Nov. 21, 1967 E. M. ARENTZEN 3,353,871

CONTINUOUS MINING MACHINE WITH OSCILLATING ROTARY CUTTER HEADS

Filed Aug. 5, 1964 6 Sheets-Sheet 1

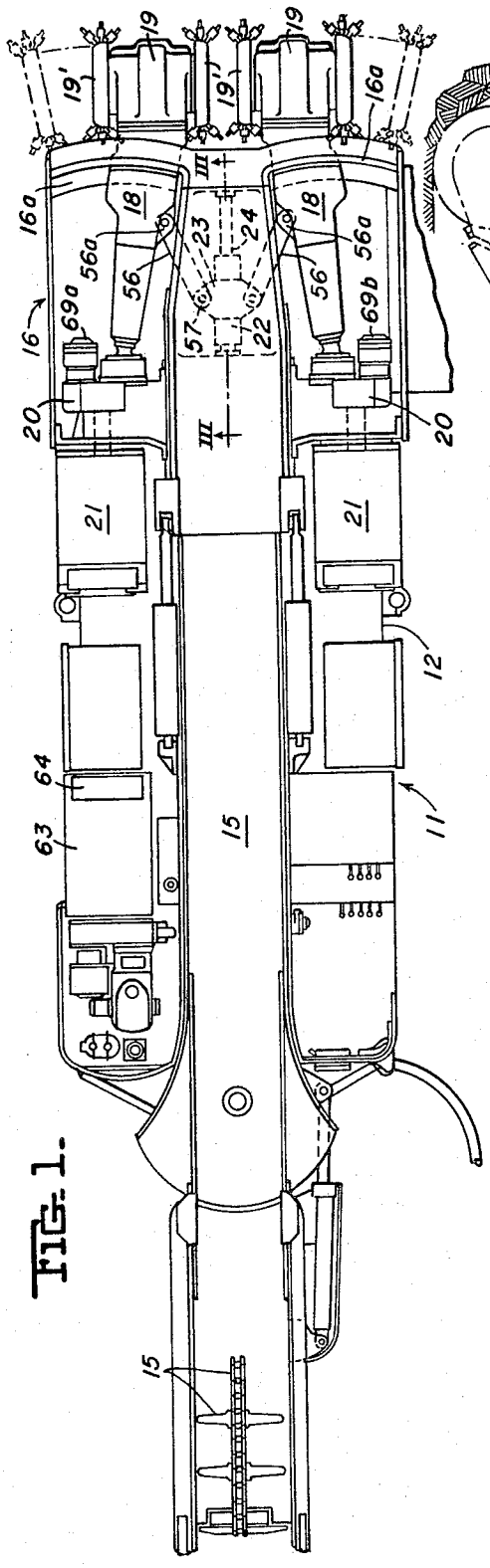


FIG. 1.

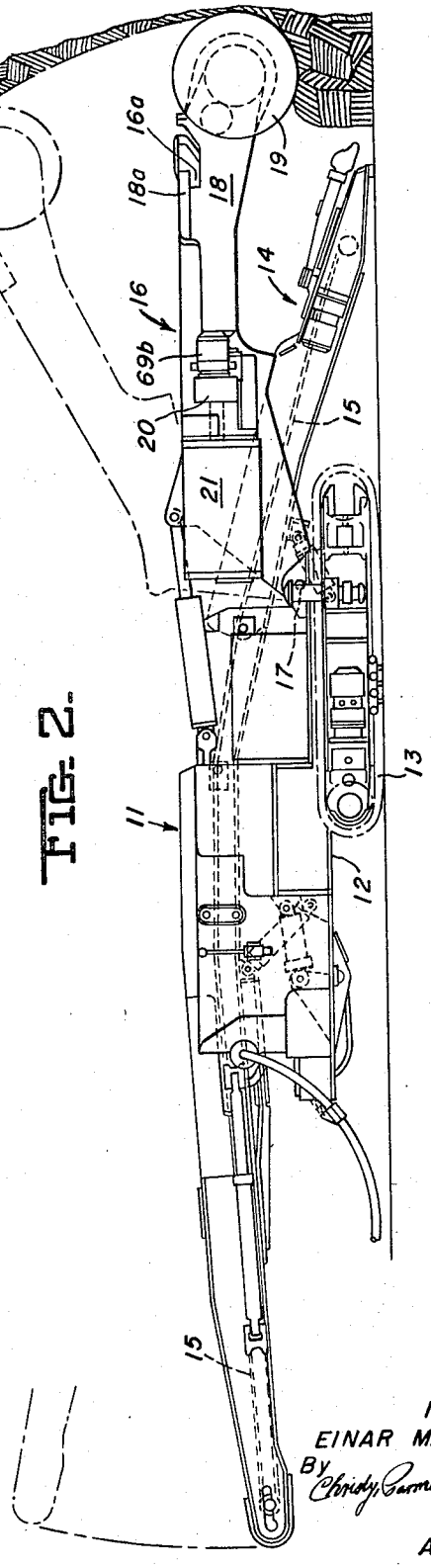


FIG. 2.

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CONTINUOUS MINING MACHINE WITH OSCILLATING ROTARY CUTTER HEADS

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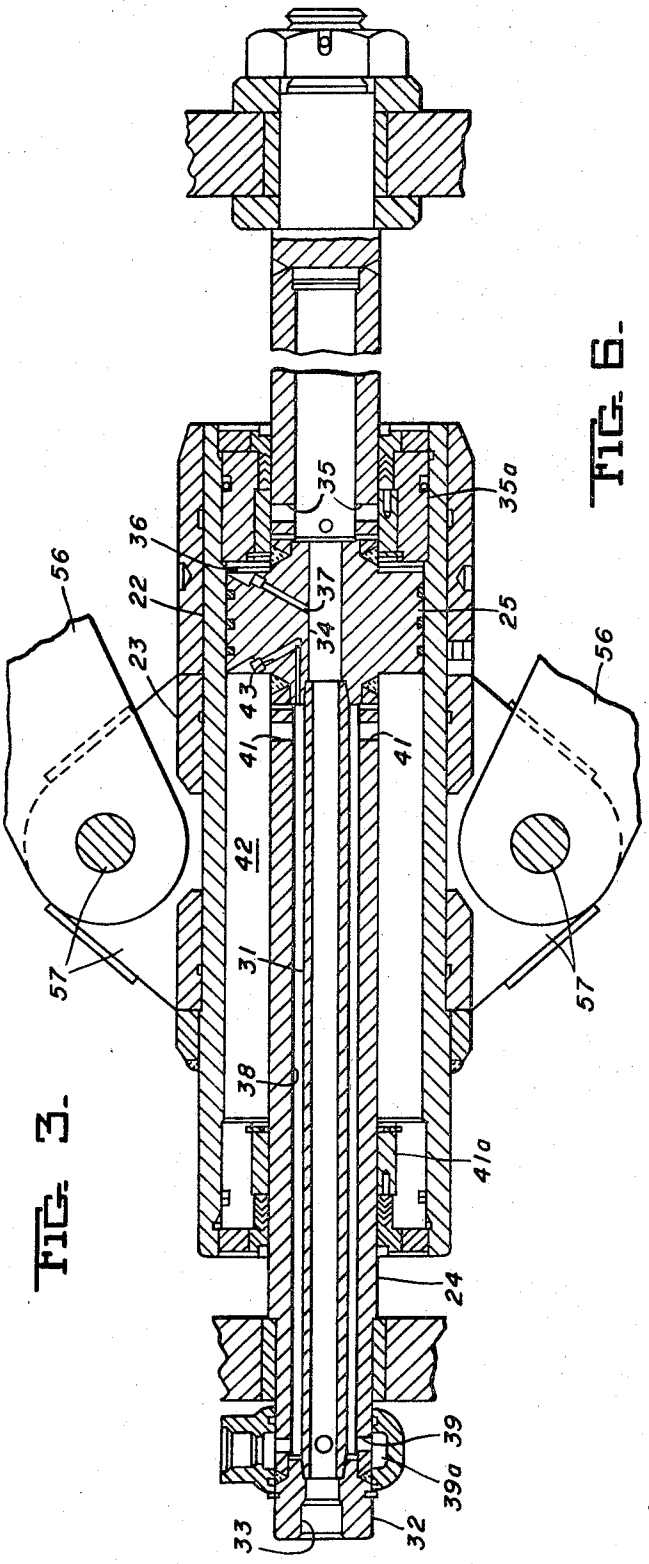


FIG. 3.

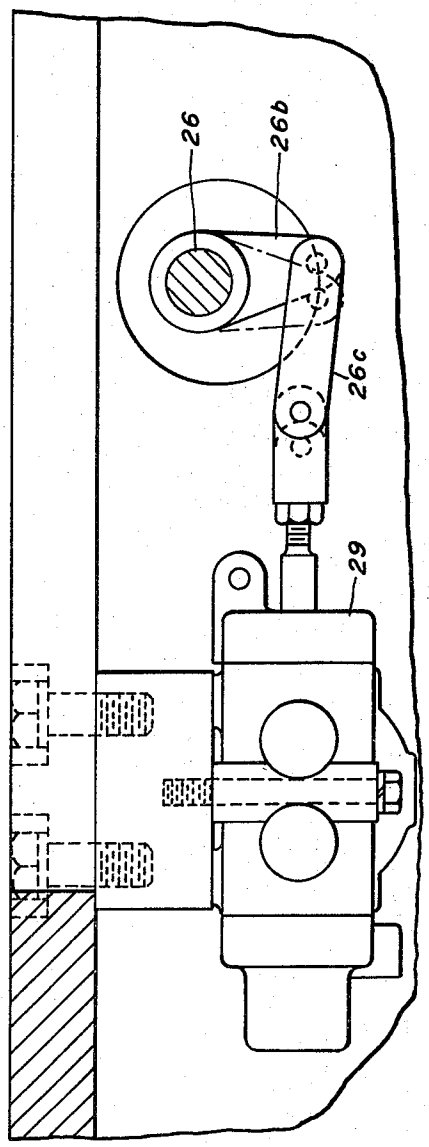


FIG. 6.

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CONTINUOUS MINING MACHINE WITH OSCILLATING ROTARY CUTTER HEADS

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FIG. 4.

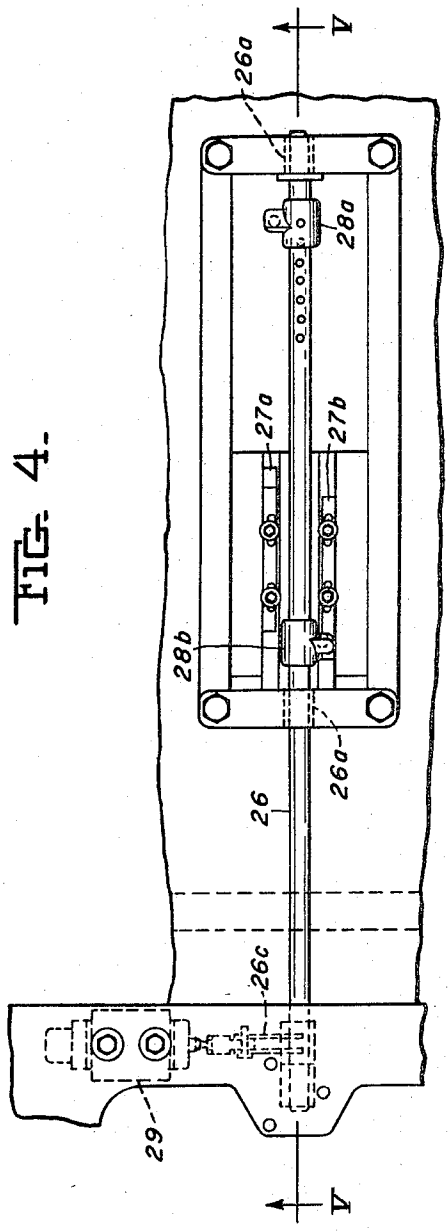
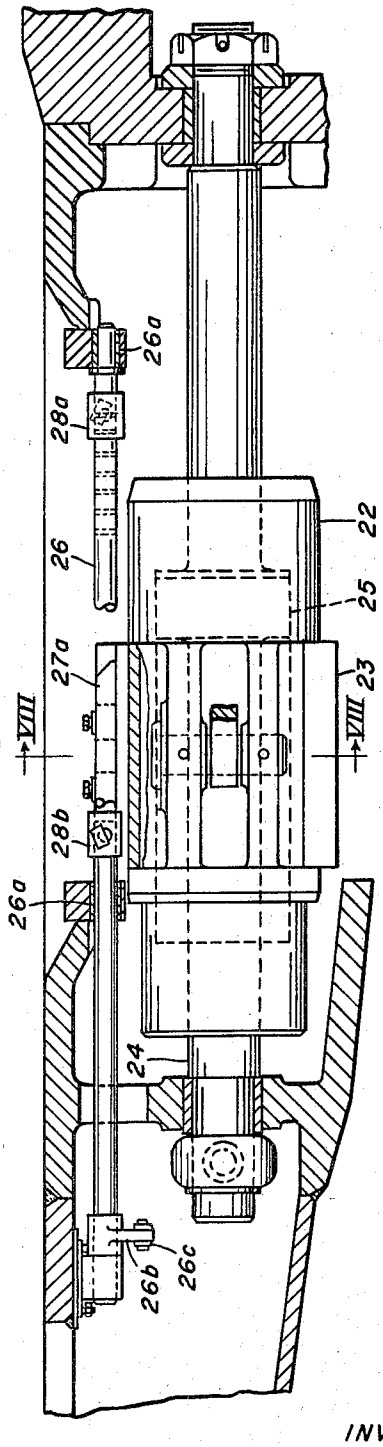


FIG. 5.



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FIG. 8.

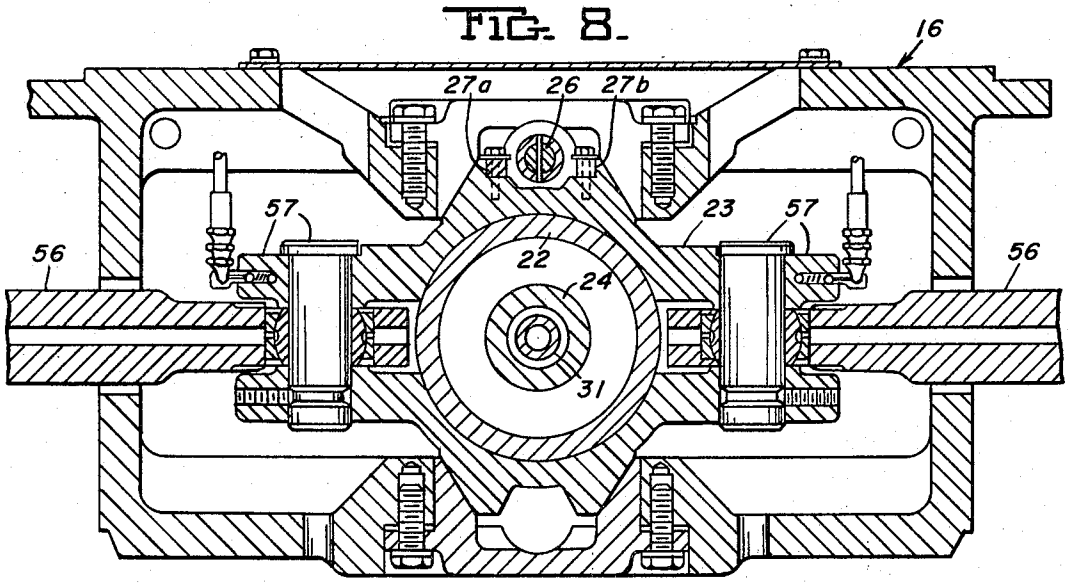
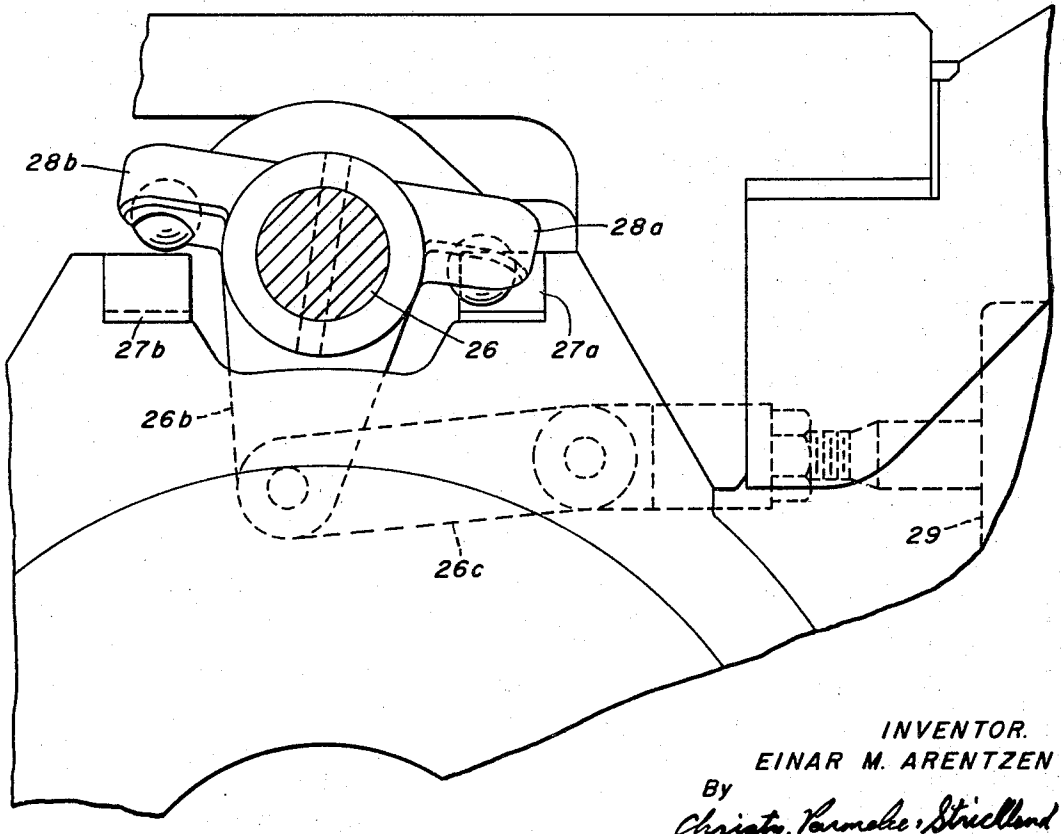


FIG. 7.



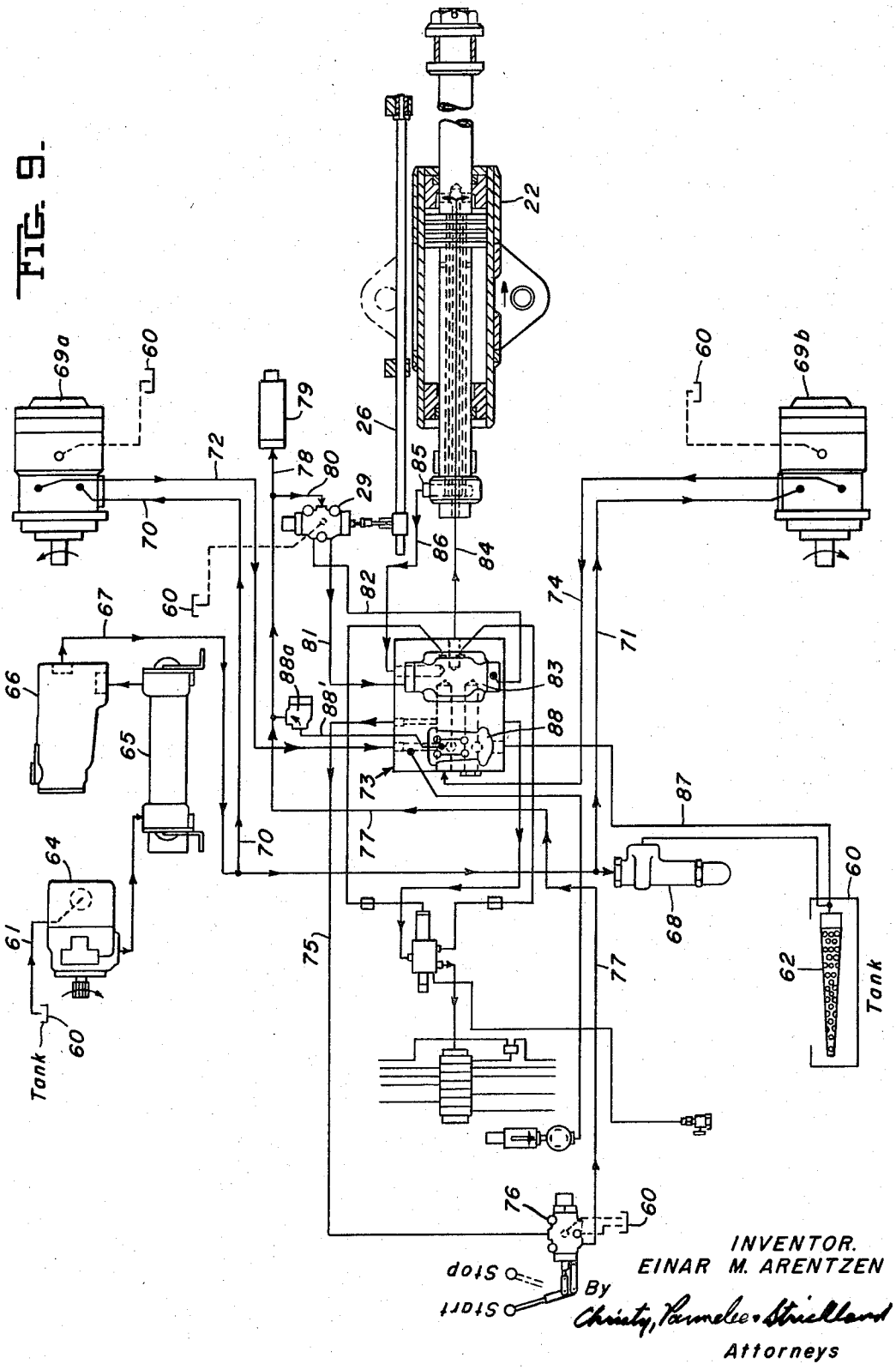
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CONTINUOUS MINING MACHINE WITH OSCILLATING ROTARY CUTTER HEADS

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FIG. 9.



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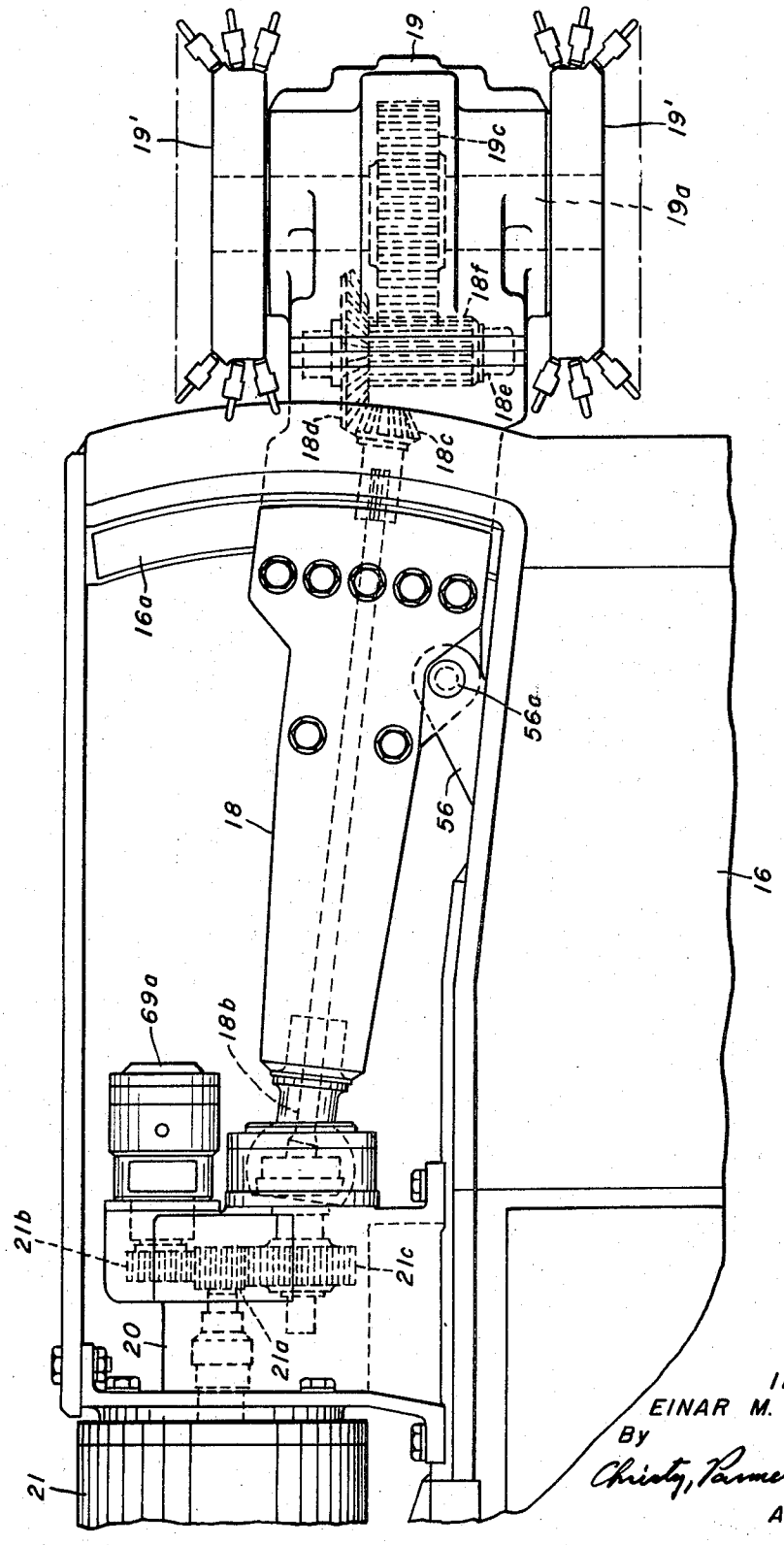
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CONTINUOUS MINING MACHINE WITH OSCILLATING ROTARY CUTTER HEADS

Filed Aug. 5, 1964 6 Sheets-Sheet 6

FIG. 10.



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United States Patent Office 3,353,871 Patented Nov. 21, 1967

3,353,871

CONTINUOUS MINING MACHINE WITH OSCILLATING ROTARY CUTTER HEADS

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Filed Aug. 5, 1964, Ser. No. 387,583
16 Claims. (Cl. 299—71)

This invention is for a continuous mining machine with hydraulically oscillated cutter supporting arms designed for the mining of minerals from the working face of a seam.

The instant invention is for an improvement in the continuous mining machine disclosed in United States Patent No. 2,695,164, granted to me on November 23, 1954. The machine is constructed primarily for the mining of coal, but it is applicable to the mining of other materials. By way of illustration, however, it will be described specifically in connection with the mining of coal.

In my patent above referred to, the machine has a mobile chassis having a wide supporting boom at its forward end that may be moved selectively under manual control in a vertical arc and on which are two arms, one at each side of the longitudinal axis of the machine, that are oscillated simultaneously across the boom in a generally horizontal arc. Each arm has a rotating cutter head at its outer end that rotates about a horizontal axis. As the machine engages the working face in the mine, the cutter heads rotate, digging and breaking out the coal or other mineral, while the arms swing toward and away from each other. At the start the boom is generally elevated so that the cutters "sump" into the coal seam at the roof for such distance as the operator desires. Then with the cutter heads revolving and being moved simultaneously toward and away from each other by the oscillating arms, the boom is lowered toward the mine floor. Simultaneous opposed movement of the arms is desirable so that the cutting forces at the front of the machine are balanced. The wide amplitude through which the arms move enables the entry or tunnel to be much wider than the machine.

The cutter heads of the respective arms are rotated by separate motors mechanically connected to operate in synchronism on each side of the machine through gears and separate drive shafts with universal joints therein, and oscillation of the cutter arms, as fully described in said patent, is effected by crank discs on the respective arms driven through gearing from the respective cutter head drives. Each crank disc has an eccentric crank pin. Separate links pivotally anchored to a fixed pivot midway between the two arms extend oppositely from the pivot and each engages one of the crank pins on said discs, so that as the discs revolve, the arms are caused to move toward and away from the fixed pivot, that is, toward and away from each other.

While this is a highly satisfactory machine and introduced a new concept in continuous miners, it is apparent that the arc through which the arms swing is fixed and cannot be changed where mining conditions require a tunnel or working face of narrower width and it was not possible to rotate the cutter heads without also oscillating the arms. Both crank discs must rotate in exact isochronism so that a cross drive between the two motors mechanically connected them, as above referred to, to keep them synchronous. This resulted in a condition where one of the two motors could fail without the operator being immediately aware of it and impose the work entirely on the other motor.

Moreover, the gearing so provided between the two motors and between each motor and its cutter head and its rotating crank disc is heavy, expensive, and provides no cushion to absorb shock when abnormal formations in the coal or other mineral are encountered. This not infrequently resulted in excessive wear and crank pin breakage. While this may be readily repaired, it results in down time and interferes with scheduled operations. This was especially true as larger machines were built.

The present invention is for a machine organized and operating in a similar manner, but hydraulic cylinder means operated by pumps driven by the same motors that rotate the cutter head is utilized to effect the oscillatory motion of the cutter arms instead of a mechanical linkage. This eliminates the need for gearing interconnecting the two motors as with the rotating disk arrangement of my patent; it allows the amplitude of the arc through which the arms swing to be changed, and since the motors are not connected the rotation of either cutter head may be stopped by stopping its motor; and if either motor should for any reason fail, the operator is made immediately aware of it because the cutter head which it drives stops rotating. With such a hydraulic system, pressure relief valve means may bypass the operating fluid where rock inclusions or other conditions which might overstress the parts are encountered, thus affording a safety factor lacking in a straight mechanical drive for oscillating the arms.

It is a principal object of the present invention to provide a mining machine of the oscillating cutter arm type with hydraulically oscillated arms on which the cutter heads are carried.

Another object is the provision of a continuous mining machine having a hydraulic operating system including overload relief valve means to protect the machine against damage when unusual conditions are encountered.

Still another object is the provision of a continuous mining machine having a compact and effective hydraulic power system for synchronous oscillation of cutter head arms.

A further object is to provide a mining machine having a hydraulic system for oscillation of arms with cutter heads carried thereby which are rotated by independent motors whereby the failure of a motor stops the rotation of its associated head although the arms may continue to be oscillated by the one motor drive remaining in operation.

Another object is the provision of a mining machine having a hydraulic system for oscillation of arms, which may be adjusted to vary the amplitude of the arc through which the arms swing.

A complete understanding of the instant invention may be had from the following detailed description of a specific embodiment thereof when read in conjunction with the appended drawings, wherein:

FIG. 1 is a general plan view of the machine showing the overall arrangement of the various parts;

FIG. 2 is a side elevational view of the machine positioned for operation at the working face of the mine, the cutter heads being here schematically indicated as circles;

FIG. 3 is a longitudinal vertical section of a portion of the boom with a hydraulic cylinder and piston mechanism for oscillating the cutter arms;

FIG. 4 is a top plan view of the same portion of the boom with the cover removed;

FIG. 5 is a longitudinal vertical section in the line V—V of FIG. 4;

FIG. 6 is an end elevation of the mechanism shown in FIG. 4 as viewed from the left end of FIG. 4;

FIG. 7 is a similar elevation as viewed from the right hand end of FIG. 4;

FIG. 8 is a transverse section through the cylinder and cross head in the plane of line VIII—VIII of FIG. 5;

FIG. 9 is a schematic diagram of the hydraulic circuit; and

FIG. 10 is a top plan view of one of the cutter arms and its drive.

Referring now to the drawings, wherein like reference characters designate like or corresponding parts throughout the several views, FIGS. 1 and 2 show general assembly views of the continuous mining machine designated generally as **11**. As in my patented machine, the general assembly includes a chassis **12** which is mounted on crawlers **13**. A gathering head **14** is located at the front end of the machine **11** with a conveyor **15** for receiving coal from the gathering head to carry it rearwardly for discharge.

On the forward end of the chassis **12** above the gathering head **14** is a boom **16** hinged at its downwardly offset rear end to the chassis for movement about a horizontal axis. This boom, which at its forward end extends across the full width of the machine supports two cutter carrying arms or carriers **18** one at each side of the center of the machine. These arms have their forward ends extending beyond the boom. At the outer end of each arm is a gear casing **19** that supports a cutter head **19'**, the cutter head having two spaced cutter wheels on a cross shaft **19***a* (see FIG. 10), one cutter wheel at each side of the housing **19**, being generally that shown in my said patent. The inner end of each arm is pivoted for universal movement in a gear casing and universal joint housing **20**. Each arm has a guide at **18***a* that is grooved to fit over a curved guide strip **16***a* at the front of the boom and by which the arm is slidably supported for horizontal movement and held against vertical movement relative to the boom.

The drive for rotating each of the rotary cutter heads **19** is from separate motors **21** which are supported on the boom **16**. Each motor is directly coupled to the rotary head which it drives through a drive shaft and gears, as hereinafter more fully described.

This part of the machine so far described conforms generally, except as to certain changes not here material, to my previous patent. According to this invention, a fluid pressure operated mechanism comprising a cylinder and piston, one of which reciprocates relatively to the other is provided to oscillate the cutter head carrying arms. As here shown, the fluid pressure mechanism includes a reciprocating or travelling cylinder **22** with a cross-head **23** fixed thereon which is made to reciprocate on a fixed piston rod **24**. On this rod is a stationary piston **25** positioned within the cylinder (see FIGS. 1, 3 and 4).

A pilot valve operating rock shaft **26** is rotatably supported in bearings **26***a* fixed to the boom, this shaft being positioned centrally above the cylinder **22** and extending lengthwise above it. On top of the cross head **23** are two camming strips **27***a* and **27***b*, one of these strips being at each side of and below the rod **26**. Strip **27***a* is beveled at its forward or right hand end as viewed in FIGS. 4 to 8 and the other strip is similarly beveled at its rear or left end. At spaced distances on the shaft are rocker arms **28***a* and **28***b*, **28***a* being selectively adjustable to different locations in which it may be fixed near the forward end of the rock shaft whereas **28***b* is near the rearmost limit of travel of the yoke. Arm **28***a* projects into the path of travel of camming strip **27***a* and **28***b* into the path of travel of the camming strip **27***b*. When the cylinder and yoke **23** move forwardly, that is, to the right in the drawings, the inclined or beveled end of strip **27***a* rides under the projecting end of the arm **28***a*, which is in the form of an inserted ball, and lifts it, rocking the shaft in one direction, arm **28***b* at that time being clear of its camming strip **27***b*. When the cylinder travels in the reverse direction, the beveled end of strip **27***b*, riding under arm **28***b* lifts it, rocking the shaft back to its former position.

Near the rear end of the rock shaft **26** is an arm **26***b* to which is attached a link **26***c* that is connected to the stem of a pilot valve **29** so that as the shaft is rocked one way and then the other the pilot valve is moved back and forth at the limits of travel of the cylinder to reverse the fluid pressure and reverse the travel of the cylinder as will be hereinafter more fully explained.

As best shown in detail in FIG. 3, the fixed piston rod **24** is hollow and it has a tube or pipe **31** concentrically positioned therewithin, one end of which is secured to the stationary piston **25** and its other end is fastened to a union **32**. It provides a passage through which fluid under pressure is introduced into the cylinder to effect reciprocation thereof in one direction. The conduit **31** opens into a passage **33** through the union to establish a flow path to a central passage **34** through the fixed piston **25**. Radial apertures **35** are provided through the piston rod **24** to the right of the piston **25**, as viewed in FIG. 3, whereby fluid may be ported into a chamber **36**. A bleed passage **37** is provided in the stationary piston which communicates with the central bore **34** of the piston **25** and the chamber **36** into which fluid under pressure is directed to initiate movement of the cylinder **22** to the right, as viewed in this figure. The radial apertures **35** are uncovered after a short distance of travel of the cylinder **22** to the right whereupon fluid is introduced into the chamber **36** to then continue driving the cylinder to the right at a greater speed.

The annular space **38** between the conduit **31** and the inner wall of the hollow piston rod **24** serves as a passage through which fluid is introduced through an inlet port **39** from a separate circumferential passage **39***a* in the union **32** to radial openings **41** provided through the rod adjacent the left side of the piston as seen in FIG. 3, and thence to the cylinder chamber **42** to the left of the stationary piston **25**, first through bleed port **43** and then via the radial openings **41**, as viewed in FIG. 3, it being understood that at this time the cylinder is at the opposite limit of its travel from that shown in FIG. 3 so that ports **41** are then within the packing sleeve **41***a* at the left end of the cylinder. The corresponding sleeve at the other end of the cylinder is designated **35***a*. Consequently, when fluid under pressure is introduced into the chamber **42** on the left of the fixed piston, the traveling cylinder **22** is driven to the left, and, similarly, when fluid is ported to the chamber **36** on the right of the fixed piston, the traveling cylinder is forced to the right.

Fluid from the chamber **36** on the right of the piston is expelled through the same channels above described, through which it is introduced, and this is also true for chamber **42**.

Motion is transmitted to the cutter arms **18** from the cross-head **23** on the traveling cylinder through links **56** pivotally interconnected to the arms **18** at **56***a*, and with the cross-head through a yoke and pin assembly **57**, one such link being at each side of the cross-head. Thus, when the cross-head is moved toward the front end of the machine **11**, the links **56** increase the angle between the cutter arms **18** to effect a simultaneous horizontal arcuate movement of the arms away from each other toward the outer sides of the machine. Similarly, when the cross-head is moved toward the rear of the machine, the arms are drawn toward the center of the machine, reducing the angle between the arms pulling them together toward the center. The amplitude of the arcs through which the arms swing, that is, the throw of the arms, is determined by the length of travel of the cylinder and cross-head and if no fluid pressure is supplied to the cylinder, the arms will remain fixed in any position while either or both cutter heads **19** may revolve. The arms **18** move equally and in opposite directions in synchronism as in my earlier patent, but the arms may be held stationary while the cutters are revolving, which is an added desirable feature.

The hydraulic system effecting the reciprocation of the cylinder in the manner above described may best be understood by reference to the flow diagram shown in FIG. 9. It should first be pointed out that the element marked **60** and labelled "tank" appearing at the top and bottom

of the left side of FIG. 9 is the same vessel or reservoir but for purpose of clarity the intake of the fluid system indicated at **61** is at the top of the diagram and the discharge represented by diffuser **62** is at the bottom of the diagram. The tank **60** also appears elsewhere in the diagram to indicate the same vessel.

A motor **63** on one side of the machine back of motor **21** (see FIG. 1) drives a pump **64** that circulates oil from the reservoir to a cooler **65** and from the cooler the oil flows through a filter **66** into pipe **67**. Oil that is not needed for the operation of the hydraulic mechanism flows back through a pressure relief valve **68** into the diffuser **62** in the tank **60**.

Each of the two motors **21** is geared in gear box **20** to a constant volume high pressure pump, these pumps being designated **69***a* and **69***b*. Oil from pipe **67** flows through branch pipe **70** to the intake of pump **69***a* and from the pipe **67** through branch pipe **71** to the intake of pump **69***b*. Pump **69***a* discharges high pressure fluid through pipe **72** to a bypass and reversing valve assembly, designated generally at **73**, and pump **69***b* discharges high pressure oil through pipe **74** to the same unit **73** where the output of the two pumps combine.

Part of the high pressure oil from unit **73** is carried from this unit through pipe **75** to a conventional on and off valve **76**, which has a manual operating lever movable from a "stop" position which blocks the flow of fluid to a "start" position where it is open to the passage of fluid therethrough into line **77**. This line has a branch **78** leading to a prepressured accumulator **79**, and a branch **80** which connects both line **77** and the accumulator to the single inlet port of the conventional spool type pilot valve **29** heretofore referred to. This pilot valve upon the rocking of the rock shaft **26** in one direction and then the other, passes high pressure fluid alternately into pipes **81** and **82**, to reciprocate a conventional fluid pressure operated reversing valve **83**. When fluid is flowing through pipe **81** to one side of the reversing valve, fluid is expelled through pipe **82** and the pilot valve to pipe **84** to return to the tank **60**, and vice versa. In the diagram fluid pressure is in line **81**, for which reason it is shown with arrows, while exhaust liquid is flowing through pipe **82**, to which no arrows are applied. When pilot valve **29** is reversed, this condition would be reversed and **82** would become the pressure line and **81** the exhaust.

The reversing valve distributes the high pressure fluid from the two pumps **69***a* and **69***b*, other than that used in the pilot valve circuit and that required for certain accessory functions, to the cylinder **22**. With the parts in the position shown in the diagram, high pressure fluid is passing through pipe **84** into passage **33** to move the cylinder to the right to spread the arms **28** while fluid in the space **42** to the left of the piston is exhausted through ports **39** to the circumferential passage **31** and connection **85** to pipe **86**. The exhaust liquid from pipe **86** passes through the reversing valve and internal passages in the assembly **73** to line **87** and into the diffuser **62** in the tank **60**.

When the reversing valve is moved in the other direction the pipe **84** becomes the exhaust pipe for the escape of oil from the right end of the cylinder and pipe **86** becomes the high pressure supply line to the left side of the cylinder.

In the assembly **73** there is a pressure relief valve **88** of known construction, such as a spring biased valve shunted across the high pressure and exhaust lines, so arranged as to bypass high pressure fluid from the two high pressure pumps to the exhaust line **87** when pressures exceed a predetermined maximum. It is a safety feature allowing the movement of the arms to stall before they are overstressed. For example, in moving together a rock or very hard slate may come between the arms, preventing their closing movement. In this case the relief valve opens, protecting the mechanism, particularly pivot pins for the arm reciprocating links from damage. Nevertheless the motors may continue to operate and rotate the cutters, and if the cutters gradually remove the obstruction, the arms will continue moving. Fluid under pressure is normally maintained above the pressure relief valve, but when valve **76** is moved to "stop" position, pressure in line **77** is relieved with the liquid flowing back through this line to the tank whereupon pressure over the relief valve is vented through pipe **88'** and check valve **88***a* to the line **77** so that when the handle of valve **60** is moved to stop position even though the pumps **69***a* and **69***b* are still operating, the effect of moving the stop and start valve is to relieve the pressure in line **77**, allowing pressure in the relief valve to drop, thereby shunting the high pressure fluid to the reservoir to starve the pilot valve and reversing valve and the cylinder and piston means of operating pressure. The same movement of the stop and start valve will allow liquid in line **75** to flow to the reservoir or tank, so that the output of the pumps **69***a* and **69***b*, which operate as long as the motors **21** are operating, will be bypassed to the reservoir. When the stop and start valve is in the operating position, the output of the two high pressure pumps flows through this valve, as previously explained to establish normal high pressure in the relief valve and all other parts of the hydraulic system with which they communicate. The check valve **88** prevents any backflow of pressure from the accumulator into the relief valve such as might interfere with the quick stopping of the hydraulic mechanism. The system described facilitates the removal of entrapped air which presents a problem in a hydraulic system.

Remaining elements of the diagram pertain to lubrication, gauges and so forth not particularly involved here.

In FIG. 10 the general driving arrangement for one of the cutter heads and one of the high pressure pumps is shown. In this view **21** is one of the two motors hereinbefore described, the shaft of which extends into a gear box **20**. Within the gear box this shaft has a pinion **21***a* which meshes with a gear **21***b* for driving the high pressure pump **69***a*. The same pinion also meshes with a gear **21***c* which transmits rotary motion through a universal joint to a shaft **18***b* that extends lengthwise of the cutter arm and on the forward end of which is a bevel pinion **18***c*. This in turn meshes with a bevel gear **18***d* on a shaft **18***e* parallel with the shaft of the cutter head. This shaft in turn has spur gear **18***f* that meshes with a spur gear **19***c* and the cutter head shaft. A ball-like housing on the inner end of arm **18** surrounds the universal joint and provides the axis about which the arm pivots. Each motor **21** contributes equally to the power requirements for oscillating the cutter arms, as in my prior patent, eliminating different motors on opposite sides of the machine, or a separate motor for driving the high pressure fluid mechanism.

It may be noted that since the parts **35** and **41** close just before the full limit of travel of the cylinder is reached, the restricted passages **37** and **43** restrict the escape of the out-going liquid tending thereby to cushion the motion of the arms at the ends of their strokes in addition to gradually admitting fluid at the beginning of the stroke in the opposite direction.

With this arrangement, each of the main motors **21** drives a high pressure pump and also drives a cutter head on the arm adjacent which it is positioned. As previously explained, the cutter heads may thus be rotated without the arms being reciprocated and either cutter head may be held against rotation while the other is turning. Since the two motors **21** are entirely independent, if one motor would fail, its cutter head would cease rotating thereby immediately informing the operator of the failure of the motor. The two arms **18** of course always move equally and oppositely through the same arc and the power for moving them is derived from the motors **21** through the hydraulic system, but mechanical synchronization of the two motors is not required. An added advantage is that by adjusting the rocker arm **28***a* on the shaft

26 the length of the arc may be varied as conditions in the mine may require.

It is manifest that the above-described embodiment of the invention is merely illustrative and that numerous modifications and revisions may be made within the spirit and scope of the invention.

What is claimed is:

1. A mining machine comprising a chassis, a boom connected to the forward end of the chassis for vertical movement relative to the chassis, a pair of carriers mounted on the boom for horizontal side-by-side movement, a rotary cutter on the forward end of each carrier, a separate motor for driving each cutter, means operatively connecting each motor with the cutter which it drives, a fluid pressure mechanism including relatively movable cylinder and piston members, said fluid pressure mechanism being connected to said boom and to said carriers for horizontally oscillating said carriers simultaneously in opposition to one another, and a source of fluid pressure connected to supply pressure fluid to said fluid pressure mechanism to cause the latter to continuously oscillate said carriers during the normal operation of the mining machine, said source including a separate pump driven by each motor and a fluid pressure circuit for each pump connected in a common circuit with said fluid pressure mechanism through which fluid pressure is supplied to the fluid pressure mechanism.

2. A mining machine as in claim 1 wherein pressure relief means is connected in common to the pump circuits to by-pass high pressure fluid around the fluid pressure mechanism such that the horizontal movement of both of said carriers is retarded in the event that the cutter of either carrier encounters abnormal resistance.

3. In a mining machine having a chassis with a boom swingable about a horizontal axis at the forward end of the chassis, a pair of cutter carriers each pivotally secured to the boom at its rear portion for arcuate travel at their forward portion toward and away from the boom longitudinal centerline in opposition to effect a pincer-like action, a cutter mounted for rotation on the forward portion of each carrier, a separate drive motor for each cutter, fluid pressure motor means supported on the boom between the carrier and links interconnected to the fluid pressure motor means and pivotally to each carrier intermediate its forward and rear portions arranged to pull the carriers together into side-by-side relationship and then push the carriers apart whereby oscillation of the carriers in equal arcs of travel is effected, and means responsive to the movement of the carriers for reversing the travel at each limit of movement such that the carriers are continuously oscillated during the normal operation of the mining machine.

4. In a mining machine as in claim 3 wherein the fluid motor means is a reciprocating cylinder with a fixed piston, and fluid circuit means are provided for forcing the cylinder in opposite directions.

5. In a mining machine as in claim 4 wherein the fluid circuit means includes a pair of pumps each driven by one of the separate drive motors, and a hydraulic control circuit including a pilot valve operated by the fluid pressure motor means is provided for regulating the direction of flow to the motor means to force the cylinder alternately in opposite directions.

6. In a mining machine as in claim 5 wherein a pilot valve is provided in the control circuit, and means responsive to travel of the cylinder is provided for operating the pilot valve spool to control the direction of fluid from the pumps to either one side or the other of the fixed piston of the fluid motor, there being a pressure relief valve arranged to by-pass fluid around the cylinder piston when the resistance to movement of the carriers exceeds a predetermined amount.

7. In a mining machine as in claim 6 wherein a main valve is connected in common to the two pumps and to the fluid motor, the pilot valve being operatively connected to the main valve for positioning of the main valve for the direction of fluid from the pumps through the main valve to either one or the other side of the piston to drive the cylinder in one direction or the other, and means responsive to the operation of the mechanism for operating the pilot valve.

8. A mining machine of the type having a chassis with a boom thereon at the front thereof movable in a vertical arc and having a pair of carriers thereon movable over the boom in a horizontal arc with cutters on the outer ends of the carriers rotatable about a horizontal axis and means for rotating the cutters characterized by the provision of a reciprocable hydraulic fluid pressure cylinder and piston means connected to the boom between the two carriers and connected to the two carriers for simultaneously moving said carriers equally and in opposite directions, and valve means controlled through the operation of the pressure cylinder means for reversing the movement of cylinder and piston means at the limits of travel of the carriers such that said carriers are moved continuously during the normal operation of the mining machine substantially in unison.

9. A mining machine as defined in claim 8 wherein the cutter on each carrier is driven by a separate motor and each cutter driving motor also drives a high pressure hydraulic pump, the output of said pumps being connected into a common circuit including the hydraulic fluid pressure cylinder and piston means and the valve means for controlling the operation thereof whereby both motors normally contribute equal power to driving the rotatable cutters while effecting the oscillation of the carriers.

10. A mining machine as defined in claim 9 in which the common output circuit includes a manually operable stop and start valve having stop and start positions arranged to control the fluid pressure cylinder and piston means for rendering the same operative or inoperative while the motors may continue to rotate their respective cutters.

11. A mining machine as defined in claim 9 in which the common output circuit includes a manually operable stop and start valve having stop and start positions arranged to control the fluid pressure cylinder and piston means for rendering the same operative or inoperative while the motors may continue to rotate their respective cutters, the circuit also including a relief valve for by-passing high pressure fluid from the cylinder and piston means when the resistance to movement of the carrier exceeds a predetermined maximum.

12. A mining machine as defined in claim 9 in which the common output circuit includes a manually operable stop and start valve having stop and start positions arranged to control the fluid pressure cylinder and piston means for rendering the same operative or inoperative while the motors may continue to rotate their respective cutters, the circuit also including a relief valve for by-passing high pressure fluid from the cylinder and piston means when the resistance to movement of the carriers exceeds a predetermined maximum, the stop and start valve being connected to by-pass high pressure fluid through the relief valve in the stop position and to close such by-passing in the start position.

13. A mining machine as defined in claim 8 wherein the cylinder and piston means includes valving to check the speed of operation thereof near the opposite reciprocable limits of movement thereof.

14. A mining machine comprising a chassis, a boom connected to the forward end of said chassis for vertical movement relative to said chassis, a pair of carriers mounted on said boom for side-by-side horizontal movement, a rotary cutter connected to the forward end of each of said carriers, motor means connected to said cutters for rotatably driving said cutters, hydraulically operated motor means connected to said boom and to each of said carriers for horizontally oscillating said

carriers simultaneously in opposition to one another, and means for causing said hydraulically operated motor means to horizontally oscillate said carriers continuously during the normal operation of the mining machine.

15. A mining machine as defined in claim **14** wherein said hydraulically operated motor means is connected to said boom between said carriers.

16. A mining machine as defined in claim **14** wherein means is provided for controlling the horizontal movement of said carriers such that the horizontal movement of both carriers is retarded in the event that the cutter of either carrier encounters abnormal resistance to its horizontal movement.

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