Feb. 7, 1967 E. J. HLINSKY 3,302,974

RIPPER TYPE MINING MACHINE HAVING OPPOSITELY MOVING OSCILLATING RIPPER HEADS

Original Filed Aug. 31, 1962 3 Sheets-Sheet 1

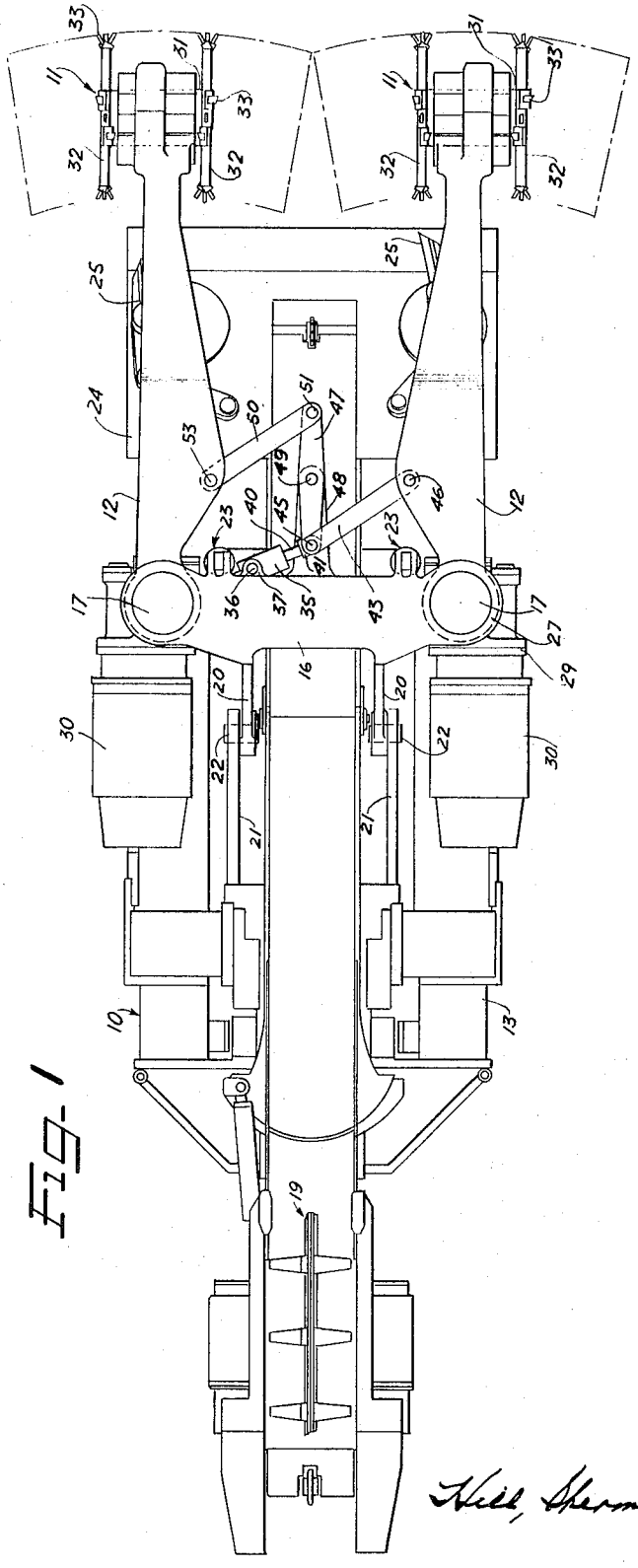


Fig. 1

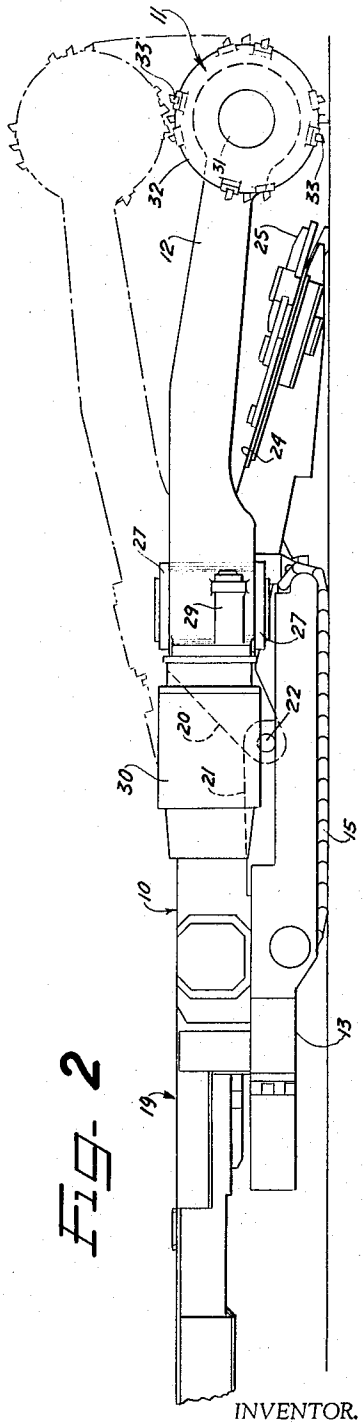


Fig. 2

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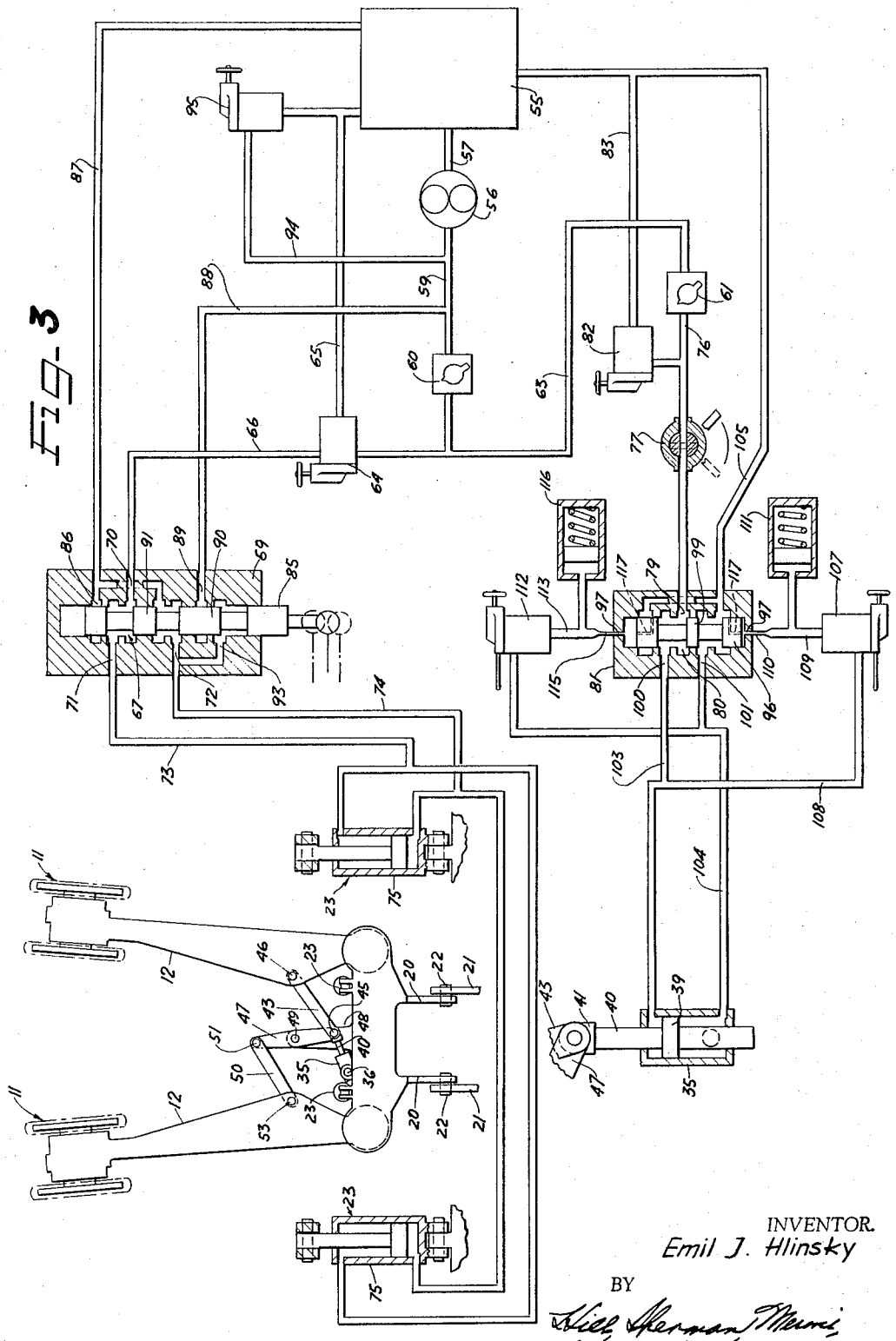
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FIG. 3



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Fig. 4

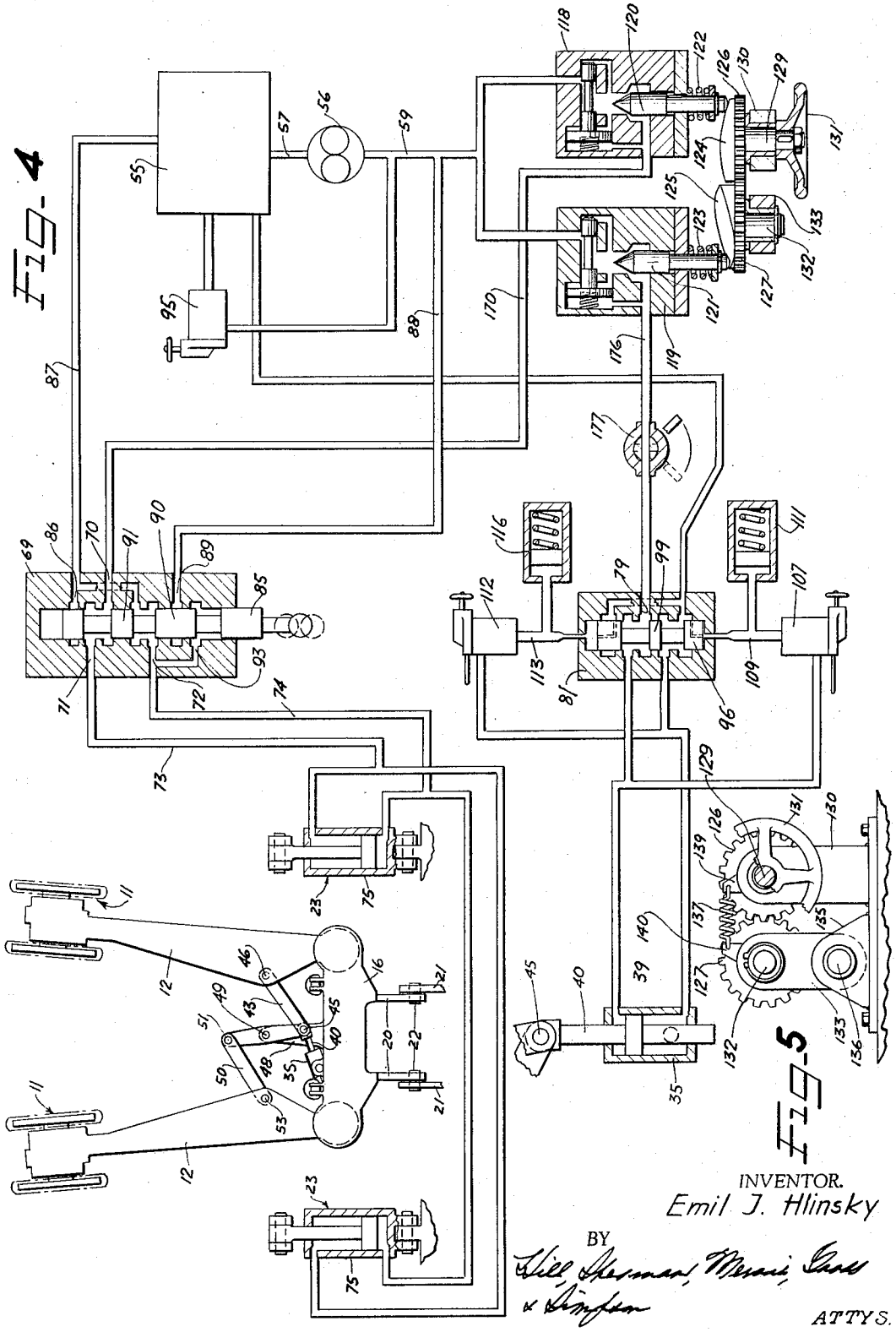


Fig. 5

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3,302,974

RIPPER TYPE MINING MACHINE HAVING OPPOSITELY MOVING OSCILLATING RIPPER HEADS

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Continuation of abandoned application Ser. No. 425,653, Nov. 25, 1964, which is a continuation of abandoned application Ser. No. 220,739, Aug. 31, 1962. This application Feb. 18, 1966, Ser. No. 540,115

15 Claims. (Cl. 299—1)

This application is a continuation of an application Serial No. 425,653, filed by me on November 25, 1964, and entitled, "Continuous Mining Machine," now abandoned, which is a continuation of application Serial No. 220,739 filed by me on August 31, 1962, and entitled, "Continuous Mining Machine," and now abandoned.

Heretofore, coal has been mined by cutting spaced grooves or kerfs in a coal face on the bias in one direction, to weaken the coal between the kerfs, to be readily dislodged upon subsequent cutting of the coal on the bias in an opposite direction.

These oppositely biased kerfs produce a generally diamond cutting pattern and are produced by oscillatably driving a rotating cutter head at generally right angles to the direction of rotation of the cutter head, as the cutter head is fed along a coal face in a direction perpendicular to the axis of rotation of the cutter head.

The machine may include two laterally spaced cutter heads and the cutter heads are oscillated in opposing directions to equalize the side thrusts on the machine. The diamond kerf pattern leaves cores of solid coal projecting from the working face, which are cut and broken from the coal face with a minimum amount of horsepower by the oscillating cutter heads.

Coal seams vary considerably in consistency and even the same seam will differ from place to place in the mine. It is, therefore, both desirable and necessary to be able to readily alter the cutting pattern and speed of oscillation of the mining heads from time to time to suit the coal seam being mined.

Heretofore, ripper types of cutter heads have been oscillated while being rotatably driven and rotation and oscillation of the cutter head has been performed with a single mechanical drive. With such machines, it has been necessary to either change the drive gearing to the cutter heads, the cutter heads themselves or the components for oscillatably driving the cutter heads to vary the cutting pattern, making it uneconomical to vary the speed of oscillation of the cutter heads while the machine is mining in one seam of coal.

A principal object of the present invention, therefore, is to remedy the foregoing deficiencies in mining machines having oscillating cutter heads by providing an improved form of oscillating drive means to the cutter heads in which the heads are oscillated independently of their drive and in which oscillation and rotation of the heads can be programmed to cut cutting patterns best suited to a specific coal seam.

A further object of the invention is to provide a continuous mining machine having oscillating cutter heads in which individual drives are provided for driving the cutter heads and the oscillating mechanism for the cutter heads, to enable the frequency of oscillation to be varied to suit a particular coal seam without changing the drives to the cutter heads.

Still another object of the invention is to provide an improved form of continuous mining machine of the ripper type having oscillating rotary cutter heads with feeding means for feeding the cutter heads vertically along

a coal seam, in which the oscillating means and feeding means are so interrelated that a change in the frequency of oscillation of the cutter head will result in an inverse change in feed of the cutter heads.

A still further object of the invention is to provide an improved form of continuous mining machine having laterally spaced rotary cutter heads journalled at the forward ends of vertically movable oscillating booms, in which fluid pressure means are provided to oscillatably drive the booms and cutter heads in opposite directions with respect to each other, and other fluid pressure means are provided to move the booms vertically, and in which the control circuit to the oscillatable drive means and the feeding means is so interrelated as to increase the speed of feeding upon a reduction in frequency of oscillatable movement of the booms and vice versa.

A still further object of the invention is to provide a continuous mining machine of a type having a rotary cutter head mounted on the end of a vertically movable boom, in which a fluid operated cylinder and piston is provided to oscillatably drive the boom, and in which the control circuit to the cylinder and piston is so arranged as to automatically change the direction of oscillation when the cylinder reaches the ends of its strokes, and when a serious overload condition is encountered.

These and other objects of the invention will appear from time to time as the following specification proceeds and with reference to the accompanying drawings wherein:

FIGURE 1 is a top plan view of a continuous mining machine constructed in accordance with the principles of the present invention;

FIGURE 2 is in view in side elevation of the continuous mining machine shown in FIGURE 1;

FIGURE 3 is a fluid diagram illustrating the fluid control circuit for the feeding means for the booms of the machine and the means for oscillatably driving the booms and mining heads;

FIGURE 4 is a fluid diagram somewhat similar to FIGURE 3 but illustrating a modified form in which my invention may be embodied, and

FIGURE 5 is a detail end view of the means for operating the fluid control valve for oscillating and feeding the mining heads.

In the embodiment of the invention illustrated in FIGURES 1 through 3 of the drawings, I have shown in FIGURES 1 and 2, a continuous mining machine **10** of the ripper type having two rotatably driven oscillatably movable mining heads **11, 11** mounted on the outer ends of individual booms **12, 12** extending in advance of a main frame **13** for the machine.

The main frame **13** is mounted on laterally spaced continuous traction tread devices **15**, propelling the machine along the ground from working place to working place at a high tramming speed, and advancing the machine toward a working face at a relatively low feeding speed, to feed or sump the mining heads **11, 11** into the working face.

The boom arms **12** extend in advance of the main frame **13** and are vertically pivoted at their rear ends, at opposite ends of an angularly movable elevating frame **16**, on pivot pins **17**.

The angularly movable elevator frame **16** extends across the forward end of the main frame **13** above a conveyor **19** and has parallel spaced arms **20** extending rearwardly therefrom along opposite sides of the conveyor **19** and transversely pivoted at their lower rear ends to parallel spaced wall members **21** of the main frame **13**, on pivot pins **22**. Hydraulic jacks **23** connected between the front of the main frame **13** and the elevator frame **16** at opposite sides of the conveyor **19** are pro-

vided to move said elevator frame about the axes of the pivot pins 22 and elevate or lower the mining heads 11.

The conveyor 19 is shown as being a conventional laterally flexible single strand chain and flight conveyor and extends from a position adjacent the ground in advance of the forward end of the main frame 13 in an upwardly inclined direction along an inclined apron 24 and rearwardly therefrom horizontally along the top of the main frame 13 beyond the rear end thereof, for discharging the mined material into shuttle cars or other material transporting means.

The inclined apron 24 has gathering devices 25 mounted thereon for gathering the mined coal and progressing it along the front end of the apron 24 rearwardly toward the center of the machine onto the receiving end of the conveyor 19. The gathering devices 25 are herein shown as being of the orbitally traveling gathering arm type of gathering devices, well known to those skilled in the art so not herein shown or described further.

The boom arms 12 may be hollow boom arms, supported in bifurcated end portions 27 of the elevator frame 16 on the pivot shafts 17, as generally shown in FIGURES 1 and 2. As shown in these figures, each boom arm has a reduction gear housing 29 carrying reduction gearing (not shown) for driving an associated mining head 11. A motor 30 is shown as being mounted on and extending rearwardly of each reduction gear housing 29. A suitable drive connection is provided between each motor 30 and the reduction gearing driven therefrom and the mining head 11, to drive a transverse shaft 31 and cutter disks 32 mounted on opposite ends of said transverse shaft. The cutter disks 32 have cutter bits 33 mounted thereon and extending from the periphery thereof and pitched at varying angles with respect to said disk to cut clearance for said cutter disks.

The means for oscillatably moving the boom arms 12 and mining heads 11 about the axes of the shaft 17 is shown in FIGURES 1 and 3 as comprising a hydraulic jack including a cylinder 35 trunnioned intermediate its ends on vertically extending trunnion pins 36 extending from opposite sides of said cylinder and pivotally mounted in vertically spaced connecting ears 37, extending forwardly of the elevator frame 16 along opposite sides of the cylinder 35. The cylinder 35 is shown in FIGURE 3 as being a double acting cylinder having a piston 39 therein having a piston rod 40 extensible therefrom. The piston rod 40 has a connector yoke 41 extending from the end thereof and having a link 43 pivotally connected thereto on a pivot pin 45. The opposite end of the link 43 from the pivot pin 45 extends within a recessed portion of an arm 12 and is pivotally connected thereto as by a pivot pin 46. The pivot pin 45 also forms a pivotal connector for one end of a lever arm 47. The lever arm 47 is pivotally mounted on a support arm 48 extending forwardly of the elevator frame 16 intermediate the ends thereof on the pivot pin 49.

The opposite end of the lever arm 47 from the pivot pin 45 is pivotally connected to a link 50 on a pivot pin 51. The link 50 extends angularly toward the front end of the main frame 13 in an inward direction toward the opposite boom arm 12 from the boom arm connected to the link 43, and is pivotally connected thereto as by a pivot pin 53. The alternate admission of fluid under pressure to one end and then the other end of the cylinder 35 will thus move the boom arms 12 in opposite directions toward and from each other, to effect oscillatable movement of the mining heads 11 during operation thereof.

Referring now in particular to FIGURE 3, diagrammatically showing one form of fluid circuit for effecting the feeding of the mining heads vertically and the oscillation of said mining heads during feeding and rotation thereof, a source of supply of fluid under pressure is shown as comprising a fluid storage tank 55 connected with a pump 56 through an intake line 57. The outlet of the pump 56 is connected with a pressure line 59, leading to a manually adjustable flow control valve 60. The flow control valve 60 has a flow control valve 61 connected in series therewith on the output side of said flow control valve 60, through a pressure line 63. The flow control valve 60 is arranged to deliver fluid under pressure at a higher rate than the flow control valve 61. As for example, the maximum delivery rate of the flow control valve 60 may be 6 gallons of hydraulic fluid per minute, while the maximum delivery rate of the flow control valve 61 may be 4 gallons of hydraulic fluid per minute. The flow control valve 60 may thus be adjusted to deliver the total amount of oil required for both the feeding and oscillating operations and the distribution of oil to the oscillating cylinder and the feeding cylinders may be controlled by the valve 61.

The pressure line 63 is also connected with a relief valve 64 having a return line 65 leading therefrom back to tank 55. A pressure line 66 leads from the output side of the relief valve 64 and has connection with a valve chamber 67 in a valve block 69, through a port 70. The valve chamber in turn has ports 71 and 72 leading therefrom. The ports 71 and 72 are connected with pressure lines 73 and 74 respectively, connected with the head and piston rod ends of cylinders 75 of the hydraulic jacks 23. The port 71 may serve as a pressure port while the port 72 may serve as a return port, and vice versa, in accordance with the direction of movement of the boom arms 12, 12.

The output of the flow control valve 61 is connected with a pressure line 76 having a two way shut off valve 77 connected therein. The pressure line 76 in turn has connection with a pressure port 79 leading to a valve chamber 80 in a valve block 81. A relief valve 82 is connected with the pressure line 76 and with tank 55 through a return line 83.

As the flow control valve 61 is set to deliver, for example, 4 gallons of oil per minute, assuming the flow control valve 60 is set to deliver 6 gallons of oil per minute, 4 gallons of oil will be available to oscillate the boom arms 12, 12 and mining heads 11, 11 while two gallons of oil will be available to move the boom arms 12, 12 on their feeding strokes. Thus as the setting of the flow control valve 61 is changed to deliver more or less fluid to the oscillating cylinder 35, the delivery of fluid to the hydraulic jacks 23 will be varied inversely with the delivery of fluid to the cylinder 35, with the result that as the speed of oscillation of the boom arms 12 is reduced, more oil is supplied to feed the boom arms vertically to take care of the increased power required to feed the mining heads when oscillatable movement of the mining heads 11, 11 is slowed down. In a contrary manner as more oil is supplied to the cylinder 35 to increase the speed of oscillation of the mining heads 11, 11, less oil will be delivered to the hydraulic jacks 23, to feed the mining heads 11, 11 vertically.

The valve block 69 is shown as having a valve spool 85 slidably mounted therein to control the supply of fluid under pressure to either of the ports 71 or 72 and the release of fluid under pressure from either of said ports through a return port 86 connected with a return line 87 leading to tank 55.

A pressure line 88 leads from the pressure line 59 upstream of the flow control valve 60 and is connected with a port 89 having communication with the valve chamber 67. The port 89 is normally blocked by a land 90 of the valve spool and is opened to the valve chamber upon movement of the valve spool 85 to its extreme inner position. When the port 89 is opened to the valve chamber 67 the pressure line 70 will be blocked by a land 91 of the valve spool, and fluid in the piston rod ends of the cylinder 75 will be returned to tank through the port 86 and return line 87. Fluid under pressure will also be supplied directly from the pump 56 through a port 93

having communication with the port 72 and pressure line 74 to supply fluid under pressure to the head ends of the cylinders 75 and rapidly raise the boom arms 12 and mining heads 11 to a position along the mine roof when it is desired to sump the mining heads into the working face at the start of a mining operation.

A relief line 94 leads from the pressure line 59 upstream of the pressure line 88 and is connected with a relief valve 95 having communication at its outlet end with the tank 55.

Referring now to the means for automatically oscillating the boom arms 12, 12 and mining heads 11, 11, the valve block 81 has a shuttle valve spool 96 slidably movable therein and operated by fluid under pressure on its opposite ends, supplied thereto through ports 97 opening into opposite ends of the valve chamber 80. The valve spool 96 is shown as having a central land 99 movable when the valve spool is in one position to afford communication from the pressure port 79 to a port 100 and when the valve spool is in an opposite extreme position to afford communication between the port 79 and a port 101. The port 100 has communication with a pressure line 103 connected to the head end of the oscillating cylinder 35. The port 101 has communication with a pressure line 104 leading to the piston rod end of the cylinder 35. A return line 105 leads from the valve block 81 to tank 55 to return fluid from either end of the cylinder 35 depending upon the position of the shuttle valve spool 96.

The pressure line 103 has a relief valve 107 connected therewith through a branch pressure line 108. The relief valve 107 has a pressure line 109 leading from its outlet side and having a reduced outlet end portion 110 connected with the port 97 to supply fluid under pressure to one end of the valve chamber 80 and move the valve spool 96 in a direction away from the position shown in FIGURE 3. An accumulator 111 is connected in the pressure line 109 to provide the pressure to move the shuttle valve spool 96 to the full extent of its travel, when the supply of fluid under pressure to the head end of the cylinder 35 has been discontinued, as the shuttle valve spool 96 moves to the full extent of its travel. In a similar manner, a relief valve 112 is connected in the pressure line 104 and has an outlet line 113 leading therefrom having a reduced discharge end portion 115 having communication with the opposite port 97 from the pressure line 109. An accumulator 116 is connected in the pressure line 113 to supply the necessary pressure to move the shuttle valve spool into the position shown in FIGURE 3 as the supply of pressure to the port 101 is blocked. The reduced end portions 110 and 115 of the pressure lines 109 and 113 assure the supply of sufficient pressure to supply the accumulators 111 and 116 with sufficient oil to effect movement of the shuttle valve spool 96 beyond its neutral position in either direction of travel of said shuttle valve spool.

It may be seen from the foregoing that when the piston 39 reaches one end of its stroke, pressure will build up to the setting of the relief valve 107. The relief valve will open and allow oil to pass through the pressure line 109 and port 97 to move the shuttle valve into position to relieve pressure from the pressure line 103 and to supply pressure to the pressure line 104. As the shuttle valve spool 96 moves to its neutral position, the accumulator 111 will supply the additional pressure necessary to move the shuttle valve spool 96 to the full end of its stroke. Fluid under pressure will then be supplied to the pressure line 104 and will be relieved from the pressure line 103 to reverse the travel of the piston 39 and the mining heads 11.

As the piston 39 again reaches the end of its stroke the relief valve 112 takes over and supplies the pressure to move the shuttle valve spool 96 in an opposite direction, to its neutral position, to be then moved to its extreme position shown in FIGURE 3 by fluid under pressure supplied by the accumulator 116. Bleed lines 117 in each end of the shuttle valve spool permit the oil in the accumulators 111 and 116 to be discharged to the tank 55 through the return line 105.

In the embodiment of the invention just described, when the feed jacks 23 move the mining heads through a broken out area, the pressure required to feed the heads along the mine face may possibly drop below that of the pressure required to oscillate the mining heads. In order to assure that the feed cylinders do not rob all of the oil, the relief valve 64 has been provided on the output side of the flow control valve 60 and the relief valve 82 has been provided on the output side of the flow control valve 61. The relief valve 82 is set lower than the relief valve 64 to assure a supply of oil to the oscillating cylinder 35 during all conditions of mining.

In the embodiment of the invention just described the oscillation of the mining heads 11 is automatically effected by the shuttle valve spool 96 operated by fluid under pressure building up in either end of the cylinder 35, and the rate of feeding movement of the mining heads vertically along the mine face is regulated by the frequency of oscillation of the mining heads.

If the coal is of such consistency that it will readily break off from the face, the kerfs can be spaced wider apart by regulation of the flow control valve 61 to supply more oil to the oscillating cylinder 35. Less oil will then be supplied to the feed jacks 23 to thereby decrease the feeding speed of the mining heads in accordance with cutting conditions. The rate of oscillation of the mining heads 11 is thus variable under control of the flow control valve 61 and the feeding rate is also variable under the control of the same flow control valve, to assure the mining heads will be fed along the mine face in accordance with cutting conditions as determined by the rate of oscillation of the mining heads. As shown in FIGURE 1, the amplitudes of oscillation of the mining heads are such that each mining head will clean off the coal face from the ribs to the center of the working place during each inward stroke thereof or during one half of an oscillation of the mining head.

In the embodiment of the invention illustrated in FIGURES 4 and 5 the fluid pressure circuit to the feed jacks and oscillating cylinder 35 is the same as in the form of my invention illustrated in FIGURE 4 so the same part numbers will be applied to the same parts as were applied to the form of the invention illustrated in FIGURE 3. In this form of the invention two flow control valves 118 and 119 are connected to the pressure line 59 in series, as in the form of the invention illustrated in FIGURE 3. The flow control valve 118 is connected directly with the port 70 through a pressure line 170. The flow control valve 119 is connected directly with the port 79 of the shuttle valve block 81 through a pressure line 176. The pressure line 176 has a shut-off valve 177 therein to stop oscillatable movement of the mining heads 11 when desired. The flow control valves 118 and 119 may be conventional commercial forms of flow control valves and have metering pins 120 and 121 respectively regulating the flow of fluid under pressure to the respective pressure line, in a conventional manner. The metering pins 120 and 121 are biased in outwardly extended relation with respect to the body for the flow control valve, by compression springs 122 and 123 respectively. The metering pin 120 is operated by cam 124 to regulate the flow of oil through the pressure line 170. The metering pin 121 is operated by cam 125 to regulate the flow of oil through the pressure line 176. The cams 124 and 125 are connected together by meshing spur gears 126 and 127 respectively. The cam 124 and spur gear 126 have a shaft 129 extending outwardly therefrom journalled in a stationary support arm 130. A hand wheel 131 keyed or otherwise secured to the outer end of the shaft 129 is provided to simultaneously rotate the cams 124 and 125.

The cam 125 and spur gear 127 have a shaft 132 extending outwardly therefrom journalled in a pivoted support arm 133, pivoted at its lower end on an upright

bracket 135, on a pivot pin 136 parallel to the shaft 132. The spur gears 126 and 127 are held in mesh by a tension spring 137 connected at one end to an arm 139 extending upwardly from the support 130. The spring 137 is connected at its opposite end to an arm 140 extending upwardly from the pivoted support 133. The purpose of the pivoted support 133 and spring 137 is to accommodate movement of the spur gear 127 out of mesh with the spur gear 126 to enable the positions of the cams 124 and 125 to be adjusted with respect to each other when desired or necessary, to provide a desired varying differential of flow through the two flow control valves 118 and 119 in cases where the consistency of the coal seam may be such that the cutting loads may not increase or decrease at the exact same rate the rate of oscillation is changed. The feed, however, is still automatically adjusted as in the form of the invention illustrated in FIGURE 3. The differential of flow through the flow control valves 118 and 119 may also be adjusted, to maintain the cutting loads generally constant.

In the operation of mining, at the beginning of a mining cycle, the rotating and oscillating mining heads may be elevated to a position adjacent the mine roof by operation of the valve spool 85 to supply fluid under pressure to the head ends of the cylinders 75, through the pressure line 88 and may be held in this position by holding fluid pressure in the cylinders. The mining heads 11 held in position along the mine roof may then be sumped in the mine face by the application of power to the continuous traction thread devices 15. When the rotating and oscillating mining heads have been sumped into the mine face to the required depth, the valve spool 85 is operated to supply fluid under pressure to the piston rod ends of the cylinders 75 and feed the mining heads downwardly along the coal face to positions adjacent the mine floor. As the rotating and oscillating mining heads reach the floor, they may again be raised to the roof for a next sumping cut, preferably by moving the valve spool 85 into position to supply pressure to the cylinders 75 directly from the pump 56 through the pressure line 88. The mining operation is thus a substantially continuous operation, the mining heads being oscillated in accordance with the consistency of the coal seam and the feeding movement of the mining heads along the coal face being automatically controlled in accordance with the cycle of oscillation of the mining heads.

Where it may be desired to make a shearing cut, the two way valve 77 may be turned to its off position to stop oscillatable movement of the mining heads. The mining heads 11 may then be raised to the mine roof and set into operation to be rotatably driven by their motors 30, and may then be fed downwardly along the mine face by the supply of fluid under pressure to the piston rod ends of the hydraulic jacks 23, to make straight shearing cuts in the mine face.

It may be seen from the foregoing that a novel and improved form of ripper type mining machine, having oscillating mining heads, has been provided in which the mining heads are oscillatably driven entirely independently of rotation of the mining heads and in which the feed rate automatically varies with the rate of oscillation of the mining heads, to assure the correct feed for the various mining and oscillating conditions of the mining heads.

It may further be seen that the mining heads are oscillatably driven independently of rotatable movement thereof by a fluid pressure cylinder and piston, and that the hydraulic circuit to the cylinder and piston is such as to automatically reverse movement of the piston as it reaches the ends of its strokes, and also to reverse movement of the piston in cases where the mining heads may encounter an obstruction in the mine face.

While I have herein shown and described several forms in which my invention may be embodied, it may be understood that various variations and modifications in the invention may be attained without departing from the spirit and scope of the novel concepts thereof, as defined by the claims appended hereto.

I claim as my invention:

1. A mining machine comprising,
a mobile frame,
a pair of boom arms extending beyond the forward end of said frame,
means mounting said boom arms on said frame for vertical movement relative to said frame and for horizontal transverse oscillating movement relative to one another,
cutter means mounted on the end of each boom arm and rotatable about a horizontal transverse axis,
said cutter means including cutter bits positioned to cut in each direction of transverse oscillating movement of said boom arms,
power means for rotatably driving said cutter means,
separate power means for oscillating and vertically moving said boom arms,
and control means for the separate power means effective to vary the rate of vertical movement of said boom arms inversely to variation in the rate of oscillation of said boom arms.

2. A mining machine comprising,
a mobile frame,
a pair of boom arms extending beyond the forward end of said frame,
means mounting said boom arms on said frame for horizontal transverse oscillating movement toward and away from each other about generally upright pivot means,
cutter means mounted on the end of each boom arm,
means rotatably driving said cutter means,
synchronizing means for said boom arms correlating oscillating movement thereof,
fluid pressure operated drive means for said boom arms having driving connection with said synchronizing means, for oscillatably driving said boom arms independently of rotation of said cutter means,
a variable rate of flow control valve supplying fluid under pressure to said fluid pressure operated drive means and operable to selectively vary the oscillating rate of said boom arms,
and shiftable valve means downstream of said flow control valve for controlling the supply of fluid under pressure to said fluid pressure operated drive means and cooperating therewith to effect oscillation of said boom arms.

3. The structure of claim 2,
wherein the synchronizing means correlating oscillating movement of the boom arms comprises an oscillatable driving member pivotally mounted intermediate its ends for movement about an axis parallel to the axes of oscillation of said boom arms and intermediate said boom arms,
wherein a linkage connection is provided from each end of said driving member to an individual boom arm,
wherein the fluid pressure operated drive means comprises a fluid pressure operated cylinder having head and piston rod ends and having a piston rod extensible from the piston rod end thereof and pivotally connected with said driving member,
wherein the shiftable valve means alternately supplies fluid under pressure to the head and piston rod ends of said cylinder to effect oscillatable movement of said boom arms,
and wherein the variable rate of flow control valve means is operable to selectively vary the rate of oscillation of said boom arms independently of rotation of said cutters.

4. A mining machine comprising a mobile main frame,
a pair of boom arms extending beyond the forward end of said main frame,

means mounting said boom arms on said main frame for movement about a horizontal axis extending transversely of said main frame and for oscillatable movement about laterally spaced parallel axes perpendicular to said horizontal axis,

a group of horizontally spaced cutters rotatably mounted on each boom arm for rotation about horizontal transverse axes,

power means for vertically feeding said boom arms and cutters about said horizontal axis extending transversely of said main frame,

other power means for rotatably driving said cutters, separate power means connected with said boom arms,

means cyclically reversing operation of said separate power means, for oscillating said boom arms and cutters about said parallel laterally spaced axes independently of said other power means for rotatably driving said cutters,

variable control means for said separate power means selectively operable to vary the rate of oscillation of said boom arms and cutters during rotation of said cutters and during vertical feeding movement thereof, independently of the rate of rotation of the cutters and to vary the rate of feed of said cutters inversely to variations in the rate of oscillation thereof.

5. In a mining machine,

a main frame,

a boom arm projecting forwardly of said main frame,

at least one rotary mining head journalled at the forward end of said boom arm for rotation about an axis extending transversely of said boom arm and having cutters projecting therefrom,

means mounting said boom arm on said main frame for vertical movement about a horizontal axis extending transversely of said main frame and for oscillatable movement about an upright axis perpendicular to said horizontal axis,

fluid pressure operated means for moving said boom arm about said horizontal transverse axis to feed said mining head vertically along a mine face,

means for rotatably driving said mining head and cutters,

fluid pressure operated means separate from said means for rotatably driving said mining head for oscillatably moving said boom arm about said upright axis during rotation of said mining head,

means cyclically reversing operation of said fluid pressure operated means for oscillatably moving said boom arm about said upright axis,

a shut off valve for said last-mentioned fluid pressure operated means selectively operable to discontinue oscillation of said boom arm during a mining operation,

and a variable delivery rate of flow control valve in series with said shut off valve selectively operable during and independently of rotation of said cutters and vertical feeding movement of said mining head, to vary the rate of oscillation of said boom arm independently of the rate of rotation of said cutters.

6. In a mining machine,

a main frame,

a boom arm projecting forwardly of said main frame,

at least one rotary mining head journalled at the forward end of said boom arm for rotation about an axis extending transversely of said boom arm and having cutters projecting therefrom,

means mounting said boom arm on said main frame for vertical movement about a horizontal axis extending transversely of said main frame and for oscillatible movement about an upright axis perpendicular to said horizontal axis,

fluid pressure operated means for moving said boom arm about said horizontal transverse axis to feed said mining head vertically along a mine face,

means for rotatably driving said mining head and cutters,

fluid pressure operated means separate from said means for rotatably driving said mining head for moving said boom arm about said upright axis during rotation of said mining head,

means cyclically reversing operation of said last mentioned fluid pressure operated means for effecting cyclic oscillation of said boom arm,

a first variable delivery rate of flow control valve selectively operable during and independently of rotation of said cutters and vertical feeding movement of said mining head to vary the rate of oscillation of said boom arm independently of the rate of rotation of said cutters,

a second variable delivery rate of flow control valve in series with said first flow control valve and supplying fluid under pressure thereto,

said second flow control valve having a higher delivery rate than said first flow control valve and supplying fluid under pressure to said fluid pressure operated means for moving said boom arm about said horizontal transverse axis in addition to supplying fluid under pressure to said first flow control valve, to thereby vary the rate of feed of the mining head inversely to variations in the rate of oscillation of the mining head.

7. In a continuous mining machine,

a mobile main frame,

two laterally spaced boom arms extending in advance of said main frame,

a rotary mining head rotatably mounted on each boom arm for rotation about a horizontal axis generally parallel to the face to be mined,

means for rotatably driving said mining heads,

means for mounting said boom arms on said main frame for pivotal movement about a horizontal axis extending transversely of said main frame and for oscillatory movement about parallel upright axes extending perpendicular to said horizontal axis,

hydraulic jack means connected between said main frame and said mounting means for said boom arms, for raising and lowering said boom arms and feeding said mining heads vertically along a mine face,

other hydraulic jack means connected between said mounting means for said boom arms and said boom arms, for moving said boom arms and mining heads about said upright axes, and

a fluid pressure control circuit for said hydraulic jack means for vertically moving said boom arms and said hydraulic jack means for oscillatably moving said boom arms, including

means cyclically reversing operation of said other hydraulic jack means for moving said boom arms and mining heads about said upright axes, for effecting cyclic oscillating movement of said boom arms,

and means in said circuit for varying the rate of oscillation of said boom arms and mining heads and varying the rate of vertical feed of said mining heads inversely to variations in the rate of oscillation thereof.

8. A continuous mining machine in accordance with claim 7

wherein the control circuit includes two variable rate of flow control valves of higher and lower delivery rates connected in series, in which the flow control valve of lower delivery rate is downstream of the flow control valve of higher delivery rate,

wherein a fluid pressure connection is provided from the flow control valve of lower delivery rate to the hydraulic jack means for oscillatably driving said boom arms and mining heads,

wherein a fluid pressure connection is provided from the flow control valve of higher delivery rate to the

hydraulic jack means for effecting feeding movement of said mining heads, and

wherein means are provided for selectively varying the delivery rate of the flow control valve of lower delivery rate, to vary the rate of oscillatable movement of said boom arms and mining heads.

9. A continuous mining machine in accordance with claim **8**

wherein each flow control valve has a flow regulating member movable to vary the delivery rate of flow of the respective valve,

wherein a common operating member is provided to operate said flow regulating members and is movable to operate one flow regulating member to increase the delivery rate of one valve and to operate the other flow regulating member to decrease the delivery flow rate of the other valve.

10. A continuous mining machine in accordance with claim **8**

wherein each variable rate of flow control valve has a flow regulating member movable to vary the delivery arte of flow of the valve,

wherein individual cams are provided for operaitng said flow regulating members and are so arranged as to increase the delivery rate of one valve and decrease the delivery rate of the other valve,

wherein a stationary support is provided for one cam member,

wherein a movable support is provided for the other cam member,

wherein meshing gear means connect said cam members for operation together, and

wherein yieldable means are provided to maintain said gear means in mesh, and to accommodate separation of said gear means to permit adjustment of said cam members with respect to each other.

11. In a mining machine,

a main frame,

a boom arm projecting forwardly of said main frame,

at least one rotary mining head journalled at the forward end of said boom arm for rotation about an axis extending transversely of said boom arm and having cutters projecting therefrom,

means mounting said boom arms on said main frame for vertical movement about a horizontal axis extending transversely of said main frame and for oscillatable movement about an upright axis perpendicular to said horizontal axis,

fluid pressure operated means for moving said boom arm about said horizontal transverse axis to feed said mining head vertically along a mine face,

means for rotatably driving said mining head and cutters,

a fluid pressure cylinder having a piston therein and having a head end and an opposite piston rod end having a piston rod extensible therefrom and connected with said boom arm for oscillatably moving said boom arm,

a variable delivery rate of flow control valve selectively operable during and independently of rotation of said cutters and vertical feeding movement of said mining head, to supply fluid under pressure to said cylinder and vary the rate of oscillation of said boom arm,

a shuttle valve connected with the output side of said flow control valve including a shiftable valve spool, shiftable by pressure alternately applied to opposite ends thereof, to alternately supply fluid under pressure to the head and piston rod ends of said cylinder,

fluid pressure connections from the head and piston rod ends of said cylinder to opposite ends of said valve spool for alternately shifting said valve spool upon the building up of pressure in one end and then the other end of said cylinder,

and an accumulator in each fluid pressure connection to supply the pressure to move said shuttle valve spool past neutral position in each direction of operation of said shuttle valve spool to the full extent of the travel of said valve spool as the supply of pressure to the associated fluid pressure connection is discontinued.

12. The structure of claim **11**,

wherein a relief valve is provided in each fluid pressure connection to an end of said valve spool upstream of the associated accumulator to govern the loading of the associated accumulator.

13. The structure of claim **11**,

wherein a relief valve is provided in each fluid pressure connection to an end of said valve spool upstream of the associated accumulator,

and wherein each fluid pressure connection has a restricted portion downstream of the connection of the accumulator thereto, thereby assuring the supply of sufficient fluid to said accumulators to effect movement of said shuttle valve spool beyond its neutral position in either direction of travel of said shuttle valve spool.

14. A mining machine comprising,

a mobile frame,

a pair of boom arms extending beyond the forward end of said frame,

means mounting said boom arms on said frame for vertical movement relative to said frame and for horizontal transverse oscillating movement relative to one another,

cutter means mounted on the end of each boom arm and rotatable about a horizontal transverse axis and having cutter bits positioned to cut in each direction of transverse oscillating movement of said boom arms,

power means for rotatably driving said cutter means,

separate power means for oscillating said boom arms,

other separate power means for vertically moving said boom arms,

and control means for said separate power means and said other separate power means for varying the rate of oscillation of the boom arms and the rate of vertical feeding movement of said boom arms inversely relative to one another.

15. The structure of claim **14**,

wherein the control means includes two flow control valves in series with said separate power means for oscillating said boom arms,

and a fluid pressure connection downstream of the second flow control valve and connected with said other separate power means for vertically moving said boom arms.

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