AUTOMATIC CONTROL FOR CONTINUOUS MINING MACHINE

Emil J. Hinsky, La Grange Park, Ill., assignor to Goodman Manufacturing Company, Chicago, Ill., a corporation of Illinois

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This invention relates to improvements in mining machines and more particularly relates to an improved form of low vein continuous mining and loading machine arranged with a view toward simplicity and compactness in construction and efficiency in operation.

A principal object of the present invention is to provide a novel and improved low vein continuous mining and loading machine having side cutting mining heads cutting in arcuate paths from the ribs of the working place toward the center thereof, having a simple means for preventing interference of the mining heads with each other, as they approach the center of the working face.

A further object of the invention is to provide an improved form of continuous mining and loading machine having side cutting mining heads cutting in arcuate paths from the ribs of the working place toward the center thereof, in which hydraulic control means are provided, automatically limiting travel of the mining heads toward each other and accommodating the mining heads to move in a return direction and the opposite mining head to continue its direction of mining, to cut out the cutps left at the place at the end of travel of the mining heads towards each other.

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 and loading machine in accordance with the invention, showing the mining heads extending longitudinally of the main frame of the machine;

FIGURE 2 is an enlarged fragmentary top plan view of the forward end portion of the machine shown in FIGURE 1, with one mining head broken away and the opposite mining head shown in a laterally extended position with respect to the main frame of the machine, with certain parts of the mining head broken away and certain other parts in horizontal section;

FIGURE 3 is a fragmentary transverse sectional view taken substantially along line—line 3—3 of FIGURE 2; and

FIGURE 4 is a fragmentary vertical sectional view taken substantially along line—line 4—4 of FIGURE 1; and

FIGURE 5 is a fluid diagram illustrating a modified form of means for limiting travel of the mining heads toward each other and accommodating one mining head to travel in a retractable direction and the other mining head to continue its direction of travel to mine out the vertical cut at the transverse center of the working place.

In the embodiment of the invention illustrated in FIGURE 1 of the drawings, I have shown a mining machine 10 of the scissors side cutting continuous mining type, adapted to cut out and load a seam of coal by feeding two side cutting mining heads 11, 11 sideways into the working face of a coal seam by bodily advance of the machine toward the working face, when said mining heads are in the extremely laterally extended positions indicated by the right angled intersecting dotted lines A in FIGURE 1, and then by feeding the mining heads 11 in arcuate paths toward each other across the working face about fixed vertical axes at the forward end portion of the machine.

The mining machine 10 includes generally a main frame 12 mounted on a pair of laterally spaced continuous traction tread devices (not shown), for propelling the machine from working place to working place and for advancing the machine toward a working face, to feed the side cutting mining heads 11 thereinto, when in the laterally extended positions indicated by reference characters A in FIGURE 1.

Extending along the central portion of main frame 12 is a laterally flexible single strand chain and flight conveyor 15 extending from an inclined apron 16 at the front of the machine in an upwardly inclined direction from said apron and extending over the top of the machine. The flight conveyor 15 has a laterally swingable rear end portion 17, swung from side to side and maintained in a desired position with respect to the centerline of the machine by fluid pressure operated jacks 19, in a manner well known to those skilled in the art, so not herein shown or described further.

The side cutting mining heads 11 are mounted on boom or feeder arms 20, pivotally mounted on vertical pivot pins 21 at the forward end portion of the main frame 12 at opposite sides of the conveyor 15.

The forward end portion of the main frame 12 extending along each side of the conveyor 15, is of a generally bifurcated formation having a bottom plate 22 within which the associated pivot pin 21 is threaded at its lower end, and having a vertically spaced top plate 23, through which the pivot pin 21 extends and which is abutted by the head of said pivot pin 21.

The bottom plate 24 is journalled on the pivot pin 21 in the space between the plates 22 and 23 and has a bottom plate 24 abutting the flange of a flanged bearing 25, mounted on the pivot pin 21 and which has a vertically spaced top plate 26 extending beneath the top plate 23 and abutting the flange of a flanged bearing 26 mounted on the pivot pin 21. The bottom plate 24 has an upwardly extending boss 29, journalled on the bearing 25 while the top plate 26 has a depending boss 30, journalled on the bearing 27.

Each boom arm 20 is of a generally dog leg form in plan and extends angularly outwardly from the pivot pin 21 for a portion of the length thereof and terminates into a mining head support portion 31 extending longitudinally of the main frame 12 when the mining heads 11 are in the longitudinally extended positions shown in FIGURE 1.

Each boom arm 20 also has upper and lower vertically spaced parallel gathering conveyor support arms 32 and 33, respectively, extending angularly inwardly of the plates 24 and 26 when the boom arm is in the longitudinally extended position shown in FIGURE 1, and forming a guide and support means for a vertical endless chain and flight gathering conveyor 35. The gathering conveyor 35 includes a pair of vertically spaced endless chains 36 having vertically extending flights 37 carried therebetween.

As shown in FIGURE 4, a sleeve 39 encircles the bosses 29 and 30 and is journalled thereon on anti-friction bearings 40. The sleeve 39 has sprocket teeth 41 formed integrally with its upper and lower ends and meshing with the endless chains 36 for driving said chains and changing the directions of said chains about the pivot pin 21.

The sleeve 39 also has gear teeth 43 formed integrally therewith meshing with and driven by a spur gear 44 driven from a motor pinion 45 keyed or otherwise secured to the lower end of a motor shaft 46 of a motor 47. The motor is mounted on and extends through the top plate 32 and is suitably secured to said top plate and depends therefrom in the space between the plates 32 and
The motor 47 may be a fluid pressure operated motor. The boom arms 20 and side cutting mining heads 11 are swung from side to side to feed said mining heads across the working place about the axes of the shafts or pivot pins 21 by means of hydraulic jacks 57 pivotally connected to the main frame 12 on opposite sides of the conveyer 15 and on pivot pins 58, and including cylinders 59 having piston rods 62 extending the theid frame and pivotally connected to ears 60 on pivot pins 61.

Each side cutting mining head 11 includes a drum 63 having a helical scroll 64 extending therealong. The helical scroll 64 has cutting bit carrying blocks 65 mounted thereon having the usual cutting bits 66 detachably mounted therein.

Each drum 63 also has a cutting bit carrying blocks 67 extending about its periphery at the forward end thereof. The blocks 67 carry the usual cutter bits 69 for trimming the rib of the working place as the drum is swung into the mine face when in the laterally extended position shown in FIGURE 2.

Each drum 63 has a shaft 70 suitably secured thereto extending rearwardly therefrom and journaled adjacent the drum 63 on an anti-friction bearing 71 mounted within an annular bearing support 72 on a cutter support frame and gear housing 73. The cutter support and gear housing 73 houses the gearing for driving the shaft 71 from a motor 75. The shaft 70 extends across the cutter support and housing 73 and is journaled at its free end on an anti-friction bearing 76, suitably mounted in said cutter support frame. The shaft 72 also has a spur gear 77 keyed or otherwise secured thereto, for driving said shaft from a geared reduction train 79, suitably journaled within the cutter support and housing 73 and driven from a motor pinion 80 on a motor shaft 81.

The motor 75 is mounted on the boom arm 20 between the plates 24 and 26 and abuts a transverse divider plate 83 at its shaft end and is suitably secured thereto. The motor shaft 81 extends through a flanged sleeve 84 into the cutter support and gear housing 73. The flanged portion of the flange sleeve 84 is recessed within the divider plate 83 and is suitably secured to said divider plate. The flanged sleeve 84 extends within the cutter support and housing 73 and forms a support for an anti-friction bearing 85, forming a bearing mounting for the cutter support and housing 73. The forward wall of the cutter support and housing 73 is journaled on a stud 86 secured to an end wall 87 of the boom arm 20. The stud 86 projects within an annular bearing support portion 88 of the cutter support and housing 73 and extending inwardly of the forward end wall of said cutter support and housing. An anti-friction bearing 89 carried in the annular bearing support 88 and mounted on the stud 86 forms a pivot mounting for the cutter support and housing 73.

The means for swinging the cutter support and housing 73 and the mining head 11 about the axis of the motor 81, and thereby vertically adjusting the mining head 11, is shown in FIGURES 2 and 3 as comprising a hydraulic jack 90 spaced inwardly of the motor 75 and pivotally connected at one end between two upright ears 91, extending upwardly from the lower plate 24 of the boom arm 20, on a pivot pin 93. The hydraulic jack 90 has an extendible piston rod 92 pivotally connected at its upper end to a connector 94 on a pivot pin 95.

The hydraulic jack 90 on the opposite sides of the machine may be independently supplied with fluid under pressure to independently elevate or lower the mining heads 11 and hold said mining heads in desired positions of elevation under the control of the usual fluid pressure control valves (not shown).

A deflector shield 96 extends along the retreating face of each side cutting mining head 11 and conforms generally to the paths of travel of the cutter bits 66 and has a flanged inner end portion 97 suitably secured to the front wall of the cutter support housing 73. In the diagrammatic illustration of the invention in FIGURE 5, I have shown a supply tank 101 connected to an intake line 102 leading from said supply tank and supplying fluid under pressure to a valve block 103 through a fluid pressure supply line 104. A relief valve 105 is connected between the fluid pressure supply line 104 and the tank 109 to return fluid under pressure to the connecting line 117 when individual control valves 119 are used on each hydraulic jack in their neutral positions.

The control valves 107 are slidably mounted in the valve block 103 to supply fluid under pressure to the head and piston rod ends of the hydraulic jacks 57 independently of each other, and are each biased to a neutral position by compression springs 109. The valves 107 may be well known forms of spool valves so need not herein be described in detail. In FIGURE 5, the left hand valve 107 is shown as being in position to supply fluid under pressure to the head end of the left hand hydraulic jack 57. The other valve 107 is shown in a neutral position to return fluid under pressure from the head end of the right hand hydraulic jack 57 to tank, through a line 111 leading to the valve block 103 and having communication with an annular passageway 112 communicating with a return line 113 in the valve block 103, returning fluid from the head end of the hydraulic jack 57 back to tank.

The left hand valve 107 supplies fluid under pressure to the head end of the left hand hydraulic jack 57 through a pressure line 115 leading from the valve block 103. The pressure line 115 has a control line 116 connected thereto leading to one end of a block 119 for a pilot or shuttle valve 119. In a like manner, a control line 120 leads from the line 111 to the opposite end of the shuttle valve 119 from the control line 116. The shuttle valve 119 includes a valve spool 121 in the valve block 117, biased by springs 123 on opposite ends thereof to block the passage of fluid through said valve. A return control line 125 leads from the head end of the right hand hydraulic jack 57 to the valve block 117.

Thus, when the two valves 107 are in position to supply fluid under pressure to the head ends of the cylinders 57 through the lines 115 and 111, fluid under pressure will be supplied to opposite ends of the valve spool 121 and will position said valve spool to block the passage of fluid from the control line 125 to the control line 126, and vice versa. Each hydraulic jack 57 has a port 127 leading through the wall thereof and spaced along the wall of said hydraulic jack from the lines 125 and 126. The ports 127 form return ports when fluid under pressure is admitted to the head ends of the hydraulic jacks 57 and form pressure ports accommodating the admission of fluid under pressure to the piston rod ends of the hydraulic jacks 57. The left hand port 127 has a hydraulic line 129 leading therefrom into the valve block 103 and having communication with an annular passageway 130 communicating with a return line 131 through a valve chamber 132 for the left hand valve spool 107.

In a like manner, a hydraulic line 133 leads from the port 127 in the left hand hydraulic jack 57 and has communication with a passageway 135 in the valve block 103 to a valve chamber 136 for the right hand hydraulic jack 57. Fluid under pressure will valve 107 is in the neutral position shown in FIGURE 5, the return of fluid through the valve 103 is blocked by the valve spool.

When the two valves 107 are in position to supply fluid under pressure to the head ends of the left and right hand hydraulic jacks 57, fluid under pressure will be returned from the piston rod ends of said hydraulic jacks through the ports 127 and the respective return lines 129 and 133.
As fluid under pressure is supplied to the head ends of the hydraulic jacks 57, and the mining heads approach each other, pistons 139 of the hydraulic jacks will close the ports 127. Fluid under pressure will then be applied to opposite ends of the spool 121 of the shuttle valve 117. The pressure being equal, the spool 121 will be balanced and the return fluid from the piston rod ends of the hydraulic jacks 57 to tank will be blocked by the spool 121 of the shuttle valve 119. Feeding movement of the mining heads toward each other will then stop. When this occurs, the right hand valve spool 107 may be manually moved to the neutral position shown in FIGURE 5. The line 111 will then be connected to return fluid to tank through the passageway 112, the valve chamber 136, the passageway 113 leading about the valve chamber 132 and communicating with the return line 131. Pressure will be relieved from the control line 120. Pressure in the control line 116 will then move the shuttle valve spool 121 to the position shown in FIGURE 5. Then as fluid under pressure is continued to be supplied to the head end of the left hand cylinder 57, the piston 139 will force fluid from the piston rod end of said cylinder through the line 125, the shuttle valve 117, the line 126 to the piston rod end of the right hand hydraulic jack 57. This will effect movement of the piston 139 toward the head end of said hydraulic jack and retractably move the right hand mining head 11, while feeding movement of the left hand mining head is continued.

With this form of my invention, movement of the mining heads toward each other is hydraulically blocked and either mining head may be moved in a retractable direction while the opposite mining head continues to move in a cutting direction by moving the selected spool valve 107 to its neutral position. While I have herein shown and described several forms in which my invention may be embodied, it may readily be understood that various modifications and variations 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. In a continuous mining machine, a main frame, a pair of boom arms pivotally mounted on said main frame for movement about vertical axes at the front of said main frame at opposite sides thereof, a side cutting mining head rotatably mounted on each boom arm and extending longitudinally therealong and in advance thereof, individual hydraulic cylinders and pistons connected between said main frame and said boom arms for feeding said mining head toward each other and retractably moving said mining heads with respect to each other, stop means for limiting inward movement of said mining heads toward each other and permitting retractable movement of one mining head comprising a control line connected between said cylinders adjacent one thereof, a shuttle valve in said control line, return lines leading from the same ends of said cylinders as said control line and spaced inwardly along said cylinders with respect to the connections of said control line to said cylinders, pressure lines connected to opposite ends of said shuttle valve and leading from the opposite ends of said cylinders from said control line, and holding said shuttle valve in position to block the passage of hydraulic fluid from one cylinder to the other and thereby stop feeding movement of said mining head toward each other when the pressure on opposite ends of said shuttle valve is balanced and said pistons have moved to block the return fluid from said cylinders through said return lines, and releasing pressure from one end of said shuttle valve upon the release of pressure to one of said cylinders, to accumulate the passage of fluid under pressure from one cylinder to the other, retractably move one piston and mining head upon extensible movement of the other piston and continued feeding movement of the associated mining head.

2. In a continuous mining machine, a main frame, a pair of boom arms pivotally mounted on said main frame for movement about vertical axes at the front of said main frame and at opposite sides thereof, a side cutting mining head rotatably mounted on each boom arm and extending longitudinally therealong and in advance thereof, individual hydraulic cylinders and pistons connected between said main frame and boom arms for feeding said mining heads toward each other and retractably moving said mining heads with respect to each other, stop means limiting inward movement of said mining heads toward each other prior to the ends of the strokes of said pistons and permitting retractable movement of one mining head and continued feeding of the opposite mining head under manual control, comprising a control line connected between said cylinders adjacent one end thereof, a shuttle valve in said control line, return control lines leading from the same ends of said cylinders as said control line but spaced inwardly along said cylinders from the connections of said control line thereto, said return control lines being closed by said pistons prior to the ends of the feeding strokes thereof, pressure lines leading to opposite ends of said shuttle valve and connected with the opposite ends of said cylinders from said control line and supplying pressure to hold said shuttle valve in position to block the passage of hydraulic fluid from one cylinder to the other and stop feeding movement of said mining heads toward each other upon the blocking of said return control lines by said pistons, and individual control valves for each cylinder and piston and movable into position to relieve pressure from an associated cylinder and piston and the pressure line leading therefrom, to one end of said shuttle valve to thereby relieve pressure from one end of said shuttle valve and permit movement of said shuttle valve by the exertion of pressure on the opposite end of said valve through the pressure line connected therewith into position to supply fluid under pressure from one cylinder to the other through said control line, to effect retractable movement of one mining head upon continued feeding movement of the opposite mining head.

3. In a continuous mining machine, a frame, two side cutting mining heads pivotally mounted on said frame, for movement about parallel spaced vertical axes, individual hydraulic cylinders and pistons connected between said frame and said mining heads for moving said mining heads toward and from each other, a source of supply of fluid under pressure, an individual control valve for each hydraulic cylinder and piston, connected with said source of supply of fluid under pressure, a control line connecting the same ends of said cylinders together, a shuttle valve in said control line, fluid pressure means connected from the opposite ends of said cylinders from said control line to opposite ends of said shuttle valve and biasing said shuttle valve into position to block the passage of fluid through said control line from one cylinder to the other, pressure lines connected from said control valves to the opposite ends of said cylinders from said control line, supplying fluid under pressure under the control of said control valves to move said mining heads toward each other, return control lines leading from said cylinders in inwardly spaced relation with respect to said control line, and blocked by said pistons toward the ends of feeding travel of said mining heads toward each other, whereby said shuttle valve blocking said control line will stop feeding of said mining heads toward each other, and the pressure of fluid in said fluid pressure means connected with one end of said shuttle valve being released by operation of one of said control valves, to relieve fluid pressure from its associated cylinder, to move said shuttle valve by pressure on the opposite end thereof into position to effect the flow of fluid through said control line from one cylinder to the other and to thereby permit movement of one piston in a direction to feed its mining
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head to force fluid through said control line and move the other piston in a direction to retract its mining head.

4. In a continuous mining machine, a frame, two side cutting rotatably driven mining heads mounted on said frame for feeding movement toward and from each other about parallel spaced vertical axes, individual hydraulic cylinders and pistons connected between said frame and said mining heads for moving said mining heads toward and from each other, a source of supply of fluid under pressure, an individual control valve for each hydraulic cylinder and piston connected with said source of supply of fluid under pressure, a control line connecting the same ends of said cylinders together, a shuttle valve in said control line blocking the passage of fluid through said control line from one cylinder to the other, pressure lines connected from said control valves to the ends of said cylinders opposite from said control line, supplying fluid under pressure under the control of said control valves to move said mining heads toward each other, return control lines leading from said cylinders in inwardly spaced relation with respect to said control line and blocked by said pistons toward the ends of travel of said mining heads toward each other, pressure lines connected from said first mentioned pressure lines to opposite ends of said shuttle valve and supplying pressure to move said shuttle valve to an open position upon the release of pressure in one of said first mentioned pressure lines by operation of an associated control valve, to permit the piston in one cylinder to displace fluid therefrom into the other cylinder along said control line and thereby effect movement of one mining head in a direction away from the other, while the mining head supplied with fluid under pressure from said first mentioned pressure line continues feeding movement to cut out the cusps left between said mining heads at the center of the working place.

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