Aug. 20, 1957 M. C. POTTS 2,803,444

MINE ROOF SUPPORT SYSTEMS

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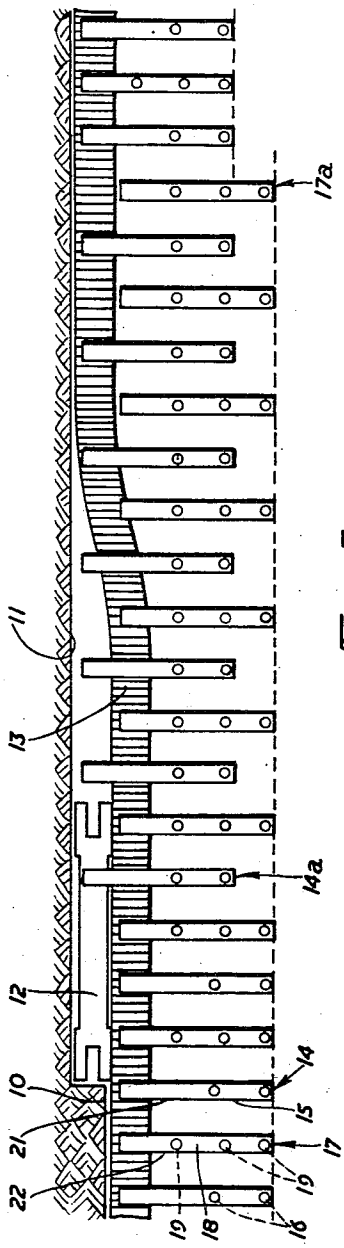

Fig. 1.

INVENTOR
MICHAEL CHARLES POTTS

BY
Reynolds, Beach & Christensen
ATTORNEYS

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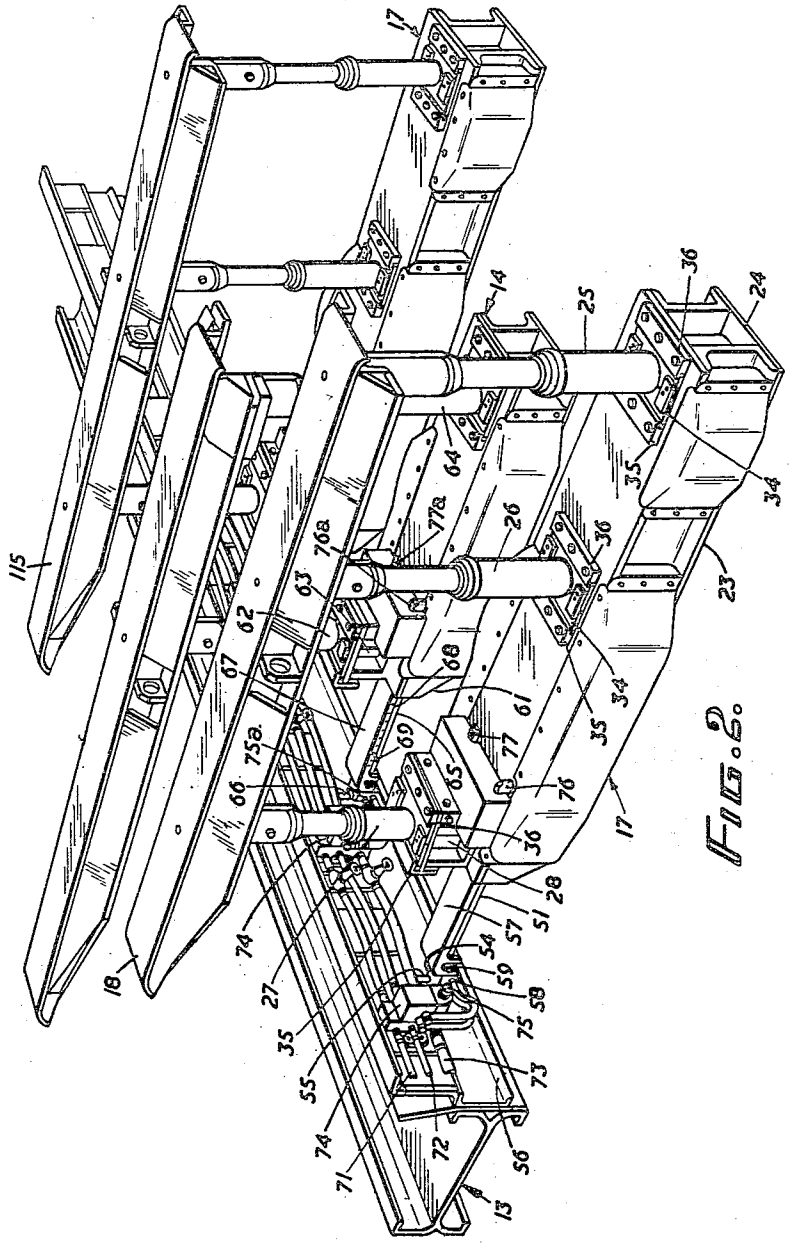

FIG. 6.

INVENTOR.
MICHAEL CHARLES POTTS
BY
Reynolds, Beach & Christensen
ATTORNEYS

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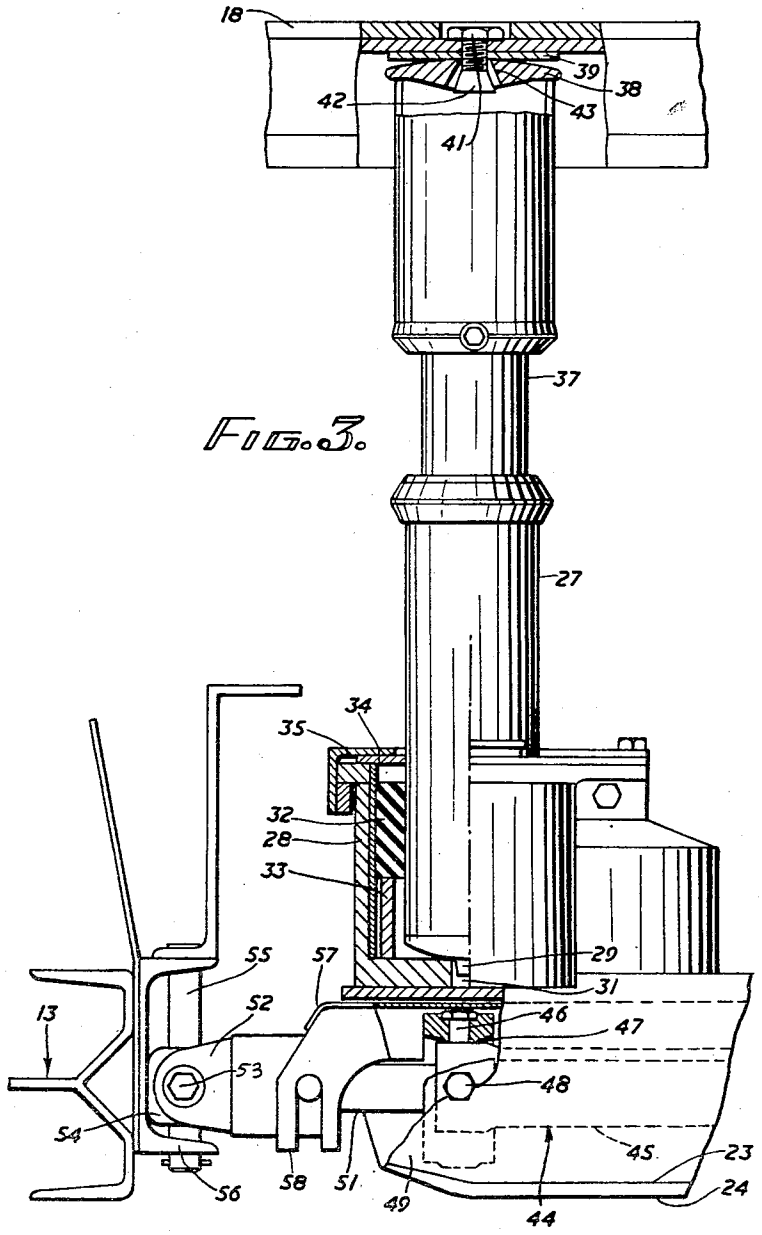

Fig. 3.

INVENTOR
MICHAEL CHARLES POTTS
BY
Reynolds, Beach & Christensen
ATTORNEYS

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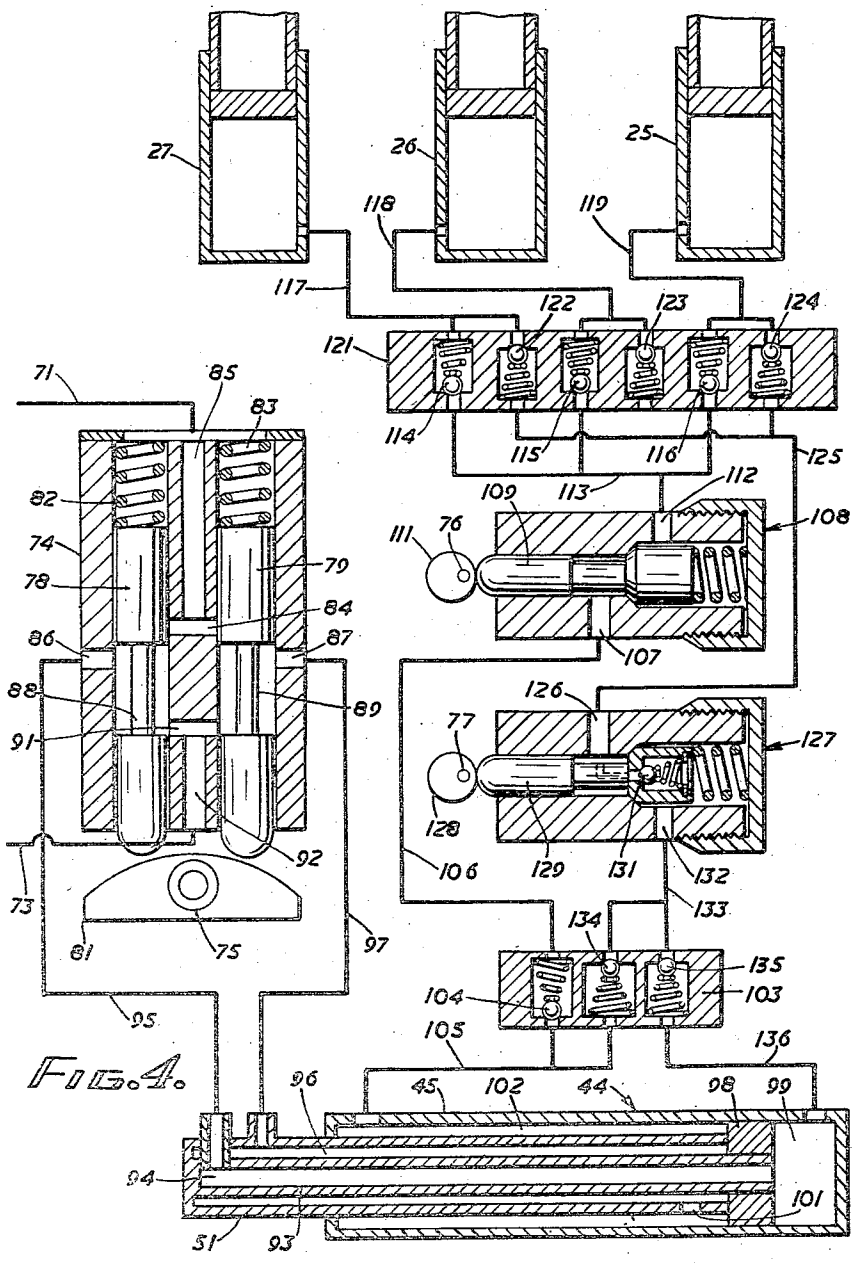

Fig. 4.

INVENTOR
MICHAEL CHARLES POTTS

BY
Reynolds, Beach & Christensen

ATTORNEYS

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MINE ROOF SUPPORT SYSTEMS

Michael Charles Potts, West Bridgford, England, assignor to Dowty Mining Equipment Limited, Tewkesbury, England

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8 Claims. (Cl. 262—1)

This invention relates to a method of and apparatus for supporting the roof of a coal mine in conjunction with coal cutting and conveying machinery constructed for mining operations by the long wall method. The term "coal cutting machinery" is used to comprehend cutter loaders, coal ploughs and the like which are arranged to traverse the long wall.

One object of the invention is to provide an improved system of support for the mine roof behind the newly cut face, while a related object is to reduce the time interval in the setting of the individual supports in this position.

Another object is to provide improved regulation in the controlled collapse of the mine roof behind the supports, and in particular to the determination of a uniform break-line behind which the roof may collapse after the removal of the support therefrom.

According to the invention, in a method of supporting the roof of a coal mine during long wall mining operations the method utilizes a plurality of extensible support units of two kinds disposed alternately along the coal face in connective association with an extended structure such as a conveyor framework, and each unit being constructed to provide extended support for the mine roof behind and over the structure; the method comprising the steps of releasing and advancing the support units of the first kind successively towards the newly cut face when the coal cutter has passed clear in its progress along the face, extending each unit so advanced to support the newly exposed roof, advancing the structure progressively towards the newly cut face in the wake of the coal cutter, releasing and advancing the support units of the second kind successively into alignment with the advanced support units of the first kind after the adjacent part of the structure has advanced fully to the position required for the next traverse of the coal cutter, and extending each unit so advanced to support the roof between the support units of the first kind.

The apparatus for carrying the method into effect comprises a plurality of support units each having a vertically adjustable roof bar, and being of two kinds disposed alternately in connective association with the structure, with their roof bars extending transversely thereto, the roof bars having forward cantilever extensions which are longer in the first kind of support unit than in the second so as to be capable of being advanced to a position in which they support the newly exposed roof in the wake of the coal cutter before the structure to which the units are connected can be advanced, and a feed jack forming the connection between the structure and each support unit for effecting relative movement between them.

The structure, to which the support units are connected, may be the framework of a conveyor which is installed along the coal face, the framework being articulated or otherwise inherently flexible so it can be advanced progressively over a part of its length. The important thing is not that the supports be connected to a conveyor frame,

but that there be a flexible framework of some sort with which the supports can cooperate.

The invention is illustrated in the accompanying drawings, of which:

Figure 1 is a diagram in plan view of the roof support systems in the mine, shown in simple form to illustrate the manner of operation;

Figure 2 is an isometric view of part of a conveyor with the roof supports which are associated with that part;

Figure 3 is a side elevation of the forward end of a roof support unit and its connection to the conveyor, certain parts of the support unit being broken away to show interior details, and

Figure 4 is a hydraulic diagram to illustrate the working of the hydraulic components of each unit.

In Figure 1, the coal face is shown at **10** on the left-hand side and the newly exposed coal face **11** at the centre and right, while a power-operated cutter loader **12** is moving to the left to extend the newly exposed face **11**. The cutter loader **12** is guided by a conveyor **13** which extends in a straight line along the coal face being cut and adjacent the cutter loader **12**, but it snakes forwardly behind the cutter loader and lies in a straight line along the newly exposed face **11** at the right-hand side of the diagram.

The roof over the long wall is supported by a plurality of support units of two kinds which are arranged alternately and extend transverse to the coal face at equal distances one from the other. Each roof support unit of the first kind **14** comprises a roof bar **15** supported by two hydraulic props **16** and will hereinafter be termed "a two prop unit." Each roof support unit **17** of the second kind comprises a roof bar **18** supported by three hydraulic props **19** and will hereinafter be termed "a three prop unit."

A cantilever portion of each roof bar extends forwardly over the conveyor, the cantilever extension **21** on each two prop unit **14** being longer than the cantilever **22** on each three prop unit **17**. The length of the cantilever **21** is such as to enable each two prop unit to be advanced towards the newly exposed face once the cutter loader **12** has passed it, while the length of the cantilever **22** of each three prop unit is such that the latter can only be advanced towards the newly exposed face **11** when the adjacent part of the conveyor has also been advanced towards the newly exposed face, the limitation of advance of the three prop unit being imposed by the proximity of the forward prop **19** of each unit **17** to the conveyor. While each three prop unit is better adapted to support the mine roof over the length of the roof bar, the provision of two prop units **14** alternating with them does enable a substantial degree of support to be given to the newly exposed roof in the wake of the cutter loader **12** by immediately advancing each two prop unit **14** as the cutter loader **12** passes.

Each roof support unit is connected to the conveyor **13** by means of a hydraulic jack, and this connection together with details of the construction of each unit will now be described with reference to Figures 2 and 3.

The three prop unit **17** shown in the foreground of Figure 2 comprises a box-section base member **23** whose lower face is formed as a skid plate **24**. A rear prop **25** and intermediate prop **26** are each socketed into the base member **23**, while a front hydraulic prop **27** is similarly socketed into a bucket-shaped mounting **28** which surmounts the forward end of the base member **23**. The base of the prop **27** is of shallow convex form and has a central spigot **29** projecting loosely into a central aperture **31** at the base of the mounting **28**. A collar **32** of rubber or like material surrounds the base portion of the prop **27** and it is raised within the mounting **28** by a distance piece

33 which rests on the bottom of the mounting. The prop 27 can thus rock to a certain extent from the vertical but is centralized by the rubber collar 32. Dirt is prevented from entering the mounting by a two-part shield plate 34 fitting around the prop, and whose front and rear edges are retained by front and rear flanges 35 and 36 respectively. Clearance is provided underneath the flanges for movement of the shield plate when the prop 27 rocks in both fore and aft and transverse directions. The telescopic portion 37 of the prop has a shallow convex cap 38 bearing within the roof bar 18 which is of inverted channel shape. Within the base of the channel a bearing plate 39 for the cap 38 is secured by a bolt 41 having a conical head 42 which extend with clearance through a central conical aperture 43 in the cap 38. The bolt 41 thus locates the head of the prop but permits limited angular movement to take place between the prop 27 and roof bar 18 as may arise when the props are engaged in thrust between a mine roof and floor which are not strictly parallel or which have other irregularities.

The rear prop 25 and intermediate prop 26 are mounted at their bases and top caps in similar manner, though the mountings for the bases are actually within the box-section base member 23. The mounting 28 for the forward prop 27 is arranged above the base member to allow the installation of a feed jack within the cavity in the forward part of the base member 23. This feed jack 44 shown in Figure 3 is double-acting and comprises a cylinder 45 whose forward end is held by vertical pivots 46 (see Figure 3) in a gimbal ring 47, the gimbal ring being supported in turn by transverse pivots 48 which project through opposite sides 49 of the box-section base member 23. The piston rod 51 extending from the cylinder 45 has a forked head 52 secured by a transverse pivot 53 on a block 54 which is in turn pivoted on a pin 55 mounted vertically in the side of the conveyor 13. The pin 55 is supported at its ends in a channel 56 at the side of the conveyor 13. The cylinder 45 and piston rod 51 are thus connected by universal joints to the base member 23 and conveyor 13 respectively which allow for angular misalignment, while the length of the pin 55 exceeds the height of the block 54 to allow for changes in level between the conveyor and the base member 23. The piston rod 51 is substantially protected by means of an extensible shield 57 comprising an inverted channel-shaped plate having slotted ears 58 engaged by a transverse pin 59 in the head 52 of the piston rod. The shield slides with the piston rod in the open forward end of the base member 23 and at all times covers the piston rod 51 from above.

The construction of each two prop unit is basically similar except that it has a shorter base member 61 having only two props, the front prop 62 being held in a mounting 63 which surmounts the base member 61, and a rear prop 64 which is socketed into the rear end of the base member. The roof bar 15 is, nevertheless, of the same length as the roof bar 18 of each three prop unit and is connected to the heads of the props 62 and 64 as described with reference to Figure 3. The base member 61 has the cylinder of a feed jack secured thereto by a gimbal bearing as in the three prop unit and the piston rod 65, visible in Figure 2, is connected to a pin 66 on the side of the conveyor 13 by a universal joint as shown in Figure 3. The piston rod 65 is likewise protected by a shield 67 though this shield has a number of transverse holes 68 into a selected one of which a stop bar 69 may be inserted for a purpose which will be described.

The distance between the front and rear props 62 and 64 is equal to that between the front and intermediate props 27 and 26 of the three prop unit while the distance between the intermediate and rear props 26 and 25 of the latter is substantially equal to the maximum advancing movement of each unit as provided by the feed jack.

The power for operating the feed jacks 45 and for setting the props is supplied by a hydraulic power unit, not shown, which supplies two pressure mains 71 and 72 and receives a return main 73, all three of which extend along the conveyor 13. One pressure main 71 supplies power for the three prop units while the other pressure main 72 supplies power for two prop units, but if desired a single pressure main can supply all the units. The supply and return of hydraulic fluid to each feed jack 44 is by way of a selector valve 74 mounted on the side of the conveyor, this valve 74 being operable by a control shaft 75 into which a Tommy bar for turning the shaft may be inserted. Each support unit has a pressurizing valve and a release valve disposed thereon behind the mounting 28 for the front prop, the pressurizing valve being operable by a control shaft 76 and the release valve being operable by a control shaft 77, Figure 2.

The construction and arrangement of the valves referred to will now be described in greater detail with reference to the hydraulic diagram of Figure 4. The selector valve 74 has valve plungers 78 and 79 shiftable by a rocker 81 on the control shaft 75 and loaded towards the rocker by springs 82 and 83 respectively. In the central position of the rocker 81, the plungers 78 and 79 close a pressure port 84 which is connected by a passage 85 with the pressure main 71. A feed port 86 opens into an annular space around a central stem 88 of the valve plunger 78, while a feed port 87 opens into a similar annular space around a central stem 89 of the valve plunger 79, the two spaces being interconnected by a return port 91 which is connected by way of a passage 92 with the return main 73.

The piston rod 51 of the feed jack 44 has a tubular insert 93 dividing a central passage 94 which is connected by line 95 with the feed port 86, from an outer passage 96 which is connected by line 97 with the feed port 87. The central passage 94 opens through the piston 98 into the piston chamber 99 of the jack while the outer passage 96 opens through an aperture 101 in the piston rod 51 into the rod chamber 102. If the control shaft 75 turns the rocker 81 to lift the plunger 78 so that it closes the return port 91 but opens the pressure port 84, then liquid from the pressure main 71 will pass through passage 85, and port 84, feed port 86, line 95 and central passage 94 into the piston chamber 99, while liquid from the rod chamber 102 will flow through aperture 101, outer passage 96, line 97, feed port 87, return port 91 and passage 92 into the return line 73. This will extend the feed jack 44 while contrary motion of the control shaft 75 will cause contraction of the feed jack 44. When the rocker 81 is in its neutral position, as shown, it is evident that both chambers 99 and 102 of the jack will communicate freely with each other and with the return main 73 through the valve 74.

A block 103 is situated adjacent the jack 44 and has a check valve 104 therein permitting flow from the rod chamber 102 through a connecting line 105 to another line 106 which is connected to the inlet 107 of the pressurizing valve 108. The pressurizing valve 108 has a spring-loaded plunger 109 which may be lifted by a cam 111 on the control shaft 76 to open the inlet port 107 to an outlet port 112. The outlet port 112 is connected by way of a branched line 113 with three check valves 114, 115, 116 which permit flow through lines 117, 118 and 119 into the hydraulic jacks 27, 26, 25 respectively. The check valves 114, 115, 116 are contained in a block 121 which houses three further check valves 122, 123 and 124 which permit flow through the lines 117, 118 and 119 from the props 27, 26 and 25 respectively into a branched line 125.

The branched line 125 is connected to an inlet port 126 of a relief valve 127 which is operable also as a release valve by means of a cam 128 on the control shaft 77, and a spring-loaded valve plunger 129. The inner end of the valve plunger 129 contains a spring-loaded relief valve 131 which opens under excessive pressure in the branched line 125 from any of the props 27, 26 or 25, to allow liquid to escape to the outlet port 132 of

the valve 127. Alternatively all three props can be released at will by turning the control shaft 77 and cam 128 to lift the plunger 129.

The outlet port 132 is connected by a line 133 with two further check valves 134 and 135 in the block 103, the valve 134 permitting flow into the line 105 which is connected with the rod chamber 102 of the jack cylinder 45, and the valve 135 permitting flow into a line 136 which is connected with the piston chamber 99. Thus the check valves 134 and 135 permit escape of pressure liquid at all times from the relief valve into either jack chamber 99 or 102, whichever is at low pressure, and thence through line 95 or 97 and the selector valve 74 to the return main 73.

The check valve 104 in the block 103, on the other hand, admits liquid from the rod chamber 102, when this is under pressure, to the pressurizing valve 108, and when the latter is operated, liquid may pass in the manner described to all three jacks 27, 26 and 25, and enable the roof bar carried thereby to be set against the roof of the mine.

Each two prop unit has a feed jack, a pressurizing valve and a relief valve incorporated in a hydraulic circuit as described with reference to Figure 4 with the exception there are two hydraulic props instead of the three illustrated. For the purpose of the ensuing description of the working of the support system, the feed jack of the two prop unit shown in Figure 2 has a control shaft 75*a* part of which is seen, a control shaft 76*a* for the pressurizing valve and a control shaft 77*a* for the release valve therein.

In Figure 1, the two and three prop units behind the coal face about to be cut are in line with their cantilevers 21 and 22 respectively overlying the conveyor which in that region is adjacent the coal face. The feed jacks 44 on each two prop unit will be fully extended while the feed jacks of the three prop units will be fully contracted. As soon as the cutter loader 12 passes each two prop unit to allow the latter to advance without interference therewith, the operator turns the control shaft 77*a* of the release valve to allow the roof bar 15 to fall clear of the mine roof, and by then turning the control shaft 75*a* of the selector valve, hydraulic pressure may be admitted into the rod chamber 102 of the feed jack 44 to contract the prop and thus enable the two prop unit to draw itself forwardly on the conveyor 13. If the full advance is not required the amount of feed may be determined by placing the stop bar 69 in an appropriate hole 68 in the shield 67 so that forward movement is limited by engagement of the forward end of the base member 61 with the stop bar 69. While pressure is maintained in the rod chamber 102 of the jack 44, the operator turns the control shaft 76*a* of the pressurizing valve to cause pressure liquid to enter the hydraulic props 62 and 64 and thus reset the roof bar 15 against the mine roof. The two prop units of Figure 1 shown in the wake of the cutter loader 12 are all in this advanced position up to the unit shown at 14*a*. When the two prop units have been thus advanced and their roof bars 15 reset, the operator turns the control shaft 75*a* of the selector valve into its neutral position so that both chambers of the jack 44 are at return pressure.

Over the part of the newly exposed coal face 11 where the two and three prop units are staggered, the rear props 64 of the two prop units will be in line with each other and with the intermediate props 26 of the three prop units. Although the roof is substantially supported by the three prop units behind the props 64, the thrust in the latter will tend to initiate a roof crack along the line of the rear props 64, so that when each three prop unit is subsequently advanced the roof will tend to subside uniformly behind the predetermined line of the initial roof crack.

The next step is to advance the part of the conveyor 13 behind the cutter loader progressively forward in a snaking movement, which the operator does by turning the control rod 75 of each selector valve to admit fluid pressure into the piston chamber 99 of the feed jack 44 of each adjacent three prop unit 17. Since the three prop units 17 are jammed between the floor and the roof, their feed jacks 44 together exert a moderate advancing thrust on the conveyor which is reacted against by the natural resilience of the conveyor without permanent deformation. As each portion of the conveyor is thus advanced into proximity with the newly exposed coal face as at the position shown adjacent the three prop unit 17*a*, the operator may advance the three prop unit 17*a* singly to bring it into line with the already advanced two prop units. This he does by first turning the control shaft 77 of the release valve to enable the props 25, 26 and 27 carrying the roof bar 18 to contract, and by then turning the control shaft 75 of the selector valve 74, pressure is admitted into the rod chamber 102 of the feed jack 44, causing the latter to contract. The three prop unit 17*a* thus draws itself forward on the conveyor framework 13 until the jack 44 is contracted when the unit 17*a* will then be in line with the forward two prop units. The operator then turns the control shaft 76 of the pressurizing valve to admit hydraulic pressure to the props 25, 26 and 27 which thereupon extend and reset the roof bar 18 against the mine roof. As soon as the roof bar 18 is reset, the operator may return the control shaft 75 of the selector valve 74 to its neutral position so that both chambers of the feed jack 44 are at return pressure.

When the cutter loader reaches the end of its travel it is reversed and takes a further cut on the newly exposed face, the sequence of operations then being the same from left to right as described from right to left.

I claim as my invention:

1. Mine roof supporting apparatus for use in conjunction with coal cutting and conveying machinery which has a structure such as a conveyor framework extending along the coal face, said apparatus comprising a plurality of support units of first and second kinds disposed alternately along said structure, each unit having a roof bar extending transversely to said structure, means for adjusting the height of the roof bar, and a feed jack operatively interposed between said unit and said structure for effecting relative movement between them, said roof bars having forward cantilever extensions which are longer in the first kind of support unit than in the second kind, whereby said units of the first kind are capable of being advanced by their feed jacks relative to said structure to support the newly exposed roof in the wake of the coal cutter before said structure and said units of the second kind can be advanced.

2. Mine roof supporting apparatus for use in conjunction with coal cutting and conveying machinery which has a flexible conveyor framework extending along the coal face, said apparatus comprising a plurality of support units of first and second kinds disposed alternately and extending transverse to the coal face behind the conveyor framework, each support unit having a base member, a feed jack interposed between the base member and the conveyor framework for effecting relative movement between them, at least two extensible hydraulic props mounted on the base member, and a roof bar supported over its rearward length on the props so that the forward length constitutes a cantilever extension, the cantilever on each support unit of the second kind being of a length to support the mine roof over the conveyor when said unit is in proximity with the conveyor, and the cantilever on each support unit of the first kind being of greater length whereby each such unit may be advanced into proximity with the conveyor and in that position support the newly exposed roof in the wake of the coal cutter.

3. Mine roof supporting apparatus for use in conjunction with coal cutting and conveying machinery which has a flexible conveyor framework extending along the

coal face, said apparatus comprising a plurality of support units of first and second kinds disposed alternately and extending transverse to the coal face behind the conveyor framework, each support unit having a base member, a feed jack interposed between the base member and the conveyor framework for effecting relative movement between them, at least two extensible hydraulic props supported by mountings respectively at the front and rear of the base member, and a roof bar, of the same length in the two kinds of support unit, comprising a rearward portion supported on the props and a forward portion constituting a cantilever which projects beyond the front of the base member, the base member and cantilever in units of the first kind being respectively shorter and longer than the base member and cantilever in units of the second kind.

4. Mine roof supporting apparatus according to claim 3, including interengaging means interconnecting the bottom end of each prop and the base member and between the top end of each prop and the roof bar, each such interengaging means locating one member to the other but being loose to permit angular movement between them, and resilient means disposed in the mounting for the base of each prop, said resilient means acting to restore the prop to the vertical with respect to the base member.

5. Mine roof supporting apparatus according to claim 3, wherein each base member comprises a hollow body with the feed jack disposed within its open forward portion, while the mounting for the front prop is fixed above the forward end of the hollow body.

6. Mine roof supporting apparatus according to claim 4, wherein the feed jack is a telescopic hydraulic jack having a cylinder mounted at its forward end in the forward part of the base member by a universal joint, and

a piston rod connected to the conveyor framework by a universal joint.

7. Mine roof supporting apparatus according to claim 6, wherein a shield for the piston rod is fixed to the forward end thereof, said shield being slidable in the base member to be extensible and retractable with the piston rod.

8. A method of supporting the roof of a coal mine during long wall mining operations, the method utilizing a plurality of extensible support units of two kinds disposed alternately along the coal face in connective association with an extended structure such as a conveyor, and each unit being constructed to provide support for the mine roof behind and over the structure by means of a roof bar whose forward portion constitutes a cantilever, this cantilever being longer in the units of the first kind than in units of the second kind; the method comprising the steps of releasing, and advancing the support units of the first kind successively towards the newly cut face when the coal cutter has passed clear in its progress along the face, extending each unit so advanced to support the newly exposed roof, advancing the structure progressively towards the newly cut face in the wake of the coal cutter, releasing and advancing the support units of the second kind successively into alignment with the advanced support units of the first kind after the adjacent part of the structure has advanced fully to the position required for the next traverse of the coal cutter, and extending each unit so advanced between the support units of the first kind.

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