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HYDRAULIC ROOF SUPPORTS AND CONVEYOR FEED JACKS

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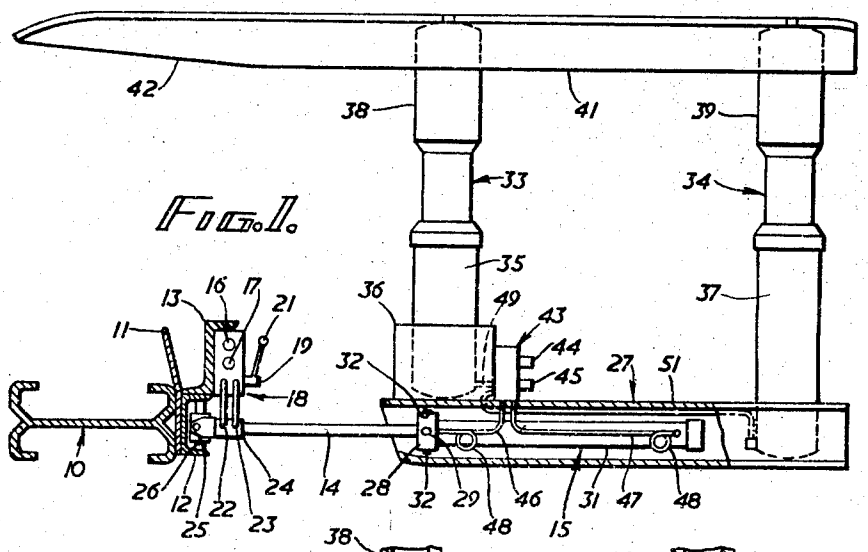


FIG. 1.

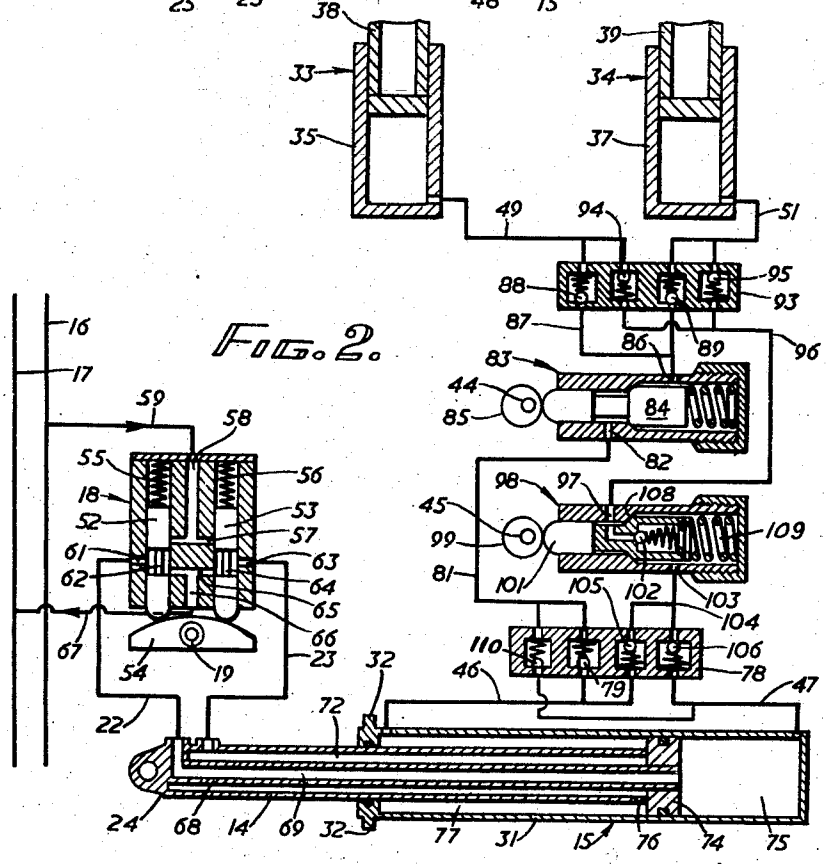


FIG. 2.

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HYDRAULIC ROOF SUPPORTS AND CONVEYOR FEED JACKS

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7 Claims. (Cl. 262—1)

This invention relates to mining machinery wherein a plurality of roof support units, each comprising a framework having two or more hydraulic props supporting a roof bar, are connected by hydraulic feed jacks to a structure such as a conveyor framework which extends along the working face of the mine, whereby the jacks may be operated when the roof support units are extended to advance the conveyor, or when the roof support units are contracted to advance said units towards the working face. A roof support system of the kind described constitutes the subject matter of Patent No. 2,803,444 issued August 20, 1957, on the co-pending application of M. C. Potts. In practise, the conveyor may be advanced behind the newly cut face in a progressive snaking movement under the force of several feed jacks which react against their respective support units. Subsequently, each support unit may in turn be drawn towards the conveyor and the working face by its feed jack.

As the operation of the props and the jacks will, for rapid movement, require considerably more power than can be supplied by hand, it is necessary that a source of hydraulic power shall be provided with a main pressure conduit and a main return conduit extending along the apparatus with branch conduits to each roof support unit.

The system according to the present invention comprises a single hydraulic power installation for all the prop units across the working face, having a pressure main and a return main extending along the conveyor structure in known manner, but whereas in previous systems of this general nature flexible branch pipes have led from the pressure and return mains for the control of the props at least, or for both the props and the jacks, of each individual roof support unit, the present system utilizes no flexible pipes between the conveyor structure and the several roof support units, and the only flexible pipes at all therebetween are short lengths which are close to and protected by parts of the conveyor structure. Instead, the branch conduits to the props, which otherwise would be unprotected, extend through the piston rod of the jack, which is essentially a part of the system in any case. Valve devices control the application of hydraulic pressure to the props or to the jack, as circumstances require. The long, unprotected flexible pipes heretofore used are liable to severe damage and may cause complete failure, since they are located in the working space. The present arrangement, utilizing the rigid piston rod for conducting hydraulic fluid to and from the props, substantially eliminates the possibility of damage, especially since the exposed portion of the piston rod can be, and usually would be, protected by a sliding shield such as is shown in the Potts application referred to above.

As will be apparent, a valving system is required to insure the correct application of hydraulic pressure to the jack, or to the props beyond the jack through the piston rod of the jack. This valving system, together with the use of the piston rod as part of the branch conduits, constitutes broadly a part of this invention.

The object of the present invention is to provide a construction and arrangement of the conduits for a minimum of obstruction and a maximum of protection.

According to the invention, mine roof supporting apparatus comprises a plurality of roof support units each including a base member, two or more hydraulic props mounted on the base member, a roof bar supported on the props, and a hydraulic feed jack connected at one end to the base member and adapted at its other end for connection to a structure such as a conveyor framework which extends along the coal face, characterized in that the hydraulic power supply for operation of the props and jacks comprises pressure and return mains associated with the structure, and, for each roof support unit, valve-controlled conduits branching from the pressure and return mains, said branch conduits including flow paths which extend to and from the props through the piston rod and cylinder chambers of the feed jack.

The invention, as applied to an arrangement in which a conveyor and a number of associated roof support units are as described in the Potts patent described above, is illustrated in the accompanying drawing, of which:

Figure 1 shows a conveyor framework in cross-section and an associated roof support unit, with the base of the latter broken away to show interior details, and

Figure 2 is a hydraulic diagram to illustrate the working of the hydraulic components in the unit.

Referring to Figure 1, the conveyor which extends along the coal face has a framework shown generally at **10**. Fixed to the rear side of the framework **10** is a plate **11**, a channel-shaped member **12** and secured to the latter is an S-shaped section **13**. One channel-shaped member as at **12** is provided for each roof support unit to form an anchorage for the piston rod **14** of a feed jack **15** mounted in the unit, while the S-shaped section **13** is co-extensive with the framework **10**, and provides a protective support for a hydraulic pressure main **16** and a hydraulic return main **17**, both of which extend along the conveyor from a source of hydraulic power to provide power for the operation of each support unit. A reversing valve **18** is fixed to the S-shaped member adjacent the channel-shaped anchorage **12**, this reversing valve controlling the supply and return of hydraulic fluid to the associated roof support unit in a manner which will subsequently be understood from the description of Figure 2. The reversing valve has a control shaft **19** and handle **21** by operation of which the pressure and return mains **16** and **17** may be brought into corresponding or reversed communication with two service pipes **22** and **23** leading from the valve **18**. The service pipes **22** and **23** lead to connections on the head **24** of the piston rod **14**, and these service pipes are preferably flexible for the reason that the head **24** is connected by a universal joint **25** to a vertical pivot pin **26** whose ends are fixed in the channel-shaped member **12**. They are short, and are well protected by the S-shaped section **13**.

The roof support unit comprises a box-section base member **27** open at the front for the reception of the feed jack **15** which is secured by a gimbal ring **28** having horizontal pivots **29** fixed in the sides of the box-section base member **27**, the gimbal ring in turn being secured to the forward end of the jack cylinder **31** by vertical pivot pins **32**. The support unit comprises a front prop **33** and a rear prop **34**, the former having a cylinder **35** socketed into a mounting **36** at the forward end of the base member **27**, and the rear prop having a cylinder **37** socketed into the rear portion of the base member **27**. The props **33** and **34** have rams **38** and **39** which carry an inverted channel-shaped roof bar **41** having a forward cantilever extension **42**.

A valve assembly **43** disposed on the base member **27** behind the mounting **36** has a pressurizing valve operable

by a control shaft 44 and a release valve operable by a control shaft 45. The front and rear ends of the jack cylinder 31 have pipes 46 and 47 respectively connected to the valve assembly 43, each pipe 46 and 47 being flexible or, as shown, rendered resilient by means of loops 48 which allow for small angular movements of the jack cylinder 31 at the gimbal ring 28. These pipes 46 and 47 are wholly protected, being within the box-section base member 27, and are not, in any case, part of the connection between the conveyor and the roof support unit, but rather, a part of the unit itself. Pipes 49 and 51 respectively connect the cylinders 35 and 37 of the props with the valve assembly 43.

The construction and arrangement of the valves referred to will now be described in greater detail with reference to the hydraulic diagram of Figure 2. The reversing valve 18, upon the conveyor, has valve plungers 52 and 53 shiftable by a rocker 54 on the control shaft 19 and loaded towards the rocker by springs 55 and 56 respectively. In the central position of the rocker 54, the plungers 52 and 53 close a pressure port 57 which is connected by a passage 58 and branch conduit 59 with the pressure main 16. A feed port 61 opens into an annular space around a central stem 62 of the valve plunger 52, while a feed port 63 opens into a similar annular space around a central stem 64 of the valve plunger 53, the two spaces being interconnected by a return port 65 which is connected by way of a passage 66 and branch conduit 67 with the return main 17.

The piston rod 14 of the feed jack 15 has a tubular insert 68 dividing a central passage 69 which is connected by line 22 with the feed port 61, from an outer passage 72 which is connected by line 23 with the feed port 63. The central passage 69 opens through the piston 74 into the piston chamber 75 of the jack while the outer passage 72 opens through an aperture 76 in the piston rod 14 into the rod chamber 77. If the control shaft 19 turns the rocker 54 to lift the plunger 52 so that it closes the return port 65 but opens the pressure port 57, and so that the plunger 53 continues to connect ports 63 and 65, then liquid from the pressure main 16 will pass through passage 58, and port 57, feed port 61, pipe 22 and central passage 69 into the piston chamber 75, while liquid from the rod chamber 77 will flow through aperture 76, outer passage 72, pipe 23, feed port 63, return port 65 and passage 66 into the return main 17. Assuming no escape of pressure fluid beyond the jack 15, this will extend the feed jack 15 while contrary motion of the control shaft 19 will cause contraction of the feed jack 15. When the rocker 54 is in its neutral position, as shown, it is evident that both chambers 75 and 77 of the jack will communicate freely with each other and with the return main 17 through the valve 18.

A block 78 is included in the valve assembly 43, beyond the jack 15. This block 78 has a check valve 79 therein permitting flow from the rod chamber 77 through the pipe 46 to a line 81 which is connected to the inlet 82 of the pressurizing valve 83. The pressurizing valve 83 has a spring-loaded plunger 84 which may be lifted by a cam 85 on the control shaft 44 to open the inlet port 82 to an outlet port 86. The outlet port 86 is connected by way of a branched line 87 with two check valves 88 and 89 which permit flow through lines 49 and 51 into the hydraulic prop cylinders 35 and 37 respectively, to urge the prop plungers upwardly. The check valves 88 and 89 are contained in a block 93, included in the valve assembly 43, which houses two further check valves 94 and 95 which permit flow through the lines 49 and 51 from the prop cylinders 35 and 37 respectively into a branched line 96, to allow lowering of the prop plungers.

The branched line 96 is connected to an inlet port 97 of a relief valve 98, which is operable also as a release valve by means of a cam 99 on the control shaft 45 and a spring-loaded valve plunger 101. The inner end of the valve plunger 101 contains a spring-loaded relief valve 102 which opens under excessive pressure in the branched line 96 from any of the props 33 or 34, to allow liquid to escape to the outlet port 103 of the valve 98. Alternatively, both props can be released at will by turning the control shaft 45 and cam 99 to lift the plunger 101 from its seat at 108, in opposition to the spring 109.

The outlet port 103 is connected by a line 104 with two further check valves 105 and 106 in the block 78, the valve 105 permitting flow into the pipe 46 which is connected with the rod chamber 77 of the jack cylinder 31, and the valve 106 permitting flow into the pipe 47 which is connected with the piston chamber 75. Thus the check valves 105 and 106 permit escape of pressure liquid at all times from the relief valve into either jack chamber 77 or 75, whichever is at low pressure, and thence through pipe 72 and 23 or 69 and 22, and the reversing valve 18 to the return main 17.

The check valve 79 in the block 78, on the other hand, admits liquid from the rod chamber 77, when this is under pressure, to the pressurizing valve 83, and when the latter is unseated, liquid may pass in the manner described to both props 33 and 34, and enable the roof bar carried thereby to be set against the roof of the mine.

The roof support unit may include more than two props extending between the base member 27 and roof bar 41. If, for example, a third prop is included, the block 93 will include two additional check valves such as the pair 88, 94 or 89, 95 in similarly arranged connections between the prop, and the pressurizing and relief valves. A three-prop unit and its valves are shown in the Potts application referred to above.

The feed jack 15 may be used both to advance the conveyor framework 10 towards the coal face or, when the props 33 and 34 are retracted, to pull the roof support unit forward towards the conveyor. In order to advance the conveyor, the handle 21 and control shaft 19 of the reversing valve 18 is turned to oscillate the rocker 54 so as to lift the valve plunger 52. When this is done the space around the valve stem 62 is cut off from the return port 65 but opens the pressure port 57 to the feed port 61. Pressure liquid thus passes through the line 22 and central passage 69 to the piston chamber 75, while liquid expelled from the rod chamber 77 passes through the outer passage 72, line 23 and port 63 and around the stem 64 of the valve plunger 53 to the return port 66. The pressure liquid in piston chamber 75 pressurizes line 47, but since check valve 106 remains closed, there is no escape of liquid beyond the latter.

In order to advance the roof support unit, the roof bar 41 and props 33 and 34 are first lowered by turning the control shaft 45 of the release valve 98 so that the cam 99 lifts the valve plunger 101 from its seat at 108. Liquid from the prop cylinders 35, 37 can then pass through the check valves 94, 95, line 96, release valve 98 and either into the rod chamber 77 through the check valve 105 or into the piston chamber 75 through the check valve 106, whichever is at low pressure. In the neutral position of the reversing valve 18 as shown in Figure 2, both chambers 75 and 77 are in communication with the return main 17 through the reversing valve 18. If the latter is actuated to start advancing the roof support unit before the props are fully collapsed, the control shaft 19 is turned to depress the plunger 53 so that pressure liquid is admitted to the rod chamber 77. The piston chamber 75 is still in communication with the return main 17, so that liquid expelled by the props 33, 34 can continue to pass through the release valve 98 and check valve 106 into the piston chamber 75 and thence to the return main 17.

At the end of the advance of the roof support unit it is necessary to extend the props 33, 34, and this is done while pressure still acts in the rod chamber 77 by operating the control shaft 44 of the pressurizing valve 83 to lift the valve plunger 84. Pressure liquid from the rod chamber 77 then flows through the check valve 79,

pressurizing valve **83**, and check valves **88** and **89** into the prop cylinders **35** and **37** respectively. When the roof bar **41** has been set by extension of the props **33, 34**, the reversing valve **18** can be returned to neutral by centralizing the rocker **54** on the control shaft **19**. Any subsequent slow yielding of the props under pressure on the roof bar **41** will cause liquid to be expelled from one or both props **33** and **34** through the check valves **94** and **95** respectively to the inlet port **97** of the release valve **98**. The spring-controlled relief valve **102** mounted in the valve plunger **101** is set to yield under the maximum permissible pressure in the props **33** and **34**, and upon this pressure being reached, liquid at the inlet port **97** can escape past the relief valve **102** to the outlet port **103**, and thence as described through either of the check valves **105** or **106** to the return main **17**.

Thus, although there is relative movement between the conveyor framework **10**, with which the pressure and return mains are associated, and the roof support unit on which the props **33** and **34** are mounted, pressure is made available at the pressurizing valve and low pressure return at the release and relief valve, through the feed jack **15** without recourse to additional conduits between the conveyor framework and the roof support unit.

Although, in the example described, it is only necessary to extend the props **35, 37** when the rod chamber **77** of the jack **15** is under pressure, it is possible to make pressure also available at the pressurizing valve **83** when the piston chamber **75** is under pressure by providing an additional check valve **110** opening from the pipe **47** into the line **81**.

I claim as my invention:

1. Mine roof supporting apparatus for use in connective association with a conveyor structure which extends along the working face of the mine, said apparatus comprising a plurality of roof support units each unit of which includes at least two hydraulic props operative to extend and contract said unit, a telescopic hydraulic jack having a cylinder part and a rod part, including a piston, of which one part is joined to said unit and the other part is adapted for connection to said conveyor structure, hydraulic connections at both ends of the cylinder part opening into the cylinder on opposite sides of the piston, two hydraulic connections adjacent the outer end of the rod part, two longitudinal passages formed in the rod part to extend between the respective hydraulic connections therein and the opposite sides of the piston thus providing direct communication between the hydraulic connections on the rod part and the respective hydraulic connections on the cylinder part, main pressure and return conduits arranged for mounting along the conveyor structure to provide a common service for all the roof support units, and for each said unit a jack control valve interposed between the main pressure and return conduits and the hydraulic connections on the jack part which is adapted for connection to the conveyor structure, and prop control valve means interposed between the hydraulic props and the hydraulic connections on the jack part which is joined to the roof support unit, said prop control valve means including a plurality of valves closing under pressure of which one at least opening from a hydraulic connection on the jack provides a pressure source for extension of the props, and one other at least opening to a hydraulic connection on the jack provides a low pressure return for relief of the props.

2. Mine roof supporting apparatus according to claim 1, wherein said valve means comprises a pressure control valve connected to said pressure source and, for each prop, a check valve opening from said pressure control valve to the prop, and a pressure release valve connected to said low pressure return and, for each prop, a check valve opening from the prop to said low pressure return.

3. Mine roof supporting apparatus for use in association with a conveyor structure which extends along the working face of the mine, said apparatus comprising a plurality of roof support units each of which includes a base member, at least two hydraulic props mounted on the base member, a roof bar supported on said props, and a hydraulic feed jack including a piston rod part and a cylinder part of which one part is connected to said base member and the other part is adapted for connection to said conveyor structure, said piston rod having two passages extending longitudinally therein and opening into said cylinder on opposite sides respectively of the jack piston; and hydraulic power supply means for operation of said props and jacks comprising main pressure and return conduits arranged for mounting along said structure to provide a common service for all the roof support units, and, for each roof support unit a feed jack control valve connected to said main pressure and return conduits, a pair of service conduits connected to said feed jack control valve and extending in part through said passages in the piston rod and through the cylinder on opposite sides of the piston to terminations beyond the feed jack, and prop control valve means interposed between the terminations of the service conduits and the props, said prop control valve means including a plurality of valves closing under pressure of which one at least opening from the termination of a service conduit provides a pressure source for extension of the props, and one other at least opening to the termination of a service conduit provides a low pressure return for relief of the props.

4. Mine roof supporting apparatus according to claim 3, wherein the cylinder of the feed jack is connected to the base member of the roof support unit, and the piston rod is adapted at its outer end for connection to the structure.

5. Mine roof supporting apparatus for use in connective association with a conveyor structure or the like which extends along the working face of the mine, said apparatus comprising a plurality of roof support units each unit of which includes at least two hydraulic props operative to extend and contract said unit, a telescopic hydraulic jack having a cylinder part connected to said unit and a rod part, including a piston slidable within the cylinder part, connected at its external end to the conveyor structure, the rod part being formed with two separate fluid passages leading from separate connections at its external end to the interior of the cylinder part at respectively opposite sides of the piston, main pressure and return conduits extending along the conveyor structure to provide a common service for all the roof support units, a jack control valve for each unit interposed between the main pressure and return conduits and said separate connections at the external end of the rod part, and operable to control the sense of relative reciprocation of the cylinder part and the rod part, separate hydraulic conduits connected to the respective ends of the cylinder part, and extending thence to both props, and prop control valve means interposed in said conduits between the cylinder part and the props, including a plurality of valves closing under pressure of which one at least is a forward flow check valve providing a pressure source for extension of the props, and including a pressurizing valve intermediate such source and the props, and operable under control to admit pressure fluid to the props to extend them, and a normally closed release valve located intermediate the props and the hydraulic conduits connected to the respective ends of the cylinder part, and operable under control to contract the props.

6. Mine roof supporting apparatus as in claim 5, including a relief valve incorporated in the release valve, and biased to remain closed until a predetermined maximum prop pressure is attained, and then to open automatically for relief of any excess above such maximum pressure.

7. Mine roof supporting apparatus as in claim 5,

wherein the prop control valve means includes a normally closed pressurizing valve openable under control, a prop pressure supply conduit leading from one end of the cylinder part to one side of the pressurizing valve by way of said forward flow check valve, further conduits leading from the other side of the pressurizing valve to the props, further check valves in said further conduits arranged to block back flow, return conduits leading from the props to one side of the release valve, and from the

opposite side of said release valve to the opposite ends of the cylinder part, and means to open said release valve to contract the props.

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