Oct. 3, 1961 J. R. BOUILLÉ 3,002,732

AUTOMATIC CYCLING CONTROL FOR CONTINUOUS MINERS

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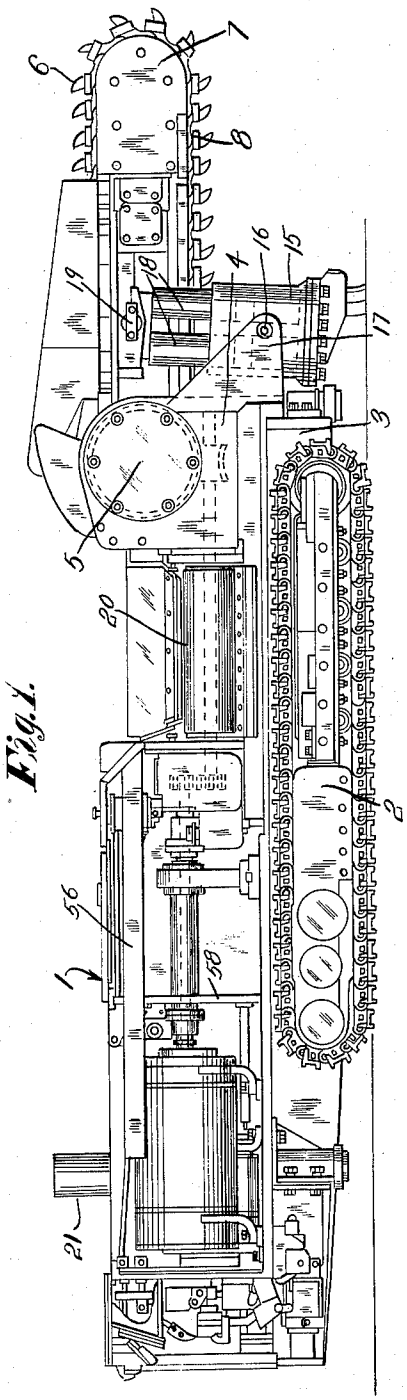


Fig. 1.

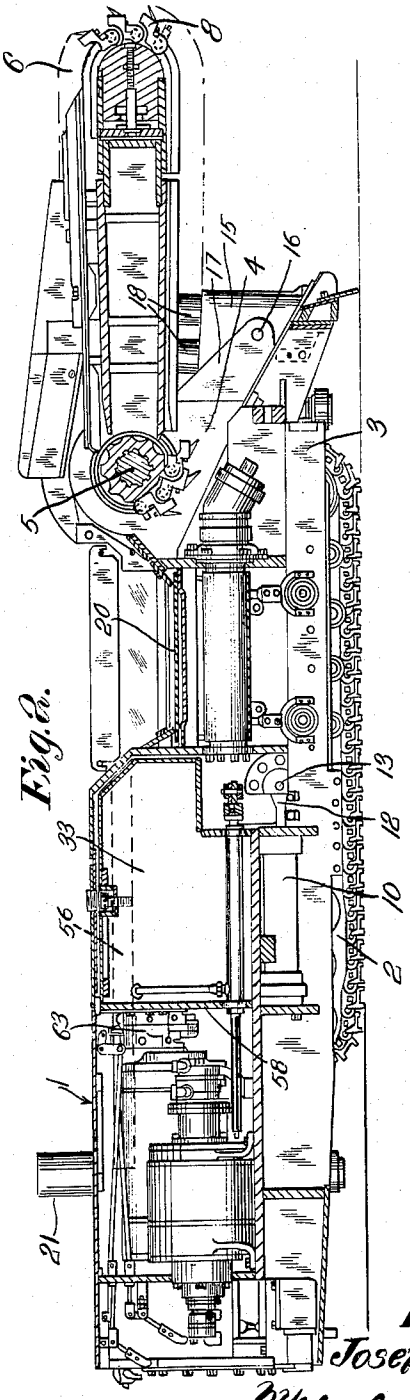


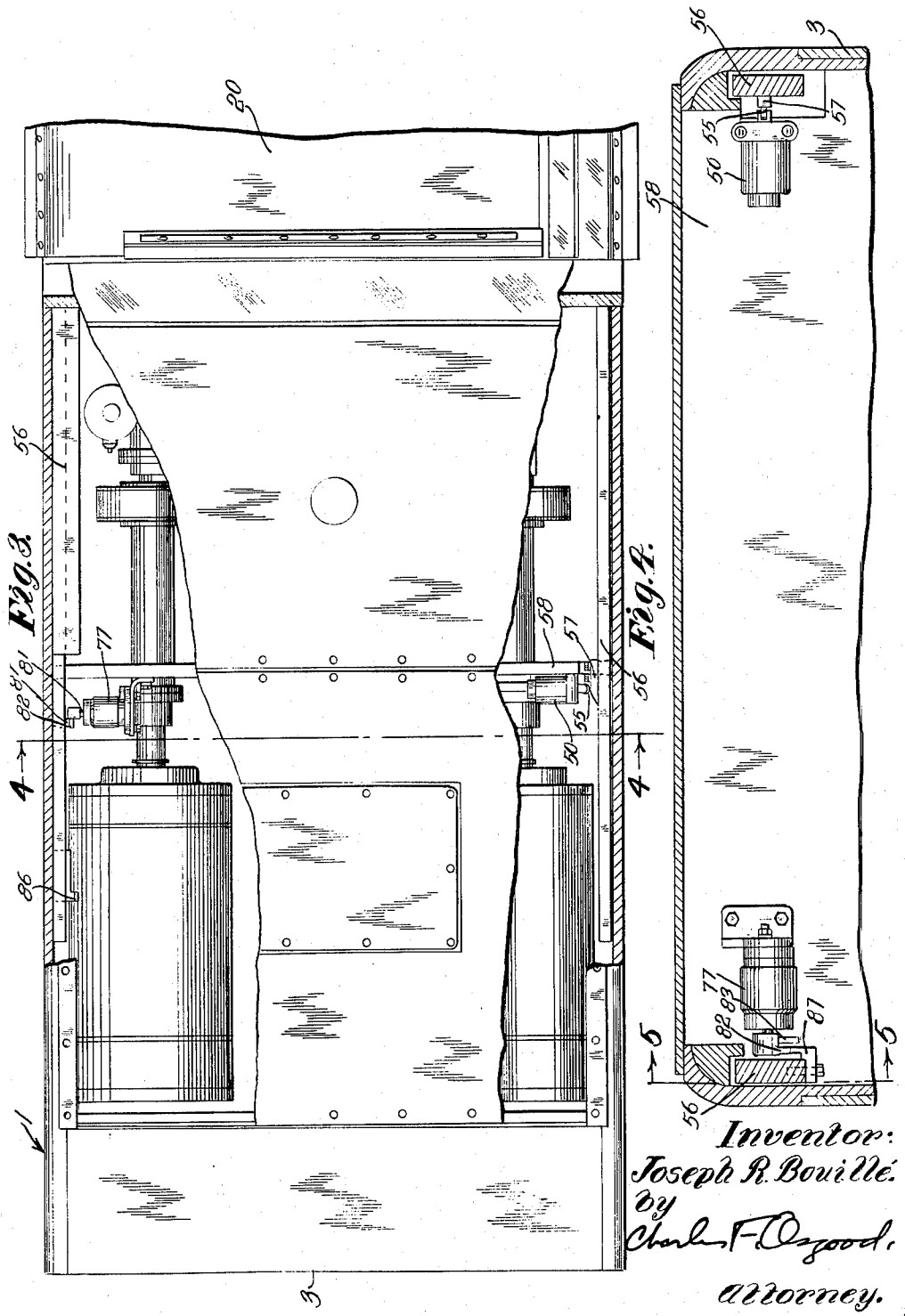
Fig. 2.

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AUTOMATIC CYCLING CONTROL FOR CONTINUOUS MINERS

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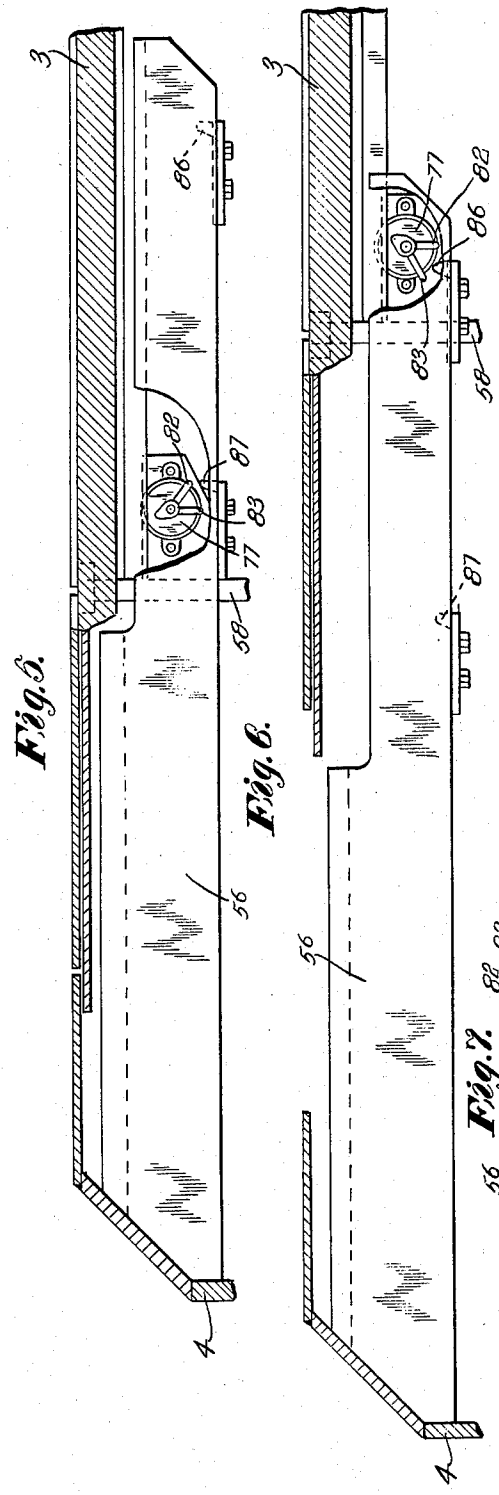


Fig. 5.

Fig. 6.

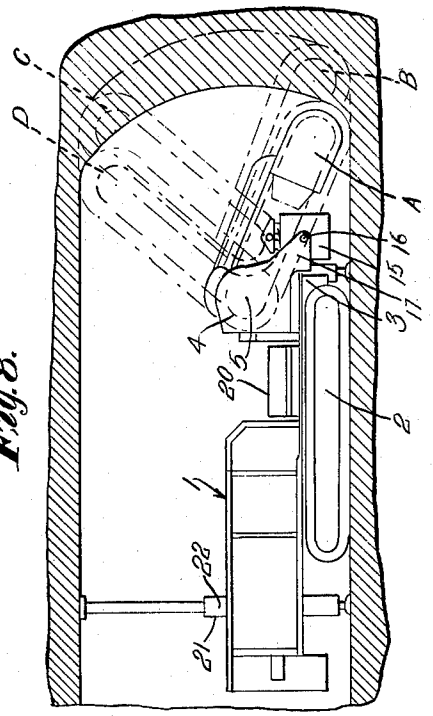


Fig. 8.

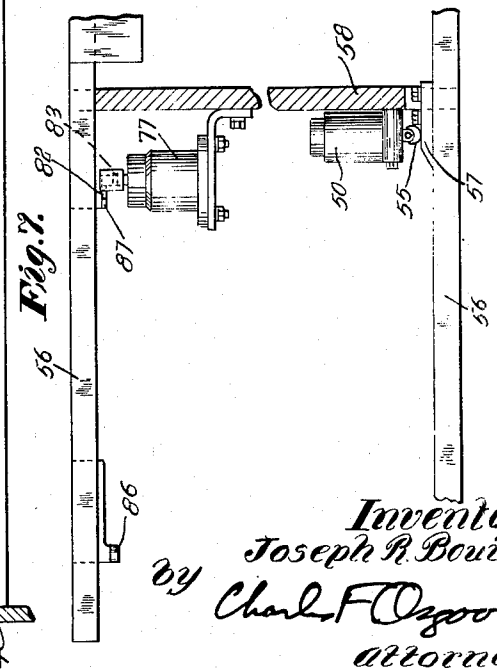


Fig. 7.

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AUTOMATIC CYCLING CONTROL FOR CONTINUOUS MINERS

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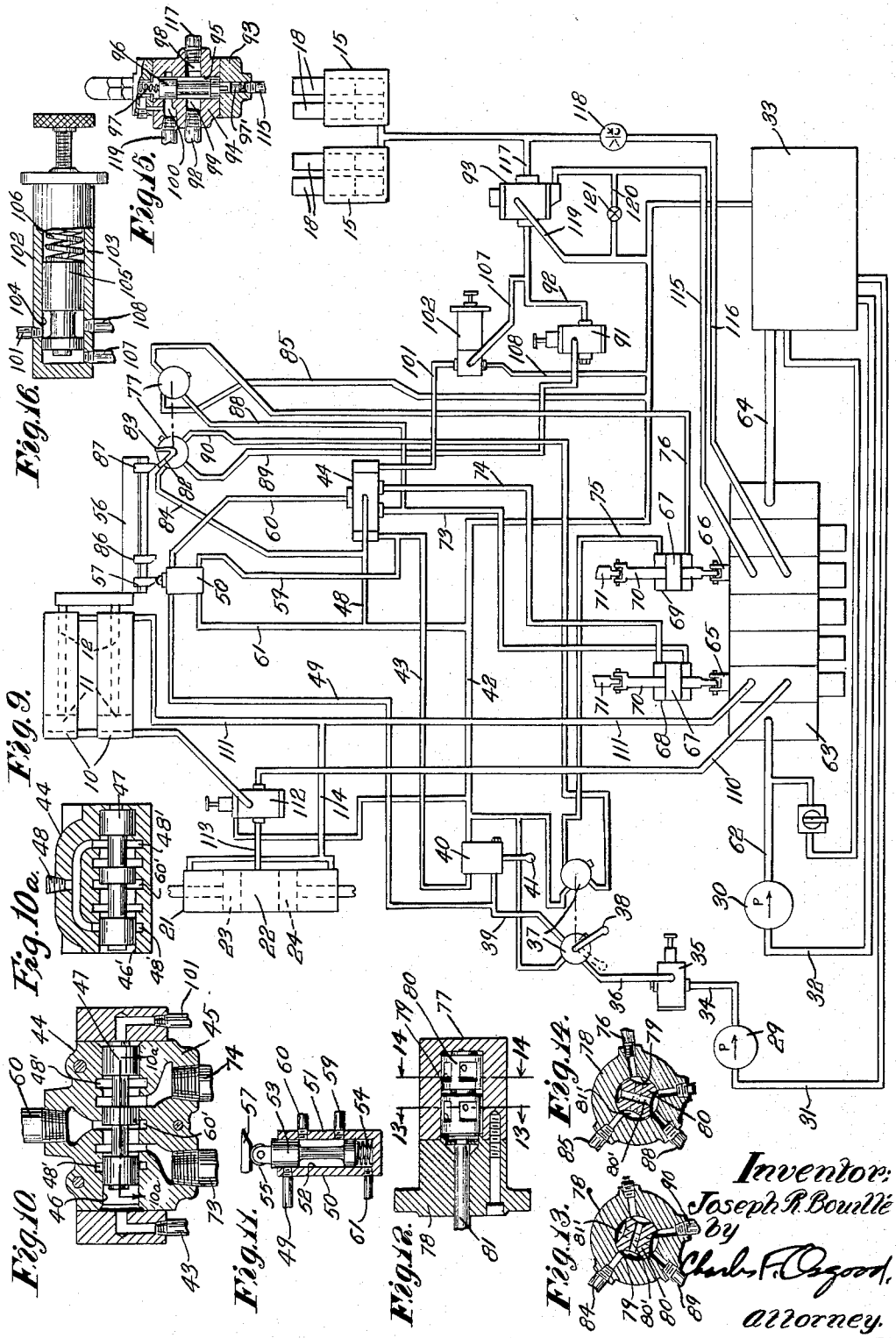


Fig. 9.

Fig. 10a.

Fig. 10.

Fig. 11.

Fig. 12.

Fig. 13.

Fig. 16.

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United States Patent Office 3,002,732 Patented Oct. 3, 1961

3,002,732
AUTOMATIC CYCLING CONTROL FOR CONTINUOUS MINERS

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Filed May 3, 1954, Ser. No. 427,327
3 Claims. (Cl. 262—29)

This invention relates to an automatic cycling control mechanism and more particularly to an automatic cycling control for a continuous miner for automatically controlling the movements of the attacking and disintegrating head of the miner during the mining operation.

In the copending application Serial No. 312,876, now Patent No. 2,939,692, filed October 3, 1952, owned by the assignee of the present invention, there is disclosed a continuous miner especially designed for use in the longwall mining of coal or similar minerals from a solid mine vein and in this miner, a vein-attacking and disintegrating head or jib is mounted on a mobile base for rectilinear back and forth movements and for swinging movement in vertical planes to effect tearing away and disintegration of the mineral. The attacking and disintegrating head, when in lowered position, may be moved rectilinearly longitudinally relative to the base to effect sumping of the head into the mine vein at the floor level, then the head may be swung upwardly to remove the mineral between the floor and the roof, thereafter the head may be retracted rectilinearly from the face at the roof level to complete the cut, and finally the head may be returned to its initial lowered position. These various operations in the miner above described are effected separately under manual control, and the present invention contemplate improvements over the miner above referred to in that the sumping, swinging, retracting and lowering operations of the attacking and disintegrating head are effected automatically in a definite sequence and without manual intervention, simply by pressing a starting push-button or knob on the machine, thereby to speed up the mining cycle.

An object of the present invention is to provide an improved continuous miner having improved control means for the attacking and disintegrating head or jib. Another object is to provide an improved automatic cycle control for a mining apparatus. Yet another object is to provide an improved automatic cycling control mechanism for the sumping, swinging, retracting and lowering movements of the attacking and disintegrating head of a continuous miner. A further object is to provide an improved automatic cycling control for the fluid actuated devices of the miner and embodying coacting mechanically and pressure fluid actuated control valves. A still further object is to provide an improved control valve device actuated by the pressure in the jib-lifting cylinder for automatically controlling operation of the retracting cylinders for the attacking and disintegrating head. Yet another object is to provide a fluid actuated vent control valve for the head swing cylinder wherein said valve is held open by the pressure in the swing cylinder as a result of the weight of the head which causes gravity swing of the head toward its lowered position, said pressure being dissipated when the head assumes its lowered position so that the control valve automatically closes. These and other objects and advantages of the invention will, however, hereinafter more fully appear.

In the accompanying drawings there is shown for purposes of illustration one form which the invention may assume in practice.

In these drawings:

FIG. 1 is a side elevational view of a continuous miner

in which an illustrative form of the invention is incorporated.

FIG. 2 is a central longitudinal vertical section taken through the miner shown in FIG. 1.

FIG. 3 is an enlarged fragmentary plan view of the rearward portion of the miner, with parts shown in horizontal section to illustrate details of the automatic cycling control.

FIG. 4 is an enlarged cross section taken on line 4—4 of FIG. 3.

FIG. 5 is a detail longitudinal vertical section taken on line 5—5 of FIG. 4, showing the rotary pilot valve and its associated control cams.

FIG. 6 is a view similar to FIG. 5, showing parts in different positions.

FIG. 7 is an enlarged detail plan view of the controls shown in FIG. 3, with part of the base frame shown in section.

FIG. 8 is a diagrammatic side view with the miner in operating position in a mine and showing the different positions of the attacking and disintegrating head during the mining cycle.

FIG. 9 is a diagrammatic view of the hydraulic fluid system.

FIG. 10 is a schematic longitudinal section taken through the fluid actuated, pilot operated, four-way valve.

FIG. 10*a* is a detail section taken on line 10*a*—10*a* of FIG. 10.

FIG. 11 is a schematic longitudinal section taken through the cam operated two-way pilot valve.

FIG. 12 is a schematic section taken through the rotary four-way double pilot valve device.

FIGS. 13 and 14 are cross sections taken on lines 13—13 and 14—14 of FIG. 12.

FIG. 15 is a schematic longitudinal section taken through the unloading fluid actuated valve device for the shear cylinders.

FIG. 16 is a longitudinal section taken through the fluid actuated pressure relay valve.

In this illustrative embodiment of the invention, as shown in the drawings, the improved automatic cycling control is associated with a continuous miner, generally designated 1, especially designed for use in the longwall mining of coal or similar minerals although, evidently, the automatic cycling control may be associated with miners of other types.

The continuous miner, as disclosed in the copending application Serial No. 312,876 above referred to, includes a mobile base 2 adapted to travel over the floor or pavement of a mine and carrying a frame 3 on which a support 4 is guided for back and forth rectilinear longitudinal movements with respect to the base frame. Pivotally mounted on this sliding support 4, at 5, is a vein-attacking and disintegrating head or jib 6, swingable in vertical planes with respect to the sliding support and the base frame. The attacking and disintegrating head includes a swingable head or jib frame 7 having a series of disintegrating chains 8 guided for circulation in vertical orbits about the head or jib frame. Arranged longitudinally of the base frame 3 are parallel, double-acting, sumping and retracting fluid cylinders 10 (FIG. 2) which contain reciprocable pistons 11 having forwardly extending piston rods 12 pivotally secured at their forward ends at 13 to the sliding support 4. Jib lifting or shear fluid cylinders 15 are pivotally mounted at 16 on side projections 17 integral with the forward portion of the sliding support, and these cylinders have parallel bores for receiving pairs of pistons 18 which are pivotally connected at 19 to opposite sides of the head or jib frame 7 of the attacking and disintegrating head.

By venting fluid from the bores of the cylinders 15, the head may swing downwardly from a raised position (FIG.

1) at a controlled rate to bring the outer end of the head to the floor or pavement level, as indicated at A in FIG. 8, and when fluid is properly supplied to the sumping cylinders 10 the support 4 may be slid rectilinearly forwardly relative to the base to sump the outer portion of the head into the mineral of the mine vein to the position indicated in dotted lines at B in FIG. 8. When pressure fluid is supplied to the lower ends of the bores of the jib lifting or shear cylinders 15, the attacking and disintegrating head may be swung upwardly in vertical planes about its pivot 5 to bring its outer portion to the roof level, as indicated at C in FIG. 8, and when pressure fluid is supplied to the opposite ends of the retracting cylinders 10 the head may be retracted from the mine vein at the roof level to the position indicated at D in FIG. 8. When fluid is again vented from the lower ends of the cylinders 15, the head may swing downwardly back to its initial position at the floor level. Thus, by sumping the attacking and disintegrating head into the mine vein at the floor level, by swinging the head upwardly in vertical planes between the floor and roof and by retracting the head from the mine vein at the roof level, a wide vertical segment of mineral may be dislodged from the mine vein and between each operating cycle the mobile base may be advanced toward the face of the mine vein to a new position and the sumping, swinging, retracting and lowering cycle may be repeated, all as is fully disclosed in the copending application mentioned above. The dislodged and disintegrated mineral may be conveyed rearwardly over the top of the head by the rearwardly moving upper runs of the disintegrating chains and the disintegrated mineral is discharged from the head onto a transverse conveyor 20 which conveys the disintegrated mineral laterally to discharge. During the operating cycle of the head, the base may be held stationary by an upright holding column or jack device 21 which includes a vertical cylinder 22 containing oppositely moving pistons 23 and 24 having the outer ends of their piston rods acting against the floor and roof of the mine. Since the detail structure of the continuous miner does not per se enter into the present invention other than its manner of cooperation with the improved automatic cycle control, further detailed description of the structure and the mode of operation thereof is herein deemed unnecessary.

Now referring to the improved automatic cycle control mechanism, it will be noted that, as shown diagrammatically in FIG. 9, conventional motor driven pumps 29 and 30 are mounted on the base frame 3, the pump 29 having relatively small capacity or volume and the pump 30 having relatively large capacity or volume. The suction sides of these pumps are connected by conduits 31 and 32 respectively to a fluid tank or reservoir 33 which may contain a liquid such as a light oil. The discharge side of the small capacity pump 29 is connected by a conduit 34 to a conventional pressure reducing valve device 35 and a conduit 36 leads from this latter valve device to a conventional rotary control valve device 37 having an operating handle 38. This control valve device 37 may be similar to that shown in FIG. 12 and is positionable between automatic and manual controlling positions; and in the latter position control of the cutting cycle of the miner may be effected manually. The valve device 37 has usual return conduits leading back to the tank 33 and leading from the valve device 37 is a conduit 39 connected to a conventional starting valve device 40 having a push-button or actuating knob 41. This likewise has a usual return conduit 42 leading back to the tank 33. A conduit 43 leads from the valve device 40 to a conventional pilot operated four-way valve device 44, shown in detail in FIG. 10. As shown, this valve device comprises a casing 45 having a bore 46 containing a reciprocable three-spool valve 47 of the fluid actuated type. The valve casing has usual ports to which the various conduits are connected in the manner shown, and a return conduit 48 communicates with exhaust grooves 48' (FIG. 10*a*) in the walls of the valve casing bore and leads back to the tank 33. A conduit 49 communicating with the conduit 39 leads to a conventional valve device 50 which is of the balanced plunger, cam-operated two-way type, shown in detail in FIG. 11. This valve device has a casing 51 provided with a bore 52 in which a plunger valve 53 is reciprocable and a coil spring 54 urges the valve in an outward direction. Journaled at the outer end of this valve is a roller 55. The sliding support 4 carries a shiftable frame 56 near its upper portion, as shown in FIG. 1 and this shiftable frame is actuated by the pistons 11 of the sumping and retracting cylinders, and carries a cam 57 which is engageable with the roller 55 of the plunger valve for holding the latter in depressed position until forward movement of the sliding support 4 is initiated, as will later be explained. The casing 51 of the valve 50 is secured to a transverse vertical plate 58 of the base frame. Leading from the casing of the valve device 50 are conduits 59 and 60, and the conduit 59 communicates with the conduit 43 while the conduit 60 leads to a central port 60' of the casing of the valve device 44. A return conduit 61 leads from the valve-casing back to the tank 33. The return conduit 48 may connect the conduit 60 back to the tank 33.

The discharge side of the large capacity pump 30 is connected by a conduit 62 to the pressure passage of the valve box 63 of a conventional control valve mechanism suitably mounted on the base frame 3, in a manner similar to that of the copending application Serial No. 312,876, mentioned above. The discharge passage of this valve box is connected by a return conduit 64 back to the tank 33. This valve box has a usual relief valve mechanism to prevent an overload in the fluid system and is formed with parallel bores containing conventional slide valves of the balanced spool type. These valves may be held in a conventional manner in central neutral position as by coil springs and may be shifted in one direction or the other to effect control of the various fluid operated devices of the miner, and two of the valves are designated 65 and 66 which respectively control the fluid supply to and the exhaust from the sumping and retracting cylinders 10 and the jib lifting or shear cylinders 15. As shown in FIG. 9, the slide valves 65 and 66 may be fluid actuated and pistons 67 reciprocable in cylinders 68 and 69 respectively have piston rods 70 connected to the stems of the valves 65 and 66. The valve stems also have manual actuators 71 which may be used to shift the valves when the automatic cycling control is cut out by the valve device 37 and the cylinders 68 and 69 are vented. Communicating with the bore of the casing of the valve device 44 are conduits 73 and 74 leading to the opposite ends of the operating cylinder 68 for the slide valve 65, while leading to the opposite ends of the operating cylinder 69 for the slide valve 66 are conduits 75 and 76 and the conduit 75 leads to the starting valve device 37, while the conduit 76 leads to a conventional rotary four-way double pilot valve device 77. This valve device is shown in detail in FIGS. 12, 13 and 14 and includes a casing 78 having a bore 79 containing a rotary double valve 80 provided with an operator 81 provided with spaced arms 82 and 83. This valve is cross ported at 80' and grooved at 81', as shown, and the valve casing has usual ports to which the several conduits are connected and usual return conduits 84 and 85 leads from the valve device back to the tank 33. The shiftable frame 56 carries longitudinally spaced cams 86 and 87 which are effective to rotate the valve 80 upon engagement with one or the other of the arms 82, 83 in the different positions of the pistons 11 of the sumping and retracting cylinders 10, as will later be described. Leading from the valve casing 78 is a conduit 88 communicating with the conduit 73. Also communicating with the ports of the valve casing 78 are conduits 89 and 90 and the latter is connected to the casing of the

valve device 37, while the former conduit 89 leads to a conventional pressure reducing valve 91. A conduit 92 leads from the reducing valve 91 to a conventional counterbalancing or unloading valve device 93, shown in detail in FIG. 15. This valve device has a casing 94 provided with a bore 95 containing a fluid actuated spool type plunger valve 96 which is constantly urged inwardly by a coil spring 97. A plunger 97' when subjected to pressure fluid serves to actuate the valve 96. The valve casing has passages 98, 99 and 100 to which certain of the several conduits are connected, as later described. Also leading from the pilot operated fluid actuated four-way valve device 44 is a conduit 101 connected to a conventional pressure relay valve device 102, shown in FIG. 16. This valve device has a casing 103 provided with a bore 104 containing a fluid actuated spool type plunger valve 105 urged in one direction by a coil spring 106. The casing has usual ports connected to the several conduits and controlled by the valve and leading from the casing is a conduit 107 communicating with the conduit 92, and a return conduit 108 leads from the valve casing back to the tank 33.

Communicating with the bore containing the slide valve 65 are conduits 110 and 111 connected to the opposite ends of the sumping and retracting cylinders 10, and connected in the conduit 110 is a conventional sequence valve device 112. A conduit 113 leads from this valve device to the cylinder 22 of the holding column or jack device 21, while a branched conduit 114 connected to the opposite ends of the cylinder 22 communicates with the conduit 111. A usual return conduit leads from the valve casing back to the tank 33. Communicating with the bore containing the slide valve 66 are conduits 115 and 116, the former leading to the casing of the counterbalancing or unloading valve device 93, while the latter conduit 116 leads to the lower ends of the bores of the jib lifting or shear cylinders 15. A conduit 117 connects the conduit 116 with the casing of the valve device 93 and arranged in the conduit 116 between the conduit 117 and the valve box is a conventional check valve device 118 which permits flow of fluid toward the cylinders 15 but prevents reverse flow back to the valve box. A return conduit 119 leads from the valve device 93 back to the tank, and a conduit 120 controlled by a hand valve 121 may provide a restricted flow through the conduit 115 back to the tank, for a purpose to be later described.

The mode of operation of the improved cycling control for effecting automatically the sumping, swinging, retracting and lowering movements of the attacking and disintegrating head or jib is as follows: When the continuous miner is disposed at the working face of the mine vein, as shown diagrammatically in FIG. 8, with the attacking and disintegrating head or jib in its lowered operating position and automatic control of the operating cycle of the head is desired, the handle 38 of the control device 37 may be shifted to the left-hand position shown in dotted lines in FIG. 9 and, with the pumps 29 and 30 running, the operator may press in the push-button 41 of the starting valve device 40 to initiate the automatic operating cycle.

Sumping

As the push-button is held in depressed position, pressure fluid may flow through conduits 34 and 36, past the valve device 37, and through conduit 39, past the valve 40, and through conduit 43 to the left-hand end of the pilot operated four-way valve device 44, shifting the spool valve 47 thereof to the position shown in FIG. 10. As shown in FIG. 10, the conduit 74 is connected to the right-hand exhaust groove 48' which communicates with the return conduit 48. Concurrently pressure fluid flows through conduit 59 to the valve device 50 which is at this time held depressed by the cam 57 (FIG. 11) with the conduit 49 cut off from communication with the conduit 60. When the valves 47 and 53 assume the positions shown in FIGS. 10 and 11 pressure fluid may flow through conduits 59, 60 and 73 to the operating cylinder or servomotor 68 for the slide valve 65 of the valve box 63, shifting the slide valve to a position to effect fluid supply to the conduit 110. When the slide valve 65 is shifted in the proper direction pressure fluid may flow through the conduit 110 to the sequence valve device 112, thereby to effect fluid supply to the holding column or jack device 21 to expand the latter and when the column is set firmly between the floor and the room, pressure fluid flowing to the rear ends of the sumping cylinders 10 effects forward movement of the pistons 11, thereby to sump the outer portion of the attacking and disintegrating head or jib into the mine vein at the floor or pavement level.

Upon initiation of forward movement of the shiftable cam frame 56, the operator may release the starter button 41, with the cam 57 moved out of contact with the roller 55 on the plunger valve 53 so that the spring 54 has moved the plunger valve to a position to effect fluid flow through conduit 49 and conduit 60 to the valve device 44 and the conduits 59 and 43 are concurrently connected to exhaust through the valve device 40 and the return conduit 42 leading back to the tank. When the conduit 43 is connected to exhaust the slide valve 47 remains in the position shown in FIG. 10.

Shearing

As the shiftable cam frame 56 moves forwardly with the head and approaches the forward end of its travel, the cam 86 engages the arm 83 of the rotary valve 80 so that as the frame 56 completes its forward movement the valve 80 is rotated to position a cross port 80' therein to connect conduit 88 with the conduit 76 thereby to effect fluid supply through conduits 88 and 76 to the operating cylinder or servo-motor 69 for the slide valve 66 of the valve box 63, to effect shifting of the slide valve to a position to effect fluid supply through conduit 116, past the check valve 118 to the head or jib-lifting cylinders 15 to swing the head of jib upwardly about its pivot to effect its upward shearing cut between the floor and roof. The conduit 75 may then be vented back through the valve device 37, conduit 90, past the valve device 77, to the return conduit 84 leading back to the tank.

When the attacking and disintegrating head or jib reaches its limit of upward swing at the roof level, the pressure in the conduit 116 communicating with the lower ends of the bores of the cylinders 15 builds up to substantially line pressure and this built-up pressure acts through conduits 117 and 107 on the pressure area of the plunger valve 105, shifting the latter to a position (toward the right in FIG. 16) to effect fluid flow through conduit 101 to the right-hand end of the spool valve 47 of the valve device 44, thereby shifting the spool valve 47 thereof toward the left to a position (opposite from that shown in FIG. 10). This effects fluid flow through conduit 74 to the operating cylinder or servomotor 68 for the slide valve 65, and at this time the conduit 73 is vented back through the left-hand exhaust groove 48' of the valve device 44 to the conduit 48 leading back to the tank. Concurrently the conduit 76 is connected back to the tank, past the double rotary valve device 77 and through conduits 88, 73 and 48, and since the conduit 75 is likewise vented through conduit 90, past the rotary valve device 77 and return conduit 84, the slide valve 66 is moved by its centering springs into neutral position exhausting the pressure in the conduit 115 and the portion of the conduit 116 between the check valve 118 and the slide valve 66, and as a result the fluid is trapped in the cylinders 15 by the check valve 118 and the valve device 93, holding the head of jib in its raised retracting position.

Retracting

The pressure flowing to the operating cylinder or servomotor 68 by way of conduit 74 acts on the piston 67 to

shift the slide valve 65 to a position to effect flow of pressure fluid through conduit 111 to the forward ends of the cylinders 10 to effect rearward movement of the pistons 11, thereby to retract the attacking and disintegrating head or jib from the mine vein at the roof level.

Lowering

The shiftable cam frame 56 moves rearwardly with the retracting pistons 11 and as the latter approach their rearmost positions, the cam 87 engages the arm 82 of the rotary valve 80 to rotate the latter to a position to effect flow of pressure fluid from the conduit 116 between the swing cylinders and the check valve 118, through conduit 117 past the valve device 93, through conduit 92 past the valve 91, through conduit 89 past the valve device 77, through conduit 90, past the the valve device 37, and through conduit 75, to the operating cylinder or servomotor 69 for the slide valve 66, thereby causing the piston 67 to shift the slide valve 66 to a position wherein pressure fluid may flow through conduit 115 to the lower end of the piston 97' beneath the valve 96 (Fig. 15), shifting the latter to a position to effect venting of the jib-lifting or shear cylinders 15 through conduits 117 and 119 back to the tank. Pressure is established in the conduit 89 as will now be explained.

The weight of the attacking and disintegrating head or jib during downward gravity swing acts on the fluid in the cylinders 15 to provide a substantial pressure which is made available through the pressure reducing valve 91 and conduit 89 leading to the double rotary valve device 77 and conduit 75 leading to the operating cylinder or servo-motor 69 for the slide valve 66. The fluids flow past this slide valve and through conduit 115 to the restricted leak conduit 120 creates just enough pressure acting on the piston 97' to shift the valve of the unloading valve device 93, connecting the conduit 117 to the conduit 119. As the disintegrating head or jib is being lowered some fluid is also being vented from the conduit 115 through the restriction-providing valve 121 in conduit 120 and upon pressure drop in conduit 115 the plunger valve 96 of the valve device 93 will be moved inwardly by the coil spring 97. This will stop the venting of the pressure fluid in conduit 117 through conduit 119 and the pressure in conduit 117 will then build up again so that fluid is forced through conduit 92 past the valve 91, conduit 89, valve device 77, conduit 90, valve device 37, conduit 75 to the servomotor cylinder 69 to again move slide valve 66 into the position to again supply the conduit 115 with pressure fluid and thus again move the plunger valve 96 upwardly so as to vent conduit 117 through conduit 119. When the jib lifting pistons 18 reach bottom and the head or jib is in its bottom position the pressure in the cylinder 15 becomes dissipated, causing the centering springs of the slide valve 66 to move the latter to its neutral position and the pressure in both of the conduits 117 and 115 is exhausted.

When the holding column or jack device 21 is released, the mobile base of the miner may then be fed forwardly to locate the miner in a new operating position at the working face and upon depressing the push-button 41 of the starting valve device 40 the operating cycle above described may be repeated. Since the particular structure and the mode of operation of the several valve devices 35, 37, 40, 44, 50, 77, 91, 93, 102 and 112 are well known to those skilled in the art and do not per se enter into the present invention, a more comprehensive description of the structure and mode of operation of these valve devices is herein unnecessary.

When it is desired to shift from automatic cycling control to manual control, the valve handle 38 may be turned to the full line right-hand position in FIG. 9, and at that time the valve device 37 is positioned to connect the conduit 75 to the return line leading back to the tank. Thus during manual control both servo-motors 68 and 69 are vented, so that the slide valves 65 and 66 may readily be shifted to the hand controls 71.

As a result of this invention, improved automatic cycling control for a continuous miner is provided wherein the operating cycle of the attacking and disintegrating head or jib is automatically controlled, thereby substantially speeding up the mining operation. By the provision of the several automatic control valves the sumping, swinging, retracting and lowering movements of the attacking and disintegrating head or jib may be effected, simply by operating a push-button on the miner, and after the operating cycle is completed the miner is automatically stopped until the operator again depresses the push-button of the starting valve. The improved automatic cycling control is relatively foolproof and may be applied to a conventional continuous miner with a minimum of modification of the miner. By the provision of the manual control valve for the automatic cycling mechanism the operating cycle of the attacking and disintegrating head may be effected manually as well as automatically, simply by changing the position of a control valve. These and other advantages of the invention will be clearly apparent to those skilled in the art.

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

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

1. In combination, in a continuous miner, a vein-attacking and disintegrating head for dislodging and disintegrating the mineral of a solid mine vein, fluid operated means for moving said head forwardly to sump the same into the mine vein at the floor level and for retracting said head from the vein at the roof level, fluid operated means for swinging said head upwardly between its lowered sumped position and its raised retracting position, and controlling means for said fluid operated means for first sumping said head, then swinging said head upwardly, then retracting said head and finally causing movement of said head downwardly back to its initial position, all automatically in a definite cycle, said controlling means including a fluid actuated valve controlled by operation of said fluid operated sumping and retracting means and means for subjecting said valve to the action of pressure fluid, said controlling means including a shiftable fluid actuated valve responsive to the pressure in said fluid actuated swinging means for controlling the movements of said first mentioned fluid actuated valve.

2. In combination, a frame, a support movable back and forth relative to said frame, a vein-attacking and disintegrating head pivotally mounted on said support to swing in vertical planes, a fluid cylinder for moving said support forwardly relative to said frame for sumping said head into the mine vein at the floor level and for retracting said head from the vein at the roof level, a fluid cylinder for swinging said head upwardly about its pivot, and controlling mechanism for effecting sumping, swinging and retracting movements of said head automatically in a definite cycle, said controlling mechanism including fluid actuated control means responsive to pressure conditions in said swing cylinder for automatically effecting operation of said cylinder for retracting said head from the mine vein whenever said head reaches its raised position, and means for subjecting said control means to the pressure in said swing cylinder, said controlling mechanism including a fluid actuated unloading valve for effecting a restricted venting of said swing cylinder to permit swinging of said head downwardly by gravity about its pivot, said control means being responsive to the pressure in said swing cylinder caused by the weight of said head

acting on the fluid in said swing cylinder during such gravity down-swing of said head, the pressure acting on said control means to hold the latter open until said head reaches its limit of down travel.

3. A combination as set forth in claim 2 wherein said control means includes a fluid actuated valve whose movement is responsive to the pressure in said swing cylinder for controlling the flow of actuating pressure from said unloading valve, and means for subjecting said fluid actuated valve to the pressure in said swing cylinder.

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