July 9, 1957 C. F. BALL 2,798,712

CONTINUOUS MINING APPARATUS OF THE PIVOTED BOOM TYPE

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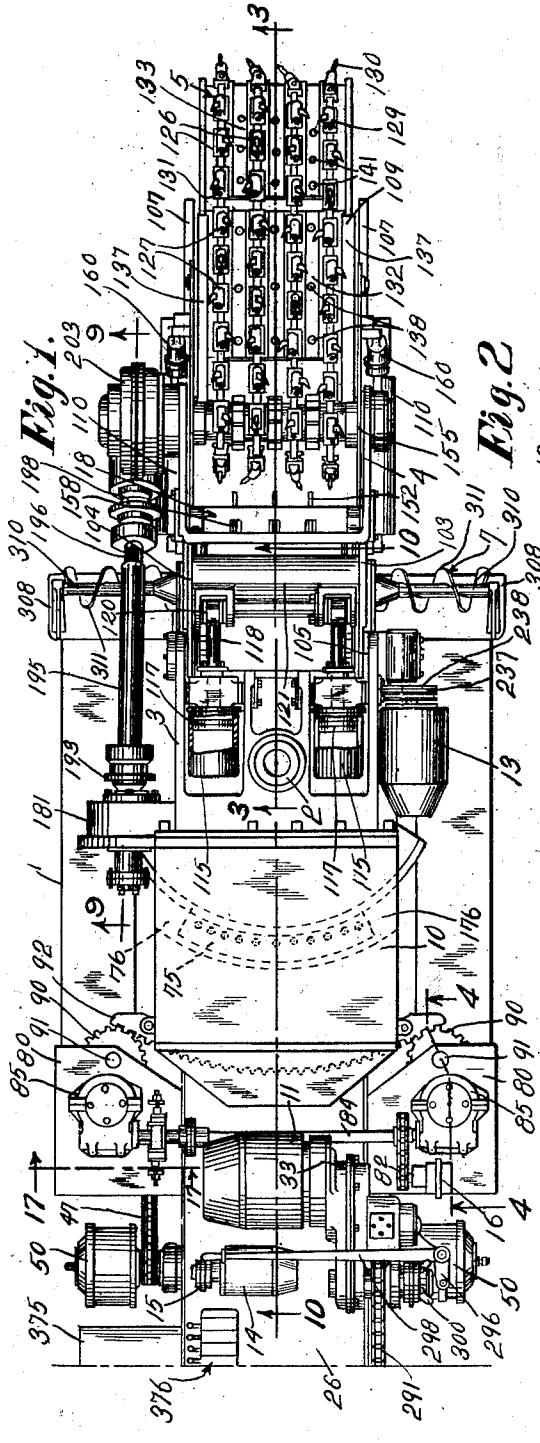


Fig. 1.

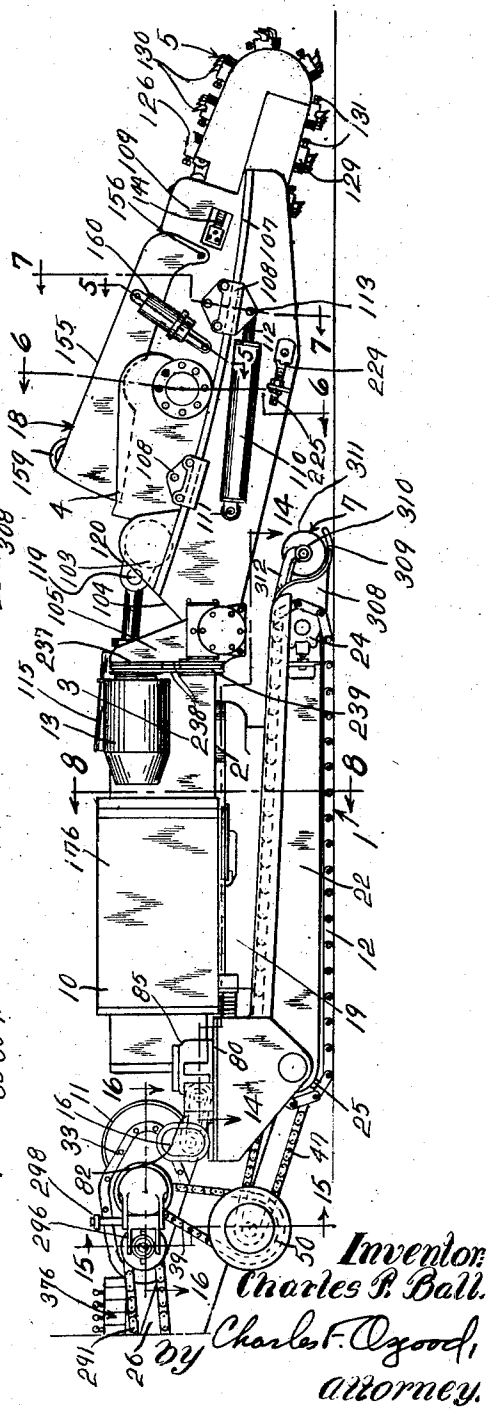


Fig. 2.

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CONTINUOUS MINING APPARATUS OF THE PIVOTED BOOM TYPE

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Fig. 3

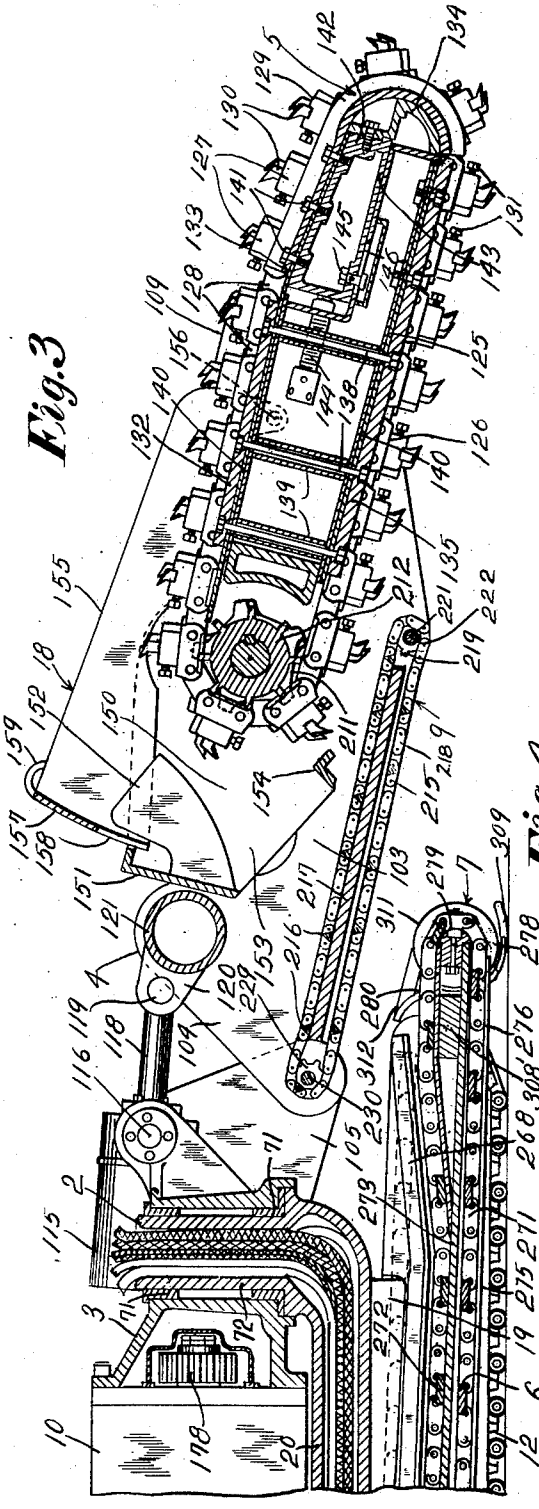


Fig. 5

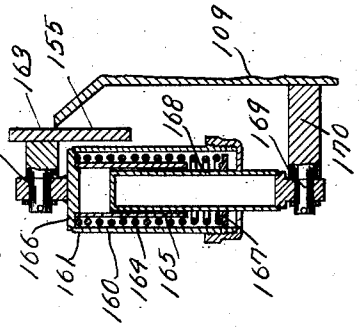
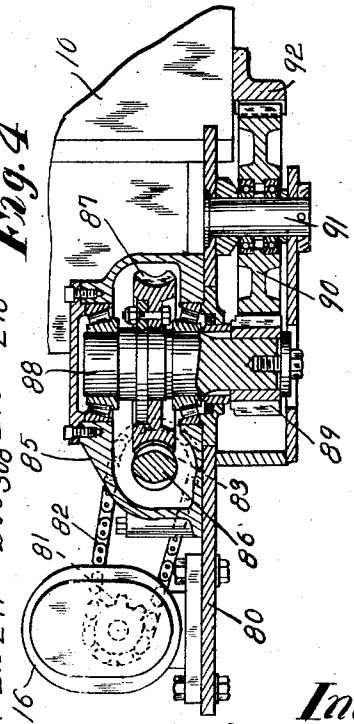


Fig. 4



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CONTINUOUS MINING APPARATUS OF THE PIVOTED BOOM TYPE

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Fig. 6

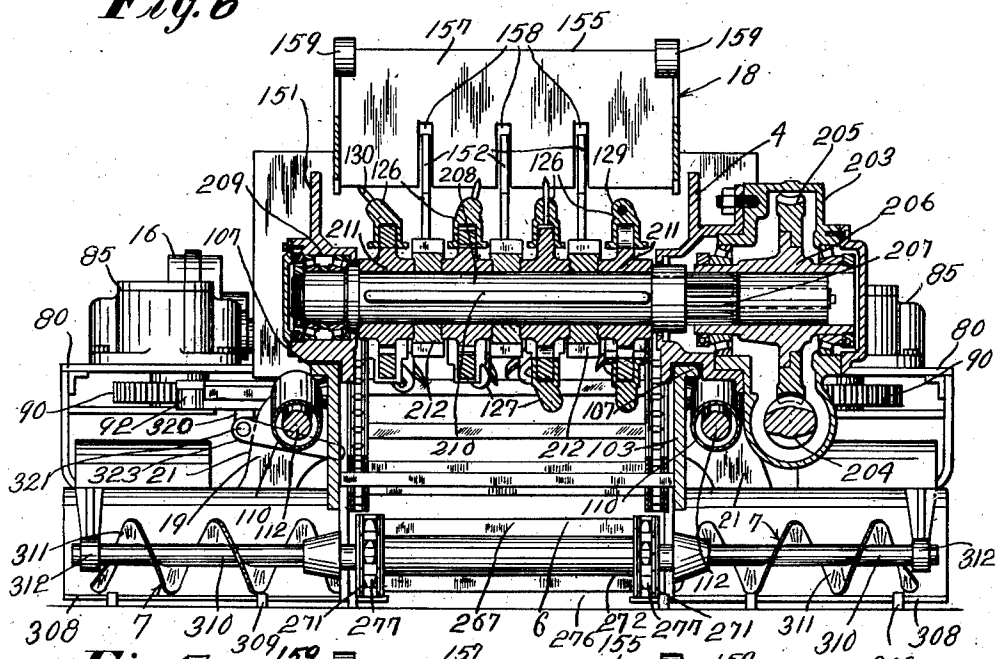
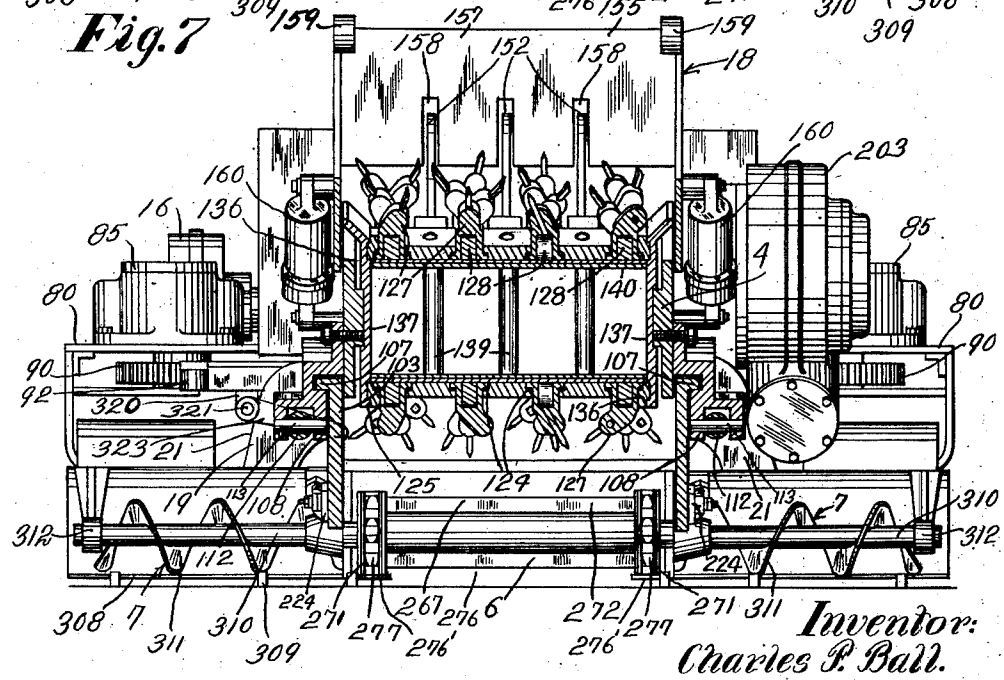


Fig. 7



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CONTINUOUS MINING APPARATUS OF THE PIVOTED BOOM TYPE

Filed March 30, 1948 11 Sheets-Sheet 4

Fig. 8

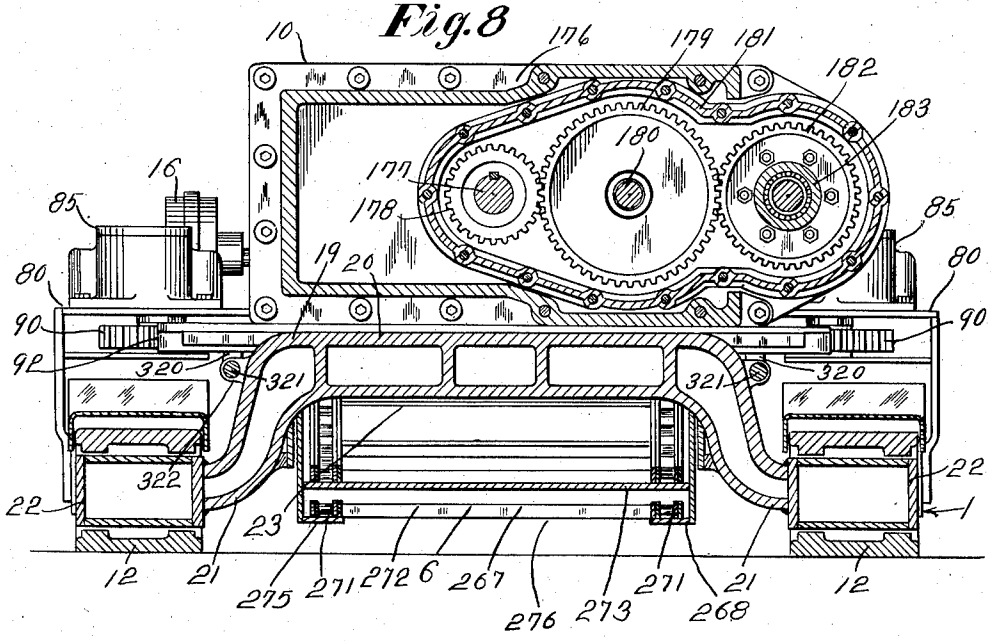
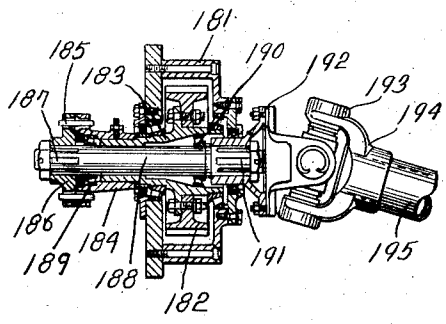
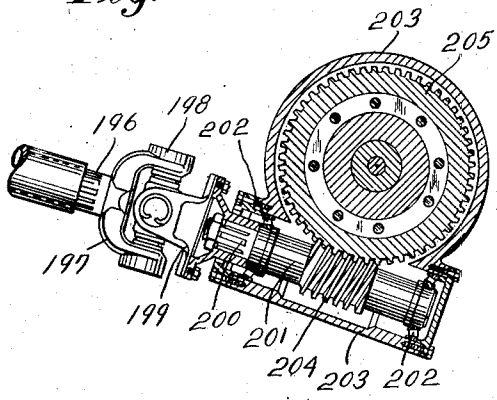


Fig. 9





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July 9, 1957 C. F. BALL 2,798,712

CONTINUOUS MINING APPARATUS OF THE PIVOTED BOOM TYPE

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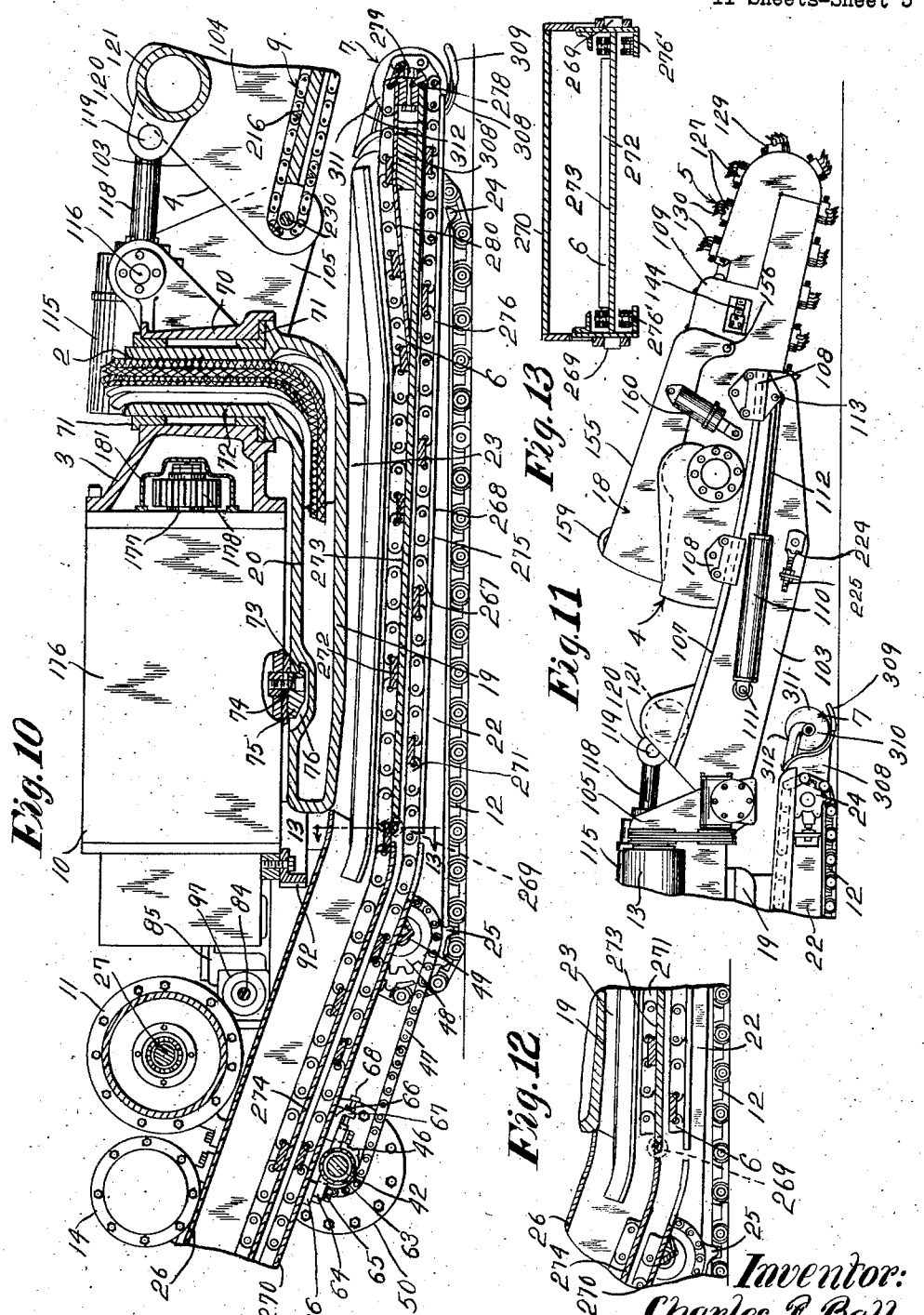


Fig. 10

Fig. 11

Fig. 13

Fig. 12

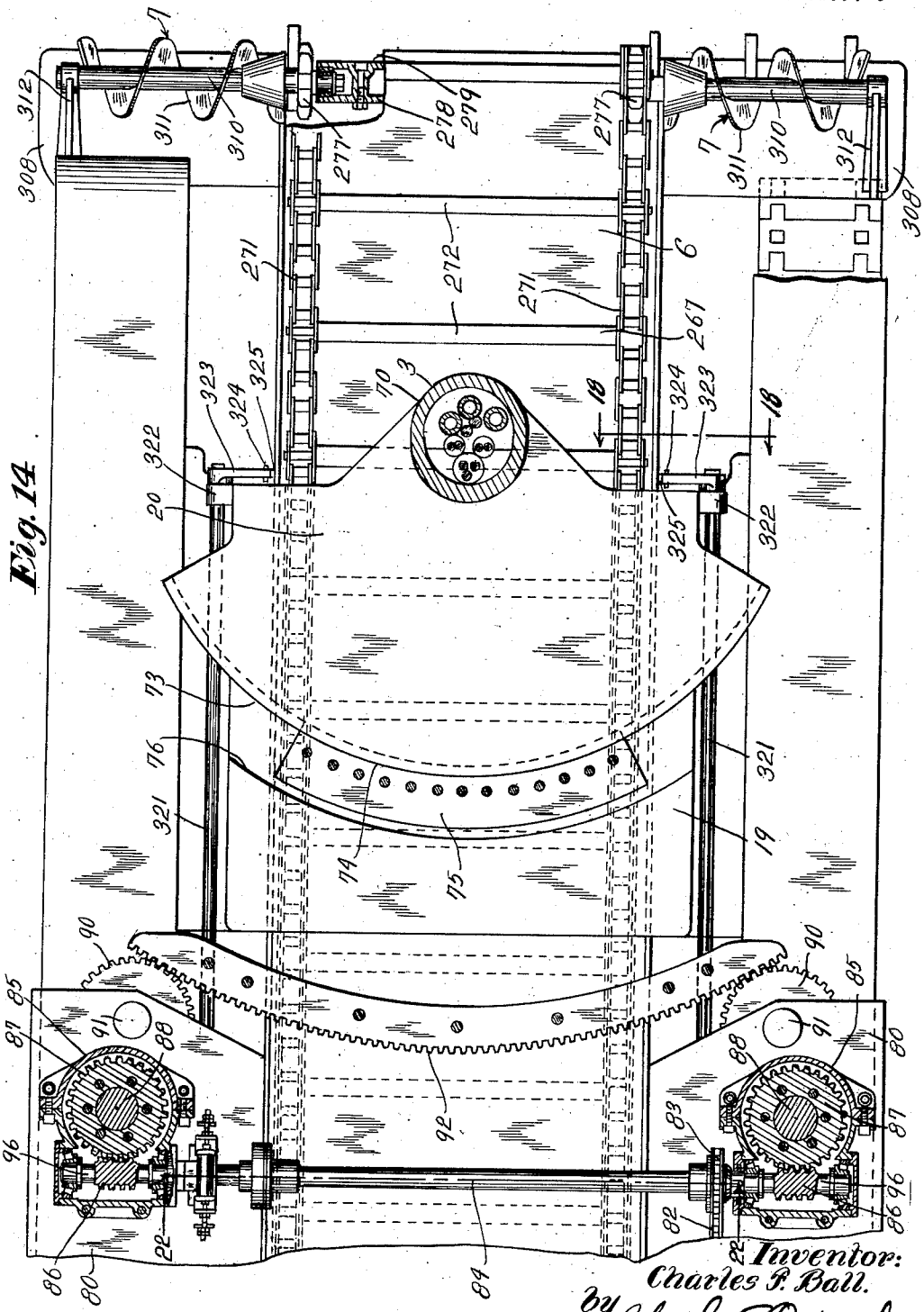
Inventor:
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July 9, 1957 C. F. BALL 2,798,712

CONTINUOUS MINING APPARATUS OF THE PIVOTED BOOM TYPE

Filed March 30, 1948 11 Sheets-Sheet 6

Fig. 14



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CONTINUOUS MINING APPARATUS OF THE PIVOTED BOOM TYPE

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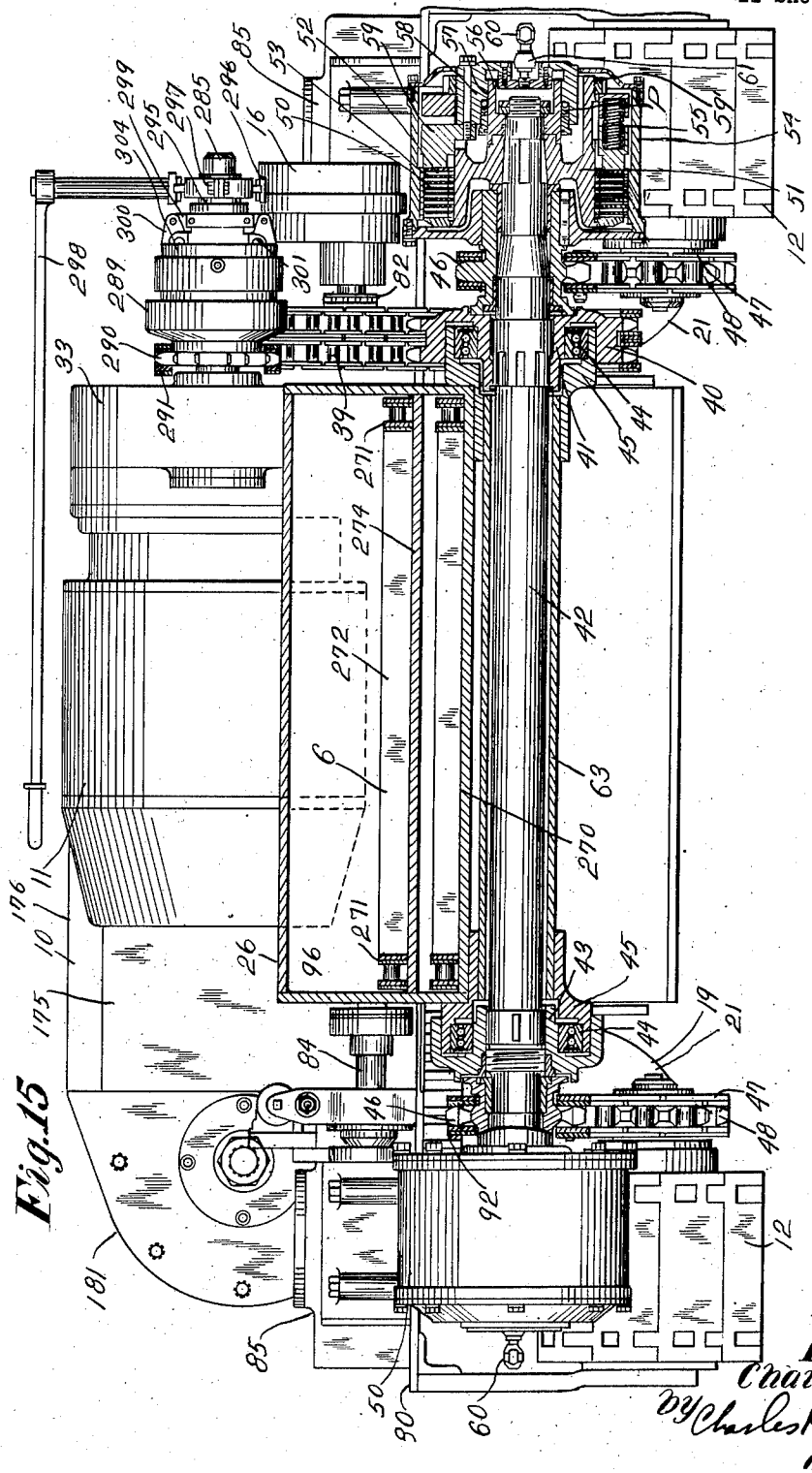


Fig. 15

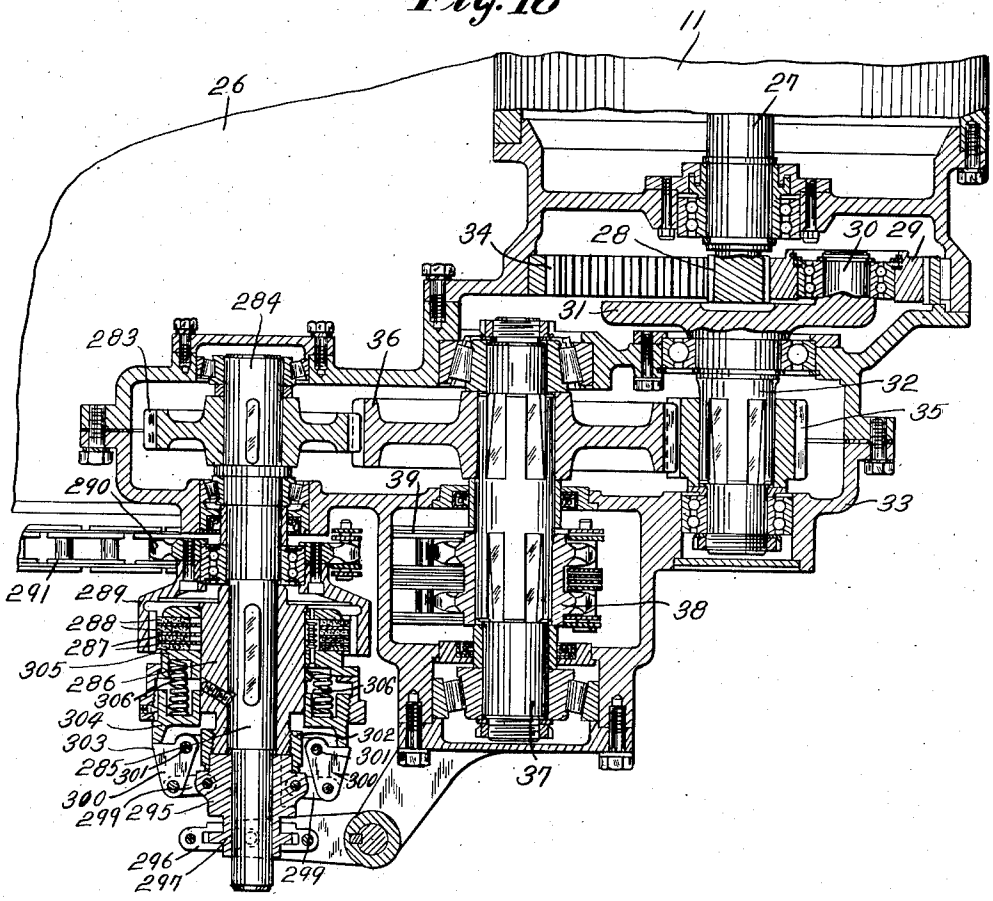
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July 9, 1957 C. F. BALL 2,798,712

CONTINUOUS MINING APPARATUS OF THE PIVOTED BOOM TYPE

Filed March 30, 1948 11 Sheets-Sheet 8

Fig. 16



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CONTINUOUS MINING APPARATUS OF THE PIVOTED BOOM TYPE

Filed March 30, 1948 11 Sheets-Sheet 9

Fig. 17

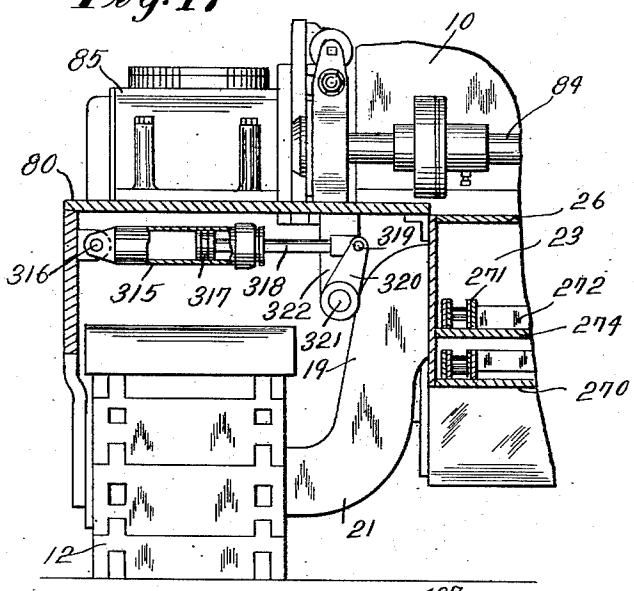


Fig. 18

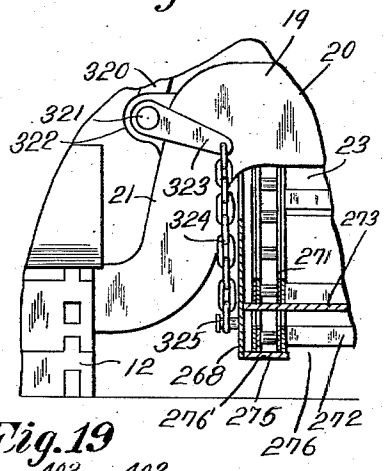


Fig. 19

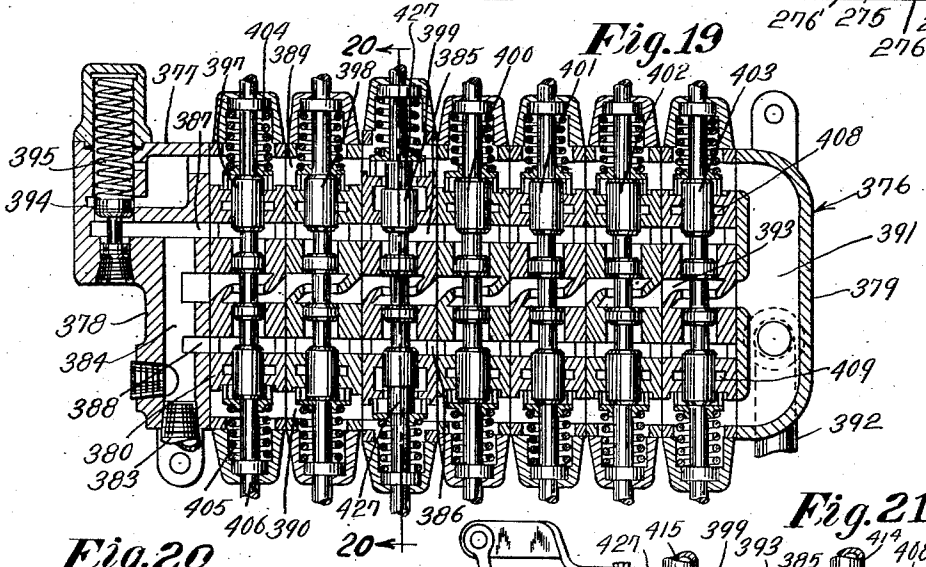


Fig. 20

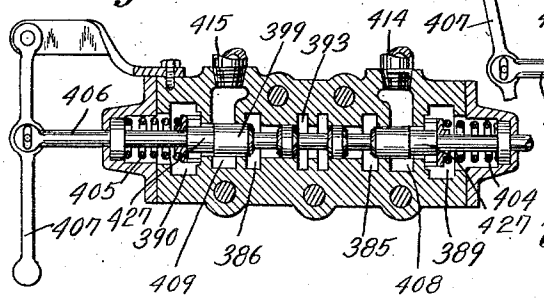
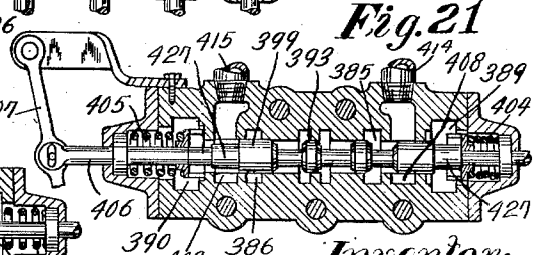


Fig. 21



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CONTINUOUS MINING APPARATUS OF THE PIVOTED BOOM TYPE

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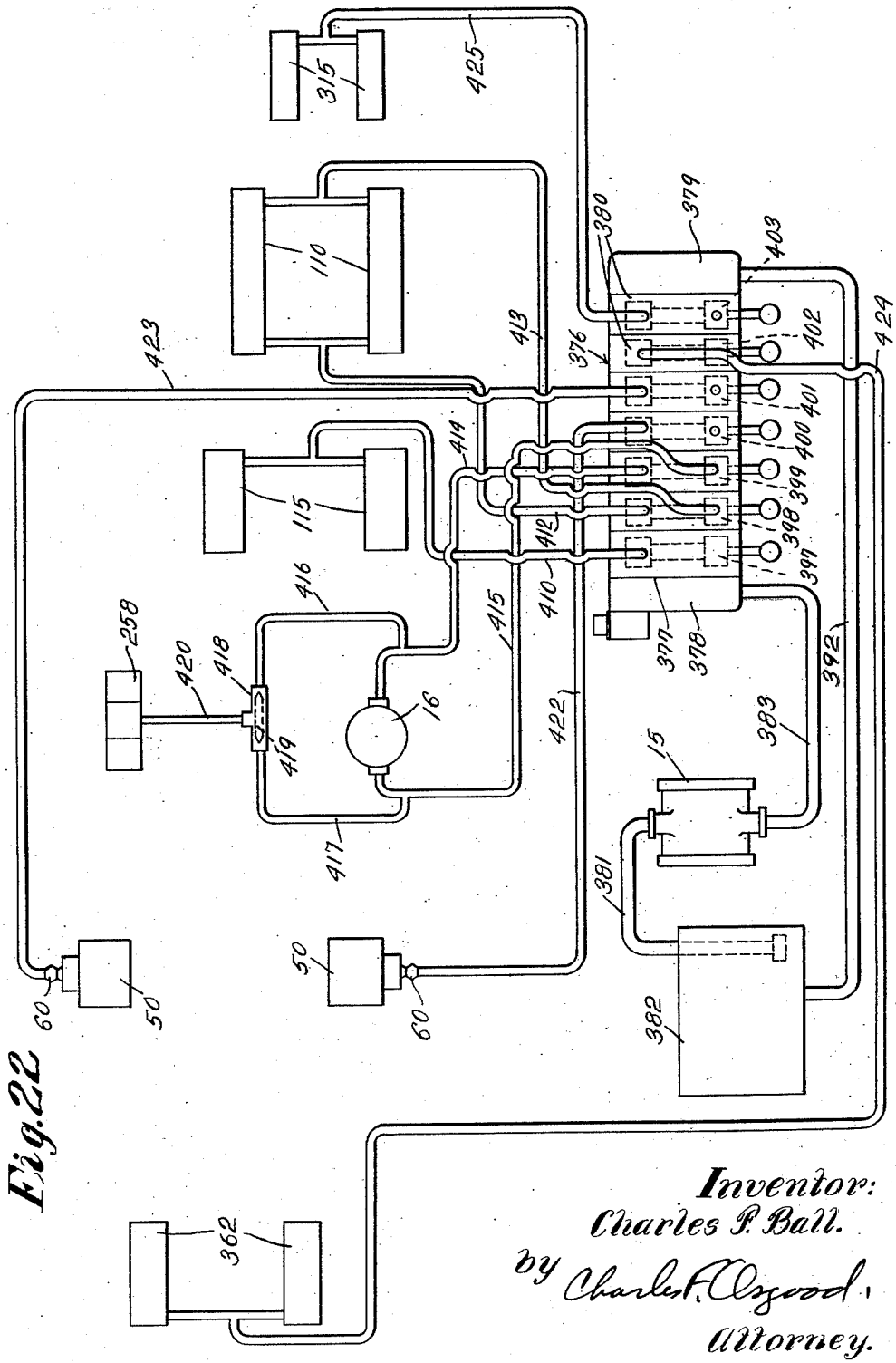


Fig. 22

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CONTINUOUS MINING APPARATUS OF THE PIVOTED BOOM TYPE

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Fig. 23

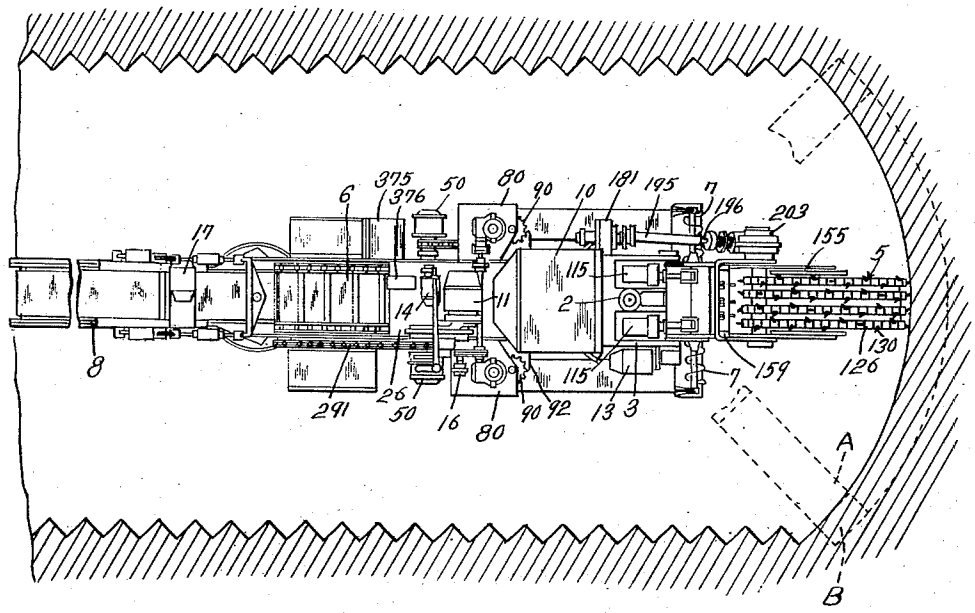
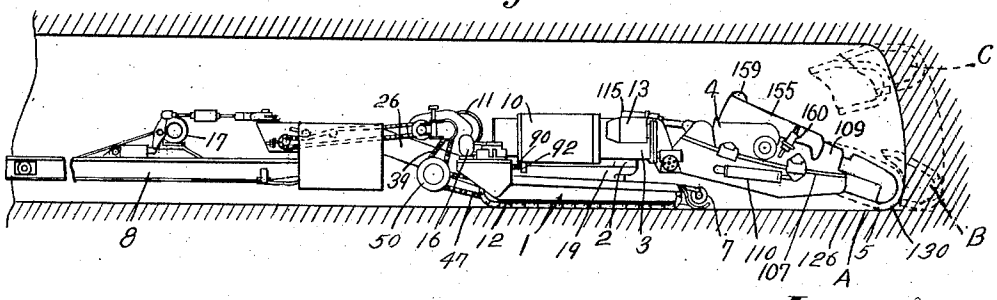


Fig. 24



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United States Patent Office 2,798,712 Patented July 9, 1957

2,798,712

CONTINUOUS MINING APPARATUS OF THE PIVOTED BOOM TYPE

Charles F. Ball, Franklin, Pa., assignor to Joy Manufacturing Company, Pittsburgh, Pa., a corporation of Pennsylvania

Application March 30, 1948, Serial No. 17,993

8 Claims. (Cl. 262—29)

This invention relates to mining apparatus and more particularly to an improved apparatus for mining coal or similar materials from a solid face in underground mines without the use of explosives and for loading the coal removed from the face as mining progresses.

The invention, from a broad aspect, may comprise a mining and loading apparatus of a low height construction especially adapted for use in underground mines having low headroom, and including vein-disintegrating apparatus for attacking in succession a series of segments of the coal face, for breaking up oversize chunks of dislodged coal, and for conveying the disintegrated coal away from the coal face to a suitable point of disposal. The invention, from a more specific aspect, may comprise a mobile base adapted to travel over the floor of a mine and carrying a swiveled frame mounted to swing horizontally with respect to the base and on which an elongated boom frame structure is pivotally mounted to swing in vertical planes with respect thereto and to swing horizontally therewith relative to the base. The boom frame is extensible to vary its length and has power devices for extending and retracting the same and supports, at its outer extremity, the coal-, face-, vein-, or seam-attacking and disintegrating mechanism. The disintegrating mechanism is preferably sumped into the coal face near the floor level by extending the boom frame by its power devices, and when the outer portion of the vein-disintegrating mechanism has been sumped within the coal face, the boom frame may be swung upwardly by power devices at a relatively high speed and with a powerful upward thrust to cause the disintegrating instruments to effect disintegration of a vertical segment of the coal face between the top of the opening produced by sumping and the roof. The disintegrated coal is moved along the top of the disintegrating mechanism to discharge into a breaker and hopper mechanism wherein any unwieldy chunks of coal are reduced to handleable size and conducted to an auxiliary conveyor on the boom frame which, in turn, discharges onto a main elevating conveyor. When the vein-disintegrating mechanism reaches the end of its upward swinging stroke, the boom frame may be retracted by its power devices to withdraw the outer portion of this disintegrating mechanism from the coal. Desirably, with the disintegrating mechanism constructed as herein later explained, no coal will need to be detached during the withdrawal. The swiveled frame may be then turned on its swivel axis relative to the base to locate the vein-disintegrating mechanism in a new position to attack an adjacent segment of the coal face, and successive segments of the coal face may be successively disintegrated until the coal for the entire width of the face is dislodged. The disintegrated coal is conveyed rearwardly of the apparatus by a main elevating conveyor which discharges onto a swiveled and tiltable rear discharge conveyor which, in turn, conveys the coal to a suitable point of disposal. The vein-disintegrating mechanism, when in lowered sumping position near the floor level, is, in a preferred embodiment of the invention, given a non-rectilinear sumping

movement so that the bottom of the disintegrating mechanism substantially follows the floor line, and the upward swinging movement is relatively rapid and powerful so that the coal is rapidly dislodged by the disintegrating instruments with a tearing action toward the free face of the coal. Any loose coal which falls to the floor from the vein-disintegrating mechanism is picked up by the front gathering devices and moved onto the elevating conveyor as the apparatus is advanced toward the face as mining progresses.

An object of the present invention is to provide an improved mining and loading apparatus of an extremely low height construction especially designed for use in underground mines having low headroom. Another object is to provide an improved mining and loading machine whereby a series of vertical segments of the coal face are dislodged from the solid to remove the coal completely across the face without the use of explosives, and the dislodged coal is conveyed from the face to a suitable point of disposal. A further object is to provide an improved mining and loading apparatus which is relatively compact and rugged in design and which is extremely flexible in operation and sensitive to control. A further object is to provide an improved mining and loading apparatus comprising a mobile base having a swiveled frame mounted thereon to swing horizontally with respect thereto and carrying an extensible boom frame structure of which the extensible portion, in turn, carries coal-detaching, face-disintegrating mechanism whereby, when the boom frame is extended and retracted, the disintegrating mechanism may be sumped into or withdrawn from the coal, and having embodied therein improved means for swinging the boom frame structure to move the disintegrating mechanism to effect a vertical swinging movement from its sumped position to its raised position near the roof level. Yet another object is to provide an improved mining and loading apparatus having improved vein-attacking and disintegrating mechanism for disintegrating the coal face in vertical segments and for removing the dislodged coal from the coal face in an improved manner. A further object is to provide an improved mounting means for the disintegrating mechanism whereby the latter, upon sumping movement thereof near the floor level, substantially follows the line of the floor, resulting in a smooth bottom. Still another object is to provide improved means for effecting sumping and withdrawing movements of the coal seam attacking and disintegrating mechanism, for effecting vertical swinging movements of such mechanism, and for adjusting such mechanism into different lateral vein-attacking and dislodging positions. Yet another object is to provide an improved extensible boom frame structure for supporting the vein-attacking and disintegrating mechanism, and having improved means for extending and retracting the boom frame to effect sumping and withdrawal movements of the vein-attacking and disintegrating mechanism proper. A further object is to provide an improved breaker and hopper mechanism associated with the vein-attacking and disintegrating mechanism for receiving the dislodged coal, for reducing the oversized chunks of dislodged coal, and for conducting the dislodged coal to the conveying means of the apparatus. A still further object is to provide an improved supporting and guiding structure for the coal-detaching and disintegrating mechanism. Still another object is to provide an improved chute mechanism for receiving the dislodged coal discharged from the coal detaching and disintegrating mechanism, and embodying a chute section so held as to yield in the event of engagement with the mine roof. These and other objects and advantages of the invention will, however, hereinafter more fully appear.

In the accompanying drawings there is shown for pur-

poses of illustration one form which the invention may assume in practice.

In these drawings:

Fig. 1 is a plan view of a preparred illustrative form of the improved mining and loading apparatus.

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

Fig. 3 is an enlarged view in longitudinal vertical section taken substantially on line 3—3 of Fig. 1, with the disintegrating mechanism shown slightly raised.

Fig. 4 is an enlarged detail vertical sectional view taken substantially on line 4—4 of Fig. 1.

Fig. 5 is a detail sectional view taken substantially on line 5—5 of Fig. 2.

Fig. 6 is an enlarged cross-sectional view taken substantially on line 6—6 of Fig. 2.

Fig. 7 is an enlarged cross-sectional view taken substantially on line 7—7 of Fig. 2.

Fig. 8 is an enlarged cross-sectional view taken substantially on line 8—8 of Fig. 2.

Fig. 9 is an enlarged longitudinal vertical sectional view taken substantially on line 9—9 of Fig. 1.

Fig. 10 is an enlarged view in longitudinal vertical section taken substantially on line 10—10 of Fig. 1.

Fig. 11 is a fragmentary side elevational view of the forward portion of the apparatus shown in Fig. 2, with the cutting and disintegrating mechanism in extended sumped position, but slightly raised from the bottom.

Fig. 12 is a fragmentary sectional view taken on the plane of Fig. 10 and illustrating details of the pivotal connection between portions of the frame of the elevating conveyor.

Fig. 13 is a cross-sectional view taken substantially on line 13—13 of Fig. 10.

Fig. 14 is an enlarged horizontal sectional view taken substantially on line 14—14 of Fig. 2.

Fig. 15 is an enlarged cross-sectional view taken substantially on line 15—15 of Fig. 2.

Fig. 16 is an enlarged horizontal sectional view taken substantially on line 16—16 of Fig. 2.

Fig. 17 is an enlarged detail view in cross section taken substantially on line 17—17 of Fig. 1.

Fig. 18 is an enlarged fragmentary cross-sectional view taken substantially on line 18—18 of Fig. 14.

Fig. 19 is a horizontal sectional view through the control valve mechanism.

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

Fig. 21 is a view similar to Fig. 20, showing the control valve in a different position.

Fig. 22 is a diagrammatic view illustrating the hydraulic fluid system.

Fig. 23 is a diagrammatic plan view showing the mining and loading apparatus in operating position in a mine.

Fig. 24 is a diagrammatic side elevational view of the mining and loading apparatus shown in Fig. 23, with the vein-attacking and disintegrating mechanism shown in full and also in dotted lines, in extended sumped position.

The improved mining and loading apparatus, as shown in the drawings, constitutes an improvement over that of a copending application to Harold F. Silver, Serial No. 11,688, filed February 27, 1948, which is owned by applicant's assignee, and generally comprises a mobile base, herein a tractor or crawler base 1, adapted to travel over the floor of a mine, and carrying a vertical swivel 2 on which a supporting frame 3 is mounted to swing horizontally with respect to the base, and which, in turn, has an extensible boom frame structure 4 mounted thereon to swing in horizontal planes with the supporting frame with respect to the base and to swing in vertical planes relative to the supporting frame. The extensible boom frame carries, at its outer end, vein-attacking and disintegrating mechanism, generally designated 5, for detaching and disintegrating the coal in vertical segments from the solid. While at times I may refer to this vein-attacking mechanism as a coal-, face,- or seam-attacking mechanism, it is to be understood that except as may be required by the prior art or specifically set forth in the claims this apparatus is not limited to use with coal. Extending rearwardly through the base is a main elevating conveyor 6 having adjustable front gathering device generally designated 7 and discharging onto a rear discharge or tail conveyor 8 (Figs. 23 and 24) mounted to swing horizontally and to tilt vertically on the rearward portion of the base. An auxiliary conveyor, generally designated 9, is mounted on the boom frame to convey the disintegrated coal discharged from the cutting and disintegrating mechanism to the main elevating conveyor irrespective of the adjusted position of the vein-attacking and disintegrating mechanism 5 with respect thereto. A motor 10, carried by the swiveled frame 3, serves to drive the vein-, face-, or coal-attacking and disintegrating mechanism 5; a motor 11 drives the crawler treads 12; and a motor 13 drives the auxiliary conveyor 9. A motor 14 drives a pumping means 15 for delivering fluid under pressure to the various hydraulically operated devices of the apparatus. A motor 16 serves to swing the supporting frame 3 on its swivel horizontally with respect to the base, and a motor 17 drives the rear discharge conveyor 8. The crawler treads 12 of the tractor base serve to propel the apparatus about the mine and to steer the apparatus, and the supporting frame and boom frame are swingable horizontally relative to the base to locate the vein-attacking and disintegrating mechanism in different laterally disposed, radially extending positions with respect to the base. When the vein-attacking and disintegrating mechanism 5 is lowered into sumping position near the floor level, the boom frame may be extended by power devices to sump the outer portion of the vein-attacking and disintegrating mechanism into the coal near the floor level. Thereafter the boom frame may be swung upwardly by power devices to move the vein-attacking and disintegrating mechanism in vertical planes in an arcuate path to tear away or dislodge the coal in its path, and, finally, the boom frame may be retracted by its power devices to withdraw the outer portion of the attacking and disintegrating mechanism from the coal. During vertical swinging of the vein-attacking and disintegrating mechanism, the coal is detached or torn away toward the free face of the coal, and the dislodged coal is moved by the vein-attacking and disintegrating mechanism rearwardly along the top thereof to discharge through a breaker and hopper mechanism, generally designated 18, which reduces any oversized chunks of the dislodged coal as required for further handling and conducts the disintegrated coal to the auxiliary conveyor 9 which, in turn, discharges the coal onto the main elevating conveyor 6. The front gathering devices 7 gather up any loose coal which has fallen to the floor and move it onto the elevating conveyor 6 as the apparatus is advanced toward the coal face. This elevating conveyor discharges the disintegrated coal onto the rear discharge conveyor 8, which, in turn, conveys the coal to a suitable point of delivery. By swinging the vein-attacking and disintegrating mechanism about the swivel of the supporting frame, it may be located in different radial positions to attack and disintegrate the coal in a series of vertical segments of the coal face so that the entire width of the face may be disintegrated in successive steps.

The tractor or crawler base 1 comprises a frame 19 of generally inverted U shape, as shown in Fig. 8, and including a horizontal top portion 20 having downwardly extending side or leg portions 21 which are suitably rigidly secured to side frames 22 each providing a usual guideway for an endless crawler tread 12. The inverted U frame provides a bottom space 23 through which the elevating

conveyor 6 extends in the manner shown. The crawler treads are of a conventional articulated tread plate construction, and the side frames carry front idler sprockets 24 which are adjustable in a conventional manner with respect to the side frames to enable variation in the chain tension. Rear drive sprockets 25, suitably journaled on the side frames, engage and drive the crawler treads. The tread driving motor 11, which is herein preferably an electric motor, is carried by an upwardly and rearwardly inclined portion 26 of the base frame 19 and is arranged transversely of the base and has its power shaft 27 horizontally disposed. Fixed to the motor shaft is a spur pinion 28 (Fig. 16) meshing with spur planet gears 29 journaled on stub shafts 30 integral with a planet carrier 31, the latter herein having a shaft 32 coaxial with the motor shaft and suitably journaled in bearings supported within a gear housing 33 carried by the base frame portion 26. The planet gears mesh with a large internal gear 34 keyed to the housing. As the planet gears are driven, they roll around the internal gear as a trackway to provide a substantial speed reduction between the pinion 28 and the carrier shaft. Keyed to the carrier shaft 32 is a spur gear 35 meshing with a spur gear 36, in turn keyed to a shaft 37 parallel with the carrier shaft 32 and likewise journaled in the gear housing. Keyed to the shaft 37 is a double chain sprocket 38 engaging an endless drive chain 39 which engages and drives a double chain sprocket 40 (Fig. 15) having its hub 41 keyed to a horizontal transversely extending shaft 42, herein arranged parallel with the shaft 37. As also shown in Fig. 15, secured to the end portion of the shaft 42 opposite from that to which the chain sprocket 40 is secured is the hub of a member 43. The hubs of the chain sprocket 40 and the member 43 are journaled on bearings 44 carried within bearing supports 45 suitably adjustably mounted, as later described, at the sides of the base frame portion 26. Coaxial with the hubs 41 and 43 and journaled on the end portions of the shaft 42 are chain sprockets 46 connected by endless drive chains 47 to chain sprockets 48, the latter in turn secured to transverse shafts 49 (see also Fig. 10) suitably journaled within the crawler side frames 22 and to which the tread drive sprockets 25 are secured. The sprockets 46 are connectible to the drive shaft 42 by multiple disk clutches 50 (Fig. 15) each comprising a hub member 51 keyed to the end portion of the shaft 42 and having splined thereto clutch disks 52 interleaved with clutch disks 53 splined to a clutch-casing 54 having its hub keyed to the hub of the chain sprocket 46. The interleaved clutch disks 52, 53 are held in frictional engagement by pressure supplied by coil springs 55 set at a predetermined load. Secured to each end of the shaft 42 is a piston 56 contained in a cylinder bore 57 formed in a reciprocable member 58 to which an operating member 59 for the clutch disks is secured. The springs 55, 55 act on these members 59 at one end and against an adjustable stop 59' carried by the hub member 51 at their other ends. The member 58 carries a packing P sealingly engaging the exterior of the piston 56 to prevent oil leakage. Fluid may be supplied to the cylinder bore, in a manner to be later explained, through a swivel connection 60 and a conduit 61 communicating with the cylinder bore. When fluid under pressure is supplied to the cylinder bore, the member 58 is moved outwardly relative to the piston 56 to effect compression of the clutch loading springs 55, thereby to remove the loading pressure from the clutch disks to effect clutch release. The clutches 50 for the crawler treads may be independently controlled, as later described, so that the treads may be employed to effect steering of the apparatus as it travels over the mine floor. Surrounding the shaft 42, as shown in Fig. 15, is a tubular member or sleeve 63 having its end portions received within and secured, as by welding, to the bearing support members 45. Secured to the tubular member 63 at the inner sides of the hubs of the members 45 are brackets 64 (see Fig. 10) which are secured, as by screws 65, to plates 66, herein secured as by welding to the base frame portion 26. The screws 65 pass through longitudinal slots in the brackets 64 so that when the screws are loosened, the brackets may be adjusted endwise relative to the base frame portion 26 to vary the tension of the drive chains 47. For adjusting these brackets, certain of the plates 66 have depending lugs 67 carrying adjusting screws 68 which engage the adjacent ends of the brackets 64. Thus, when the screws 65 are loosened, the screws 68 may be adjusted to vary the position of the brackets 64 with respect to the plates 66, and the brackets, when adjusted, may be firmly clamped in position by again tightening the screws 65.

The swiveled supporting frame 3, mounted on the base frame 19, has, at its forward side, a bearing engaging portion 70 (Fig. 10) engaging spaced sleeve bearings 71 supported by an upright cylindrical bearing support 72, herein formed integral with the forward portion of the base frame. Arranged eccentrically with respect to the swivel axis at the rearward side of the latter is an arcuate guide 73 formed integral with the base frame 19 and received in a guideway 74 provided by a curved guide member 75 secured to the bottom of the swiveled frame. The top of the base frame is arcuately recessed at 76 to receive and to permit swinging movement of the curved guide member 75 in the manner shown. The parts 73, 75 cooperate to provide a guide for the swiveled frame supplementing the swivel bearing mounting so that the swivel frame is adequately guided in all positions of horizontal angular adjustment. The horizontal frame portion 20 and the upright bearing support 72 are made hollow, as shown in Fig. 3, and certain of the power conductor cables or wires and certain of the fluid conduits extend longitudinally through the hollow frame and upwardly through the bearing support at the center of the swivel, for compactness, thereby eliminating the necessity of draping the cables, wires, or conduits about the apparatus.

The extensible boom frame 4 and face-disintegrating mechanism 5 are carried by the swiveled frame 3 to swing horizontally therewith relative to the base frame in a manner to be later explained. The means for horizontally swinging the swiveled frame 3 on its swivel mounting includes the hydraulic motor 16 (see Fig. 4) which is reversible and which is supported by a horizontal frame structure 80 mounted on the base frame 19. This motor has secured to its power shaft a chain sprocket 81 which is connected by an endless drive chain 82 to a chain sprocket 83, the latter herein keyed to a transverse shaft 84 journaled at its end portions within gear housings 85 secured to the frame structure 80. Secured to the end portions of the shaft 84 and arranged within the gear housings are worms 86 meshing with worm wheels 87 secured to vertical shafts 88, the latter likewise being suitably journaled within the gear housings 85. Keyed to the lower ends of the shafts 88 are spur gears 89 which mesh with spur gears 90 journaled on stub shafts 91 secured within the frame structure 80. The gears 90 are so arranged and constructed that their rotation is synchronized, with the teeth thereof movable smoothly into and out of meshing engagement with the teeth of an arcuate gear segment or rack 92 secured to the swiveled frame 3 rearwardly of the supplemental guides 73, 75, as clearly shown in Figs. 10 and 14. When the swivel frame 3 is swung horizontally in one direction or the other, the teeth of the gear segment 92 move out of mesh with one of the gears 90, and when the swivel frame is swung back toward alignment with the base, the teeth of the gear segment return into mesh with the gear. The control means for the hydraulic motor 16 will later be described. Thus, by the provision of the spaced swinging gears 90, 90 and gear segment 92 arranged and constructed as disclosed, a comparatively wide range of horizontal swing of the swivel frame 3 with respect to the base is possible.

The extensible boom frame structure 4 comprises a rearward boom part or swinging frame 103 having laterally spaced side portions 104 pivotally mounted on laterally spaced side frame portions 105 formed integral with the swivel frame 3. The rear boom part 103 have curved lateral guides 107 along the sides of its upper portion with which longitudinally spaced guides 108, 108, secured to the sides of the outer boom part or outer sliding frame 109, are engaged. Thus, the outer boom part or sliding frame may slide back and forth along the guides 107 relative to the rear boom part to effect shortening and elongation of the boom frame. The means for extending and retracting the boom comprises double acting hydraulic feed cylinders 110, pivoted at 111 to swing in vertical planes to the opposite sides of the rear boom frame part 103 and containing reciprocable pistons having forwardly projecting piston rods 112 which are pivotally connected at 113 at their forward ends to depending lugs integral with the front guide brackets 108. The seam-, vein-, face-, or coal-attacking and disintegrating mechanism 5 is carried by the outer boom frame part 109 in a manner to be later explained. The upper guides 107 are so arranged and constructed that a substantially rectilinear motion is imparted to the outer tip end of the vein-attacking and disintegrating mechanism during sumping thereof near the floor level. For swinging the extensible boom frame in a vertical direction about its pivotal mounting on the forward portion of the swivel frame 3, a pair of single acting hydraulic swing or lift cylinders 115, 115 are swiveled at 116 on brackets at the top of the swivel frame to swing in vertical planes, and these cylinders contain reciprocable pistons 117 having piston rods 118 projecting forwardly through the front packed heads of the cylinders. The forward ends of the piston rods are pivotally connected at 119 to lugs or arms 120, herein secured, as by welding, to a transverse tubular member or sleeve 121, herein in turn secured at its ends, as by welding, to the tops of the side portions 104 of the rear boom frame part 103 rearwardly of the chute mechanism 18, as shown in Fig. 3. Thus, by supplying fluid to the cylinders 110 and 115, the boom frame may be extended and retracted as desired and may be swung in vertical planes about its pivot relative to the swivel frame 3. By trapping the liquid within these cylinders, the parts may be locked in adjusted position. The control valve means for these cylinders will later be described.

The vein-attacking and disintegrating mechanism 5, which has been variously referred to as the coal-, face-, vein-, and seam-attacking and/or disintegrating mechanism, depending upon the aspect of its use, or for other reasons, and which may logically be designated by any or all of such terms, comprises a plurality, herein preferably four in number, of chain guideways 124, provided on the exterior of a guide frame 125 (Fig. 3) of fabricated box-like construction and welded to the sides of the outer boom part 109. Endless chains 126, herein shown for purposes of illustration as of the seven-bit-position type, though they may, of course, assume other forms, are guided for circulation in these guideways, and each comprises a series of chain blocks 127 pivotally connected together by usual strap links 128. Each chain block has a lateral lug 129 formed with a usual socket for receiving the shank of a vein-attacking instrument, herein shown in the form of a standard cutter bit 130. The bit shanks are held in the lug sockets by usual set screws 131. The block lugs are relatively inclined laterally to locate the bits in relatively inclined positions to provide for proper lacing of the bits in a well known manner. With a seven-position chain, the bits on each chain will move in seven orbits each laterally offset from the next, and the four chains will result in twenty-eight orbits. The guideways of the guide frame are provided by upper parallel plates 132 extending longitudinally along the rearward portion of the guide frame 125, and downwardly inclined front guide plates 133, arranged in common vertical planes with the plates 132, and the inclined front plates cooperate with a curved end guide 134 at the outer tip end of the guide frame. The guideways at the bottom of the guide frame are provided by longitudinal guide plates 135 similar to the upper plates 132. Cooperating with the top and bottom guide plates are side guide strips 136 which are welded to the vertical side plates 137. The guide plates, the side guide strips and the curved end guide cooperate to guide the four cutter chains in orbital paths about the guide frame. The tops of the side plates are flared outwardly and cooperate to provide a trough whereby the coal dislodged from the coal face may be conducted to the discharge chute without substantial spillage, as later explained. The upper and lower guide plates 132 and 135 are detachably held in position on the guide frame by bolts 138 which pass through tubular reinforcing elements or struts 139 secured, as by welding, to the top and bottom cross plates 140 of the guide frame. The front upper guide plates 133 are detachably secured to the guide frame as by screws 141. The curved end guide 134 is secured to an adjustable frame section 142 guided at 143 for longitudinal adjustment by adjusting screws 144 accessible through the sides of the guide frame. Bolts 145, carried by the adjustable frame section, extend through longitudinal slots 146 in the guide frame 125, and the bolts may be tightened to lock the adjustable frame section in adjusted position. The bolts 145 are likewise accessible through the side of the guide frame. Thus, by adjusting the frame section 142, the tension of the chains 126 may be varied as desired. The chain blocks 127 have usual lateral gibs near their bases for engagement with the guide plates and side strips for retaining the chains in their guideways; and the curved end guide 134 has only a smooth convex outer guiding surface about which the chains pass as they travel around the outer tip end of the guide frame. Evidently, if desired, separate chain carrying bars of a conventional design, arranged vertically edgewise, may be secured together to provide the guideways for the chains. While four chains are disclosed, it will be evident that a smaller or larger number of chains may be employed if desired. The relations of the bit blocks on the several chains will be later noted in some detail.

It has been noted that in the sumping position of the disintegrating apparatus the front guide plates 133 are inclined downwardly more than the plates 132. These are intended to be disposed at such an angle to the plates 132 that when the upwardly swingable disintegrating apparatus has attained to a particular elevation—the normally intended roof height, the portion of the chain orbit just above the plates 133 will be parallel to the mine bottom, and so all the coal that would be removed during withdrawal of the disintegrating mechanism, if the latter were to be horizontally rectilinearly withdrawn, will already be removed, and the fact that the then downward curvature of the guides 107 will cause the bits to move away from the roof during withdrawal will be immaterial.

The vein-attacking and distintegrating mechanism 5 tears and dislodges the coal from the solid, and as disintegration of the coal progresses, the loose coal is moved rearwardly by the top runs of the chains along the top of the disintegrating mechanism, and is discharged into the breaker and chute mechanism 18 which includes a chute 150 extending around the sides of the rearward portion of the trough provided by the flared side plates 137 and through which the coal is conducted to discharge onto the auxiliary conveyor 9. This chute includes a casing 151 (Figs. 3, 6 and 7) secured to the outer boom part 109 and having projecting forwardly from its rear wall a plurality of parallel breaker plates or bars 152 which project forwardly into a position wherein they cooperate with the bits 130 in the breaking up of large lumps or chunks of coal to a size wherein the coal may readily flow through the bottom chute discharge 153 to the auxiliary conveyor. The chute frame has a transverse bottom portion 154 of angular cross section which

serves to deflect the coal from the paths of the chains and to direct the coal toward the auxiliary conveyor, as shown in Fig. 3. The chute device 150 has a pivoted upper chute section 155 which is pivoted at 156 at the sides of the lower chute casing 151. The rearward wall 157 of the pivoted chute section has vertical slots 158 which receive the breaker plates 152, in the manner shown, and permit the distance between the top of the upper chute section and the top of the lower chute casing to be diminished. Formed on the upper sides of the pivoted chute section are curved skidlike abutments 159 to prevent catching on the roof or any overhead obstruction, and these curved abutments are yieldingly held in raised position by spring devices 160. These spring devices are arranged at opposite sides of the outer boom part 109 and each includes (see Fig. 5) a cylindrical housing 161 pivotally connected at 162 to the side portions 163 of the pivoted chute section 155. Enclosed in this housing is a coil spring 164 positioned by a tubular guide 165 secured to the upper head plate 166 of the housing, and this spring acts on a collar 167 secured to a tubular member 168 which is pivoted at 169 on a lateral lug 170, secured, as by welding, to the adjacent side of the outer boom frame part 109. The springs 164 of the spring devices constantly urge the pivoted chute section 155 yieldingly in an upward direction.

It will be noted that in order for advantage to be derived from the downward slope of the forward portion of the upper section of the chain orbit, it is essential that the desired roof height be substantially above the top of the relatively low height apparatus shown. Where the apparatus is to be used in low coal, such downward slope would generally be omitted, and, in such event, the need for the skidlike abutments would probably be increased, as they would be likely to engage the roof more frequently.

The endless chains 126 of the vein-attacking mechanism 5 are driven by the motor 10 (Fig. 10) whose casing 176 forms a part of the swivel frame 3. The curved guide member 75 is secured to the bottom of the motor casing 176 in the manner also shown in Fig. 10. This motor has its power shaft 177 horizontally disposed with its axis extending radially with respect to the swivel axis 2 of the swivel frame 3. Keyed to the forward end of the motor power shaft is a spur pinion 178 (see also Fig. 8) meshing with a large spur gear 179 journaled on a stub shaft 180 suitably mounted in a gear housing 181 secured to the front motor head. The gear 179 meshes with and drives a spur gear 182, likewise arranged within the gear housing and having its hub 183 journaled within bearings suitably supported within the housing. The gear hub 183 (Fig. 9) is secured to an outer member 184 which is connected by shear pins 185 to an end plate 186 keyed at 187 to a shaft 188, herein arranged coaxial with the gear 182 and extending through the gear hub in the manner shown in Fig. 9. The shaft 188 is journaled within a rear bearing 189 supported by the member 184, and within a front bearing 190 supported within the gear hub 183. Keyed at 191 to the forward end of the shaft 188 is an element 192 of a conventional universal joint 193, which has an element 194 secured to a longitudinally extending drive shaft 195. This drive shaft extends along one side of the boom frame and has splined thereto, and arranged telescopically therein, a shaft 196 which has secured to its forward end an element 197 of a conventional universal joint 198. This universal joint has an element 199 thereof keyed at 200 to the rear end of a shaft 201, herein suitably journaled within bearings 202 supported within a gear housing 203 which is secured to the adjacent side of the front boom frame part 109. Secured to the shaft 201 is a worm 204 meshing with a worm wheel 205, arranged in the gear housing 203 and having its hub 206 suitably journaled within bearings supported within the housing. The gear hub 206 is keyed at 207 to a transverse shaft 208. The shaft 208 (Fig. 6) extends across the front boom frame part 109 and has its end opposite from that secured within the worm gear hub journaled in bearings supported within a bearing boss 209 integral with the adjacent side of the front boom frame part 109. Secured, as by a key 210, to the shaft 208 are chain sprockets 211, herein shown as secured to the shaft 208 at such angles to each other that the bit blocks of the four chains will dispose the bits in transverse rows making a small angle with lines parallel to the axis of the shaft 208, and with the median lines of such rows perpendicular to the planes of the chain orbit and spaced from each other a plurality of times the width of each row, whereby there may be spaced, but slightly deadend, impacts of the bits on the coal, and yet at times the concurrent action of bits in a row may be effective to detach relatively large chunks of coal. Also secured to the shaft 208 by the key 210 and arranged between the hubs of the chain drive sprockets 211 are impeller elements 212 which serve to throw out the loose coal from between the chain sprockets at the rearward portions of the chains. When the vein-attacking and disintegrating mechanism 5 is fed forwardly by moving the outer boom frame part 109 along the curved guideways 107 relative to the rear boom frame part, the splined shaft 196 slides relative to the shaft 195 so that chain drive is maintained irrespective of the position of the disintegrating mechanism with respect to the driving motor.

Now referring to the structure of the auxiliary conveyor 9 carried by the boom frame, it will be noted that guided on the rear boom frame part 103 (Fig. 3) is an endless conveyor 215 having transverse scraper bars 216 which travel rearwardly along the upper surface of a transverse plate 217, secured, as by welding, to the sides 104 of the rear boom frame part 103. The endless side chains 218 of the endless conveyor are guided by front idler sprockets 219 journaled on suitable bearings supported by a transverse shaft 221, and these sprockets are maintained in laterally spaced relation by a spacing sleeve 222 surrounding the shaft. The projecting ends of the shaft are guided in longitudinal slots in the sides of the rear boom frame part, and brackets 224, provided with adjusting screws 225, are provided for adjusting the shaft together with the idler sprockets longitudinally relative to the rear boom frame part to vary the tension of the conveyor chains. Threaded on the screws 225 are conventional adjusting and locking nuts engaging the opposite sides of lateral lugs secured to the outer sides of the rear boom frame part. Rear drive sprockets 229, secured to a transverse shaft 230, engage the side chains 218 of the endless conveyor. The shaft 230 is suitably journaled within the rear boom frame part 103 in coaxial relation with the boom frame pivot. The motor 13 (Figs. 1 and 2) is preferably an electric motor and has fixed to its power shaft a multiple pulley 237 which is connected by multiple endless drive belts 238 to a multiple pulley 239 which is operatively connected through suitable gearing to the shaft 230. Thus, during running of the motor 13, the auxiliary conveyor 215 is circulated in its orbit to move the loose coal received thereon rearwardly along the top surface of the plate 217 to discharge at its rear end onto the main elevating conveyor 6.

Now referring to the main elevating conveyor 6, it will be noted that an endless conveyor 267 is guided within suitable guideways in a front conveyor frame 268 (Figs. 8 and 10) extending longitudinally through the space 23 beneath the base frame 19, and this conveyor frame is pivotally mounted, at 269, on a rear conveyor frame 270 formed within the upwardly inclined rearward portion 26 of the base frame. This endless conveyor has side chains 271 to which are secured transverse scraper bars 272 which travel along the upper surface of an upper plate 273 of the pivoted front conveyor frame and the upper surface of an upper plate 274 of the rear conveyor frame 270. The pivoted front conveyor frame has a bottom frame 275 which is centrally open at 276 along

its length so that any loose coal or dirt which is carried forwardly through the lower portion of the conveyor frames by the return, bottom run of the conveyor may drop down by gravity to prevent jamming and clogging. The open bottom frame provides narrow side guides at 276' for the bottom runs of the conveyor side chains 271, as shown in Fig. 13. The endless conveyor, at its forward end, is associated with the front gathering devices 7 and is guided by chain sprockets 277 and passes around a transverse guide member 278 secured to the conveyor frame and having a convex outer guiding surface 279, and extending rearwardly from the upper side of the convex guiding surface is an inclined guide plate 280 for directing the upper runs of the conveyor chains toward the upper plate 273. The elevating conveyor is driven by the motor 11 which also drives the crawler treads 12, and, as shown in Fig. 16, meshing with and driven by the spur gear 36 is a spur gear 283 keyed to a transverse shaft 284, herein arranged parallel with the shaft 37 and likewise suitably journaled within the gear housing 33. The shaft 284 has an extension 285 projecting outwardly from the side of the gear housing, and keyed to this shaft extension is a member 286 which has keyed thereto clutch disks 287 which are interleaved with clutch disks 288 keyed to a clutch casing 289 having its hub journaled on a bearing supported by the shaft 284. Secured to the casing hub is a chain sprocket 290 which is connected by an endless drive chain 291 which is operatively connected to the elevating conveyor.

The operating means for pressing the clutch disks 287, 288 together comprises a reciprocable shifter member 295 mounted on the shaft extension 285 and operated by a shipper yoke 296 engaging an annular flange 297 on the shifter member and operated by a suitable operating lever 298 (see Figs. 1 and 15). The member 295 is connected by links 299 to pivoted elements 300 pivotally mounted at 301 on a collar 302 threadedly secured to the member 286. Projections 303 on the pivoted members 300 engage an operating ring 304 slidably guided on the member 286. Arranged between the ring 304 and a clutch loading ring 305 are coil springs 306. When the shifter member 295 is slid inwardly along the shaft extension, the elements 300 are swung about their pivots to slide the rings 304 and 305 inwardly along the member 286 and to cause the pressure of the springs 306 to cause the operating ring 305 to effect application of the clutch. When the shifter member 295 is slid outwardly along the shaft extension, the ring 305 is no longer forced against the disks and so the clutch is released.

The front gathering devices 7, associated with the elevating conveyor 6, may assume various forms but herein comprises horizontal side frame portions 308 integral with a cross connecting bar 308' carried at the forward end of the pivoted front conveyor frame 269. The cross connecting bar passes through the orbit of the endless conveyor rearwardly of the transverse guide member 278, as shown in Fig. 10, and is secured to the plates 273 and 280. These side frame portions project laterally from the sides of the front conveyor frame and have curved feet 309 which are slidably engageable with the mine floor. The forward portion of the elevating conveyor which is guided by the idler sprockets 277 drives oppositely extending horizontal shafts 310 of screw gathering conveyors or feeding scrolls 311. These conveyor shafts are arranged in axial alignment at the opposite sides of the front receiving end of the elevating conveyor. The side frame portions 308 extend beneath the scrolls 311, as shown in Fig. 2, and have brackets 312 secured to their outer sides and in which the outer ends of the scroll drive shafts 310 are journaled. The feeding scrolls or gathering conveyors 311, when in lowered position, have their bottoms running close to the floor level just above the arcuate guide feet 309 of the side frame portions so that, as the apparatus is advanced, any loose coal which has fallen to the floor from the attacking and disintegrating mechanism 5 may be gathered by the scrolls and moved inwardly toward the receiving end of the elevating conveyor. By the provision of the open bottom beneath the return run of the endless conveyor, the ability to clean up the floor is substantially improved and the possibility of clogging is substantially reduced. As above mentioned, the front conveyor frame 268 is pivotally mounted at 269 to swing in a vertical direction, thereby to vary the elevation of the front receiving end of the conveyor together with the feeding scrolls, with respect to the mine floor, and the means for swinging this front conveyor frame comprises transversely disposed single acting hydraulic cylinders 315 (one of which is shown in Fig. 17) which are pivotally connected at their outer ends at 316 to the outer sides of the base frame. Reciprocable in these cylinders are pistons 317 having piston rods 318 pivotally connected at 319 to levers 320 secured to longitudinal shafts 321. The shafts 321 are suitably rotatably mounted in brackets 322 secured to the base frame and have fixed to their forward ends levers 323 (see Fig. 18) connected by chain sections 324 attached at their lower ends by pins 325 to the sides of the pivoted front conveyor frame 268. Thus, when fluid under pressure is supplied to the cylinders 315, the pistons 317 may be operated to effect, through the levers and chain sections, raising and lowering of the front gathering devices with respect to the mine floor. The means for supplying fluid under pressure to these cylinders will later be described.

Now referring to the hydraulic fluid system of the apparatus, it will be noted that mounted on the frame 80 at one side of the base frame near the operator's seat 375, as shown in Fig. 1, is a valve mechanism generally designated 376. This valve mechanism may assume various forms and herein includes a horizontal valve box 377 composed, as shown in Figs. 19, 20 and 21, of a series of sections suitably held together and including end sections 378 and 379 and intermediate valve sections 380. The pumping means 15, as shown diagrammatically in Fig. 22, has its intake connected by a conduit 381 with a liquid tank 382 which preferably contains a light oil. The pump discharge is connected by a conduit 383 to an inlet passage 384 in the end section 378 of the valve box. Parallel supply passages 385 and 386 extend longitudinally through the valve box sections 380 and communicate, at one end, through ports 387 and 388 with the inlet passage 384. The opposite ends of the passages 385 and 386 are blocked off by the end valve box section 379, as shown in Fig. 19. Extending longitudinally through the valve box sections 380 at the outer sides of and in parallelism with the supply passages 385 and 386 are exhaust passages 389 and 390 which communicate with an exhaust passage 391 in the end valve box section 379. A conduit 392 connects the exhaust passage 391 back to the tank 382. Also extending longitudinally through the valve box sections 380 is a central bypass passage 393 arranged midway between the supply passages 385 and 386 in parallelism therewith, and this bypass passage connects the inlet passage 384 with the discharge passage 391. An automatic relief valve 394, normally held closed by a spring 395 set at a predetermined load, is adapted to open upon overload to connect the inlet passage 384 with the exhaust passage 389. The valve box sections 380 have parallel transverse bores containing reciprocable slide valves 397, 398, 399, 400, 401, 402 and 403 respectively, of the balanced spool type normally held in central position by oppositely acting coil springs 404 and 405 in a conventional manner. These valves have valve stems 406 provided with individual operating levers 407, as shown in Fig. 20, conveniently located near the operator's station. Communicating with the valve receiving bores of the box sections 380 between the inlet passages 385 and 386 and the exhaust passages 389 and 390 are annular grooves 408 and 409, and these

grooves, upon proper positioning of the slide valves, may be connected either with the adjacent one of the supply passages 385 and 386 or with the adjacent one of the exhaust passages 389 and 390. When the valves are in their central position, as shown in Fig. 19, liquid under pressure may flow freely from the inlet passage 384 through the bypass passage 393 to the exhaust passage 391 and through the discharge conduit 392 back to the tank; but when any of the valves is positioned to supply fluid to one of the annular grooves 408, 409, flow through the bypass passage 393 is cut off by the valve. The groove 408 which communicates with the bore which receives the slide valve 397 is connected by a conduit 410 and branch conduits to one end of the tilt cylinders 115 for the pivoted boom frame. The grooves 408 and 409 of the bore which receive the slide valve 398 are connected by conduits 412 and 413 and branch conduits to the opposite ends of the cylinders 110 for extending and retracting the extensible boom frame. The annular grooves 408 and 409 which communicate with the bore which receives the slide valve 399 are connected by conduits 414 and 415 to the opposite sides of the reversible hydraulic motor 16 for swinging the swiveled frame 3. The conduits 414 and 415 are connected through branch conduits 416 and 417 to the opposite ends of a casing 418 of a shiftable shuttle valve device 419 which controls the flow of liquid under pressure through a conduit 420 to the brake cylinder 258. Thus, whenever the motor 16 is operated, and irrespective of its direction of rotation, fluid may flow through one or the other of the conduits 416 and 417 under the control of the shuttle valve device 419 and through the conduit 420 to the brake cylinder 258 to release the brake. The annular groove 408 which communicates with the bore which receives the slide valve 400 is connected by a conduit 422 leading to the swivel connection 60 of one of the hydraulically operated clutches 50, while the groove 408 communicating with the bore which receives the slide valve 401 is connected by a conduit 423 with the swivel connection of the other hydraulically operated clutch 50. The groove 408 communicating with the bore which receives the slide valve 402 is connected by a conduit 424 and branch conduits with one end of the cylinders 362 for tilting the tail conveyor. The groove 408 which communicates with the bore which receives the slide valve 403 is connected by a conduit 425 and branch conduits with one end of the cylinders 315 for elevating the front gathering device. The slide valve 399 which controls liquid flow with respect to the reversible swing motor 16 is of a special design so that when it is in its centrally located position, both of the annular grooves 408 and 409 communicate with the exhaust passages 389 and 390. Thus, whenever the slide valve 399 is in its central position, the brake cylinder 258 is connected to exhaust so that whenever the motor 16 is stopped, the brake which locks the swivel frame 3 against swinging movement is automatically applied by the coil springs 253. In order to connect the grooves 408 and 409 to exhaust when the slide valve 399 is in central position, as shown in Fig. 20, the end spools of the valve are reduced in cross section, as at 427, and the grooves 408 and 409 are widened, as shown, so that fluid may freely flow through the grooves 408 and 409 to the exhaust passages 389 and 390. Whenever the slide valve 399 is slid in one direction or the other to connect one of the grooves 408, 409 with one of the supply passages 385, 386, as shown in Fig. 21, communication of the reduced portion 427 with the exhaust passage is cut off, as shown at the right hand end of Fig. 21.

The general mode of operation of the mining and loading apparatus above described is as follows: The apparatus may be propelled about the mine by the crawler treads 12 of the tractor base driven by the motor 11 under the control of the friction clutches 50 which are normally held applied by the coil springs 55. When both clutches 50 are held applied by the springs, the crawler treads may be driven at the same speed to propel the apparatus in a straight path, and when one or the other of the clutches is partially or wholly released by hydraulic pressure supplied to the clutches under the control of the slide valves 400 and 401, one crawler tread or the other may be driven at a different speed from the speed of the other to effect steering of the apparatus either toward the right or toward the left, as desired. When the apparatus is located at the coal face, as shown diagrammatically in Fig. 23, liquid under pressure may be supplied to the hydraulic swinging motor 16 under the control of the slide valve 399 to effect swinging of the swivel frame 3 horizontally on its swivel mounting relative to the base to locate the vein-attacking and disintegrating mechanism 5 laterally at the right hand rib in the dotted line position indicated at A in Fig. 23 and a similar position shown in full lines in Fig. 24. When the swinging motor 16 is running, liquid under pressure is supplied to the brake release cylinder 258 to effect release of the brake, and when supply of liquid under pressure to the motor 16 is interrupted, regardless of its direction of operation, the cylinder 258 is connected to exhaust and the brake is held applied by the coil springs 253 to lock the swivel frame 3 against swinging movement. When the vein-attacking and disintegrating mechanism 5 is located at the right hand rib, it may be lowered to the floor level by the hydraulic cylinders 115 under the control of the slide valve 397, and when properly positioned, liquid may be trapped in the swing cylinders 115 to hold the vein-attacking and disintegrating mechanism in its lowered position. When the vein-attacking and disintegrating mechanism 5 assumes its lowered sumping position at the right hand rib, liquid under pressure may be supplied to the feed cylinders 110, under the control of the slide valve 398, to effect extension of the boom frame structure 4 to feed the outer portion of the vein-attacking and disintegrating mechanism beneath the coal in a direction radially from the position A to the position B indicated in dotted lines in Fig. 23 and a similar position in Fig. 24. During the sumping operation, the curved guides 107 on the rear boom frame part 103 guide the outer frame part 109 in such manner that the outer portion of the vein-attacking and disintegrating mechanism has its forward end move in a substantially rectilinear path along the mine floor. Upon completion of the sumping operation, liquid may be trapped in the feed cylinders 110 to hold the boom frame in extended position, and liquid under pressure may be supplied to the swing cylinders 115 under the control of the slide valve 397 to effect swinging of the vein-attacking and disintegrating mechanism upwardly in an arcuate path about the boom frame pivot to a raised position similar to the dotted line position indicated at C in Fig. 24 to effect disintegration and tearing away of the coal toward the free face, thereby to remove a vertical segment of the coal between the floor and room. During this upward swinging movement of the vein-attacking and disintegrating mechanism, the swing cylinders apply a rapid and powerful upward thrust to the endless chains of the vein-attacking and disintegrating mechanism to cause the disintegrating instruments to break or tear loose the coal in relatively large chunks from the face.

Upon completion of the upward swinging operation, liquid may be trapped in the swing cylinders 115 and liquid may be supplied to the feed cylinders 110 under the control of the slide valve 398 to effect retraction of the boom frame to withdraw the outer portion of the vein-attacking and disintegrating mechanism from the face. As hereinbefore explained, if the height being cut is that for which the apparatus is particularly designed, there will be no detachment of coal from the vein during this withdrawal movement. During the mining oper-

ation of the apparatus, the pivoted top segment 155 of the hopperlike chute is held in raised position relative to the lower chute casing by the spring devices 160. And as the endless chains 126 detach the coal from the solid, the dislodged coal is carried rearwardly along the top runs of the chains to discharge into the breaker and chute mechanism 18, and the breaker bars 152 cooperate with the chains to break up any very large chunks of coal so that the disintegrated coal may pass down through the chute and discharge onto the auxiliary conveyor 9. Due to the arrangement of the auxiliary conveyor beneath the discharge opening 153 of the chute in all positions of the vein-attacking and disintegrating mechanism, the loose coal passing through the chute is discharged onto the auxiliary conveyor irrespective of the extended or retracted position of the boom frame. The auxiliary conveyor 9 discharges onto the main elevating conveyor 6 which conveys the coal rearwardly along the base to the tail conveyor 8 which, in turn, conveys the coal to a suitable point of disposal. The vein-attacking and disintegrating mechanism 5, by suitable operation of the swinging motor 16, may be swung laterally about the swivel axis of the swinging frame 3 to locate the same in different radial positions, so that a series of adjacent vertical segments of coal may be successively removed from the coal face, until the coal across the entire width of the face has been removed and loaded out. Any loose coal which falls to the floor instead of being carried back by the chains will be cleaned up by the front gathering devices 7 and moved onto the elevating conveyor as the apparatus advances toward the face as the face is advanced.

As a result of this invention, an improved mining and loading apparatus is provided whereby coal may be removed from a solid face without the use of explosives, and the dislodged coal, as it is removed from the face, may be reduced in size as necessary and conveyed from the face to a suitable point of disposal. By the particular arrangement of the mining and loading apparatus disclosed, extremely low height is attained, whereby the apparatus may readily operate in underground mines having low headroom. By the provision of the extensible boom frame structure arranged and constructed as disclosed, the vein-attacking and disintegrating mechanism may be sumped into the coal near the floor level, with its advance end moving in a substantially rectilinear path, and the hydraulic cylinders for extending and retracting the boom enable rapid sumping and return movements, while the powerful and relatively high speed hydraulic means for swinging the boom upwardly enables rapid disintegration and tearing away of the coal so that the coal is dislodged from the face rapidly and in relatively large chunks, greatly expediting the dislodging operation. The novel chute arrangement with the pivoted upper chute section affords extremely effective means for receiving the dislodged coal discharged from the vein-attacking and disintegrating mechanism and for conducting the disintegrated coal to the conveying means of the apparatus, and the associated breaker means effectively reduces the size of overlarge chunks so that the coal passes readily through the chute and along the conveyors. These and other advantages of the improved mining and loading apparatus will be clearly apparent to those skilled in the art.

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

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

1. In a mining apparatus, a mobile base, a frame pivotally mounted on said base to swing in vertical planes with respect thereto and having upwardly curved guides which slope forwardly and downwardly in the lower position of said frame, an outer frame guided on said guides for movement longitudinally with respect to said pivoted frame, coal-attacking and disintegrating mechanism carried by said outer frame, motor operated means for moving said outer frame along said curved guides when said first frame is in its lower position to effect feeding of said attacking and disintegrating mechanism into the mineral of a solid mine vein with its outer tip end moving along a substantially rectilinear path in substantial parallelism with the mine floor, and motor operated means for swinging said frame in vertical planes about its pivot to move said attacking and disintegrating mechanism arcuately to effect dislodgement and disintegration of the solid mineral between the mine floor and roof.

2. In a mining apparatus, mineral-attacking and disintegrating mechanism comprising a plurality of parallel endless mineral-attacking and disintegrating chains, means for supporting and guiding said attacking and disintegrating mechanism for movements in vertical planes and endwise longitudinally of the mechanism, said supporting and guiding means positionable to locate the outer tip ends of said chains in adjacency to the mine floor with said attacking and disintegrating mechanism forwardly and downwardly inclined, said supporting and guiding means including forwardly and downwardly sloping, upwardly curved guides for guiding the outer tip ends of said chains along a substantially rectilinear path at the level of the mine floor, motor operated means for feeding said chains along said curved guides to effect sumping of the outer tip ends of said chains in such substantially rectilinear path within the mineral of a solid mine vein, and motor operated means for moving said attacking and disintegrating mechanism in vertical planes to effect upward movement of said chains toward the mine roof.

3. In a mining and loading apparatus, mineral-attacking and disintegrating mechanism for dislodging mineral from a solid mine vein comprising series of mineral-detaching devices guided for movement in orbits parallel to a common upright plane, with the upper runs traveling rearwardly at the top of said mechanism for conveying the dislodged and disintegrated mineral rearwardly to discharge at the rear portion of said mechanism, and a chute mechanism surrounding the rear portions of the orbits of said devices at said rear discharge portion of said mechanism for receiving the dislodged mineral and for directing the disintegrated mineral downwardly with respect to said attacking and disintegrating mechanism, said chute mechanism including a lower chute portion and a relatively movable upper chute portion, and parallel mineral breakers secured to said lower chute portion and projecting into adjacency to the paths of said devices in adjacency to said rearward discharge portion for reducing the size of the dislodged mineral as the latter is discharged from said attacking and disintegrating mechanism, and said movable upper chute portion having parallel slots for receiving said breakers when said upper chute portion moves downwardly relative to said lower chute portion.

4. In a mining apparatus, a support, a frame pivotally mounted on said support to swing in vertical planes with respect thereto and having parallel side portions, mineral attacking and disintegrating mechanism carried by said frame forwardly of the frame-pivot for dislodging the mineral from a solid mine vein, the frame-pivot being located rearwardly of and below the upper portion of said attacking and disintegrating mechanism, a chute mechanism carried by said frame enclosing the rearward portion of said attacking and disintegrating mechanism for receiving the dislodged mineral discharged rearwardly from said attacking and disintegrating mechanism, extensible fluid jack devices pivotally mounted on said support and having forwardly extensible portions, and a transverse member connected between said side portions of said frame rearwardly of said chute mechanism and to which said extensible portions are pivotally connected,

said jack devices upon fluid supply thereto effecting swinging of said frame together with said chute mechanism about the frame pivot.

5. In a mining apparatus, a forwardly and downwardly inclined frame having curved, upwardly concaved, upper guides, a slidable frame mounted on said frame and having longitudinally spaced guides engaging said curved guides, mineral-attacking and disintegrating mechanism carried by said sliding frame, and fluid cylinders connected between said frames for moving said sliding frame along said curved guides to effect movement of the outer portion of said attacking and disintegrating mechanism along a substantially rectilinear path at a relatively slow disintegrating speed to effect sumping of said outer portion of said mechanism into the mineral of a solid mine vein, said fluid cylinders also operable to retract said sliding frame along said curved guides to effect withdrawal of said mechanism from the mineral.

6. In an apparatus for detaching mineral from a solid mine vein, in combination, a portable base, a curved guideway supported by said base and swingable about a horizontal axis, said guideway being upwardly concave, means for swinging said guideway about said axis, a carriage reciprocable along said curved guideway, a mineral disintegrating apparatus supported on said carriage and projecting forwardly therefrom and having a portion thereof in advance of said guideway, means for reciprocating said carriage on said curved guideway, said guideway being so curved that when in lowered position said mineral disintegrating apparatus extends the mine bottom substantially horizontally as said carriage moves forwardly along said guideway, said disintegrating apparatus having its upper forward portion so sloped that at the end of a predetermined upward swinging movement of said guideway said portion will be substantially parallel to the mine floor.

7. In an apparatus for detaching mineral from a solid mine vein, in combination, a portable base, a curved guideway supported by said base and swingable about a horizontal axis, said guideway being upwardly concave, means for swinging said guideway about said axis, a carriage reciprocable along said guideway, a mineral disintegrating apparatus supported on said carriage and projecting forwardly therefrom and having a portion thereof in advance of said curved guideway, means for reciprocating said carriage on said curved guideway, said guideway being so curved that when in lowered position said mineral disintegrating apparatus extends the mine bottom substantially horizontally as said carriage moves forwardly along said guideway, said disintegrating apparatus having its upward forward portion so formed that by sumping and swinging movements of said disintegrating apparatus a segment of mineral from the face of the

mine vein having parallel upper and lower limits will be disintegrated.

8. In an apparatus of the character disclosed, mineral-attacking and disintegrating mechanism for dislodging mineral from a solid mine vein comprising a series of mineral-detaching devices movable in parallel vertical orbits for disintegrating the mineral and for moving the disintegrated mineral rearwardly, a chute mechanism surrounding the rearwardly portion of said attacking and disintegrating mechanism for receiving the dislodged mineral and for directing the mineral received thereby downwardly with respect to said attacking and disintegrating mechanism, said chute mechanism including a lower chute portion and a relatively movable upper chute portion, and parallel mineral breakers secured to said lower chute portion and projecting vertically into adjacency to the paths of said mineral-detaching devices at the rearward discharge portion of said attacking and disintegrating mechanism for reducing the size of the dislodged mineral, said movable upper chute portion having parallel slots for receiving said breakers when said upper chute portion moves downwardly relative to said lower chute portion.

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