at the end of the cylinder sleeve 51. The end of the skirt 53 remote from the cylinder sleeve 51 has welded thereto a stiffener ring 57, and a seal 50 including annular sealing members 58 and 59 with sealing lips 61 and 62 respectively are held to the end of the stiffener ring 57 by means of clamping rings 63, 64 and 66, said rings and sealing members being held in place by a plurality of cap screws 67 threaded into the stiffener ring 57.

The piston 52 has a skirt 68 and a skirt tube 69 is fitted around the annular piston skirt 68 and is held in place by welding. As seen in Fig. 4A, the exterior of the skirt tube 69 is guided within the sealing rings 58 and 59 and is provided with an end sleeve 71 which bears against and fits within the ram member 36. An annular ring 73 is fitted to the outside of the end sleeve 71 and a dust sleeve 74 is welded to the periphery of the annular ring 73, and extends along the outside of the skirt 53 toward the end of the cylinder sleeve 51.

The ram member 36 has a pair of spaced apart jaws 76 and 77, and aligned openings 78 and 79 for receiving the pin 34 holding the cross head 32 in position spanning the pair of piston and ram assemblies 31, as seen more clearly in Fig. 2. The ram member 36 has an arcuate surface 81 which matches a similar arcuate surface 82 on the end of the crosshead 32 so that the thrust of the ram member 36 against the crosshead 32 may be taken along the mating arcuate surfaces 81 and 82.

The cylinder sleeve 51 is also provided with a cylinder head 84 having a flange 86 bearing against the end of the cylinder sleeve 51. A control mechanism housing 87 has a flange 88 which bears against a flange 89 at the

end of the cylinder sleeve 51, the cylinder head 84 being thus held in position between the flanges 88 and 89 by cap bolts 91.

The piston 52 is bored centrally thereof as at 92 and also counter bored at 93 to receive a nut 94 having a shoulder 96 adapted to fit in the counter bore 93, the nut 94 being held in position in the piston 52 by means of countersunk socket head screws 97. As seen more particularly in Fig. 4, the nut 94 is interiorly threaded to receive a screw shaft 99, which upon rotation in a preferred direction will move the piston 52 toward the cylinder head 84. In the embodiment shown, the screw shaft 99 is of the multiple thread type and has five threads which gives a large amount of translative movement of the piston 52 for each revolution of the screw 99.

In order that rotation of the screw 99 in moving the piston back to the cylinder head 84 will not cause rushing of air past the mating thread surfaces of the screw 99 and the nut 94, a closed sleeve 101 surrounds the free end of the screw 99 and is held to the skirt 68 of the piston 52, being held in position by weldments 102. As seen more clearly in Fig. 3, the volume 100 between the end of the screw 99 and an end wall 103 of the sleeve 101 is so chosen that the pressure in the volume 104 enclosed between the piston 52 and the cylinder head 84 and pressure in volume 100 are substantially equal at all times, so that air will be prevented from moving back and forth past the clearance between the threads of the nut 94 and the threads of the screw 99.

As seen also with reference to Figs. 3 and 4, the screw shaft 99 is rotated to effect compression of the air between the piston 52 and the cylinder head 84, such pressure being effective upon release of the screw shaft 99 to advance the piston 52 and the ram 32 rapidly with the crosshead 32 against the seam of coal 20. As seen more particularly in Fig. 1, the frame 12 affords a support for a drive motor 106 mounted to one side of the trough section 24. The motor 106 has a drive shaft 107 and a universal coupling 108 which is on the line of centers of the stub shafts 38, so that the piston and ram assembly 31 associated therewith may freely swivel about the stub shafts 38 while the motor 106 remains in fixed position on the main frame 12.

A driven shaft 109 having a drive pinion 111 fast thereon is journaled at one end within a needle bearing 112 supported within a driving clutch member 113 splined to the shaft 109. The shaft 109 is supported at its other end and turns within an outer race 114 of an overrunning sprag type brake having an inner race 116 keyed at 115 to the driven shaft 109, the outer race 114 thereof being held against rotation in a drilled shaft support 118 by a key 117, said shaft support 118 being formed integrally with the housing 87.

A driven clutch member 119 is keyed at 121 to the driven shaft 109 and is supported within bearings 122 held in a bearing support 123 formed integrally with the housing 87. Clutch plates 124 connect the driving clutch member 113 to the driven clutch 119, and a clutch throwout yoke 126 controls the clutching between the driving clutch member 113 and the driven clutch member 119.

The pinion 111 meshes with a gear 127 supported on bearings 128 which in turn are supported on a bearing surface 129 formed as a part of an extension 131 of the screw 99. As seen in Fig. 4 the extension 131 is supported in a bearing 132 held in an annular boss 133 extending inwardly from an end wall 134 of the housing 87. The shaft extension 131 is also supported on a ball bearing 120 held in the cylinder head 84 and between a shaft seal and thrust assembly, indicated generally by the reference numeral 125, and a lock nut 135 threaded to the shaft extension 131.

A multi-disc clutch 136 includes clutch plates 137 externally splined to an internally splined hub 138 extending from the gear 127, and clutch discs 139 splined on the inside diameter thereof to an externally splined hub 141,

which in turn is splined to a hub 142 of the outer race 143 of an overrunning clutch 144 having an inside race 146 held by a spline 147 to the shaft extension 131 of the screw 99.

The clutch 136 is maintained in clutching position by means of springs 148 held in bores 149 on the exterior of the cylinder head 84 and bearing against a piston 151 movable within a cylinder 153 held by cap screws 154 to the outside of the cylinder head 84. Pressure from the springs 148 against the piston 151 is transmitted by thrust ball bearings 152 against a pressure disc 155 freely mounted on the shaft extension 131. Pressure disc 155 bears against pressure pins 154 passing through bores 156 in the hub of the driven gear 127. Pressure to release the clutching engagement of the clutch discs 136 is afforded through a pressure line 157 and acting against a face 158 of the piston 151 and in a direction opposed to the force of the springs 148, under conditions as will appear as this specification proceeds.

An auxiliary housing 160 has a circular flange 161 which is held by cap screws 162 to the housing 87. The housing 160 contains a shaft 163 which is splined at 164 to the end of the shaft extension 131 protruding into the housing 160. The shaft 163 is made a part of an internal race 166 of an overrunning sprag type clutch 167 having an outer race 168 formed integrally with a shaft 169 for driving an auxiliary pump 171 to supply pressure fluid to the line 172 extending through the wall of the housing 161 under conditions as will appear in more detail as this description proceeds.

Referring now particularly to Figs. 5, 6, 7 and 8 of the drawings, each piston and ram assembly 31 has welded to the bottom thereof a plate 173 having formed integrally therewith a downward extending boss 174 reduced as at 176 to provide a shoulder 177 for a flanged bushing 178 which rests upon the support plate 41 and between the shoulder 177. A plate 180 is held by countersunk screws 185 to the plate 173 and partially encircles the boss 174 along an arcuate surface 190 thereof. The plate 180 provides additional bearing surface for the piston and ram assembly 31 on the support plate 41. The portion of reduced diameter 176 of the boss 174 is also fitted with a flanged bushing 179 which bears against the under side of the support plate 41, and is held in position by a circular plate 181 held to the boss 174 by cap screws 182. The support plate 41 has an arcuate flange 183 which matches an arcuate flanged member 184 held to the plate 173 by cap screws 186. The boss 174 thus provides a turning center for the piston and ram assembly 31 with respect to the support plate 41.

Such turning of the piston ram assembly 31, however, is limited by a resilient pad 187 which is bonded on its underside as at 188 to the upper side of the support plate 41, the upper side of the resilient pad being bonded as at 189 to a plate 191 which is held in position to the underside of the plate 173 by cap screws 192. As seen more particularly in Figs. 7 and 8 the turning of the piston ram assembly 31 with respect to the support plate 41 is limited by the resistance to shearing afforded by the resilient pad 187.

The resilient pad 187 forming part of the support 41 thus affords limited swiveling movement of each individual ram and piston assembly 31 occasioned by variation in resistance encountered by the crosshead 32 throughout its length, such variation in some cases causing the crosshead to assume positions where it no longer would be at right angles to the individual piston and ram assemblies 31. Since each ram and piston assembly lies on a fixed turning center there would be involved a degree of swiveling movement of one or the other of such piston and ram assemblies so that there would arise at the same time a condition of non-parallelism of the assemblies in accommodating the skewing movement of the crosshead 32.

Referring now particularly to Fig. 3 of the drawings,

there is shown an hydraulic circuit which controls the operation of the mechanism thus far described and additionally insures the completion of a compression stroke of the piston 52 of each ram and piston assembly, and frees the driving mechanism after such return or compression stroke for a power stroke, so that each piston 52 and ram member 36 is free to move rapidly under the force of the compressed air to advance the crosshead 32 rapidly against the coal seam 20.

It may be noted in describing the piston and ram assemblies of Fig. 3, that one of such assemblies and the control mechanism therefor bears reference numerals alone, while the other of such assemblies bears reference numerals having an additional letter *a* reference character. All references to apparatus bearing only the numeral reference includes also the numeral and letter reference. Where necessary, for understanding of the operation and function, and in cases where the condition of one of the assemblies is affected by the condition of the other, reference to the separate assemblies by their appropriate numeral designation and their appropriate numeral and letter designation will be made. All apparatus common to both assemblies bears the numeral designation only, by way of example, certain pumps, pressure lines and valve apparatus.

The hydraulic system comprises a tank or reservoir 196 connected by a line 197 to a main pump 198. The output from main pump 198 is connected by a pressure line 199 to an on-off spool type valve 201. A pressure line 202 connects on-off valve 201 to auxiliary valves 203 and 203*a* connected in series, each of which is actuated to open position by a push rod 204 which is shifted axially to the right as seen in Fig. 3 by the movement of piston 52 to position adjacent the the cylinder head 84. The conjoint opening of the valves 203 passes pressure fluid by way of a pressure line 206 which branches into pressure lines 157 leading to cylinders 153, the pressure fluid being operable to release clutch 136.

Consider the operation of the mechanism thus far described for achieving a "cocking" or compression stroke of the piston 52 within the cylinder 51. The piston 52 will be considered at the start of such stroke in an extended position as shown in Fig. 3. The invention herein comprehends a master switch for controlling the operation of the motors 106, which operation also starts the main pump 198.

As has been explained, the two screw shafts 99 are of opposite hand and must therefore be turned by motors operating in different directions. The provision of such a design eliminates any whipping torques caused by sudden release of load upon each of the motors, as will be explained. It may be understood, however, that screw shafts 99 may be provided with threads of the same hand for the sake of interchangeability and that the motors 106 in such case run in the same direction.

For purposes of description the ram and piston assembly and control mechanism therefor in the lower half of the drawing of Fig. 3, and bearing the numeral designation alone, will be considered, but it is believed that the operation of the mechanism of the upper half of Fig. 3, and bearing both numeral and letter reference characters, will be readily understood.

The motor 106 turns shaft 109, clutch members 113 and 119 being engaged through the medium of the clutch throwout yoke 126 which is in the clutch engaging position because of the position of the push rod 204 being shifted to the left under the urgence of a spring 214. The push rod 204 actuates a throwout lever 207 to engage clutch members 113 and 119, the throwout lever being urged to such position additionally by a spring 208.

The pinion 111 and the inner race 116 are free to run with respect to the overrunning clutch 114, 116, the arrow on the inner race 116 indicating the direction of freedom of movement of the inner race 116 with respect to the outer race 114. The pinion 111 drives the gear 127,

and since fluid is blocked from the clutch control cylinder **153** by the series connected valves **203**, the return spring **148** causes engagement of the clutch **136** thus driving the hub **142** forming the outer race of the sprag or overrunning clutch **144**. The inner race **146** of overrunning clutch **144** is adapted to overrun the outer race **142** in the direction of the arrow shown on the inner race **146**, and the hub **142** and gear **127** thus drive the screw shaft **131** in a counter-clockwise direction as viewed from the right as seen in Figs. 3 and 4.

Such counterclockwise movement of the screw shaft **99** thus moves the piston **52** and ram member **36** to the right to compress air between piston **52** and cylinder head **84**.

The piston skirt **69** and cylinder sleeve **51** define an annular chamber **210** behind the piston **52**. This annular chamber **210** communicates by means of a conduit **209** with the confined space **104** between piston **52** and cylinder head **84**, so that a differential total force will exist across the piston **52**. The conduit **209** is connected by a conduit **211** in series with a valve **212** to a source of compressed "makeup" air **213**.

The counterclockwise movement of screw shaft **99** moves the piston to the end of the push rod **204** extending into the cylinder **51** to move the push rod **204** to the right against the load of the return spring **214**. Movement of the push rod **204** in turn moves a finger **216** to actuate and open valve **212** to the supply of "make-up" air **213**. If the pressure of the air in volume **104** is less than the pressure of the source **213** additional air under pressure moves past a check valve **217** to the confined space **104**.

The piston **52** and ram **36** may now be considered to be in a "cocked" or "ready-for-fire" position, but before the piston **52** may move in a "firing" or power stroke, the screw shaft **99** must be free for turning in the piston **52**. The movement of the piston to such "cocked" position then accomplishes the following operations.

The first of these is release of the clutching elements **119** and **113** by rocking of the throwout lever **207** in a clockwise direction against the spring **208**. Assuming that piston **52** reaches the cocked position before piston **52***a*, the push rod **204** is effective to open valve **203**. Since the valves **203** are connected in series and the valve **203***a* associated with the other ram and piston assembly **31** is still closed, pressure fluid from pump **198** is effectively blocked thus cutting off the flow of pressure fluid to the cylinder **153**.

A bleed pressure line **218** is connected between each of cylinders **153** and **153***a* and tank **196**, there being a bleed valve **219** connected therein which regulates the rate at which pressure fluid is released from the cylinders **153** and **153***a*.

With fluid still released from cylinder **153** clutch **136** remains engaged. The pressure of the compressed air between piston **52** and cylinder head **84** would normally drive piston **52** to the left at the same time effecting clockwise rotation of the screw shaft **99**. The sprag clutch **144**, however, overruns only when the inner race **146** thereof rotates in a counterclockwise direction with respect to outer race **142**. The shaft **131**, then, is locked to the outer race **142** tending to turn same in the same direction (clockwise). The tendency of the outer race **142** to turn clockwise is of course restrained by the clutch **136** which locks the outer race **142** to the driven gear **127**. The gear **127**, however, is restrained against rotation in a clockwise direction by the pinion **111** which now must be driven in a counter-clockwise direction, such tendency of counter-clockwise rotation of the inner race **116** of the sprag clutch **114**, **116** associated therewith causing the clutch **114**, **116** to lock.

In the meantime the motor **106***a* of the ram and piston assembly **31***a* will have retracted its piston **52***a*, the operation of motor **106***a* being in a counter-clockwise direction as shown. When the piston **52***a* is retracted, valve **203***a* will open thus completing the path for passage of pressure fluid from main pump **198** to cylinders **153** and **153***a*, the pressure applied to said cylinders being effective to release their respective associated clutches **136** and **136***a*.

In the case of the ram and piston assembly **31** the release of clutch **136** will cause shaft **131** to rotate in a clockwise direction (as seen from the right), and since outer race **142** is locked to the inner race **146** in that direction, the two rotate together as a unit with shaft **131**. When the side of the cross-head driven by piston **52** strikes the mine face, the piston may rebound backward, initially faster than the screw **99** would move it. An important function of the overrunning clutch **142—146** is that, in such case, it overruns in the direction to permit the rebound to run its course without transmission of shock loads to the supporting sleeve **51**. As soon as the rebound slows down to the normal retracting speed of the screw, it will be picked up smoothly by the latter and moved on back to its "cocked" position.

Means are provided to maintain the clutch **136** open until the firing stroke of piston **52** is completed, and during the firing stroke when the shaft **131** is turning in a clockwise direction, shaft **163** which is splined to shaft **131** also moves in a clockwise direction. During the cocking stroke of piston **52**, when shaft **131** is turning in a counterclockwise direction, shaft **163** also turns in a counterclockwise direction, but in such direction of rotation of the shaft **163**, the inner race **166** of sprag clutch **167** overruns outer race **168**. On the other hand, clockwise rotation of shaft **163** causes sprag clutch **167** to lock thereby driving auxiliary pump **171**.

A fluid line **221** connects tank **196** to the pump **171**, and pumped fluid therefrom passes by way of pressure line **172** past a check valve **222** to join pressure line **218** to continue to supply pressure fluid to clutch operating cylinder **153**.

The firing stroke of piston **52** and ram **36** is continued by the air trapped between piston **52** and cylinder head **84**, the power stroke being carried to completion until the ram **36** and its cross head **32** strikes immovable material or until the pressure of the air trapped in space **210** equals the pressure of the air between piston **52** and cylinder head **84**.

Upon completion of movement of the piston **52** the turning movement of screw **99** stops, giving rise to the commencement of a similar set of sequences as described above. In the meantime, however, push rod **204** is returned to its original or start position by the return spring **214**. Such movement of the push rod closes valve **203**, which would normally cut off the supply of pressure fluid to cylinder **153** but for the operation of auxiliary pump **171**, which insures that clutch **136** remains open until the screw shaft **99**, **131** stops turning. Only when valve **203** is closed and pump **171** is no longer delivering pressure fluid will clutch **136** be re-engaged.

Concomitantly with the closing of valve **203** clutch **119**, **113** is closed, thus making the motor **106** effective once more to repeat the sequence of operations described for its associated ram and piston assembly.

Referring again particularly to Figs. 1 and 2 of the drawings, the improved machine **11** is operated by first causing the gathering head **16** to sump into a seam of coal **20**. The piston and ram assemblies **31** and **31***a* are lowered by the cylinders **46** into position just above the kerf which has been cut by the sumping operation of the gathering head **16**. The operator of the machine starts the motors **106** and **106***a* and also actuates the "start" valve **201** to start the percussive action of the ram and piston assemblies **31** and **31***a* and the crosshead **32** connecting them together, the picker members **33** thereon fragmenting the coal from the seam **20**.

It may be noted that the vertical side plates **28** afford clearance for the ram and piston assemblies so that they may be lowered about their trunnion shafts **38** into position immediately above the gathering head **16**.

As the coal is fragmented from the seam **20** the crosshead **32** and piston and ram assemblies **31** and **31***a* are raised by the lifting cylinders **46**. The means for supplying fluid under pressure to the lifting cylinders **46**, and the control means therefor, may take any convenient and well known form and are therefore not shown or described. The gathering head **16** then conveys coal fragmented from the seam by the picker members **33** onto the chain flight conveyor **22** for removal onto a shuttle car, belt conveyor or the like.

The operation described is repeated for each particular setting of the picker members **33** until the coal is fragmented from the seam up to the top thereof. The machine is then spotted before another part of the seam **20**, the sumping operation first completed and then the percussive operations begun as described.

It will be apparent from the foregoing description that there has been described a novel and efficient machine for fragmenting minerals from a seam by a continuous operation and without the need of explosives. By mounting each ram and piston assembly for limited swinging movement, the assemblies may adopt positions of non-parallelism in accordance with the resistance encountered by the crosshead connecting the assemblies. Further, according to the present invention positive assurance is had of a piston and ram assembly completing a power stroke and of simultaneous and conjoint operation in initiating a power stroke.

While the invention has been described in terms of an embodiment which has been preferred for the purpose of illustrating the novel principles thereof, it is not intended that the scope thereof be limited by the precise embodiment shown nor otherwise than by the terms of the claims here appended.

I claim:

1. In a mining machine for fragmenting material from a solid seam thereof, a pair of ram assemblies spaced laterally of each other, a crosshead hingedly connected at its ends to said spaced ram assemblies, said crosshead having picking elements thereon adapted to contact said seam, each of said ram assemblies comprising a cylinder and a piston therein operatively connected to said crosshead, means for retracting said piston so as to compress elastic fluid within said cylinder for subsequent rapid movement by said piston and said crosshead against said seam, said means comprising a threaded member in threading engagement with said piston, means for causing rotation of said threaded member in one direction for retractive movement of said piston and for free rotation of said threaded member in a reverse direction upon movement of said piston by the pressure of said elastic fluid comprising a motor for turning said threaded member in a direction to retract said piston, means drivably connected with said motor for turning said threaded member in a direction to retract said piston, a main clutch operable during retracting movement of said piston to connect said motor with said last named means, a second clutch included with said driving means and operable during retractive movement of said piston, means operable upon the reaching of the retracted position of said piston for disengaging said main clutch and for causing the disengagement of said second clutch for free rotation in an opposite direction of said threaded member upon movement of said piston by said elastic fluid, said last named means being operable to prevent the movement of both of said pistons by said elastic fluid until both of said pistons have reached their retracted positions.

2. A mining machine according to claim 1 characterized by means operable upon rotation of said threaded member in said opposite direction for holding said second clutch in disengaged position until said piston has reached a limit of travel.

3. A mining machine according to claim 2 wherein said second clutch is operated by pressure fluid and is operated only after both of said pistons have reached retracted position.

4. An improved mining machine according to claim 3 wherein additional fluid under pressure is made available to maintain said second clutches in disengaged position so long as either piston has failed to reach a limit of travel.

5. A mining machine according to claim 1 characterized by a fluid pressure system for operating said second clutch and wherein valve means are operable by movement to retracted position of said piston, and wherein said valve means are connected in series so that fluid pressure is made available for operating said clutch only after both of said pistons have reached their retracted position.

6. In a mining machine for fragmenting material from a solid seam thereof, a ram including a cylinder and a piston therein operatively connected to said ram, means for retracting said piston so as to compress elastic fluid within said cylinder for subsequent rapid movement by said piston with said ram into contact with said seam, said means comprising a threaded member in threading engagement with said piston, means for causing rotation of said threaded member in one direction for retractive movement of said piston and for free rotation of said threaded member in a reverse direction upon movement of said piston by the pressure of said elastic fluid comprising a motor for turning said threaded member in a direction to retract said piston, means drivably connected with said motor for turning said threaded member in a direction to retract said piston, a main clutch operable during retracting movement of said piston to connect said motor with said last named means, a second clutch included with said driving means and operable during retractive movement of said piston, means operable upon the reaching of the retracted position of said piston for disengaging said main clutch and for causing the disengagement of said second clutch for free rotation in an opposite direction of said threaded member upon movement of said piston by said elastic fluid.

7. The invention as defined in claim 6 wherein means are operable upon rotation of said threaded member in said opposite direction for holding said second clutch in disengaged position until said piston has reached a limit of travel.

8. An improved mining machine according to claim 6 characterized by a fluid pressure system for operating said second clutch and wherein fluid pressure is made available to operate said second clutch upon reaching of the retracted position by said piston.

9. An improved mining machine according to claim 8 wherein additional fluid under pressure is made available upon rotation of said threaded member in said opposite direction to operate said second clutch until said piston has reached a limit of travel.

10. The invention as defined in claim 6 characterized by a source of elastic fluid under pressure and wherein said means which are operable upon the reaching of the retracted position of said piston are additionally operable to augment the supply of elastic fluid within said cylinder.

11. In a mining machine for fragmenting material from a solid seam thereof, a ram including a cylinder and a piston therein operatively connected to said ram, means for retracting said piston so as to compress elastic fluid within said cylinder for subsequent rapid movement by said piston with said ram into contact with said seam, said means comprising a threaded member in threading engagement with said piston, a motor for turning said threaded member for retracting said piston, a source of elastic fluid under pressure, and valve means operable upon retraction of said piston to augment from said source the pressure in said cylinder after retracting movement of said piston.

12. In a mining machine for fragmenting material

from a solid seam thereof, a ram including a cylinder and a piston therein operatively connected to said ram, means for retracting said piston so as to compress elastic fluid within said cylinder for subsequent rapid movement by said piston with said ram into contact with said seam, said means comprising a threaded member in threading engagement with said piston, a motor for turning said threaded member for retracting said piston, a source of elastic fluid under pressure, and valve means operable upon retraction of said piston to augment from said source the pressure in said cylinder after retracting movement of said piston, and an overrunning clutch interposed between said motor and said threaded member for enabling said piston to move freely after retraction thereof by the pressure of said elastic fluid in a direction to cause said ram to strike said seam.

13. In a mining machine for fragmenting material from a solid seam thereof, a ram including a cylinder and a piston therein operatively connected to said ram, means for retracting said piston so as to compress elastic fluid within said cylinder for subsequent rapid movement by said piston with said ram into contact with said seam, said means comprising a threaded member in threading engagement with said piston, a motor for turning said threaded member for retracting said piston, a source of elastic fluid under pressure, and valve means operable upon retraction of said piston to augment from said source the pressure in said cylinder after retracting movement of said piston, and an overrunning clutch interposed between said motor and said threaded member for enabling said piston to move freely after retraction thereof by the pressure of said elastic fluid in a direction to cause said ram to strike said seam, the movement of said piston in a direction toward said seam closing said valve means.

14. In a mining machine for fragmenting material from a solid seam thereof, a pair of ram assemblies spaced laterally of each other, a crosshead hingedly connected at its ends to said spaced ram assemblies, said crosshead having picking elements thereon adapted to contact said seam, a support for each of said ram assemblies, a substantially vertical pivot member connecting said support and said ram assembly so as to provide separate pivoting movement of said ram assembly in accordance with the skewing of said crosshead in encountering material of varying resistance throughout its length, and elastic means interposed between said support and said ram assembly for providing limited restraint to pivoting movement of said ram assembly.

15. In a mining machine for fragmenting material from a solid seam thereof, a pair of ram assemblies spaced laterally of each other, a crosshead hingedly connected at its ends to said spaced ram assemblies, said crosshead having picking elements thereon adapted to contact said seam, a support for each of said ram assemblies, a substantially vertical pivot member connecting said support and said ram assembly so as to provide separate pivoting movement of said ram assembly in accordance with the skewing of said crosshead in encountering material of varying resistance throughout its length, and means interposed between said support and said ram assembly for providing limited restraint to pivoting movement of said ram assembly comprising an elastic pad bonded along its upper and lower surfaces to said ram assembly and said support.

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