Dec. 8, 1959 R. G. HAWORTH ET AL 2,916,274

MINING MACHINE HAVING AN ARCUATE CUTTER FEED

Filed Feb. 19, 1953 4 Sheets-Sheet 1

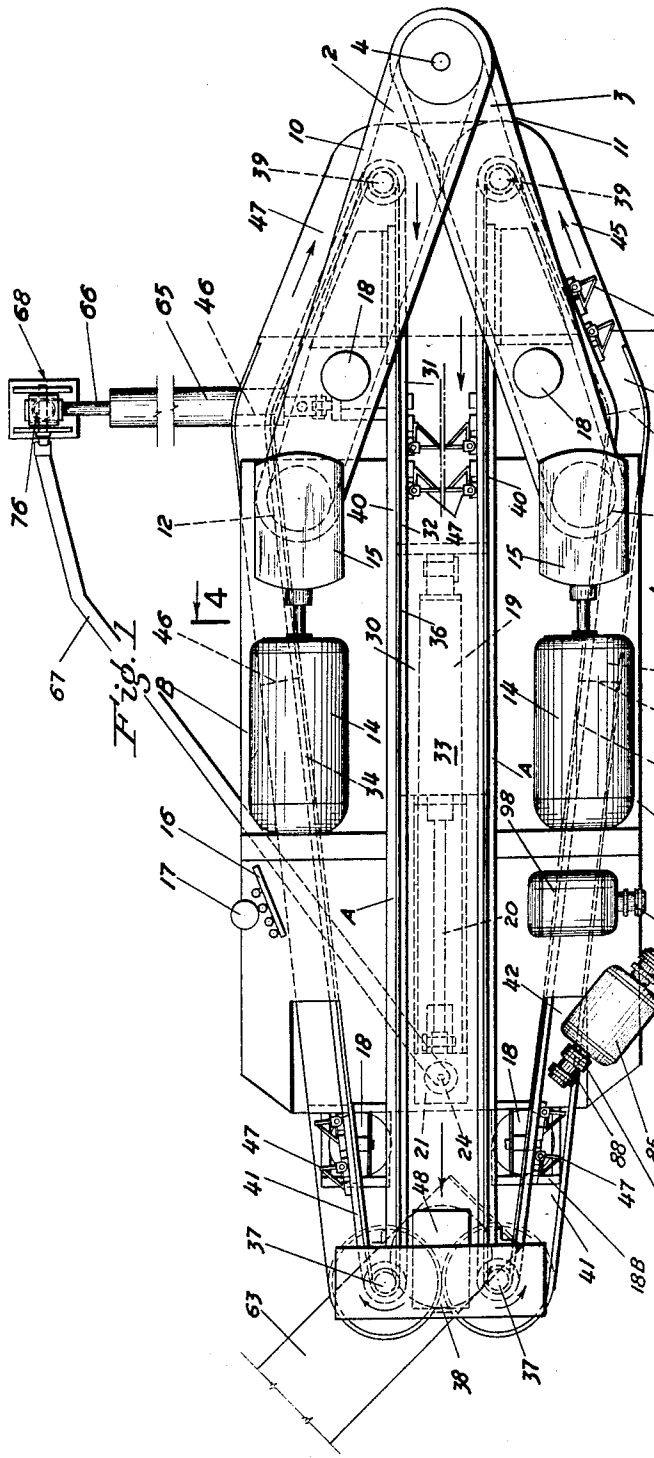


Fig. 1

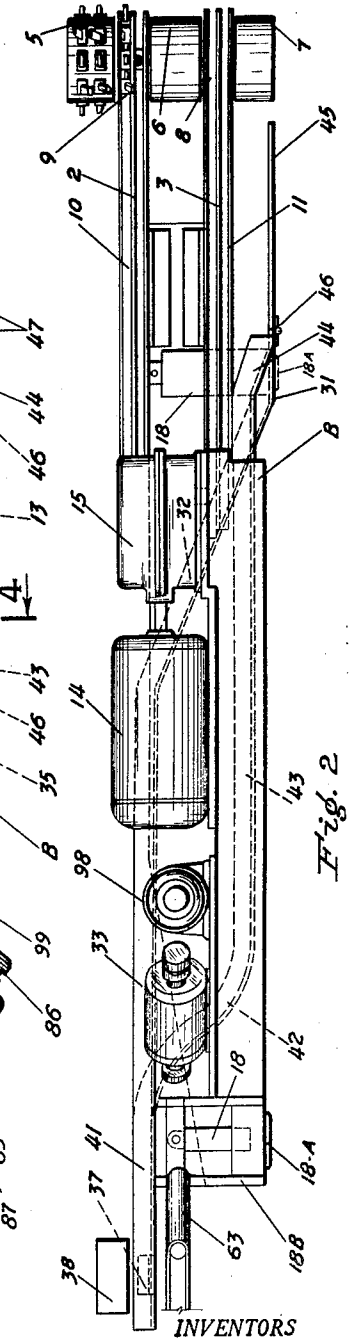


Fig. 2

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Filed Feb. 19, 1953 4 Sheets-Sheet 2

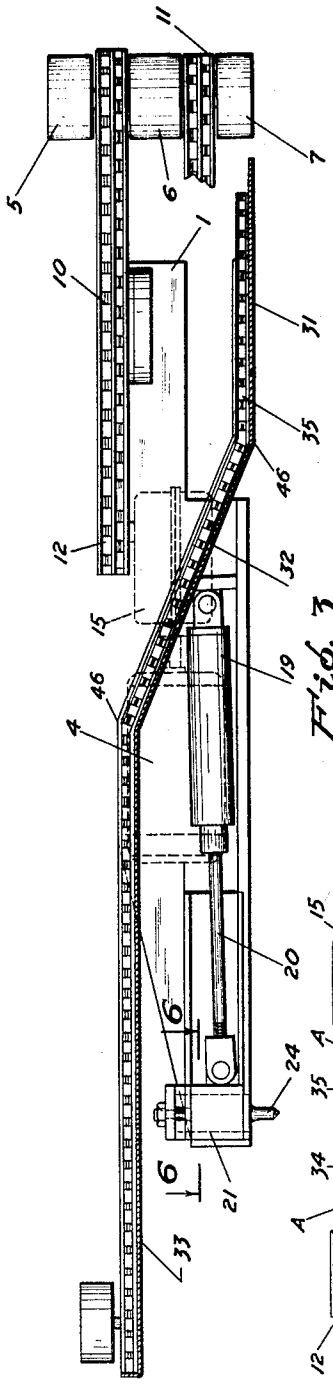


Fig. 3

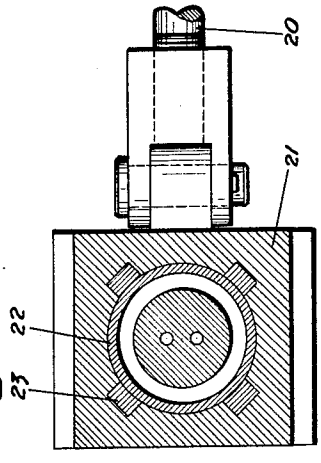


Fig. 6

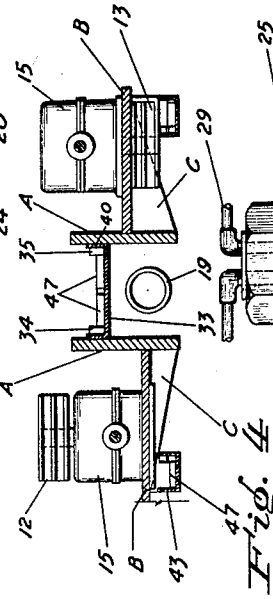


Fig. 4

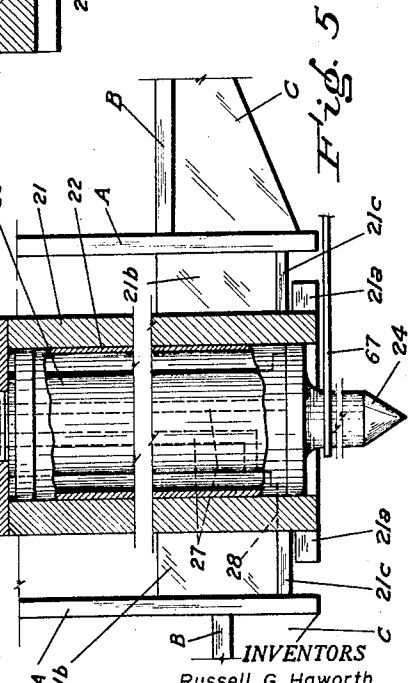


Fig. 5

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MINING MACHINE HAVING AN ARCUATE CUTTER FEED

Filed Feb. 19, 1953 4 Sheets-Sheet 3

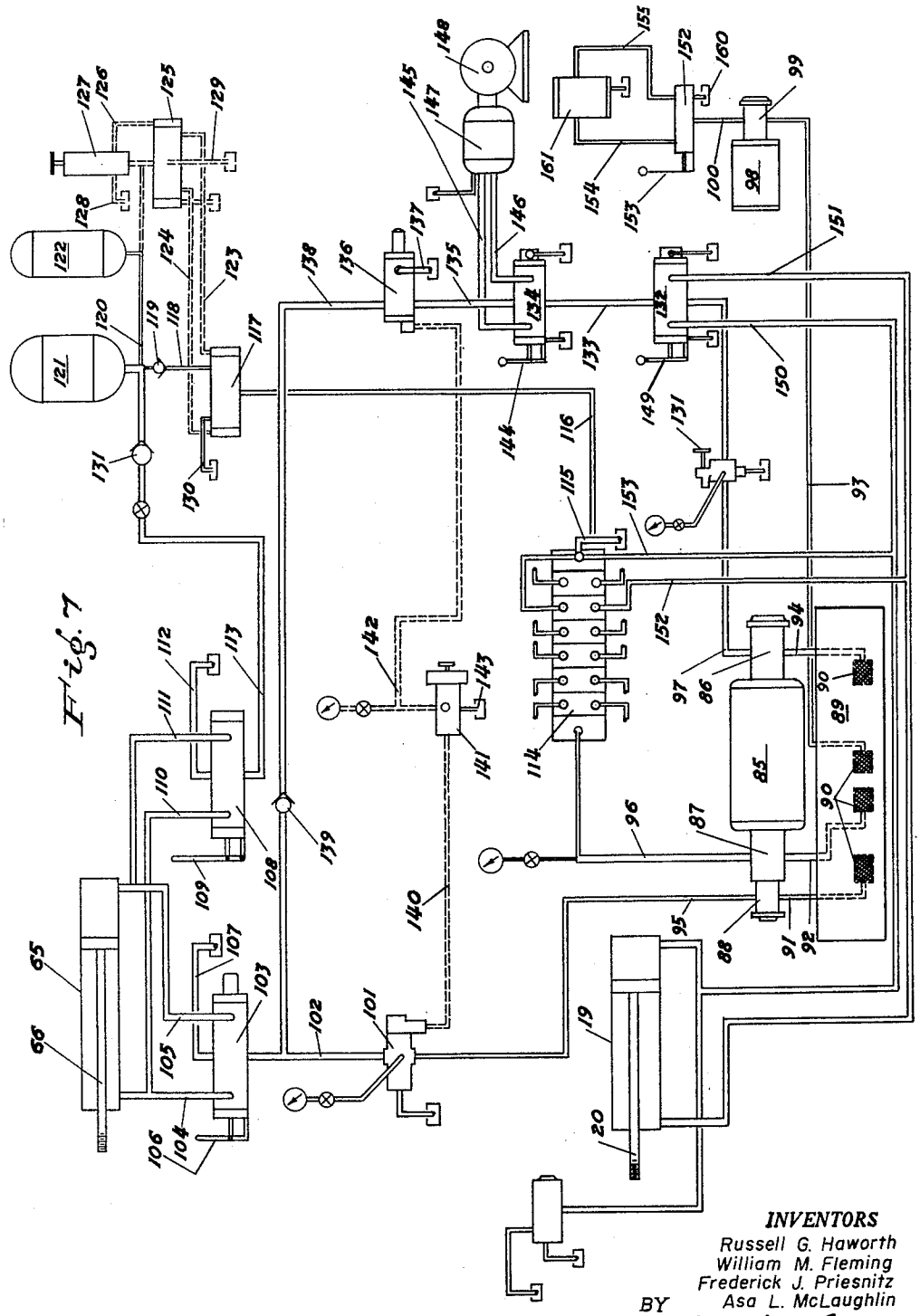


Fig. 7

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Filed Feb. 19, 1953 4 Sheets-Sheet 4

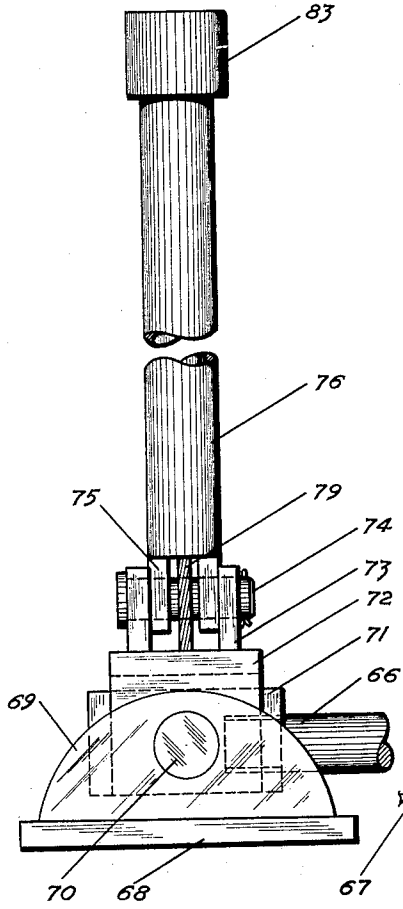


Fig. 8.

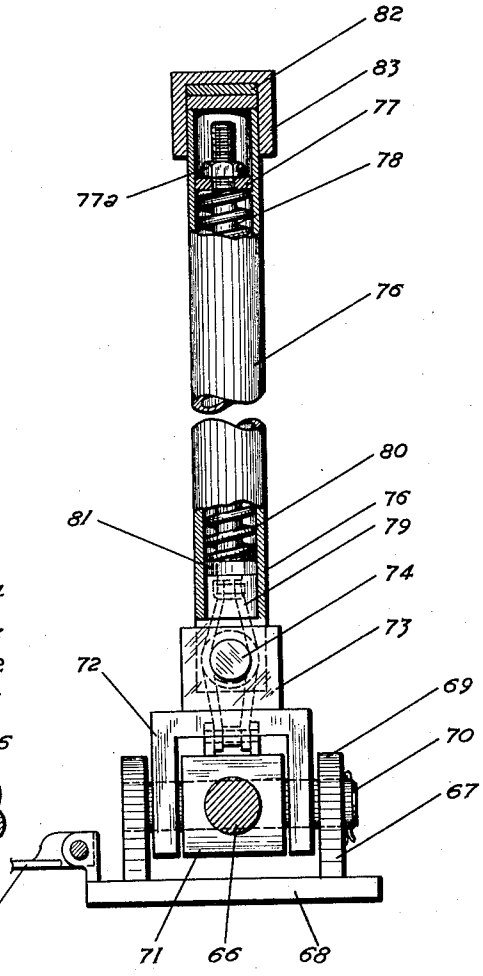


Fig. 9

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MINING MACHINE HAVING AN ARCUATE CUTTER FEED

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Application February 19, 1953, Serial No. 337,792

4 Claims. (Cl. 262—19)

This invention relates to new and useful improvements in mining machinery and apparatus of the general type shown in copending application, Serial No. 71,774 filed January 21, 1949, now Patent Number 2,754,101 of July 10, 1956.

An important object of the present invention is to provide machinery which will operate in the limited space of the mine as stated in said copending application and whereby the machine can be run in mole-like fashion into the vein of ore to pick up ore at the face and deliver it rearwardly of the machine so that the space required for removing the deposit is no larger than the vein and there is only a minimum of earth disturbance.

Another object of the invention is to provide for increased mobility and maneuverability of the machine in close quarters, as well as to increase the arc of movement of the machine and cutter head by the provision of hydraulic jack means so constructed and arranged that their arc of movement is substantially the same as the cutting head, whereby the cutting head can be moved rapidly in its cutting and return movements.

Another object of the invention is to provide a cross-feed jack anchor which can be adjusted to various ceiling heights and will automatically return to a vertical position when tilted therefrom.

A further object of the invention is to provide an operator's station on the mining machine from which he can see all essential operations and has all controls for the various operations within his easy reach.

Other objects and advantages of the invention will become apparent during the course of the following description.

In the accompanying drawings forming a part of the description and wherein like numerals are employed to designate like parts throughout the several views.

Fig. 1 is a plan view of the preferred type of mining machine,

Fig. 2 is a side elevation thereof,

Fig. 3 is a longitudinal vertical section of the same,

Fig. 4 is a transverse vertical section taken about on the line 4—4 of Fig. 1,

Fig. 5 is an enlarged vertical section of the pivot of the sump jack,

Fig. 6 is a horizontal section of the sump jack taken on the line 6—6 of Fig. 3,

Fig. 7 is a schematic view showing the various hydraulic controls of the mining machine,

Fig. 8 is a side elevation of an improved form of roof jack for the machine, and

Fig. 9 is an elevation of the roof jack turned at right angles to Fig. 8 and with parts of the jack broken away to illustrate the construction thereof.

Referring now more particularly to the drawings wherein for the purpose of illustration and not for limitation, are shown the preferred embodiments of the invention, the numeral 1 designates the main frame or base of the mining machine. This main frame consists of a central frame composed essentially of a pair of stout

laterally spaced vertical plates A heavily interbraced and extending lengthwise of the machine, and a pair of outrigger frames B extending laterally outward and horizontally from the outer side faces of the two vertical plates A. These outrigger frames are rigidly supported by triangular gusset plates C as indicated in Figs. 4 and 5.

As shown in Fig. 1 the two vertical plates A extend forwardly and rearwardly beyond the ends of the outrigger frames B and form supports for a centrally located endless conveyor to be presently described. As shown in Fig. 1, the rear corners of the outrigger frames are cut away or beveled to allow greater swing of a conveyor associated with the rear end of the machine. The mining machine is supported above the mine floor by four inverted hydraulic jacks **18** located at approximately the four corners of the frame. The lower ends of these jacks terminate in circular sections **18***a* having a rounded base and slidable vertically in a frame **18***b*. The machine is supported by and is movable on the mine floor on these jack base sections **18***a*. By extending or contracting the jacks **18**, the machine can be raised or lowered with relation to the mine floor, and can be leveled or tilted in any direction.

A pair of horizontal cutter bar arms **2** and **3** are secured to the forward end of the central frame in forwardly converging relation, the left arm **2** being secured to the top of the frame while the right arm **3** is secured to the bottom of the frame. The forward ends of these two arms are disposed one above the other for the support of bearings for a vertical cutter head shaft **4**.

As in aforesaid copending application, sectional drum-like cutter heads **5**, **6** and **7** are keyed to this shaft. The double sprockets **8** and **9** are splined to the shaft between the sectional heads as shown in Fig. 2. These heads are provided with removable cutter bits extending from their peripheries to disintegrate the ore such as sylvinite as the machine forces the rotary cutter heads into and across the face of the vein to be mined.

Double sprocket chains **10** and **11** drive the sprockets **8** and **9** from double sprockets **12** and **13** and carry the usual cutter bits as shown, to cooperate with the cutter heads in cutting the ore. A separate electric motor **14** and gear box **15** is provided on each outrigger frame for driving the double sprockets. These motors are controlled from a switch board **16** at an operators station **17** where all of the other controls of the machine are located.

To advance and pivot the machine, a hydraulic sump jack cylinder **19** is anchored solidly to the frame vertical plates A, in a position as shown in Fig. 1, and has a piston rod **20** provided with a block **21** slidable horizontally in longitudinal guides in the frame **1**.

To the bottom of block **21** is bolted auxiliary blocks **21***a*, Fig. 5, upon which the majority of the weight of the rear of the machine is supported to hold a floor engaging pin **24** into the mine floor. This weight is transferred from the blocks **21***a* to blocks **21***b* welded to the inside of the two vertical frame plates A, and removable wear plates **21***c* are bolted to the bottoms of blocks **21***b* to engage the top of the auxiliary blocks **21***a*.

The vertical frame plates A are heavily cross braced in all other areas except where the pivot jack block **21** must travel lengthwise of these plates A. Vertically slidably mounted in the block **21** is a special hydraulic jack cylinder **22** provided with radial ribs **23** sliding in ways of the block **21**. The cylinder **22** terminates at its lower end in a floor engaging pin **24**. A top section **25** is fastened to the block **21** and serves to fasten a piston rod **26** within the cylinder **22**. This piston rod is provided with hydraulic passages **27** extending lengthwise therethrough and open on opposite sides of the piston

head 28 whereby fluid under pressure through the conduits 29 will move the cylinder vertically as controlled from the operator's station.

The radial ribs 23 prevent the jack cylinder from turning in the block 21, thereby forcing the pivot pin 24 to rotate in the mine floor as the machine is swung to cut across the face of the vein. To sump the machine into the face, the piston rod 20 is retracted with the pivot pin cylinder also retracted. This cylinder 22 is then extended until the pin 24 drives into the mine floor and starts to relieve the corner jacks 18 of the weight of the machine. The sump piston is then extended to force the cutter head of the machine into the face to the desired distance. As shown in Figs. 1 and 3, the length of cylinder 19 is substantially greater than the diameter of cutter heads 5, 6 and 7 thereby permitting successive sumping advances for a plurality of arcuate cuts from a single pivot setting before the entire machine is advanced to a new pivot setting in the manner previously described.

In order to positively and mechanically convey the ore from the working face to a remote point with the low clearance type of machine disclosed herein, a novel type of conveyor has been incorporated into the machine. This conveyor is composed of a conveyor trough or bottom 30 having vertical sides 40 extending centrally and longitudinally of the machine from front to rear thereof, from a front horizontal portion 31 adapted to rest upon the floor, then at an upward and rearward incline 32, and then into a rear horizontal portion 33 arranged above the rear of the machine and extended therebeyond in spaced relation to the floor, in order that other conveyors can be disposed beneath its discharge and to receive material therefrom and convey it away from the machine.

This portion of the trough or bottom 30 is provided for the conveyance of the ore away from the face of the vein. A pair of endless belts or chains 34 and 35 generally move in opposite directions, but have corresponding complementary runs 36 movable in the same direction and in the central trough 30, form the other important part of the new conveyor. Each endless belt or chain is driven around idlers, guides and sprockets mounted on axes perpendicular to the trough section with which it is associated and these belts or chains are of the universal type to make both horizontal and vertical bends in the length of the trough and keep their flights in conveying contact therewith. Each belt or chain 34 and 35 is driven by a sprocket 37 located at the rear or discharge end of the conveyor on opposite sides of the trough 30 and are driven from the gear box 38 operated by a shaft from a hydraulic motor 161.

The drive sprocket 37 for chain 34 is driven in a clockwise direction to move the endless chain as shown by the directional arrows in Fig. 1; while the other drive sprocket 37 for chain 35 is driven in a counter-clockwise direction to move this chain in the directions indicated by the arrows in Fig. 1. Thus the two endless chains have their complementary adjacent and parallel runs 36 moving in the same direction rearwardly through the trough 30. The forward ends of these conveyor chains pass around sprockets or guides 39 operating on vertical axes extending perpendicular of the forward horizontal portion 31 of the bottom. The portions of the runs 36 of the two endless chains which traverses the trough 30 are guided by the upright stationary sides 40 of the conveyor bottom or trough, and the outer runs of the two conveyors move through chain return troughs or chutes located at opposite sides of the trough 30 and each return trough has a rear horizontal portion 41, a downwardly and forwardly inclined portion 42 which continues into a horizontal portion 43 arranged lengthwise of each side of the machine just above the ground until it passes out of the front end of the frame where it inclines downwardly again at 44 to merge into a shovel or collector pan or plate 45 hinged as at 46 to the forward end of a plate extension of the machine frame. The forward edge of this pan 45 extends forwardly to a point just rearwardly of the rotary cutter heads 5, 6 and 7 to catch the ore disintegrated from the mine face. The two endless chains 34 and 35 are provided with laterally and outwardly extending flights 47 which are complementary, so that as the complementary runs 36 of the two chains move parallel and rearwardly of the machine in the same direction, the flights thereof come into alignment with one another transversely of the conveyor bottom 30 to move the ore rearwardly to the rear discharge section 33 which is provided with a discharge opening 48.

As these same flights move in opposite directions around the forward sprockets 39 and upon the pan 45, they pick up ore kicked back on the mine floor and onto the pan 45 by the cutter heads and slide it along the central conveyor trough 30. All of the conveyor troughs are constructed in sections which can be taken apart for replacement or repair.

In order to swing the forward end of the mining machine about its pivot jack 24 to make an arcuate cut in the face of the ore vein with the cutter head operating, one or more cross feed hydraulic jacks 65 may be employed. The cross feed jack 65 is usually connected to the machine on the left or operator's side, but could be mounted on the opposite side if desired. Each jack consists of a hydraulic cylinder universally connected to the side of the mining machine frame 1 just ahead of the outrigger portion of the frame. A piston operates in this cylinder and has a rod 66 connected to the base 68 of a floor supported anchor post which will be presently described. When the piston is operated to extend its rod 66, the rod moves the base 68 and an associated guide means or anchor positioning bar 67 to the limit of the rod 66. The direction of flow of the hydraulic oil is then reversed in cylinder 65, retracting the rod 66. The anchor at base 68 is firmly held, causing the front of the machine, and cutter head sections 5—6—7 to swing across the face. When the rod 66 is fully retracted, the operation is repeated until the cutter heads have made a cut across the full width of the face.

This positioning bar 67 is fastened at one end to anchor pin 24, preferably by having pin 24 extend through a hole provided adjacent the end of the said bar, so as to permit a free swinging action. The opposite end of bar 67 is connected to base 68 by a clevis. This bar causes the anchor post supported on base 68 to swing in a semi-circle concentric with the semi-circle which the cutter head makes across the face. As the anchor post is pushed away from the machine in resetting for another cut, the positioning bar 67 maintains the distance between pin 24 and base 68 constant.

The anchor at 68 is then positioned to hold firm against a thrust from rod 66, instead of holding firm against a pull as described above. The rod 66 is then fully retracted. With the anchor acting against a thrust, the rod 66 is extended, pushing the cutter head back across the face, which operation is repeated until the cutter head 5—6—7 has returned completely across the face to the right hand corner, and is ready to be sumped in and make another cut across the face.

The anchor post, as shown in Figs. 8 and 9, is composed of a floor engaging plate 68 having pivot ears 69 with a hinge pin 70 which passes through a block 71 on the end of the piston rod 66 and the pair of ears of a yoke 72. The top of this yoke is provided with a second pair of ears 73 arranged in planes at right angles to the lower ears. A pin 74 pivotally connects the ears 73 to a pair of ears 75 formed on the lower end of a cylinder 76. A piston 77 operates in this cylinder and has a stem 78 connected by chains or cables 79 extending through the yoke 72 to the block 71, so that as the cylinder is tilted from its vertical position, the piston will be drawn by the cables further down into the cylinder 76.

A compression spring 80 surrounds the piston stem 78 and bottoms upon a stop 81 to be compressed upon

downward movement of the piston. Thus, when the cylinder 76 is tilted from its vertical position and released, the spring 80 will return the cylinder to a vertical position. A nut 77a threaded on the piston rod moves the piston head relative to the rod to adjust the tension of the spring 80. The upper end of this cylinder is provided with shims 82 and a removable roof engaging cap 83. The length of the anchor jack can be made greater or smaller as desired by reducing or increasing the length of the engaging cap 83, or the shims 82. The overall length of the anchor post in use is always slightly longer than the distance from the floor to the back in the mine opening in which the machine is operating.

When the top of the anchor post is tilted away from the rod 66, it wedges between the floor and back, and cannot be moved by a thrust on the rod 66, but offers no resistance when the rod 66 pulls on it. In the same way, when the post is tilted toward the rod 66, it is firmly anchored against a pull from the rod 66, but offers no resistance against a thrust from rod 66. The universal mounting allows the top of the anchor post to be swung in a semi-circle out of contact with the roof when changing the direction from sloping toward the rod for pull anchor to sloping away from the rod for thrust anchor.

The hydraulic control system for operating all adjuncts of the mining machine, is shown schematically in Fig. 7. Electric motors 85—98 are directly connected to and drive hydraulic pumps 86—87—88—99. Oil is stored in hydraulic oil tank 89 and is drawn into each of the hydraulic pumps through oil filters 90, and pipe lines 91—92—93—94. The oil from pump 88 is driven through line 95, through relief valve 101, and to control valve 103. When control valve 103 is in a neutral position as shown, the oil from line 102 passes through valve 103 into return line 107 and thence to tank 89. When control valve handle 106 is moved to the left, the oil from line 102 passes into line 104 and thence into cross feed jack cylinder 65 causing the rod 66 to retract. If the control valve handle is moved toward the control valve 103, the oil from line 102 passes through the valve 103, into line 105, and into hydraulic cylinder 65, causing the rod 66 to thrust out. The above is the normal operation while cross feeding and cutting across the face. In order to cause the jack rod 66 to return rapidly to a resetting position after each cut, oil from the hydraulic pumps 86 and 87 can also be directed to hydraulic cylinder 65 as will be presently described. Oil from the hydraulic pumps 86 and 88, is used when the machine is being returned across the face preparatory to making another cut, and a very fast action is required for rod 66 in both directions in cylinder 65.

Oil from pump 87 is forced through line 96 into valve bank 114. From valve bank 114 it can be diverted to any of the four corner or leveling jacks, the sump jack, or the sump jack anchor or pivot jack by action of the control lever on the appropriate valve in valve bank 114 at the operator's station 17. When all of the valves in valve bank 114 are in a neutral position, the oil passes through into line 116, and thence to pressure operated valve 117. If valve 117 is in a neutral position the oil passes to line 130 and returns to the tank 89.

If valve 117 is in an open position the oil passes to line 118 through check valve 119 into line 120, and to accumulators 121 and 122. When accumulators 121 and 122, are charged to a pre-set pressure, as determined by the manual setting of valve 127, oil from line 120 passes through valve 127 into line 126, actuating control valve 125. Control valve 125 opens to allow oil to flow into line 124, which closes valve 117 and causes the flow of oil from line 116 to return to the tank 89 through return line 130. When the oil in accumulators 121—122 is released and the oil pressure in line 120 falls below the pressure setting in valve 127, the drop in pressure in line 126 causes valve 125 to open in a direction causing a flow of oil in line 123, which actuates valve 117, and allows the oil in line 116 to flow into the line 118 and thence line 120.

When it is desired that the action or rod 66 in cylinder 65 should be rapid, valve control handles 106 and 109 are both moved simultaneously in the same direction, thus causing the oil in line 102 to pass through valve 103 into line 104 or 105 as desired, and thence to cylinder 65 and also causing the oil under pressure in the accumulators 121—122 to move into line 120; thence through check valve 131 into line 113, into valve 108 and into line 110 or 111 as desired and thence to cylinder 65.

Oil from pump 86 moves into line 97, and through by pass valve 131 into control 132: If valve 132 is in a neutral position the oil passes to line 133 and into control valve 134. If valve 134 is in a neutral position, the oil passes to line 135 and into valve 136. If valve 136 is open, the oil passes to line 138, through check valve 139 and into line 102 and valve 103, where its direction of flow can be controlled by control valve handle 106 as previously described.

The action of control valve 136 is controlled by the pressure of the oil in line 140. When the oil pressure in line 140 drops below a predetermined amount, the valve 141 opens so that return line 143 is closed, and the oil from line 140 flows into line 142 and thence to valve 136, causing valve 136 to open and allow the flow of oil in line 135 to pass into line 138. When the pressure in line 140 exceeds the predetermined amount, valve 141 closes to line 140 and opens to lines 142 and 143, releasing pressure on line 142, and causing valve 136 to close line 138, and open line 137, allowing the flow of oil in line 135 to flow through valve 136 into return line 137, and thence to the tank 89.

When the control handle on the valve marked "sump jack" in valve bank 114, is operated the oil from line 96 passes into line 152 or 153 as desired, thence into line 150 or 151 and into cylinder 19, causing rod 20 to either retract or project. This is the normal operation for sumping the machine into the face; when it is desired to move the pivot jack block 21 to a new setting, or while moving the machine for a longer distance, a faster action on the jack 19 is required. In this instance both the sump jack valve and valve 132 are operated simultaneously. When valve control handle 149 is operated, line 133 is closed and either line 150 or 151 is opened according to the direction in which the control handle 149 is moved. Oil from line 97 then flows into line 150 or 151, to cylinder 19.

When valve 134 is operated by valve control handle 144, line 135 is closed and either line 145 or 146 is opened according to the direction in which handle 144 is moved. The oil flows from valve 134 to line 145 into hydraulic motor 147, into line 146 to valve 134, and returns to the tank through line 135, valve 136 and line 137. When either valve 132 or 134 is used, the return oil goes to the tank by the above described route. Hydraulic motor 147 drives winch 148 which may be positioned on the mining machine as desired for the usual purposes.

Oil from hydraulic pump 99 flows through line 100 to valve 152. When control handle 153 is in a neutral position the oil flows to return line 160 and back to tank 89. When the control lever 153 is operated, the oil flows into line 154 and into hydraulic motor 161, returning through line 155 to valve 152 and then to the tank 89 through line 160. This hydraulic motor drives gear box 38.

We claim:

1. In a mining machine having a frame, inclusive of a floor-engaging pivot toward the rear of the machine about which the machine swings in an arcuate path in its ore-disintegrating action, a cutter positioned on the forward end of the machine for movement along said arcuate path, means for driving the cutter in an ore-

disintegrating attack during said arcuate movement, an anchor post disposed in spaced relation to said machine and provided with a universal mounting at its base, whereby the top of said post can be moved into and out of selective wedging engagement with the mine room roof in thrust-resistant and pull-resistant positions, frame-moving means including a power unit for applying a generally horizontal component of force toward or away from the base of said anchor post when in said positions, and having swingable connections with said base and said frame so as to direct said force toward or away from said post assembly without distortion of the power unit or said post assembly during any increment of arcuate movement of said machine about said pivot, and means supported from said frame for guiding said post in an arcuate course corresponding to the arcuate path of said cutter.

2. In a mining machine having a frame, inclusive of a floor-engaging pivot toward the rear of the machine about which the machine swings in an arcuate path in its ore-disintegrating action, a cutter positioned on the forward end of the machine for movement along said arcuate path, means for driving the cutter in an ore-disintegrating attack during said arcuate movement, an anchor post disposed in spaced relation to said machine and provided with a universal mounting at its base, whereby the top of said post can be moved into and out of selective wedging engagement with the mine room roof in thrust-resistant and pull-resistant positions, frame-moving means including a power unit for applying a generally horizontal component of force toward said post when it is in push-resistant position and having swingable connections with said base and frame so as to direct said force against the post assembly without distortion of the power unit or said post assembly during any increment of arcuate movement of said machine about said pivot, and means supported from said frame for guiding said post in an arcuate course corresponding to the arcuate path of said cutter.

3. In a mining machine having a frame, inclusive of a floor-engaging pivot toward the rear of the machine about which the machine swings in an arcuate path in its ore-distintegrating action, a cutter positioned on the forward end of the machine for movement along said arcuate path, means for driving the cutter in an ore-disintegrating attack during said arcuate movement, an anchor post of greater length than the maximum height of the mine room disposed in spaced relation to said machine and provided with a universal mounting at its base, whereby the top of said post can be moved into and out of selective wedging engagement with the mine room roof in thrust-resistant and pull-resistant positions, frame-moving means including a power unit for exerting a generally horizontal component of force away from said post when it is in pull-resistant position and having swingable connections with said base and frame so as to direct said force away from said post assembly without distortion of the power unit or said post assembly during any increment of arcuate movement of said machine about said pivot, and means supported from said frame for guiding said post in an arcuate course corresponding to the arcuate path of said cutter.

4. In a mining machine having a frame, inclusive of a floor-engaging pivot toward the rear of the machine about which the machine swings in an arcuate path in its ore-disintegrating action, a cutter positioned on the forward end of the machine for movement along said arcuate path, means for driving the cutter in an ore-disintegrating attack during said arcuate movement, an anchor post disposed in spaced relation to said machine and provided with a universal mounting at its base, whereby the top of said post can be moved into and out of selective wedging engagement with the mine room roof in thrust-resistant and pull-resistant positions, frame-moving means including a power unit for applying a generally horizontal component of force toward or away from the base of said anchor post when in said positions and having swingable connections with said base and said frame so as to direct said force toward or away from said post assembly without distortion of the power unit or said post assembly during any increment of arcuate movement of said machine about said pivot, and guide means in pivotal connection with said frame and post for positioning the anchor post relative to the machine when the machine remains stationary.

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