March 15, 1966 F. PAWLING ET AL 3,240,125

ROOF SUPPORT ASSEMBLY

Filed March 30, 1964 2 Sheets-Sheet 1

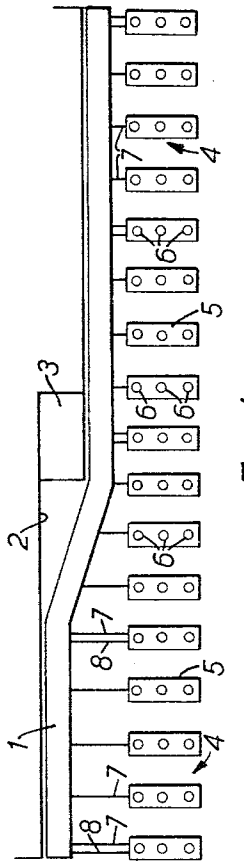


FIG. 1.

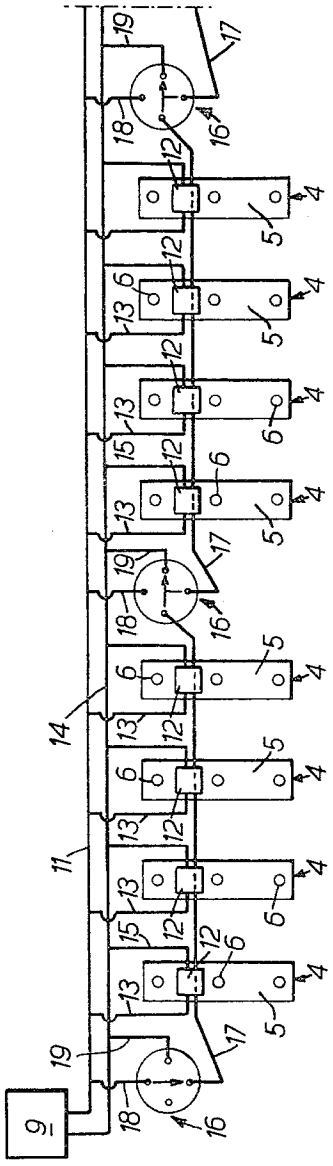


FIG. 2.

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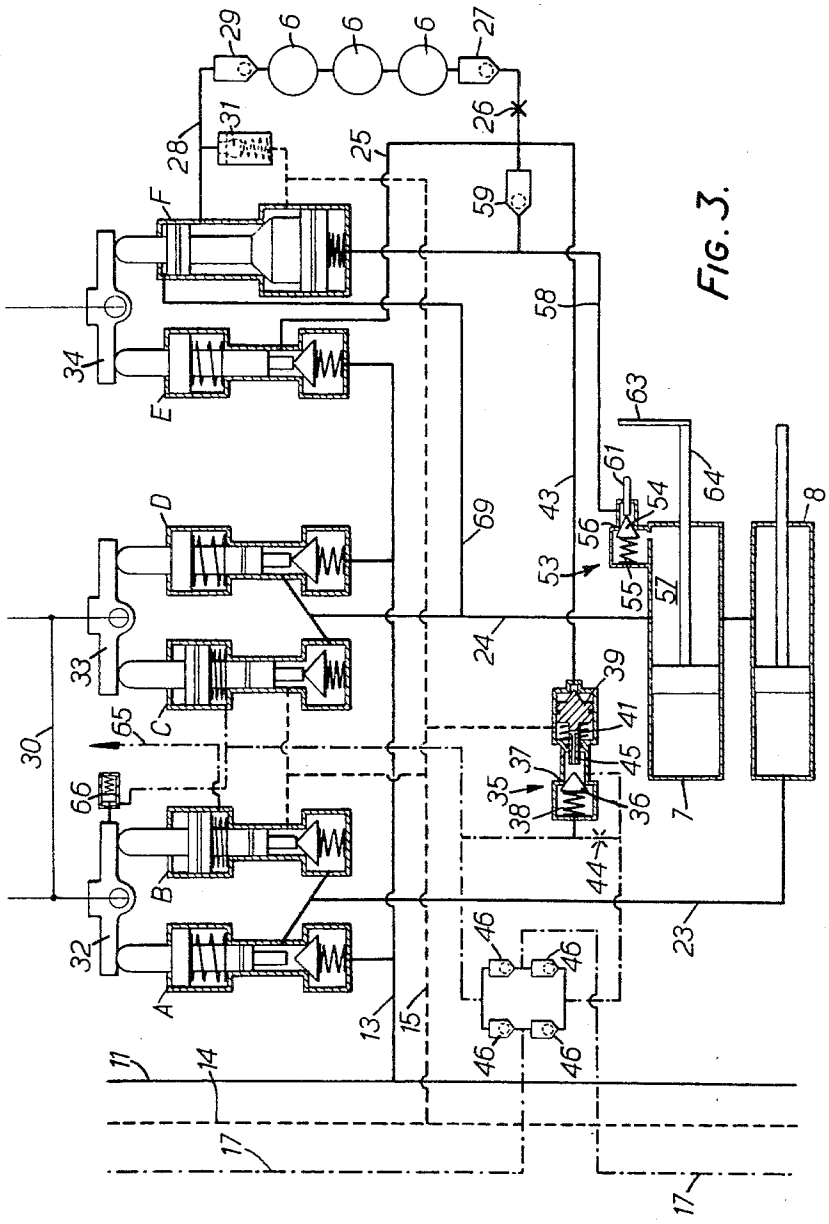



FIG. 3.

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United States Patent Office 3,240,125 Patented Mar. 15, 1966



3,240,125

# ROOF SUPPORT ASSEMBLY

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Filed Mar. 30, 1964, Ser. No. 355,769
Claims priority, application Great Britain, Apr. 5, 1963, 13,715/63
3 Claims. (Cl. 91—189)

This invention relates to roof support assemblies suitable for use in mines.

The present invention provides a roof support assembly including a series of advanceable roof supports arranged in groups, each group including a plurality of roof supports, the groups and their constituent roof supports being distributed along the working face, control means for remotely-causing the advance, one by one, of the roof supports in each group, and safety means operable to prevent remotely-caused advance of the roof supports in any selected group while allowing remotely-caused advance of the roof supports in another group.

The control means may include means for sending a signal to each roof support to select an advancing operation of that roof support, the safety means being operable to prevent the signal from being sent to the roof supports in the selected group.

The signalling means may be operable to send a signal to the first roof support in a group, which signal is then passed from roof support to roof support in that group. The signal may be passed by one roof support to another only when said one roof support has completed its advancing operation. The signal may be passed from one roof support to another alternatively in one direction or the opposite direction. The signal may be a fluid-pressure signal or may be an electrical signal.

Preferably, each roof support can be caused to undergo an advancing operation, while the safety means is preventing remotely-caused operation of that roof support, by manual operation of controls located on that roof support or an adjacent roof support.

It is known to arrange mine roof supports in groups, with the roof supports in each group associated with a control valve and a pilot line from a fluid pressure source. Operation of a control valve causes a fluid pressure signal to be sent along the associated pilot line to the first roof support in the corresponding group to cause that first roof support to undergo an advancing operation. When the first roof support completes its advancing operation, it sends the signal on along the pilot line to the next roof support in the group. Thus the several roof supports in the group undergo advancing operations one after the other. By arranging the roof supports in groups, the advancing of the roof supports can be more closely controlled than would be the case if all the roof supports constituted a single group and advanced automatically one after the other.

In the known arrangement described each control valve had two positions, one in which the pilot line was connected to a fluid pressure source, and the other in which the pilot line was shut off from that source. If a given group of roof supports failed to complete the advancing sequence, due to a fault or obstruction affecting one of the roof supports, the relevant control valve would then be operated to isolate the pilot line from the pressure source, so that a man could investigate and correct the faulty roof support. Upon such correction the pressure stored in the pilot line could set off an advancing operation of the next roof support, with consequent risk of injury to the man.



By this present invention not only will the control valve isolate its pilot line from the source of fluid pressure, but also it will connect the pilot line to a low pressure zone so that the signal is lost, and advance cannot resume automatically except as the system is free from the probability of accident or injury.

One embodiment of the present invention will now be described, by way of example, with reference to the accompanying drawings of which,

FIGURE 1 is a diagrammatic view of mining apparatus including a roof support assembly and with the hydraulic connections omitted,

FIGURE 2 is an enlarged diagrammatic view of part of the roof support assembly showing the hydraulic connections, and,

FIGURE 3 is a diagrammatic view of the hydraulic valve assembly of a roof support.

Referring to the accompanying drawings, the mining apparatus illustrated includes a conveyor **1** extending along the working face **2** of a coal mine. A cutting machine **3** of known type traverses the working face, and is situated between the working face **2** and the conveyor **1**. Since the cutting machine **3** is guided by the conveyor **1**, the conveyor must advance after an appreciable cut in order that the cutter can cut during the next traverse. The mining apparatus also includes a roof support assembly, of any known type, such as includes a series of advanceable roof supports **4** located on the opposite side of the conveyor **1** to the working face **2** and cutting machine **3**. These roof supports are distributed along the working face in groups, for instance four to each group, and are advanced individually and successively, as the working face is cut away. In the form of roof support shown, each support **4** includes a floor-engaging sole beam **5** carrying three upright hydraulically-operable telescopic props **6**, and the three props **6** carry a roof beam (not shown). Each roof support **4** is connected to the conveyor **1** by a single-acting hydraulically-operable jack **7**, whereby at an appropriate time the roof support **4** is advanced towards the conveyor **1**, and every fourth roof support **4** has a hydraulically-operable double-acting jack **8** for advancing the conveyor **1** relative to the roof supports **4**. The jack **8** is not connected to the conveyor **1** and engages and pushes forward the conveyor **1** only when applying an advancing force to it. The numbers of roof supports in a group, the numbers of props in a roof support, and the like, as given above, are intended to be illustrative and not restrictive.

The roof support assembly also includes a hydraulic power unit **9**, which includes a pressure fluid source, and from which a line **11** supplying hydraulic fluid under pressure extends along the series of roof supports **4**. Each roof support has a valve assembly **12**, shown in detail in FIGURE 3, connected to the supply line **11** by a branch supply line **13**. A hydraulic fluid return line **14** also extends from the power unit **9** along the series of roof supports **4**, and the valve assembly **12** of each roof support **4** is connected to the return line **14** by a branch return line **15**.

The roof supports **4** are arranged in groups, for example groups of fours, and FIGURE 2 shows the first two groups. The roof supports **4** in each group are automatically advanceable individually after advance of the conveyor **1** (as will be described later) and the automatic advance of the roof supports in each group is controlled by group control valves **16**. In each group, a hydraulic pilot line **17** connected to the control valve **16** at one end of the group is connected to the valve assembly **12** of each roof support **4** in the group in turn and is then connected to the control valve **16** at the other end of the

group. Each control valve 16 is also connected to the supply line 11 by a branch line 18, and to the return line 14 by a branch line 19.

The operation of the valve assembly 12 of each roof support 4 will be described later with reference to FIGURE 3, but for the moment it will suffice to say that, when a roof support 4 receives a hydraulic pressure signal along the pilot line 17, the roof support 4 undergoes an advancing operation and, when the advancing operation has been completed, passes on the signal by way of pilot line 17 to the next roof support 4. Each control valve 16 is operable, either manually or by remote control, to connect the relevant pilot line 17 by way of its branch line 18 to the supply line 11 or by way of branch line 18 the return line 14. In practice, pressure maintaining vales and pressure reducing valves may be included in the system to ensure that the hydraulic pressure in the pilot line 17, when connected to the supply line 11, is maintained at a value considerably less than the full pressure generated in the supply line 11 by the power unit 9.

With the described arrangement, the roof supports 4 in any selected group can be caused to advance automatically, while the automatic advance of roof supports 4 in any other group is prevented. For example, if it is desired that the first group adjacent the power unit 9 should be automatically advanced, the control valve 16 at the left hand end of the group is operated to connect the pilot line 17 to the supply line 11 by way of branch line 19, as shown in FIGURE 2. Thus the first roof support 4 receives a hydraulic pressure signal along the pilot line 17 and therefore undergoes an advancing operation. When the advancing operation of the first roof support 4 has been completed, the first roof support 4 passes on the hydraulic signal to the second roof support 4 in the group, and so on until all four roof supports in the group have advanced. During this operation, the right hand end of the pilot line 17 of the first group is connected to the return line 14 by the control valve 16 at the right hand end of the group, by way of branch line 19, as shown in FIGURE 2. When all the roof supports 4 in the first group have advanced, the control valve 16 at the left hand end of the group is operated to connect the left hand end of the pilot line 17 to the return line 14 instead of to the supply line 11.

When the automatic advance of the roof supports 4 is taking place in the first group, automatic advance of the roof supports 4 in the second and subsequent groups is prevented because, as shown, the control valves 16 at the left hand and right hand ends of the second group (shown in FIGURE 2) and subsequent groups are connecting both ends of the pilot line 17 of the second group and subsequent groups by way of branch lines 19 to the return line 14. Thus no roof support 4 in the second group or a subsequent group can receive a hydraulic pressure signal along its pilot line 17. Thus, while automatic advance is taking place in the first group, a man can safely work in a position adjacent the roof supports 4 in the second or subsequent groups, for example to repair a faulty roof support or to adjust the position of a roof support by manual operation of its valve assembly 12, without the fear of an automatic advance of roof supports starting in the group in which he is working.

If a fault occurs during the automatic advance of the roof supports in the first group so that automatic advance ceases before all the supports in the group had advanced, further automatic advance can be prevented by operating the relevant control valve 16 (that valve at the left of the first group) to connect the pilot line 17 to the return line 14 instead of to the supply line 11. It is then safe for a man to investigate the fault and maybe advance the remaining supports in the first group by manual operation of the relevant valve assemblies. In such an event, it may be safe to initiate automatic advance in the second group while the fault in the first group is being repaired.

Also, with the arrangement shown in FIGURE 2, the roof supports 4 in each group can be advanced, by operation of the control valve 16 at the left hand end or the right hand end, in a sequence which travels from left to right or in a sequence which travels from right to left along the group. Further, if desired, automatic advance can take place in more than one group at a time, by suitable operation of the relevant control valves 16.

The operation of the valve assembly 12 of each roof support 4 in the form shown herein, will now be described with reference to FIGURE 3. The valve assembly 12 of a roof support 4 with a double-acting jack 8 includes six valve units A, B, C, D, E and F. Valve unit A controls the supply of hydraulic fluid to the jack 8 in a jack-extending sense and is connected to the branch supply line 13 and to a line 23 leading to the jack 8. Valve unit B is connected to the line 23 and to the branch return line 15.

Valve unit D controls the supply of hydraulic fluid to the jack 7 and jack 8 in a jack-contracting sense and is connected to the branch supply line 13 and to a line 24 leading to the jacks 7 and 8. Valve unit C is connected to the line 24 and to the branch return line 15.

Valve unit E controls the supply of hydraulic fluid to the props 6 and is connected to the branch supply line 13 and to the props 6 through a line 25 including a restrictor 26 and a non-return valve 27. Valve unit F controls the release of hydraulic fluid from the props 6 and is connected to a line 28 leading from the props 6 and to the branch return line 15. The line 28 includes a non-return valve 29, and a pressure relief valve 31 is connected in parallel with the valve unit F between the line 28 and the branch return line 15.

The valve units A and B are associated with a pivotally-mounted lever 32 which is connected to a similar lever 33 associated with the valve units C and D. The levers 32 and 33 co-ordinate the action of valve units A, B, C and D. In those roof supports without a double-acting jack 8, valve units A and B and lever 32 are omitted. The action of valve units E and F are co-ordinated by a pivotally-mounted lever 34. The levers 32, 33 are ganged to one another as shown by the connection 30.

The valve assembly of each roof support 4 includes a pilot valve 35 which, before an advance of the roof support begins, closes the pilot line 17. The pilot valve 35 includes a valve member 36 urged towards a valve seat 37 by a spring 38, and also includes a piston 39 carrying a piston rod 41. The piston 39 can be moved against the force exerted by a spring 42 by a sufficient hydraulic pressure in a line 43 to cause the piston rod 41 to lift the valve member 36 off the valve seat 37. The line 43 is connected to line 25. The piston rod 41 has a bore 45 which, when the piston rod 41 is not engaging the valve member 36, brings one side of the valve member 36 into communication with the branch return line 15. When piston rod 41 engages the valve member 36, the valve member 36 closes the bore 45.

Four non-return valves 46 are connected in the pilot line 17 to enable the roof support to be caused to undergo an advancing operation by the receipt of a signal along pilot line 17 from the adjacent left hand roof support or from the adjacent right hand roof support. A small restrictor 44 is connected in the pilot line 17 across pilot valve 35 to ensure that pressure cannot be trapped in the portion of pilot line 17 between valves 46 and valve units B and C by providing a leak to the branch return line 15 through the bore 45 in piston rod 41.

A prop re-setting valve 53 is associated with the support-advancing jack 7. The re-setting valve 53 includes a valve member 54 urged by a spring 55 onto a valve seat 56 to isolate the chamber 57 of the jack 7 from a line 58 connected to valve unit F and to line 25 through a non-return valve 59. A lifter rod 61 can be moved to lift the valve member 54 off its seat 56, as the jack 7 becomes fully contracted, by a trip 63 carried by the piston rod 64 of the jack 7.

FIGURE 1 shows the cutting machine 3 travelling from left to right along the working face 2. After the cutting machine 3 has passed the first few roof supports 4 in the series, it is necessary to advance the conveyor 1 in front of these roof supports 4 and then to advance the roof supports 4. Each roof support 4 having a conveyor-advancing jack 8 is operated to cause the jack 8 to apply an advancing force to the conveyor 1, the roof support 4 being set against the roof and acting as an anchorage. This is achieved by pivoting lever 32 in an anti-clockwise direction to open valve unit A and thus pressurizing the line 23 and the pushing side of jack 8. This movement of the lever 32 may be caused by manual operation of lever 32 or by pressurization of a hydraulic line 65 connected to valve unit B. The line 65 may be connected through a manually or remotely controlled valve to the main supply line 11. After the lever 32 has been pivoted in the anti-clockwise direction to cause the jack 8 to be pressurized in the conveyor-advancing sense, a spring-operated latch 66 holds the lever 32 in this position. The anti-clockwise movement of lever 32 causes a similar movement of lever 33, but such movement does not change the state of valve units C and D from that shown in FIGURE 3. The latch 66 is connected to the pilot line 17 in such a manner that pressurization of the pilot line 17 releases the latch 66 so that valve unit A closes and returns lever 32 and consequently lever 33 to the position in FIGURE 3.

When the first portion of the conveyor 1 has been advanced, as shown in FIGURE 1, the associated roof supports 4 can then be advanced. The control valve 16 at the left hand end of the first group is operated, manually or otherwise, to pressurize the pilot line 17 and hence a hydraulic pressure signal is sent along line 17 to the first roof support 4. Referring now to FIGURE 3, the hydraulic pressure signal reaches the roof support through the portion of line 17 shown in the upper left-hand part of FIGURE 3. The hydraulic pressure signal releases the latch 66 as already explained, and operates on valve unit C to cause clockwise movement of levers 32 and 33. As a result, valve unit A closes valve unit B opens, valve unit C closes and valve unit D opens. Thus the pushing or jack-extending side of jack 8 is connected to the branch return line 15, and the jack-contracting sides of the jacks 7 and 8 are connected through the line 24 with the branch supply line 13. The conveyor-advancing jack 8 is not actually connected to the conveyor 1 but merely pushes against the conveyor 1 when applying an advancing force to it. Therefore, at this stage, the jack 8 contracts and takes no part in advancing the support.

Line 24 is also connected by a line 69 to valve unit F, and the pressurization of line 24 causes the valve unit F to be opened to bring the line 28 into communication with the branch return line 15, thus releasing the hydraulic pressure in the props 6 and so releasing the roof support 4 from the roof. The jack 7 then contracts and advances the roof support 4 towards the conveyor 1 with the conveyor 1 acting as an anchorage.

When the jack 7 is fully contracted, or in other words when the roof support is fully advanced up to the conveyor 1, the trip 63 on the lifter rod 64 of the jack 7 engages the piston rod 61 and opens the re-setting valve 53. The line 58 is therefore brought into communication with the main supply line 11 through the branch supply line 13, now-open valve unit D, line 24, jack 7 and re-setting valve 53. The pressure in line 58 acts upon valve unit F to close it and then passes through non-return valve 59, restrictor 26 and non-return valve 27 to extend the props 6 and so reset the roof support 4 against the roof.

The hydraulic pressure in line 58 is also present in line 43, since these two lines interconnect intermediate non-return valve 59 and restrictor 26. When the props 6 have been extended to give a satisfactory roof-supporting force, as evidenced by a build-up of pressure in line 43 to a predetermined value, this value of pressure is arranged to operate on the piston 39 and to open pilot valve 35. Thus the portion of the pilot line 17 between the control valve 16 and the first roof support 4 is brought into communication with the portion of the pilot line 17 between the first roof support and the second roof support (that is the portion of the pilot line 17 in the lower left portion of FIGURE 3) with the result that the hydraulic pressure signal in the pilot line 17 reaches the second roof support in the series and causes it to undergo an advancing operation. In this way, each roof support in the group is advanced in turn.

If it is desired to operate the valve assembly 12 manually, this can be done by manually operating levers 32, 33, 34. This can be useful to complete the suspended operation of a group of roof supports after the trouble has been cured, and even if operation of subsequent groups has occurred.

As explained before, the roof supports 4 in each group can also be advanced in a sequence which travels from right to left along the group, and this is done by operation of the control valve 16 at the right hand end of the group. In this case, the signal reaches the valve assembly 12 of each roof support 4 along the lower left portion of the pilot line 17 in FIGURE 3, and is eventually passed onto the next roof support through the portion of the pilot line 17 in the upper left portion of FIGURE 3.

We claim:

1. A roof support assembly including a series of fluid-pressure-operated roof supports arranged in groups, a valve assembly included in each roof support, and connectible to a fluid pressure source, a pilot line connected in succession to the valve assembly of each roof support in a given group, a control valve operatively connected ot each group, and connected to a source of fluid pressure and to said pilot line, to pressurize the latter, each valve assembly when so pressurized being arranged to cause its roof support to undergo an advancing operation, and upon completion thereof to pass a pressure signal along the pilot line to initiate an advancing operation of the following roof support, and said control valve being shiftable to connect the associated pilot line to low pressure, whereby the pressure signal is lost and the advancing sequence is halted.

2. A roof support assembly as in claim 1, wherein each valve assembly is arranged for manual operation at will, to effect an advancing operation of its roof support.

3. A roof support assembly as in claim 1, including a control valve in the pilot line at the opposite ends of each group, for selective operation to regulate the direction of an advanced sequence in such group.

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