Jan. 31, 1967 D. H. H. BOLTON ETAL 3,301,136

ADVANCEABLE ROOF SUPPORT ASSEMBLIES

Filed Jan. 8, 1965 3 Sheets-Sheet 1

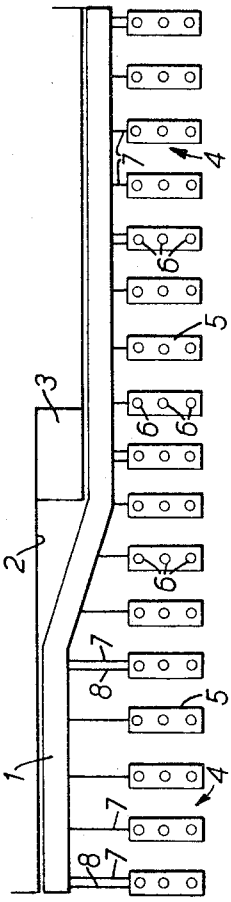


FIG. 1.

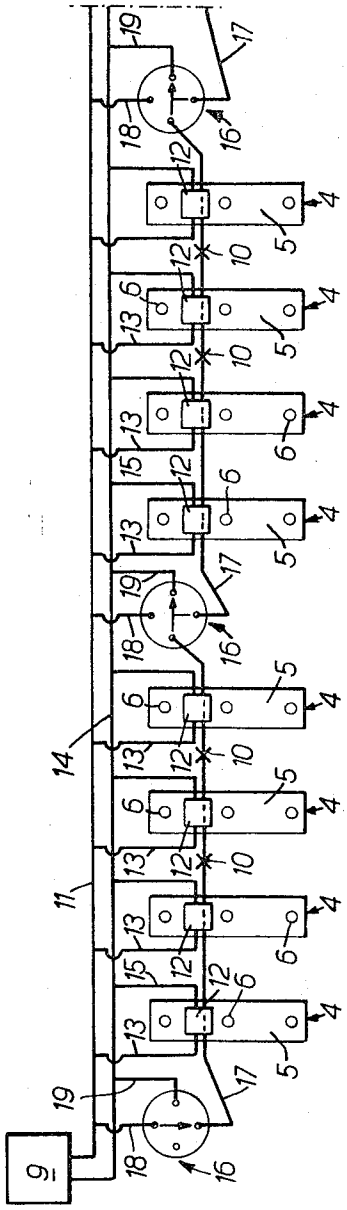


FIG. 2.

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ADVANCEABLE ROOF SUPPORT ASSEMBLIES

Filed Jan. 8, 1965 3 Sheets-Sheet 2

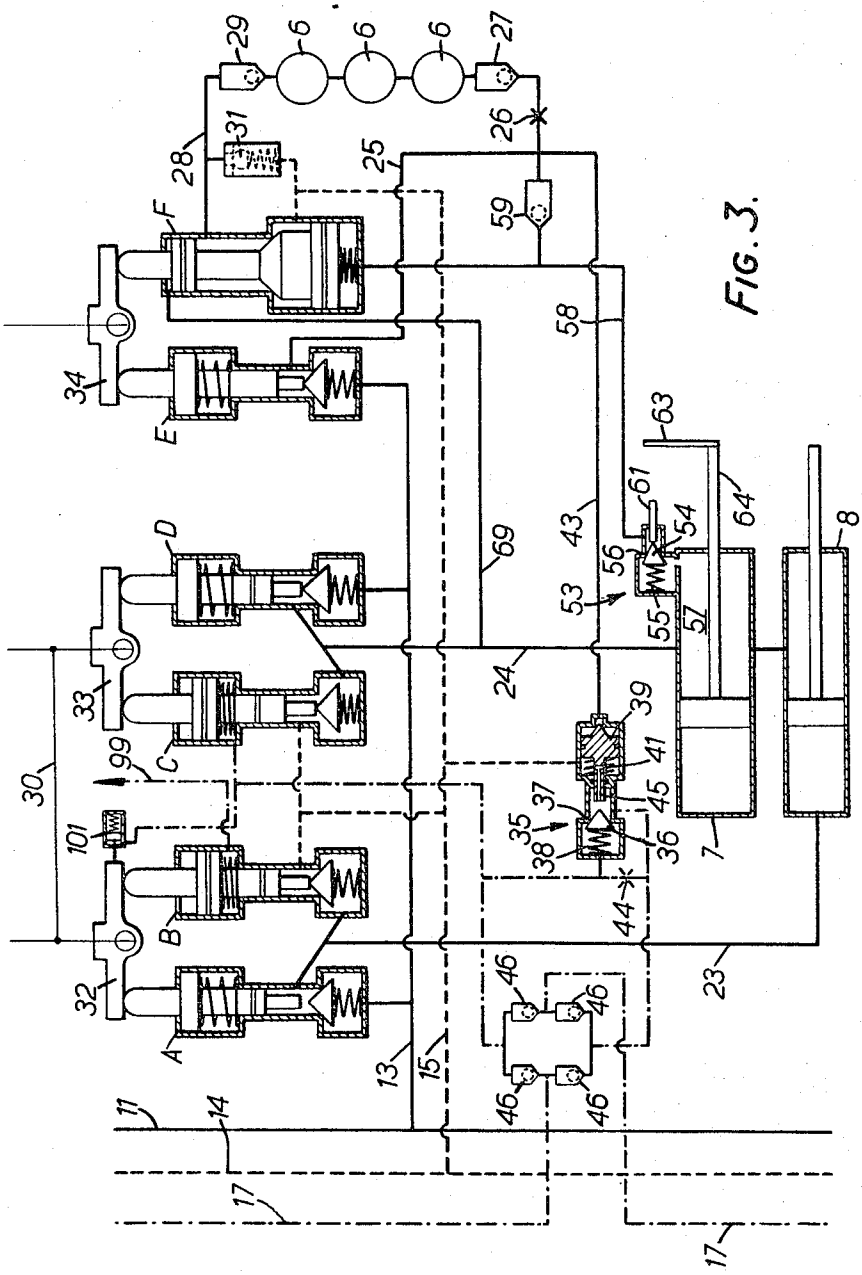


FIG. 3.

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Filed Jan. 8, 1965 3 Sheets-Sheet 3

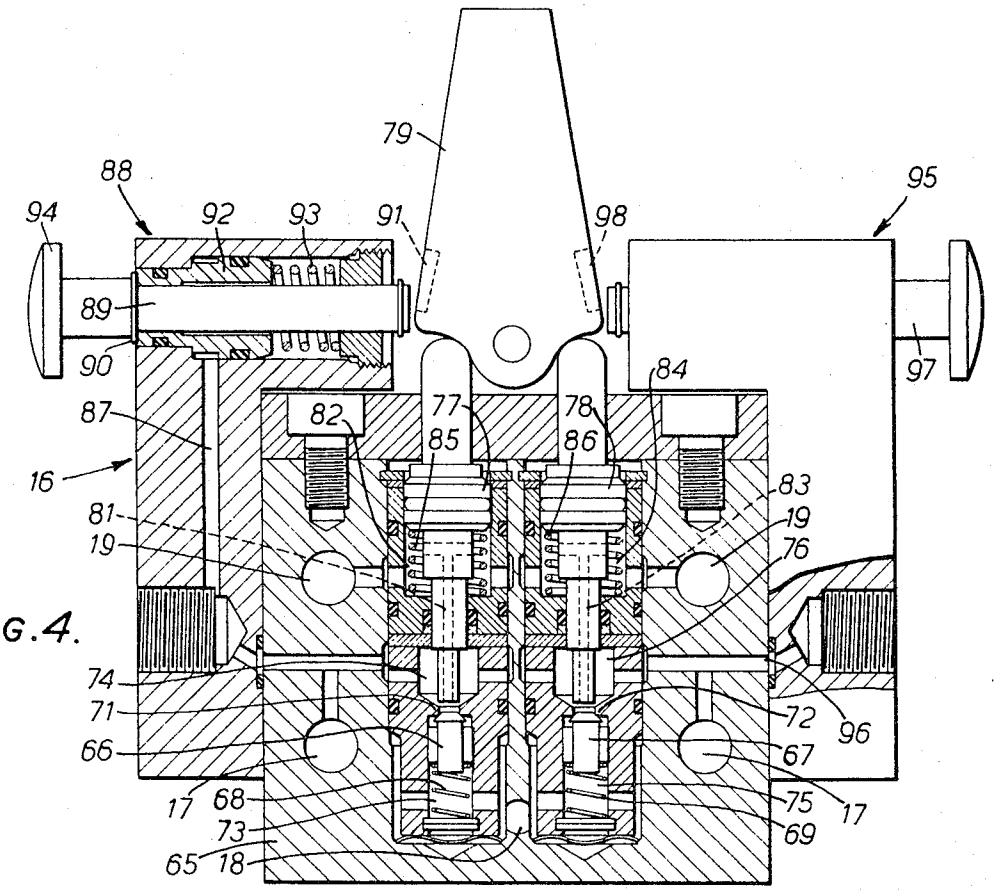


FIG. 4.

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ADVANCEABLE ROOF SUPPORT ASSEMBLIES

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5 Claims. (Cl. 91—189)

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

The present invention provides an advanceable roof support assembly including a series of advanceable fluid-pressure-operated roof supports, a conduit connected to each roof support in turn, each roof support being caused to undergo an advancing operation by the receipt of a fluid-pressure signal along the conduit and being arranged to pass the signal on along the conduit upon completion of the advancing operation, and a control valve operable to connect the conduit to a source of fluid pressure to cause the signal to pass along the conduit to each roof support in turn, the control valve being so constructed that a fall in fluid pressure in the conduit below a predetermined value causes the control valve to isolate the conduit from the source of fluid pressure.

The last roof support in the series to receive the signal may operate, upon completion of the advancing operation, to connect the conduit to low pressure so that the pressure in the conduit falls below the predetermined value with consequent isolating operation of the control valve.

One of more manually-operable safety valves may be located at suitable positions along the conduit, each safety valve being operable to reduce the pressure in the conduit below the predetermined value with consequent isolating operation of the control valve.

When the control valve isolates the conduit from the source of fluid pressure, the control valve may connect the conduit to a region of low pressure.

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 installation and with the hydraulic connection omitted,

FIGURE 2 is a diagrammatic view of two batches of roof supports showing the hydraulic connections,

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

FIGURE 4 is a sectional view of a control valve of a batch of roof supports.

With reference to the accompanying drawings, mining apparatus includes a conveyor 1 extending along the working face of a coal mine, and a cutting machine 3 which travels along the working face 2 and is situated between the working face 2 and the conveyor 1. The cutting machine 3 is guided by the conveyor 1. The mining apparatus also includes a roof support installation including advanceable roof supports 4 located on the opposite side of the conveyor 1 to the working face 2 and cutting machine 3. Each roof support 4 includes a ground-engaging sole beam 5 carrying three 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 for advancing the roof support 4 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 the conveyor 1 only when applying an advancing force to it.

A hydraulic power unit 9 supplies hydraulic fluid under pressure along a line 11 to the series of roof supports 4. Each roof support has a valve assembly 12 connected to the supply line 11 by a branch supply line 13. A hydraulic fluid return line 14 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 batches, for example batches of four, and FIGURE 2 shows the first two batches. The roof supports 4 in each batch can be caused to advance one after the other, after advance of the conveyor 1 (as will be described later), and the advance of the roof supports in each batch is controlled by batch control valves 16. In each batch, a hydraulic pilot line 17 connected to the control valve 16 at one end of the batch is connected to the valve assembly 12 of each roof support 4 in the batch in turn and is then connected to the control valve 16 at the other end of the batch. 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.

One or more manually-operable safety valves 10 are located at suitable positions in each pilot line 17, and when operated open the relevant pilot line 17 to atmosphere or to the return line 14.

The operation of the valve assembly 12 of each roof support 4 will now be described with reference to FIGURE 3. The valve assembly 12 of a room 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 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 level 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 35, 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 resetting 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 piston 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.

A control valve 16 will now be described with reference to FIGURE 4. The control valve 16 includes a housing 65 made up of various parts secured together and including two valve members 66, 67 urged by springs 68, 69 respectively against valve seats 71, 72 respectively. When valve member 66 is engaging valve seat 71, a chamber 73 communicating with the branch supply line 18 is isolated from a chamber 74 communicating with the pilot line 17 connected to the adjacent roof support on the left-hand side of the control valve 16. Similarly, when valve member 67 is engaging valve seat 72, a chamber 75 communicating with the branch supply line 18 is isolated from a chamber 76 communicating with the pilot line 17 connected to the adjacent roof support on the right-hand side of the control valve 16.

Each valve member 66, 67 is movable away from the respective valve seats 71, 72 by plungers 77, 78 respectively. A pivotally-mounted lever 79 is manually operable to alternatively actuate the plunger 77 or the plunger 78. The plunger 77 has a bore 81 which extends from the end of the plunger 77 adjacent the valve member 66 to a chamber 82 communicating with the branch return line 19. Similarly, the plunger 78 has a bore 83 which extends from the end of the plunger 78 adjacent the valve member 67 to a chamber 84 communicating with the branch return line 19. Chamber 82 contains a spring 85 urging the plunger 77 away from the valve member 66, and chamber 84 contains a spring 86 urging the plunger 78 away from tthe valve member 67.

Chamber 74 communicates not only with a pilot line 17 but also communicates through a conduit 87 with a latch assembly 88. The latch assembly 88 includes a plunger 89, one end of which is engageable in a recess 91 in the lever 79 when the lever 79 has been moved in an anti-clockwise direction to cause plunger 77 to move valve member 66 away from the valve seat 71. A piston 92 is a running fit on the plunger 89, and a spring 93 urges the piston 92 and plunger 89 away from the lever 79, the piston 92 engaging a shoulder 90 on the plunger 89.

When chamber 73 is brought into communication with chamber 74 by movement of lever 79, thus pressurising the pilot line 17, conduit 87 is also pressurised and the pressure acts on piston 92 and overcomes the force exerted by spring 93 so that piston 92 is moved to the right. Plunger 89 is then manually pushed into the recess 91 so as to hold the lever 79 in the anti-clockwise position. The strength of spring 93 is so chosen that, when the pressure in pilot line 17 falls to a predetermined value, the spring 93 moves the piston 92 and plunger 89 to the left, thus releasing lever 79. The lever 79 and plunger 77 are then returned to the position shown in FIGURE 4 by the

spring 85, and spring 68 forces valve member 66 onto its valve seat 71. The pilot line 17 is thus isolated from the branch supply line 18 and brought into communication with the branch return line 19.

The end of plunger 89 remote from the lever 79 has a knob 94 which can be pulled, when the plunger 89 is engaging the lever 79, to cause the plunger 89 to move relative to the piston 92 and release the lever 79.

A latch assembly 95 similar to the latch assembly 88 communicates with chamber 76 by way of conduit 96, and includes a plunger 97 which is engageable in a recess 98 in the lever 79 when the lever 79 has been moved to a clockwise position to cause valve member 67 to be moved away from its valve seat 72 by plunger 78.

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, it is necessary to advance the conveyor 1 in front of these roof supports and then to advance the roof supports. Each roof support with a conveyor-advancing jack 8 is operated to cause the jack 8 to apply an advancing force to the conveyor 1, the roof support being set against the roof and acting as an anchorage. This is achieved by pivoting lever 32 (FIGURE 3) in an anti-clockwise direction to open valve unit A and thus pressurise the line 23 and the pushing side of jack 8. Fluid in the opposite side of jack 8 leaves by way of the cylinder 7, line 24, valve C, and line 15 to return line 14. This movement of lever 32 may be caused by manual operation of lever 32 or by pressurisation of a hydraulic line 99 connected to valve unit B. The line 99 may be connected through a manually or remotely controlled valve (not shown) 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 pressurised in the conveyor-advancing sense, a spring-operated latch 101 holds the lever 32 in this position; details have been omitted herein, but see U.S. Serial No. 394,359, filed September 3, 1964. 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, since the valve unit C is shown open, and valve unit D is shown closed, and such movement does not change their status. If lever 33 is moved in a clockwise direction, however, valve unit C is closed and valve unit D is opened. The latch 101 is connected to the pilot line 17 in such a manner that a subsequent pressurisation 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 roof supports 4 can then be advanced. The control valve 16 at the left hand end of the first batch is operated (in a manner to be described in more detail later) to pressurise 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 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 contacts and takes no part in advancing the support.

Line 24 is also connected by a line 69 to valve unit F, and the pressurisation 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 piston rod **64** of the jack **7** engages the piston rod **61** and opens the re-setting valves **53**. The line **58** is therefore brought into communication with the main supply line **11** through the branch supply line **13**, 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**. 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 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.

Before a control valve **16** is operated to pressurise a pilot line **17**, one pilot line **17** is in communication with the branch return line **19** through chamber **74**, bore **81** and chamber **82**, and the other pilot line is in communication with the branch return line **19** through chamber **76**, line **83** and chamber **84**. Thus both pilot lines **17** are in communication with the branch return line **19**. When the control valve **16** is operated to pressurise the pilot line **17** leading to the right, handle **79** is pivoted in a clockwise direction to depress plunger **78**. The plunger **78** engages valve member **67** which closes the end of bore **83** and thereby isolates the pilot line **17** from the branch return line **19**. Further movement of plunger **78** moves valve member **67** off its valve seat **72** and chamber **75** is brought into communication with chamber **76** thereby pressurising the pilot line **17**. Conduit **96** is also pressurised, with the result that plunger **97** is moved to the left and engages recess **98** to hold lever **79** in the clockwise position.

Lever **79** is held in this clockwise position in which the pilot line **17** is pressurised, until plunger **97** is pulled out of recess **98** manually or until the pressure in pilot line **17** falls to a predetermined valve to cause the spring in latch assembly **95** to move plunger **97** out of recess **98**. Normally, such a fall in pressure occurs when all the roof supports in a batch have advanced, since the last roof support opens the pilot line **17** to the next control valve **16** and therefore to the branch return line **19**. A fall in pressure will also occur if a serious leak occurs in the hydraulic system. Further, the sequential advance of the roof supports in a batch, once started, can be stopped at any time by manual operation of one of the safety valves **10** in the batch pilot line **17**, since operation of the safety valve

10 opens the pilot line **17** to atmosphere and the resulting fall in pressure causes release of the lever **79** by the latch assembly **95**.

By appropriate operation of the control valves **16**, the roof supports **4** in each batch can be advanced in a sequence which travels from left to right along the batch or in a sequence which travels from right to left along the batch.

If desired, each roof support can be operated manually by operation of levers **32**, **33** and **34**. Also, instead of or additionally to each control valve **16** being arranged for manual operation, each control valve **16** may be arranged for operation from a remote position, for example from an end of the working face **2**.

We claim as our invention:

1. An advanceable roof support assembly including a series of advanceable fluid-pressure-operated roof supports, a conduit connected to each roof support in turn, each roof support including a valve assembly responsive to the receipt of a fluid-pressure signal along said conduit to cause the roof support to undergo an advancing operation and responsive to the completion of the advancing operation to pass the signal on along said conduit, a source of fluid pressure and a control valve operable to connect the conduit to the source of fluid pressure to cause the signal to pass along said conduit to each roof support in turn, the control valve including means responsive to a fall in pressure in said conduit below a predetermined value to cause the control valve to isolate the conduit from the source of fluid pressure.

2. A roof support assembly according to claim **1** wherein the valve assembly of the last roof support in the series to receive the signal along the conduit operates, upon completion of the advancing operation, to connect the conduit to low pressure so that the pressure in the conduit falls below the predetermined value with consequent isolating operation of the control valve.

3. A roof support according to claim **1** wherein at least one manually-operable safety valve is located in the conduit, and is arranged to be operable to reduce the pressure in the conduit below the predetermined value with consequent isolating operation of the control valve.

4. A roof support according to claim **1** wherein, when the control valve isolates the conduit from the source of fluid pressure, the control valve connects the conduit to a region of low pressure.

5. A roof support according to claim **3** wherein a plurality of manually operable safety valves are located at intervals along the conduit, each such safety valve being operable to reduce the pressure in the conduit below the predetermined value, with consequent isolating operation of the control valve.

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