Aug. 3, 1965 M. C. POTTS ETAL 3,198,087

ROOF SUPPORT ASSEMBLIES

Filed Aug. 26, 1963 2 Sheets-Sheet 1

FIG.1.

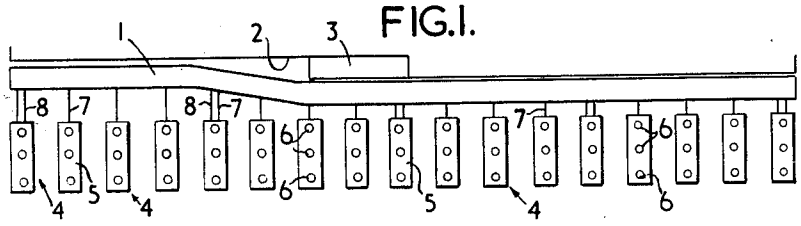



FIG 2

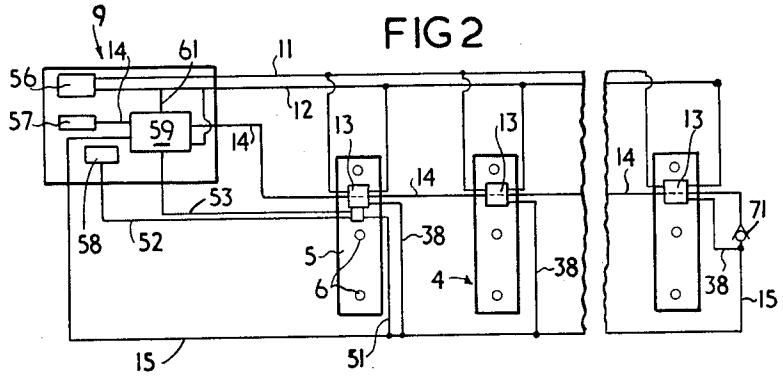
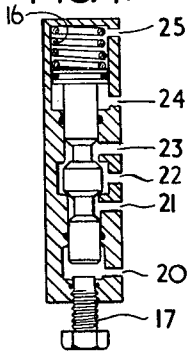



FIG.4.



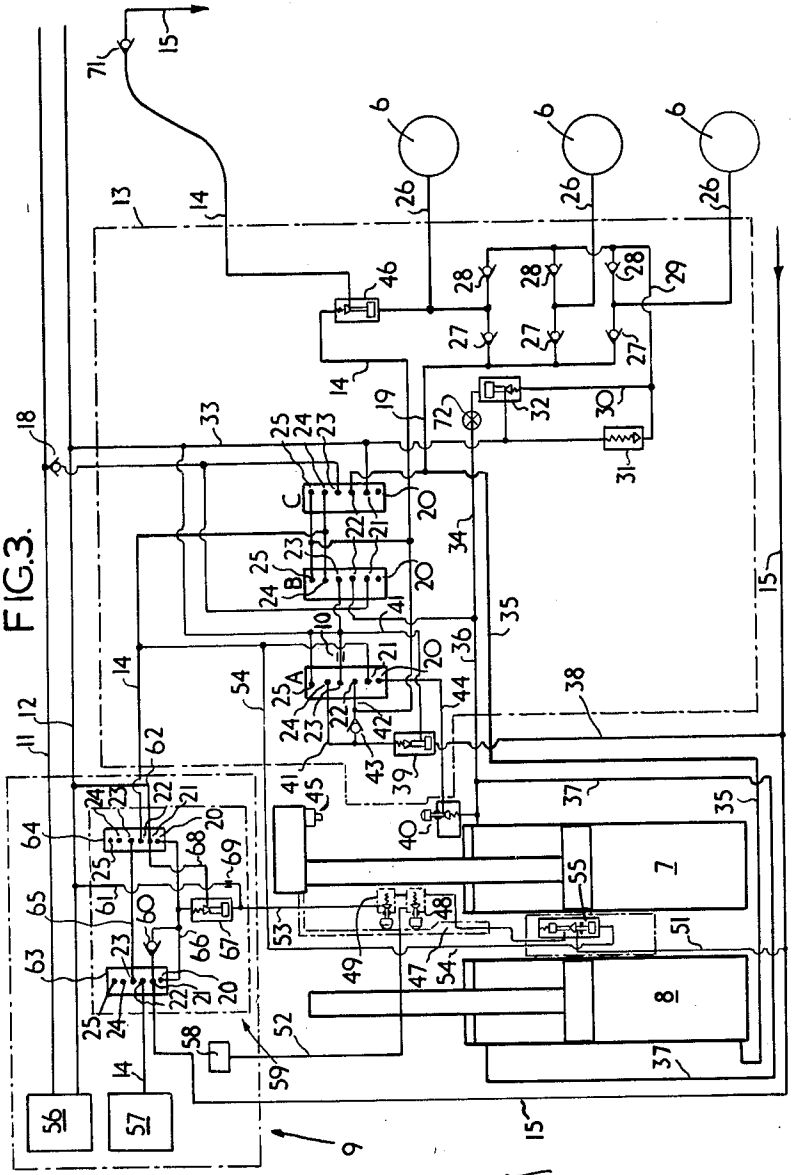

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FIG.3.



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3,198,087

# ROOF SUPPORT ASSEMBLIES

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Claims priority, application Great Britain, Sept. 3, 1962, 33,755/62
8 Claims. (Cl. 91—189)

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

The present invention concerns a roof support assembly of the general type that includes a series of roof supports advanceable in a predetermined sequence, each roof support including a fluid-pressure-operable control valve assembly whose operation causes the roof support to undergo an advancing operation, means for sending a fluid-pressure signal to initiate operation of the control valve assembly of the first roof support in the sequence, each control valve assembly being operable, following advance of its own roof support, to send the signal to the next roof support in the sequence, to initiate operation of its control valve assembly, a conduit associated with the control valve assembly of the last roof support in the sequence in such a manner that completion of the advancing operation of the last roof support in the sequence causes a fluid pressure to occur in the conduit, the roof support assembly, according to this invention, also including valve means, hereinafter referred to as a change-over valve, having an inlet connectable to a source of fluid pressure and being operable to connect the inlet alternatively to the signal sending means, to await a signal from the last roof support of the series, or to the conduit, to initiate advance of the first roof support of the series.

The occurrence of a fluid pressure in the conduit is caused by the completion of the advancing operation of the last roof support in the sequence, and this fluid pressure so occurring may cause the inlet of the valve means to be connected to the conduit.

When the inlet of the valve is connected to the conduit, the valve may become locked in this position until a new advancing sequence is selected, the means locking the valve being independent of a loss of pressure from the source of fluid pressure. The locking means is the subject of our allowed application Serial No. 302,786, filed August 19, 1963.

The locking means may include means for trapping fluid under pressure.

One embodiment of the 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, with the hydraulic connections and roof bars omitted,

FIGURE 2 is a similar view on a larger scale of part of the mining apparatus, showing the hydraulic connections,

FIGURE 3 is a similar view showing the hydraulic circuit associated with the power unit and with the first roof support and,

FIGURE 4 is a diagrammatic axial sectional view showing the construction of a hydraulic valve unit, three of which are associated with each roof support, and two of which constitute the change-over valve means of this invention.

With reference to the accompanying drawings, a coal mining apparatus includes a conveyor **1** which extends along the working face **2** of a coal mine and acts as a guide means for a coal cutting machine **3**. A series of roof supports **4** are arranged along the working face and



lie on the opposite side of the conveyor **1** to the working face **2**.

Each roof support **4** includes a ground-engaging sole beam **5** which carries a number, for example three as shown, of hydraulically-operable telescopic props **6** and a roof-engageable bar (not shown) carried by the props **6**. Each roof support **4** is connected to the conveyor **1** by a single-acting hydraulically-operable jack **7** anchored to the conveyor and used for advancing the support **4** up to the conveyor **1** serving as an anchorage, and some roof supports (for example every fourth roof support as shown) are additionally connected to the conveyor **1** by a double-acting hydraulically-operable jack device **8** for advancing the conveyor relative to the roof support **4** using the roof support **4** as an anchorage.

A hydraulic power unit **9** is located at one end of the working face and a main hydraulic pressure line **11** and a hydraulic return line **12** extend from and to the main pressure source **56** of the power unit **9** along the working face. Each roof support **4** includes a hydraulic control valve assembly **13** to which the pressure and return lines **11**, **12** are connected. Each control valve assembly **13** controls the supply of hydraulic fluid to and the return of hydraulic fluid from the props **6** and the jack or jacks **7**, **8** of the roof support **4**.

With the exception of the last roof support in the series, the control valve assembly **13** of each roof support **4** is connected to the control valve assembly of its adjacent roof support in one direction, from left to right in the drawings, along the working face by a main hydraulic pilot line **14** which is also connected between the pilot pressure source **57** of the power unit **9** and the control valve assembly **13** of the first roof support **4**. A secondary hydraulic pilot line **15** to which the main pilot line connects after the last roof support has been advanced extends from the control valve assembly of the last roof support in the series to the power unit **9** and is connected by a branch line **38** to the control valve assembly of every roof support.

As shown in FIGURE 3 the control valve assembly **13** of each roof support **4** includes three valve units A, B and C, each of which is constructed as shown in FIGURE 4. Each valve unit A, B or C is a six-ported two-position valve. When a valve unit is in the position shown in FIGURE 4, which position will be referred to as the neutral position, port **22** is in communication with port **23**. When a valve unit is caused to take up its other position, for example by application of hydraulic pressure to port **20** or port **24**, which position will be referred to as the operated position, port **22** then communicates with port **21** instead of port **23**. The valve unit is resiliently urged towards its neutral position by a spring **16** and can be brought into the operated position manually by turning a screw **17**.

As shown in FIGURE 3, the main pilot line **14** on entering the control valve **13**, is connected to the ports **24** of valve units B and C. The main pressure line **11** is connected through a non-return valve **18** to port **23** of valve unit C and port **21** of valve unit B. The return line **12** is connected to port **21** of valve unit C, to port **23** of valve unit B, to port **25** of valve unit A and through a restrictor **10** to port **23** of valve unit A. Ports **20** of valve units B and C are not used.

Initially, when the main pressure line **11** has been pressurised and before the main pilot line **14** is pressurised, valve units A, B and C are in their neutral positions. Thus, the main pressure line **11** communicates with the props **6** through valve unit C, line **19**, and three lines **26** which each includes a non-return valve **27** and are connected to the props **6**. The props **6** are therefore pressurised and the roof support is in a roof-supporting condition. The props **6** are also connected through lines **26**

and non-return valves 28 with lines 29, 30 connected to a prop relief valve 31 and a prop release valve 32 respectively.

If the hydraulic pressure in any one of the props 6 exceeds a predetermined maximum, the relief valve 31 is operated by the pressure to allow fluid to escape through valve 31 and line 33 to the return line 12. The prop release valve 32 can be operated to connect line 30 to line 33 and the return line 12, so as to collapse the props 6, by the pressurisation of line 34 which is connected to the release valve 32. This operation will be described later.

Also, before the main pilot line 14 is pressurised, the main pressure line 11 communicates through valve unit C with line 35 which is connected with the pushing side of conveyor advancing jack 8. Thus the conveyor 1 is continuously urged towards the working face 2 when the props 6 are set and the roof support is in a roof-supporting condition.

The return line 12 is connected through line 33, ports 23 and 22 of valve unit B with line 34 and line 36. Line 36 is connected to the pulling side of support advancing jack 7, and to line 37 which is connected to the pulling side of conveyor advancing jack 8.

The secondary pilot line 15 is connected by the line 38 to a valve unit 39 in such a manner that pressurisation of line 38 opens the valve unit 39. Valve 39 is connected in a line 41 which is connected to port 24 of valve unit A and the return line 12.

A line 42 is connected between port 22 of valve unit A and line 41 and includes a non-return valve 43 which allows flow from port 22 of valve unit A to line 41 and prevents flow in the opposite direction.

A line 44 connected between port 20 of valve unit A and line 36 includes a valve unit 40 which is opened by a projection 45 adjacent the leading end of the support advancing jack 7 when the jack 7 is fully or nearly fully contracted, i.e. when the support 4 has been advanced up to the conveyor 1. One of the lines 26 is connected to a valve unit 46 in line 14 in such a manner that the presence of a prop-setting pressure in line 26 opens the valve unit 46.

Thus, to summarise the foregoing description of the control valve assembly 13, when the main pressure line 11 has been pressurised and before the main pilot line 14 has been pressurised, the condition of valve units A, B and C are such that the props 6 are set, the conveyor advancing jack 8 is pushing the conveyor 1 forward and the support advancing jack 7 is free, i.e. it is neither pushing or pulling.

The further operation of the control valve assembly 13 will be described when the operation of the mining apparatus as a whole is described.

The support advancing jack 7, whose extension is a measure of the distance through which the conveyor 1 has been advanced relative to the support 4, carries a cam member 47 which is associated with two valve units 48, 49. Valve unit 48 is connected on one side to the secondary pilot line 15 via line 51 and on the other side to the power unit 9 via line 52 and to one side of the valve unit 49. The other side of valve unit 49 is connected to the power unit 9 via line 53. Also, the line 51 includes a valve unit 55 which opens when the pressure in a line 54 connected to the main pilot line 14 has fallen to a predetermined value.

The power unit 9 includes a main pressure source 56 to which the main pressure line 11 and return line 12 are connected, a pilot pressure source 57 to which the main pilot line 14 is connected, a warning device 58 to which line 52 is connected, and a change-over valve 59.

The change-over valve 59 is connected in the main pilot line 14 and is connected to the secondary pilot line 15, to line 53 and to the return line 12 by lines 61, 62. The change-over valve 59 includes two valve units 63, 64 which are similar in construction to valve units A, B and C in the control valve assemblies 13. Ports 24 and 25



of valve units 63, 64 are not used, ports 23 are connected to one another by line 65, port 22 of valve unit 63 is connected to the pilot line 14, port 21 is connected to the secondary pilot line 15 and through a non-return valve 60 to a line 66 connected to both ports 20 and to one side of a valve unit 67. The other side of valve unit 67 is connected to port 21 of valve unit 64 by line 68 and thence to the return line 12 via line 62. Port 22 of valve unit 64 is connected to the pilot line 14. Valve unit 67 is opened by a predetermined pressure in line 53 which is connected to the return line 12 by line 61 which includes a restrictor 69.

In the neutral position of valve units 63, 64 line 65 connects the portion of main pilot line 14 leading from the pilot pressure source 57 to the portion of the main pilot line 14 leading to the control valve 13 of the first roof support. Therefore, line 65 is a portion of the main pilot line 14.

The function and operation of the apparatus described above will become clear from the following description of a complete cycle of operations of the apparatus.

Initially, the valve units A, B and C of the control valve assembly 13 of every roof support 4 are in their neutral positions with the result that, assuming the main pressure source 56 to be pressurising the main pressure line 11, all the roof supports are set against the roof, all the conveyor advancing jacks 8 are urging the conveyor 1 towards the coal face and all the support advancing jacks 7 are free.

As the cutter 3 moves to and fro along the working face 2 in coal-cutting operations, the cutter 3 and the conveyor 1 are advanced by the conveyor advancing jacks 8 reacting from the anchored support. Thus the jacks 8 together with the free support advancing jacks 7, gradually extend. Eventually it will become necessary for the roof supports 4 to be advanced, one by one, towards the conveyor 1.

To initiate the first advancing sequence of the roof supports 4, the pilot pressure source 57 is switched on to pressurise that portion of the main pilot line 14 which passes through the change-over valve 59 and enters the control valve assembly 13 of the first roof support 4. The main pilot pressure operates valve units B and C causing the ports 22 to communicate with their ports 21 instead of their ports 23. Thus, the operation of valve unit B causes main pressure from main pressure line 11 to be applied to lines 34, 36, 37. Pressure in line 34 opens valve unit 32 to cause release of the props 6 and hence release of the roof support from the roof; pressure in line 36 pressurises the pulling side of the support advancing jack 7, which is connected to the conveyor 1, to cause the roof support to advance towards the conveyor 1, the latter acting as an anchorage, and pressure in line 37 causes the conveyor advancing jack 8 to retract since it is not actually connected to the conveyor 1. The pushing side of conveyor advancing jack 8 is connected by operation of valve unit C to the return line 12 through lines 35, 33 and it will be seen that line 19 is similarly connected to the return line 12, thus enabling the props 6 to collapse. The pushing side of support advancing jack 7 is permanently connected to atmosphere by a port (not shown).

When the roof support 4 is nearly fully advanced up to the conveyor 1, the projection 45 on the leading end of support advancing jack 7 engages and opens valve unit 40 which causes line 44 to become pressurised from line 36. Thus, valve unit A is operated. Pilot pressure at port 21 is thus communicated to port 22 and therefore through lines 42 and 14 to valve unit 46 and through non-return valve 43 and line 41 to port 24. Since valve unit 39 is closed, the pressure is now trapped in port 24 and the valve unit A is locked by this pressure in the operated position.

Pilot pressure in line 14 is also applied to ports 25 of valve units B and C which are thereby returned to their

neutral positions. Thus the props 6 are pressurised to return the roof support to a roof-supporting condition, the pulling sides of support advancing jack 7 and conveyor jack 8 are connected to the return line 12 and the pushing side of conveyor advancing jack 8 is connected to the main pressure line 11. Thus, after an advance of the roof support, valve unit 40 is actuated to cause the roof support 4 to become reset against the roof and to cause the conveyor advancing jack 8 to resume pushing the conveyor 1 forwardly.

If necessary, line 35 may include a restrictor to ensure that the conveyor advancing jack 8 does not resume pushing the conveyor 1 forwardly until the props 6 have had sufficient time to reset the roof support against the roof.

The attainment of a satisfactory pressure in the props 6 and hence in lines 26 causes valve unit 46 to open. Thus, when the roof support has been satisfactorily reset against the roof, valve unit 46 opens and pilot pressure in line 14 is passed on to the next roof support in the series, and this next roof support now undergoes an advancing operation.

Each roof support in turn advances and when the valve unit 46 in the control valve assembly 13 of the last roof support 4 in the series opens, main pilot pressure is applied through a non-return valve 71 to the secondary pilot line 15.

Pressurisation of the secondary pilot line 15 indicates that an advancing sequence of the roof supports has been completed and, if desired, an indicating means for this purpose may be provided on the power unit 9. Since the secondary pilot line 15 is connected at the change-over valve 59 through port 21 of valve unit 63, non-return valve 60 and line 66 to ports 20 of valve units 63 and 64, these valve units are operated. Thus the main pilot line 14 is broken, the portion leading to the pilot pressure source 57 being connected to the secondary pilot line 15 and the portion leading to the control valve assembly 13 of the first roof-support (and to the control valve assemblies of all the other roof supports) is connected to the return line 12. Since valve unit 67 is closed, pressure is now locked in line 66 by non-return valve 60 and valve units 63 and 64 are held in the operated position.

Therefore, the portion of the main pilot line 14 passing from the change-over valve 59 through the control valve assemblies 13 of all the roof-supports 4 to the non-return valve 71 is de-pressurised. Also, pressure in the secondary pilot line 15 opens the valve unit 39 in each control valve assembly 13 to connect line 41 to the return line 12, hence unlocking the valve units A which return to their neutral positions.

Thus, the hydraulic circuit has now been brought back to its initial condition, with the exception that the portion of the main pilot line between the pilot pressure source 57 and the change-over valve 59 is connected to and pressurises the secondary pilot line 15.

As the pressure in the portion of the main pilot line 14 extending from the change-over valve 59 through the various control valves 13 drops, the pressure in line 54 drops also and, when a predetermined low pressure has been reached, valve unit 55 opens and allows the pressure in the secondary pilot line 15 to reach one side of the valve unit 48 and one side of valve unit 49 through line 51. The purpose of valve unit 55 will be explained later.

As the cutter 3 continues to cut coal, the conveyor advancing jacks 8 will push the conveyor 1 forward and, with the support advancing jack 7, gradually extend. When the support advancing jack 7 of the first roof support has extended a predetermined amount (less than and preferably about three-quarters of the full extension), the cam member 47 will engage and open valve unit 48 to cause line 52 to be pressurised from line 51 and the secondary pilot line 15. Pressurisation of line 52 operates the warning device 58 and this indicates that an advancing sequence will shortly be starting. A further small extension of the support advancing jack 7 causes the cam member 47 to engage and open valve unit 49 to cause line 53 to become pressurised from line 51 and the secondary pilot line 15. Pressurisation of line 53 opens valve unit 67 and line 66 is connected to the return line 12 via lines 68 and 62. Thus, the valve units 63 and 64 are unlocked and return to their neutral positions. The portion of the main pilot line 14 leading from the pilot pressure source 57 to the change-over valve 59 is therefore re-connected by line 65 to the portion of main pilot line 14 leading to the control valve assembly 13 of the first roof support, and the pressure from the main pilot source 57 initiates an advancing operation of the first roof support and, therefore, all the roof supports advance in turn. The pressure in the secondary pilot line 15 leaks away to the return line 12 via lines 51, 53 and 61.

Thus, every time the conveyor 1 is advanced a predetermined distance in front of the first roof support (a distance less than the full extension of the jack 7), cam member 47 opens valve unit 49 to initiate a fresh advancing sequence provided, of course, that the previous advancing sequence has finished. If the previous advancing sequence has not finished there is no pressure in the secondary pilot line 15 and the opening of the valve unit 49 will not cause opening of the valve unit 67. When the previous advance sequence finishes, pressurisation of the secondary pilot line 15 will cause the change-over valve 59 to operate, and the portion of the main pilot line 14 passing through the control valve assemblies 13 will be de-pressurised to eventually cause valve unit 55 to open and allow pressure from the secondary pilot line 15 to reach valve unit 67 through already open valve unit 49.

The apparatus described is used with those cutters 3 which have to be continually urged against the working face 2. The speed of operation of the cutter 3 and the time taken for an advancing sequence of the series of roof supports to be completed are so arranged that, when an advancing sequence has been initiated by the predetermined extension (preferably about three-quarters of the full extension) of the support advancing jack 7 of the first roof support 4, the advancing sequence is completed before any conveyor advancing jack 8 has become fully extended. If a conveyor advancing jack 8 did become fully extended the cutter 1 would not be urged against the portion of the working face 2 in front of the jack 8.

If there is a power failure or if the power unit 9 is shut down when an advancing sequence has commenced but not finished, the locking in their operative positions of valve units A of the control valve assembly 13 of those roof supports which have advanced ensures that, when the power unit 9 is re-started, the advancing sequence carries on from the position along the series of roof supports that it had previously reached. If the valve units A were not locked in their operative positions after the advance of their roof supports they may have reverted to their neutral positions because the system pressure has leaked away and subsequent re-starting of the power unit 9 would cause a fresh advancing sequence to commence instead of the previously-commenced sequence finishing.

If there is a power failure or if the power unit 9 is shut down when an advancing operation has been completed, and a fresh advancing operation has not started, the locking in their operative positions of valve units 63 and 64 in the change-over valve 59 ensures that, when the power unit 9 is re-started, the secondary pilot line 15 is re-pressurized. If valve units 63 and 64 were not locked in their operating positions, they may have reverted to their neutral positions because the system pressure has leaked away and subsequent re-starting of the power unit 9 would

cause a fresh advancing sequence to commence straight away, instead of being commenced by the opening of the valve unit **49**.

As described previously, the valve units A, B, C, and the valve units **63**, **64** are constructed in the manner shown in FIGURE 4 and can be manually operated if desired, so that the position of any roof support in the series can be adjusted by manual operation of screw **17** if necessary.

The valve unit **55** ensures that a fresh advancing sequence cannot be initiated until the pressure in the portion of the main pilot line **14** passing through the control valve assemblies **13** of the roof supports has fallen sufficiently to ensure that all the valve units A, B and C are in their neutral positions.

In one installation of the described apparatus, the full pressure in the main pressure line **11** was 3,000 lbs. per sq. in., and the pressure in the main pilot line **14** was 1,700 lbs. per sq. inch. The advancing sequence was initiated when the support advancing jack **7** (whose maximum extension was 24 inches) had extended 15 inches.

An advancing sequence of the series of roof supports took 15 minutes and the cutter **3** cut 3 inches every 8 minutes.

In this installation, each control valve **13** includes a manually-operable valve unit **72** in line **34**. This valve unit **72** is normally left open but, if a support is manually operated, the valve unit **72** can be closed manually to prevent release of the props **6** when pressure is applied to the pulling side of the support advancing jack **7**. This enables the conveyor to be moved backwards if necessary.

Although in the described embodiment, the locking of the valve units **63** and **64** in the change-over valve **59** is achieved by means of a trapped fluid under pressure, a similar effect may also be obtained by means of a mechanical latch.

We claim as our invention:

**1.** A roof support assembly for use in mines, including a series of roof supports advanceable in a predetermined sequence, means operatively connected to each roof support to advance the same, control means operable to send a signal to the first roof support in the sequence to initiate the advance of said first roof support, a signaling means operatively associated with each roof support, and operable upon completion of the advance of its roof support to send a signal to the next roof support in the sequence and so to initiate advance of said next roof support, said control means including a signal source and a cut-off device operable to isolate the signal source from said first roof support, locking means for locking the cut-off device in the isolating position independently of a future loss of a signal from the signal source, and release means operable to release said locking means.

**2.** A roof support assembly as in claim **1**, including a fluid pressure signal source, the signaling means for the first and all subsequent roof supports being arranged for operation by a fluid pressure signal.

**3.** A roof support assembly as in claim **1**, including a fluid pressure source, the locking means including valve means for trapping fluid under pressure.

**4.** A roof support assembly as in claim **1**, including actuating means operated by completion of the advancing operation of the last roof support in the sequence to operate the cut-off device to isolate the signal source from the first roof support.

**5.** A roof support assembly as in claim **4**, including a fluid pressure signal source, the control means being operable to send a fluid pressure signal to the first roof support, and wherein the actuating means includes a conduit arranged to be pressurized by fluid from said source upon completion of the advancing operation of the last roof support, and operatively connected to the cut-off device, to actuate the latter and so to isolate the signal source from the first roof support.

**6.** A roof support assembly as in claim **5**, wherein the release means is also operatively connected to said conduit, and is operable by pressure therein to unlock the locking means.

**7.** A roof support assembly as in claim **6**, wherein the cut-off device is arranged to connect the signal source to the conduit by actuation of the cut-off device to isolate the signal source from the first roof support.

**8.** A roof support assembly for use in mines, including a series of roof supports advanceable in a predetermined sequence, means operatively connected to each roof support to advance the same, control means operable to send a fluid-pressure signal to the first roof support in the sequence to initiate the advance of said roof support, a signalling means operatively associated with each roof support, and operable upon completion of the advance of its roof support to send a fluid-pressure signal to the next roof support in the sequence and so to initiate the advance of said next roof support, said control means including a fluid-pressure signal source and a cut-off device operable to isolate the signal source from the first roof support, and actuating means including a conduit arranged to be pressurized by fluid from said source upon completion of the advancing operation of the last roof support, and fluid-pressure signal source and a cut-off device operable latter and so isolate the signal source from the first roof support, the cut-off device being arranged to connect the signal source to the conduit when the cut-off device is isolating the signal source from the first roof support.

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FRED E. ENGELTHALER, *Primary Examiner.*

# UNITED STATES PATENT OFFICE

# CERTIFICATE OF CORRECTION

Patent No. 3,198,087

August 3, 1965

Michael Charles Potts et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 8, line 42, strike out "fluid-pressure signal source and a cut-off device operable" and insert instead -- operatively connected to the cut-off device to actuate the --.

Signed and sealed this 22nd day of February 1966.

EAL)
test:

NEST W. SWIDER
esting Officer

EDWARD J. BRENNER
Commissioner of Patents