HYDRAULIC CONTROL SYSTEMS AND DEVICES THEREFOR

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Abstrac:
A hydraulic control system for use with mineral mining roof support installations the system having a control device which can be manually set into various positions to effect certain operations in the components of the installation, such as retraction and extension of roof engaging props, and shifting of support units and a conveyor. The system can perform a certain sequence of operations entirely automatically and the system employs valve devices with two servo pistons either of which is adapted to actuate the valve device when exposed to pressure medium. One servo piston is used when the installation is controlled manually and the other piston is used when the installation is controlled automatically. The automatic section of the system includes one or more timing mechanisms and fluid flow regulators which initiate various parts of the control sequence.

19 Claims, 11 Drawing Figures
Fig. 9.
Fig. 11.
HYDRAULIC CONTROL SYSTEMS AND DEVICES THEREFOR

BACKGROUND TO THE INVENTION

The present invention relates to a hydraulic control system and components thereof and is particularly concerned with a control system for use with a mine roof support installation.

With such an installation it is desirable to employ a control system which will enable the props of the individual support frames or assemblies to be retracted or extended and the frames to be shifted at the required time.

Hydraulic control systems are known in which the control of operations is effected remote from the installation or else in situ. In the latter case, each support frame is associated with a manually operable control unit which effects control of the adjacent support frame. In this way the operator can to some extent be safeguarded by the frame bearing the control unit whilst the neighbouring unit is being shifted. The remote control system usually employs a manually operable appliance which is operated whenever a particular operation in the installation is to be performed. Other remote control systems employ certain devices which effect some change in an operating cycle automatically. It is well known, for example, that when an individual frame of the installation is to be shifted, the props of the frame are first retracted, the frame is then bodily shifted and finally the props are extended to set against the roof. It is, under certain circumstances, possible to shift the frame while maintaining the props underside, either full or partial load, but this is only possible if the roof of the mine working is substantially smooth and flat.

In general, where mine conditions are liable to change the known control systems are inflexible and there is a need for an improved system which is more versatile and enables the operator to effect a variety of different operations not possible with known systems in order to cope with different conditions. Where conditions permit, it is desirable for the system to perform an entirely automatic control sequence.

A general object of this invention is to provide an improved control system and components thereof.

SUMMARY OF THE INVENTION

In its broadest aspect the invention provides a hydraulic control system comprising a plurality of valve devices, a plurality of pressure medium conduits interconnecting said valve devices and a number of consumer appliances, and a single manually operable control device for hydraulically activating selected valve devices to cause pressure medium to be fed to and from said appliances to perform various operations.

In another aspect the invention provides a hydraulic control system comprised of a source of pressure medium, a combination of valve devices and pressure medium conduits connected to consumer appliances, e.g., the props and shifting ram of a mine roof support system, and a manually operable control device for selectively activating the valve devices to feed pressure medium to and from the appliances. At least one of the valve devices has two servo pistons and associated working chambers, the pistons being adapted to operate the valve devices in the same manner when the pressure medium is conveyed to the associated working chamber, one of the working chambers being operably connected to said control device and the other of the working chambers being operably connected to part of the system for automatically effecting a sequence of operations on said appliances.

In another aspect the invention provides in combination with a mine roof support installation composed of a plurality of roof support assemblies, and each with hydraulically operated props, and at least one shifting ram for moving the assemblies in relation to one another a hydraulic control system; said system comprising a source of pressure medium, valve devices, and pressure medium conduits connected to said props and said ram, and a manually operable control device settable to various operating positions to actuate selected valve devices to cause pressure medium to be fed to and from the props and the ram to effect various operating cycles including extension and retraction of certain of the props and shifting of certain of the assemblies, wherein the control device includes a setting which when adopted causes the retraction of the props of one assembly and the shifting of the assembly effected by the associated ram to be initiated simultaneously.

The aforesaid valve device with two pistons may comprise a housing, a first valve composed of a closure element engageable on a seating disposed in said housing, a second valve composed of a closure element engageable on a seating disposed in said housing, a plunger disposed in contacting relationship with the closure elements of said first and second valves, a spring acting to urge the closure element of the first valve onto its seating and acting through the plunger to urge the closure element of the second valve off its seating, a first servo piston and a first working chamber thereof disposed adjacent the second valve, and a second servo piston and a second working chamber thereof disposed adjacent the working chamber of the first servo piston and inlets to the working chambers of the first and second servo pistons whereby admission of pressure fluid into either of said chambers through the associated inlet displaces one or both servo pistons to urge the closure element of the second valve onto its seating and, through the plunger, the closure element of the first valve off its seating.

In a preferred construction the control device comprises a hydraulic control device comprising a plate having a first bore and a plurality of additional bores the addition of bores being arranged on a common pitch circle, a housing attached to said plate, a rotatable member disposed within the housing and scaled in relation thereto, the rotatable member having at least one bore which can be brought into registration with each of said additional bores in the plate as the member is rotated, a shut-off valve operably disposed to open or close communication between said first bore in the plate and said at least one bore in the rotatable member, and means for actuating said shut-off valve.

By utilizing control valve devices with two servo pistons, one for manual control and one for automatic control, the number of valve devices required for the overall system is reduced.

Among the special operations that the system can perform on a mine roof support installation a special mention may be made of an operation whereby the retraction of the props of a support frame and the shifting
of the frame are performed simultaneously thus speeding up the shifting process. Obviously, when conditions permit, the system can be switched over to entirely automatic control. However, in difficult conditions manual control can be effected and one of the facilities of the system enables the front and rear props of a frame to be extended or retracted independently. Thus, the props can be readily aligned.

Where the roof conditions are difficult, an operator can effect the shifting operation manually in the various operating stages known per se, i.e., retraction of the props, shifting of the frame and re-setting of the props.

BRIEF DESCRIPTION OF DRAWINGS

The invention may be understood more readily and various other features of the invention may become more apparent from consideration of the following descriptions in conjunction with the accompanying drawings, wherein:

FIG. 1 is a schematic diagram of a hydraulic control system utilized with a mine roof support installation;

FIG. 2 is a schematic diagram of a further form of hydraulic control system also utilized with a mine roof support installation;

FIG. 3 depicts a modified part of a hydraulic control system arrangement;

FIG. 4 is a sectional view of one form of control device which can be used in the control arrangements;

FIG. 5 is a side view of a unit composed of the control device and various valve devices associated therewith;

FIG. 6 is a plan view of the unit shown in FIG. 5;

FIG. 7 is a sectional view of a servo control valve device which can be used in the control system;

FIG. 8 is a side view of the valve device shown in FIG. 7;

FIG. 9 is a schematic diagram of another hydraulic control system utilized with a mine roof support installation;

FIG. 10 is a sectional view of another control device which can be used in the control arrangements; and

FIG. 11 is a plan view of the device shown in FIG. 10.

DESCRIPTION OF PREFERRED EMBODIMENTS

Before considering the hydraulic control systems or arrangements of the invention, it may be more informative to consider the construction of a control device usable in such arrangements.

Referring initially to FIG. 4 there is shown a control device generally designated S. The device S has a plate 10 provided with a number of axially extending bores serving to establish connection with the device S.

In this construction there are twelve such bores Z1 to Z12 arranged to lie on a common pitch circle described from the center of the plate 10. The plate 10 has an inner planar surface 11 and a recessed portion 12 separated from the surface 11 by an annular shoulder 13. A pot-like housing 14 is detachably secured to the plate 10 as by screw-threaded engagement. A rotatable member 15 is located partly within the housing 14.

This member 15 has a disc-like portion which is sealed in relation to the internal surface of the housing 14 by means of a sealing ring 16 and an axial portion 22 which extends through a central hole in the housing 14.

The portion 22 is sealed in relation to the inner surface of the hole in the housing 14 by means of sealing rings 23 and 24. The member 15 also has a spigot portion 17 which is pivotally received in a bore 18 disposed centrally of the plate 10. The portion 17 is sealed in relation to the internal surface of the bore 18 by means of a sealing ring 19. The spigot portion 17 centralizes the member 15 in relation to the plate 10 and has a longitudinal bore which establishes connection with a main pressure conduit denoted P so that in force the fluid for the device is fed into the centre of the spigot portion 17. The outlet of fluid from the device passes through a further axial bore 20 in the plate 10. The bore 20 is disposed inwardly of the bores Z1 to Z12 in relation to the axis of the plate 10 and communicates with an annular space 21 formed between the face 11 of the plate 10 and the inner-end face of one disc portion of the member 15.

The portion 22 of the member 15 has an internal bore 25 with stepped parts of successively smaller diameter containing a plunger-operated non-return valve 26. The valve 26 has a closing element 27 in the form of a ball which is urged against a seating 29 by means of a spring 28 located in the spigot portion 17. The seating 29 is located by a shoulder of a recessed part of the main bore 25. A sleeve 30 abuts the seating 29 and the sleeve 30 is provided with a number of radial gaps 44 providing communication between the interior and the exterior of the sleeve 30. The sleeve 30 and the seating 29 are retained by a hollow locking part 31 which is in screw-threaded engagement with part of the bore 25. A plunger 32 is guided for longitudinal movement within the part 31 and the plunger 32 has an end portion 33 engageable with the element 27. Sealing rings are disposed between the part 31 and the bore 25, the plunger 32 and the part 31 and the seating 29 and the bore 25. A lever 34 eccentrically mounted on the end piece 35 of the portion 22 serves to effect displacement of the plunger 32 to lift the element 27 off the seating 29 and open the valve 26.

The housing 14 is provided with an annular recess 36 which is disposed externally of the pitch circle of the bores Z1 to Z12 relative to the central axis of the device S. The recess 36 accommodates a roller bearing 37 which supports the member 15 for rotation about the central axis of the device S. The disc-like portion of the member 15 contains a further bore 38 which accommodates a ball 40 urged to the left of the drawing by means of a spring 39. The housing 14 has a complementary surface formed with a series of depressions 41 arranged on a pitch circle to form a detent means with the ball 40 such that the ball 40 can locate in any one of these depressions 41 to bring the member 15 into various operating positions.

The disc portion of the member 15 is further provided with a bore 42 facing the surface 11 of the plate 10. The bore 42 receives a replaceable piston member 45 which is urged by a spring 46 against the surface 11.

A sealing ring is provided between the member 45 and the bore 42 and a resilient packing member 47 is disposed between the outer end of the bore 42 and the face 11. The member 47 serves to seal the interior of the member 45 in relation to the gap 21. The inner end of the member 45 forms a piston surface and when pressure fluid is conveyed through the member 45, the pressure of the fluid acts on the piston surface to urge the member 45 towards the face 11 to assist the sealing action of the member 47. The interior of the member
45 is disposed radially outwardly from the centre of the device S by a distance corresponding to the radius of the pitch circle of the bores $Z_1 - Z_2$ so that as the member 15 is rotated the interior of the member 45 can be brought into sealed communication with each of the bores $Z_1 - Z_2$ in turn. The interior of the member 45 in turn radially of the disc portion and the passage 43 leads to a space disposed between the sleeve 30 and the bore 25. This space in turn communicates with the interior of the sleeve 30 and hence with the valve 36 via the gaps 44 in the sleeve 30. Instead of a single bore 42 with the member 45 communicating with a single passage 43 a number of bores 42, and accommodating a member 45 adjoining the passage 43 communicating with the valve 26, can be provided.

As will become more apparent hereinafter, the bores $Z_1 - Z_2$ can be connected to various components in a hydraulic system or arrangement and would normally be operably utilized in pairs. In FIG. 4, the bore $Z_1$ is shown to be in communication with the interior of the sleeve 30 but the valve 26 blocks communication between the interior of the sleeve 30 and the entry bore 18. By actuating the lever 34, the element 27 can be moved off the seating 29 to establish communication between the bores $Z_1$, 18. Rotation of the member 15 can bring any of the bores $Z_1 - Z_2$ into communication with the bore 18 and this is preferably done when the valve 26 is closed so that there is no appreciable friction between the packing member 47 and the face 11. The return path of pressure fluid from some appliance to which fluid is transmitted from one of the bores $Z_1 - Z_2$ selected by the member 15 is via another of the bores $Z_1 - Z_2$ and through the space 21 to the bore 20. The balls 40 and the associated depressions 41 effectively locate the member 15 in various positions corresponding to selection of each of the bores $Z_1 - Z_2$.

FIGS. 10 and 11 depict an alternative control device S made in accordance with the invention. As shown the device S is composed of a base plate 901 to which is attached a pot-like housing 903. The roller bearing and ball locating catch as described in connection with FIG. 4 are utilized to index the rotation of the member 902 relative to the housing 903. The member 902 has a disc portion which is provided with two radial passages 904,904 closed at the outer periphery of the disc portion by means of plugs. The passages 904,904 communicate with axial bores 905,905, respectively, which extend to the annular surface 906 of the disc portion. As shown in FIG. 10, the bores 905,905 are disposed at different distances from the axis of the member 902. Each bore 905,905 accommodates a sleeve 907 which is urged outwardly from the bore 905,905 by means of a spring 908. The periphery of each sleeve 907 is formed with a seal 909 which seals the sleeve 907 in relation to the interior of the bore 905,905. In addition, each sleeve 907 has at its outer end a further seal 910 which engages the inner surface 911 of the plate 901. The sleeves 907 are so constructed that the pressure of fluid therein tends to increase the sealing action of the seals 910. Between the disc portion of the member 902 and the surface 911 of the plate 901 there is defined a chamber 921 which communicates with a bore 922 provided in the plate 901. The bore 922 would normally be connected to pressure fluid return conduit.

The bores 904,904 communicate via a chamber 912, with the interior of the member 902 which in turn can communicate with a bore 913 provided at the centre of the plate 901. This bore 913 is intended to connect to a pressure medium conduit. The interior of the member 902 is provided with a non-return valve 914 with a closure element in the form of a ball engageable on a seating. A spring 923 biases the closure element onto the seating to close the valve 914 to thereby block the space 912 from the bore 913. A plunger 915 guided for axial displacement within the member 902 can lift the element off the seating against the force of the spring 923 to open the valve 914. When the valve 914 is open, the pressure medium can pass from the bore 913 through the valve 914 and the space 912 to the passages 904,904 and thence to the bores 905,905.

As shown particularly in FIG. 11, the plate 901 is pierced with a number of bores 916, in this example, six, disposed on a common pitch circle described from the centre of the plate 901. The plate 901 is also pierced with a number of further bores 916, in this example, six, arranged on a common pitch circle described from the centre of the plate 901 which has a radius less than that of the circle on which the bores 916 lie. The pitch circles for the bores 916,916 are such that the bores 916 align with the bore 905 and the bores 916 with the bore 905 as the member 902 rotates. As shown in FIG. 11, each of the bores 916 is angularly disposed between two of the bores 916 relative to the centre of the plate 901 and vice versa. Thus, as the member 902 is rotated the bores 916,916 are alternatively brought into register with the bores 905,905.

The member 902 can be rotated by means of a lever 917 and the housing 903 may bear indicia representing the various operative positions or settings of the member 902. In addition to effecting rotation of the member 902, the lever 917 can be pivoted in the direction of arrow 918. The lever 917 is formed with surfaces 919, 920 and by pivoting the lever 917 the surface 919 can engage the plunger 915 to displace the latter and thereby open the valve 914. If the lever 917 is released at this stage the spring 923 will operate to close the valve 914 and urge the plunger 915 against the surface 919 of the lever 917 to pivot the lever 917 in the reverse direction to arrow 918. By displacing the lever 917 sufficiently far in the direction of arrow 918 to cause the surface 920 to engage the plunger 915, the valve 914 will remain open and the spring 923 will not under these circumstances affect the position of the lever 917.

Thus, rotation of the member 902 effected by the lever 917 is used to select the bores 916,916 into which pressure fluid is to be fed and subsequent pivoting of the lever 917 opens the valve 914 to permit pressure fluid to enter the selected bore 916,916.

Normally, the bores 916,916 would be operated in pairs with the bore of each pair of bores being connected to the pressure conduit, via the bore 913 and the valve 914 and the other bore being connected to the return conduit, via the chamber 921 and the bore 922. However, the return path can be provided externally of the device S.

Various examples of complete control systems will now be described commencing with the arrangement depicted in FIG. 1.

A hydraulic control arrangement which may employ the device S discussed above, will now be described with reference to FIG. 1. The control arrangement is
operably connected to a number of displaceable mine roof supports, frames or assemblies. One such assembly is depicted in the drawing as employing four hydraulically actuated telescopic props 60,60A, where the numerals 60A denote the rear props and the numerals 60 denote the front props relative to the mineral face. A hydraulically actuated shifting ram 62 is used to move the support assembly and the ram 62 has a piston rod 61 connected to a conveyor (not shown).

The control device S previously described in connection with FIG. 4 or FIGS. 10 and 11, is represented in a schematic manner in FIG. 1 where I to VII denote various operating positions of the device S. A main pressure feed conduit P and a return conduit R are installed in the mine gallery and the device S for each assembly is connected to the conduits P and R via corresponding branch conduits denoted P1 and R1 respectively. In FIG. 1 the device S is connected to two such branch conduits P1R1 by way of the bores 18,20 respectively (see FIG. 4 and FIG. 10 reference numerals 913,922). The props 60 of the support assembly have allocated thereto a common double-acting servo-control valve device 63 with servo-pistons 63,631 and similarly the props 60A have allocated thereto a common double-acting servo-control valve device 63A with servo pistons 63A,631A. A preferred construction for these valve devices and other similar servo-control valve devices to be introduced later, will be described hereinafter. The valve devices 63,63A control the extension i.e., the setting of the props 60,60A. The servo-piston 63,631 of the valve device 63 effect the same operations and are merely moved by different control pressures derived when the arrangement is working under manual control or automatic control. The valve devices 63,63A are connected to the appropriate working chambers 60 of the props 60,60A via conduits 64,64A respectively, and the valve devices 63,63A are connected to the conduits P and R via conduits 67,68 and 67A,68A respectively. The props 60,60A also have allocated thereto a common double-acting servo-control valve device 69 with servo-pistons 69,691 which control the retraction, i.e., robbing of the props 60,60A. The valve device 69 is connected to the appropriate working chambers 60 of the props 60,60A via conduits 70. The valve device 69 is also connected to the conduits P and R via conduits 71,72 respectively.

Further working valves 65,65A are associated with the valves 63,63A and each valve 65,65A is connected between the main return conduit R and the conduit 64,64A via a conduit 66,66A. Each of the valves 65,65A operate hydraulically and constitutes a pressure-relief valve and a retraction facility.

Double-acting servo control valve devices 73,79 with servo-pistons 73,731,79,791 are operably associated with the shifting ram 62. More particularly, the valve devices 73,79 are connected to working chambers 62,621,622 of the ram 62 respectively via conduits 74,82 and to the conduits P and R via conduits 75,76 and 80,81 respectively. Similarly, to the valve devices 63,63A the valve device 73 is associated with a further working valve 77 which is connected between the conduits 74 and R via conduit 78. The valve 77 operates hydraulically to relieve the chamber 621 of the ram 62 and constitutes a pressure relief valve which effectively controls the counter pressure exerted on the conveyor by the plough guided thereon.

A servo-control valve device 85 has a single servo-piston 851 which is operably connected to a regulator 83 via a conduit 84, and the valve device 85 is controlled by the regulator 83 in accordance with the quantity of fluid flowing in the conduit 84. The valve device 85 is in turn connected to a reversing valve 86 and to a control conduit ST. The valve 86 is connected to the conduits P and R and the valve 86 has a single servo-piston 861 connected via a conduit 86 and a timing mechanism 88 to the conduit P. The timing mechanism 88 may be composed of a retardation valve controlled by a throttled pressure accumulator which provides a certain pressure to operate the valve after a certain time interval. The control conduit ST leads to the adjacent support assembly and includes a valve 89.

The control device S is connected to six conduits 90-95 which are connected to the various valves mentioned above and in this example the device S can be brought into seven operating positions denoted I to VII which are represented diagrammatically in FIG. 1.

The arrangement operates as follows:

**Position III**

With the device S in position III all the conduits 90 to 95 are connected to the return conduit R and the props 60,60A of the support assembly are extended and set against the roof of the mine working. The valve 77 is closed and the chamber 62 of the ram 62 is blocked in respect of the conduit R so that the ram 62 rigidly holds the conveyor. The valves 64,65A prevent the props 60,60A from being overloaded. If overloading should occur, the pressure in the chamber 601 in question will cause the appropriate valve 65,65A to open to allow the pressure fluid to discharge into the conduit R.

**Position II**

With the device S in position II the conduit 92 is connected to the main pressure conduit P so that the servo-piston 731 of the valve device 73 is exposed to pressure. This results in the conduit 74 being connected to the conduit P via the conduit 76 and the chamber 62 of the ram 62 is charged with pressure fluid. The piston rod 61 of the ram 62 consequently extends to urge the conveyor towards the mineral face.

**Position IV**

When the device S is put into position IV the conduits 94,91 are connected to the main pressure conduit P. The valves 65,65A are subjected to control pressure via the conduits 94 and consequently the chambers 601 of the props 60,60A are connected to the return conduit R. The servo-piston 691 of the valve device 69 is also subjected to control pressure via the conduit 91 and consequently the chambers 60 of the props 60,60A are connected to the pressure conduit P via the conduits 70,71. The props 60,60A are thus retracted.

**Position V**

When the device S is put into position V the conduits 93,94 are connected to the pressure conduit P. The valves 65,65A are subjected to control pressure via the conduits 94 consequently and the chambers 601 of the props 60,60A are connected to the return conduit R. The servo-piston 791 of the valve device 79 is also subjected to pressure via the conduit 93 and the valve device 79 operates to connect the chamber 621 of the ram 62 to the pressure conduit R. The props 60,60A are thus released from the roof pressure and the entire as-
Assembly is moved up relative to the conveyor by retraction of the ram 62.

Position I

When the device is set to position I the conduit 90 is connected to the pressure conduit P. The servo-piston 63A of the valve device 63A is thus subjected to pressure and the valve device 63A operates to connect the chambers 60 of the front props 60 to the pressure conduit P. The two rear props 60A therefore extend to become set against the roof independently of the front props 60.

Position VI

When the device S is set to position VI the conduit 95 is connected to the pressure conduit P. The servo-piston 63 of the valve device 63 is thus subjected to pressure and the valve device 63 operates to connect the chambers 60 of the front props 60 to the pressure conduit P. The two front props 60 therefore extend to become set against the roof independently of the rear props 60A.

Position VII

When the device S is put into position VII the conduits 90, 95 are connected to the pressure conduit P and the servo-piston 63, 63A of the valve devices 63, 63A are subjected to pressure. The valve devices 63, 63A operate to connect the chambers 60 of all the props 60, 60A with the pressure conduit P so that all the props 60, 60A extend to become set against the roof. It is possible to effect these operations entirely automatically as will now be described. In this case the servo-pistons of the control valve devices with a double suffix (11) are actuated but these pistons effect the same operatives as the pistons bearing a single suffix (1). Upon activation of the automatic control sequence the valve 86 is connected to the pressure conduit P so that pressure can be applied to the valves 65, 65A via the conduit 96 to release these valves 65, 65A. Thereby the chambers 60 of the props 60, 60A are connected to the return conduit R and thus relieved. The servo-piston 69 of the valve device 69 is also subjected to pressure via a conduit 96 so that the valve device 69 operates to connect the chamber 60 of the props 60, 60A to the pressure conduit P so that the props retract. When the valve 86 is subjected to pressure, the mechanism 88 is also activated. After a pre-determined time interval, the mechanism 86 operates to release the valve 86 so that the conduit 96 is now connected to the return conduit R and the pressure conduit P is connected, via conduits 97, 99 to the servo piston 79 of the valve device 79. The valve device 79 then operates to connect the chamber 62 of the ram 62 to the pressure conduit P to shift the assembly. Pressure fluid in the chamber 62 can discharge to the return conduit R via the conduit 74, the valve 77 and the conduit 78. When the shifting movement has ceased the flow of pressure fluid in the conduit 82 decreases to zero and the regulator 83 accordingly reduces the pressure in the conduit 84, to relieve the servo-piston 85 of the valve device 85. The valve 85 now operates to connect the conduit ST to the pressure conduit P and the servo-pistons 63, 63A of the valve device 63, 63A are subjected to pressure. The valve devices 63, 63A operate to connect the chambers 60 of the props 60, 60A to the pressure conduit P so that the props 60, 60A extend to become set against the roof. When the pre-determined setting load of the props 60, 60A is reached the pressure in a conduit 99 connected to the chambers 60 of the props 60A reaches a sufficiently high value to displace the servo-piston 73 of the valve device 73. The valve device 73 now operates to connect the chamber 62 of the ram 62 to the pressure conduit P to extend the piston rod 61 and thereby displace the conveyor towards the mineral face. When the pressure in the conduit ST reaches a pre-determined value, the valve 89 also opens so that pressure is transmitted to the control device S of the adjacent support assembly to initiate the sequence for this assembly. It is possible to operate, for example, five assemblies so that each assembly is automatically shifted in succession.

FIG. 9 depicts a modified arrangement somewhat similar to FIG. 1 and like reference numerals denote like parts. In contrast to FIG. 1, the arrangement of FIG. 9 has no facility for automatic operation. However, the arrangement has an apportioning device 101 connected to the chamber 62 of the shifting ram 62. The device 101 is connected to the main pressure conduit P and the return conduit R and receives control pressure from a control conduit 101. The device 101 operates in accordance with the pressure in the conduit 101 to precisely control the flow of pressure fluid to the chamber 62 to thereby enable the conveyor to be shifted by a pre-determined amount; such devices known as per se. The arrangement of FIG. 9 employs similar servo-control valve devices and working valves to the arrangement of FIG. 1, and operates in the same manner as described hereinbefore, when the device S is set into any of the positions I - VII. Since the arrangement of FIG. 9 only operates manually, the servo-control valve devices only have one servo-piston in contrast to the arrangement of FIG. 1.

FIG. 2 depicts a further hydraulic control arrangement for a mine roof support assembly with two relatively movable frames A, B. A, B are each composed of two props 160, 160A interconnected by floor and roof rails. The numeral 160 denotes the front props nearest the mineral face and the numeral 160A denotes the rear props. The frames A, B are shifted in succession to advance the assembly by means of a shifting ram 162 interconnecting the frames A, B. The control arrangement for the support assembly is somewhat similar to that of FIG. 1 and is composed of valve devices 163 to 179 which generally correspond to the valve devices of FIG. 1, and again the suffixes (1) and (11) denote the servo-pistons of the servo-valve devices which, it will be recalled, effect the same operation on the valve devices in question. The valve devices 163, 165, 167, 168, 169, 170 and 172 have two servo-pistons whereas the valve devices 176, 177, 178, 179 only have a single servo-piston. In function the valves 164, 166, 171, 173 correspond to the working valves 65, 65A of FIG. 1, the valve devices 165, 167, 170, 172 correspond to the control valve devices 63, 63A of FIG. 1, and the valve device 163 corresponds to the control valve device 69 of FIG. 1. No detailed description of these devices of their interconnection is given since this has been discussed at some length in connection with FIG. 1. In addition the arrangement of FIG. 2 has a further valves 190-197. The valves 190, 191, 192, 193, 194 and 195 are non-return valves which can open in both directions depending on the pressure conditions and the valves 196 and 197 are non-return valves which can open in only one direction. The arrangement also has two timing mechanisms 190, 199 like 88 in FIG. 1 and regulators 206, 108 like 83 of FIG. 1. In FIG. 2, there is also a con-
control device S (FIG. 4) which in this example has eleven switching positions. The device S is connected to nine conduits denoted 180 to 188 which 90-95 in FIG. 1. The operation of the arrangement depicted in FIG. 2 is as follows:

Position VI

With the device S set in position VI all the conduits 180 to 188 are connected to the return conduit R and the props 160, 160A of both frames A,B are set against the roof. The chambers 162,162 of the ram 162 are non-pressurized. The valves 164,166,171 and 173 serve as pressure relief valves and open should excess pressure occur in the associated chamber 160 to allow the pressure fluid in this chamber 160 to discharge via conduits 200 and into the return conduit R.

Position V

If the device S is set to position V the conduits 180,188 are connected to the pressure conduit P. The valves 171, 173 are subjected to control pressure via the conduit 180 and operate to connect the chamber 160 of the props 160, 160A of the frame A with the return conduit R so that these chambers 160 are relieved of pressure. The servo-piston 163 of the valve device 163 is also subjected to pressure via the conduit 188 and the valve device 163 operates to connect the chambers 160 of the props 160,160A of the frame A to the pressure conduit P. These props 160,160A thus retract whilst the props 160,160A of the frame B remain in the set roof-support condition, since there is no connection between their chamber 160 and the return conduit.

Position IV

When the device S is set to position IV the conduits 180 and 183 are connected to the pressure conduit P. The valves 171,173 are subjected to control pressure via the conduit 180 and operate to connect the chambers 160 of the props 160,160A of the frame A with the return conduit R so that these chambers 160 are relieved of pressure. The servo-piston 169 of the valve device 169 is subjected to pressure via the conduit 183 and the valve device 160 operates to connect the chamber 162 of the ram 162 to the pressure conduit P via a conduit 202. The ram 162 thus causes the frame A to be shifted in relation to the frame B.

Position III

When the device S is set to position III the conduit 183 is connected to the pressure conduit P so that the servo-piston 169 of the valve device 169 is subjected to control pressure. The valve device 169 operates to connect the chamber 162 of the ram 162 to the pressure conduit P via the conduit 202. The ram 162 thus causes the frame A to be shifted in relation to the frame B. The position III would be normally set after position V whereas in contrast the cycle of operations performed by adopting position V and then position III are performed together and move rapidly by adopting position IV. However, the provision of position III enables the frame A to be shifted under load in which case position V would be an unnecessary pre-requisite.

Position II

With the device S set to position II the conduit 181 is connected to the pressure conduit P. The servo-pistons 170,172 of the valve devices 170,172 are subjected to control pressure and these valves 170,172 operate to connect the chambers 160 of the props 160,160A of the frame A to the pressure conduit P via the conduit rod. The props 160,160A of the frame A thus extend and become set against the mine roof.

Position I

If the device S is set to position I the conduit 182 is connected to the pressure conduit P and pressure acts on the valves 166,171. The valves 166,171 operate to connect the chamber 162 of the front props 160 of the two frames A and B to the return conduit R. The valves 164,173 are not affected by control pressure since the valves 190,193 are blocked. At the same time, the servo-piston 163 of the valve device 163 is subjected to control pressure, via a branch conduit 203, and the valve device 163 operates to charge the chamber 160 of the front prop 160 of the frames A,B with pressure fluid from the pressure conduit P. The props 160 thus retract.

Position VII

When the device S is set to position VII the conduits 187,188 are connected to the pressure conduit P. The valves 164,166 are subjected to control pressure and to relieve the pressure in the chambers 160 of the props 160,160A of the frame B by connecting the chambers 160 of the return conduit R. The servo-piston 163 of the valve device 163 is also subjected to pressure via the conduit 188 and the valve device 163 operates to connect the chamber 160 of the props 160,160A of the frame B to the pressure conduit. These props 160,160A thus retract whilst the props 160,160A of the frame A remain in the set condition since there is no connection between their chambers 160 and the return conduit.

Position VIII

With the device S set in position VIII the conduits 184,187 are connected to the pressure conduit P. The valves 164, 166 are subjected to control pressure via the conduit 187 and operate to connect the chambers 160 of the props 160,160A of the frame B with the return conduit R so that these chambers 160 are relieved of pressure. The servo-piston 168 of the valve device 168 is subjected to pressure via the conduit 184 and the valve device operates to connect the chamber 162 of the ram 162 to the pressure conduit P via a conduit 205. The ram 162 thus causes the frame B to be shifted in relation to the frame A.

Position IX

With the device S set to position IX the conduit 184 is connected to the pressure conduit P so that the servo-piston 168 of the valve device 168 is subjected to control pressure. The valve device 168 operates to connect the chamber 162 of the ram 162 to the pressure conduit P to thus shift the frame B in relation to the frame A. If position VII were not adopted before this position IX the frame B would be shifted under load. The successive setting of position VII and IX thus correspond to position VIII in a similar manner that positions V and III correspond to position IV.

Position X

With the device S set to position X the conduit 186 is connected to the pressure conduit P. The servo-pistons 165,167 of the valve devices 165,167 are thus subjected to control pressure and these valves devices 165,167 operate to connect the chambers 160 of the props 160,160A of the frame B to the pressure conduit P via the conduits 200. The props 160,160A of the frame B thus extend and become set against the mine roof.

Position XI
With the device S set to position XI the sequence of shifting operations can be effected automatically as is now described.

In position XI the conduit 185 is connected to the pressure conduit P and the timing mechanism 199 is thus subjected to pressure. At the same time, the valves 164, 166 are subjected to pressure, via a branch conduit 185' and the valve 178. The valves 164, 166 operate to connect the chambers 160' of the props 160, 160A of the frame B to the return conduit R to thereby relieve these props. The servo-piston 163' of the valve device 163 is also subjected to control pressure via the branch conduits 185', 185'' and the valve device 163 operates to connect the chambers 160'' of the props 160, 160A to the pressure conduit P. Thus the props 160, 160A of the frame B are retracted. After a pre-determined time interval the timing mechanism 199 actuates the valve 178 so that a conduit 204 is connected to the conduits 185, 185'. The servo-piston 163'' of the valve device 168 is now subjected to control pressure and the valve device 168 causes the chamber 162'' of the ram 162 to be connected to the pressure conduit P via the conduit 205 and the frame B is consequently shifted relative to the frame A. The quantity of fluid flowing through the conduit 205 is monitored by the regulator 206 and the regulator 206 controls the valve device 179. As soon as the fluid flow in the conduit 205, signifying the end of the shifting step, ceases, the servo-piston 179' of the valve device 179 is pressurized and the valve device 179 is actuated to connect the conduit 185'' to a conduit 218 via the valve 178. This causes the servo-pistons 165', 165'' of the valve 178. This causes the servo-pistons 165', 165'' of the valve device 165, 167 to be subjected to control pressure so that these valve devices 165, 167 operate to connect the chambers 160'' of the props 160, 160A of the frame B to the pressure conduit P. The props 160, 160A thus extend and become set against the roof again. During this sequence of operations, the valve 175 is also actuated by the pressure in the conduit 200, so that pressure fluid flows from the conduit 218 to the conduit 207. The timing mechanism 198 is thus initiated and the valves 171 and 173 are subjected to pressure via the valve 177. The valves 171, 173 now operate to connect the chambers 160' of the props 160, 160A of the frame A to the return conduit R to relieve these chambers. The valve device 163 also charges the chambers 160'' of the props 160, 160A of the frame A so that the props retract. After the pre-determined time interval, the mechanism 198 acts to pressurize the servo-piston of the valve device 177 and the valve device 177 operates so that the servo-piston 169'' of the valve device 169 is subjected to pressure. This causes the valve device 169 to operate to connect the chamber 162' of the ram 162 to the pressure conduit P so that the frame A is shifted relatively to the frame B.

The quantity of fluid flowing through the conduit 202 is monitored by the regulator 208 which controls the valve 176. As soon as the flow of fluid in the conduit 202 ceases, signifying the end of the shifting step, the valve 176 is actuated by the regulator 208 which pressurizes the servo-piston of the valve 176. The valve 176 then operates to cause the servo-pistons 170', 172' of the valve devices 170, 172 to be subjected to pressure so that these devices operate to connect the chambers 160' of the props 160, 160A of the frame A to the pressure conduit P. The props 160, 160A thus extend to be come set against the roof and one shifting cycle is completed.

FIG. 3 depicts a modified part of a hydraulic control arrangement for a mining installation where the shifting rams for a group of support assemblies are operated simultaneously. In this arrangement conduits 100, 101 are laid along the mine working. By means of these conduits 100, 101 a group of valve devices 73 (see FIG. 1) are controlled so that the shifting rams connected to the valve device 73 are operated simultaneously to displace the conveyor towards the mineral face. For each group of support assemblies, a non-return valve 102 is installed in the conduit 100, to isolate the associated group of valves 72 from the remaining valves.

FIGS. 5 and 6 illustrate how the various valve devices for each support assembly can be formed into a convenient constructional unit with the control device S. As shown, the device S is attached to a plate 110 to which is also attached the various servo-control valve devices designated 111 (for example, the valve device 73 in FIG. 1) and the various working valves designated 112 (for example, the valve 65', FIG. 1). The various connections between the individual valves and the device S denoted by conduits in FIGS. 1 and 2 are formed by bores 113 in the plate 110. The plate 110 is also provided with ports 114, 115 serving for connection to the main pressure conduit P and the return conduit R, respectively.

FIGS. 7 and 8 depict a preferred form of servo-control device. As shown, the valve device has a cylindrical housing 300 closed and sealed at each end by screw-threaded caps 301, 313. The housing 300 contains a number of items arranged in axial succession and held in position by the caps 301, 313. These items consist of a spacer bush 318, a valve seating 304, an aperture sleeve 308, a valve seating 305, an aperture sleeve 315, and a guide bush 320.

A closure element 306 in the form of a ball is engageable with the seating 304 and similarly a closure element 307 in the form of a ball is engageable with the seating 305. A plunger 311 is disposed between the elements 306, 307 and is guided in an axial bore 308 provided in the sleeve 308. The construction is such that when one valve 304, 306 is open, the other valve 305, 307 is closed and vice versa. The plunger 311 is preferably constructed as illustrated in the form of a diabolo so that the valve assemblies 304, 306 and 305, 307 can be opened and closed smoothly by gradually increasing or decreasing the flow path through the assembly. The element 306 is disposed in proximity to radial bores in the bush 318 and similarly the element 307 is disposed in proximity to radial bores 315 in the sleeve 315. Two servo-pistons 309, 310 are slidably mounted in the guide bush 320 and sealed in relation to the interior of the bush 320, by means of packing rings. The interior of the bush 320 also defines chambers 316, 317 into which pressure medium can be admitted to cause displacement of the pistons 309, 310. The piston 309 is provided with an internal bore accommodating a spring 312, which acts upon a plate 319 which in turn acts upon the element 307. At the end of the housing 300 adjacent the cap 301 there is provided a member 314 which is displaceably received in a recess 302 of the cap 301. The member 314 has a shaped end portion which engages the element 306 and a spring 303 disposed in the recess 302 urges the member 314 towards the element 306. The spring 303 acts on
the member 314 to bias the element 306 into sealing engagement with its seating 304 and through the plunger 311, to bias the element 307 away from its seating 305. The housing 300 contains bores denoted P and R which are connectible directly or indirectly with the main pressure medium conduit P and the return conduit R. The housing 300 also has a bore denoted Z which would be connectible to some consuming apparatus, for example, a shifting cam or hydraulic prop in the arrangement of FIG. 1. The bore Z communicates with radial bores 308 in the sleeve 308. The housing 300 additionally has bores, ST1, ST2 which would receive pressure fluid from the manual and automatic control systems respectively (see FIGS. 1 and 2). The bore ST1 is connectible to radial bores in the guide bush 320 which lead to the chamber 316. The bore ST2 leads into the chamber 317.

During normal operation, the valve 304,306 is closed as illustrated so that the pressure bore P is blocked whilst the bore Z is connectible to the return bore R via the bores ST1,308,308 and the open valve 305,307. By applying pressure to either of the bores ST1,ST2 one or other of the servo-pistons 309,310 is displaced to move the inter-engaging components 307,311,306 against the force of the spring 303 to open the valves 304,306 and close the valve 305,307.

This enables the bore Z to be connectible to the pressure bore P to activate the associated application. If the pressure applied to the bore ST1,ST2 in question decreases again, the spring 303 moves the components, 307,311,306 back to their former position to open the valves 305,307 and close the valve 304,306.

We claim:

1. In a hydraulic control system including a source of pressure medium, a combination of valve devices and pressure medium conduits connect to consumer appliances and a manually operable control device for selectively actuating the valve devices to feed pressure medium to and from the appliances to perform various operations, the improvement therein comprising at least some of the valve devices each having two servo-pistons and associated working chambers, the servo-pistons being adapted to operate the valve devices when pressure medium is conveyed to the associated working chambers, means operably connecting one of the working chambers to said control device and means operably connecting the other of the working chambers to part of the system for automatically effecting a sequence of operations on the appliances.

2. A system according to claim 1, wherein a plurality of said valve devices are formed into a common constructional unit with the control device.

3. A system according to claim 1, wherein the two servo-pistons of said valve device are disposed coaxially of one another.

4. A system according to claim 1, wherein each valve device having said two servo-pistons has two shut-off valves each with a closure element engageable on a seating with the closure elements being in engagement with a common plunger, the servo-pistons being adapted to act upon one of the closure elements to open one valve and shut the other valve.

5. A system according to claim 3, wherein the valve device has a housing and the two servo-pistons are displaceably mounted in a guide bush received in the housing, there being further provided two shut-off valves each with a closure element engageable on a seating with the closure elements being in engagement with a common plunger, the servo-pistons being adapted to act upon one of the closure elements to open one valve and shut the other valve, and wherein the closure elements are each mounted in a sleeve accommodated in the housing and the plunger extends through the seatings of the valves.

6. A system according to claim 1, wherein the control device has a setting position which initiates the automatic control sequence.

7. In combination with a mine roof support installation having a plurality of roof support assemblies, each having hydraulically operated props, and at least one shifting ram for moving the assemblies in relation to one another, a hydraulic control system comprising: a source of pressure medium, valve devices and pressure medium conduits connected to the props and the ram, and a manually operable control device for selectively actuating the valve device to actuate selected valve devices to cause pressure medium to be fed to and from the props and the ram to perform various operating steps, wherein at least some of the valve devices each have two servo-pistons and associated working chambers, the servo-pistons being adapted to operate the valve device when pressure medium is conveyed to the associated working chambers, means operably connecting one of the working chambers to the control device and means operably connecting the other of the working chambers to part of the system for automatically effecting a sequence of operations on the props and the ram.

8. In a hydraulic control system including a source of pressure medium, a combination of valve devices and pressure medium conduits connect to consumer appliances and a manually operable control device for selectively actuating the valve devices to feed pressure medium to and from the appliances to perform various operations, the improvement therein comprising: the control device having a rotatable member and a fixed plate provided with a plurality of bores, and a further bore in the plate, the rotatable member having at least one bore therein which can be bought into sealed register with each of the plurality of bores in the plate as the member is rotated, the rotatable member also having a further bore which communicates with the further bore in the plate, there being further provided a shut-off valve operably disposed to open and close communication between the further bore in the member and the at least one bore in the member, at least some of the plurality of bores in the plate being in communication through suitable hydraulic lines with associated servo-control working chambers so that the manual operation of the control device causes an associated valve member to be actuated, each valve member further including a second servo-control working chamber, and means being provided to operably connect the second working chamber to part of the system for automatically effecting a sequence of operations on the appliances.

9. A system according to claim 8, wherein the control device has a lever for effecting rotation of the member and for effecting actuation of said valve.

10. A system according to claim 9, wherein the rotatable member is partly received in a housing attached to said plate and the rotatable member has an extension part which extends through an aperture in the housing and carries said lever.
11. A system according to claim 8, wherein the shut-off valve is in the form of a closure element biased by a spring against a seating, accommodated in an axial bore of the rotatable member which constitutes said further bore, said at least one bore is provided in a disc part of the member and there is provided a displaceable plunger for moving the closure element off the seating.

12. A system according to claim 8, wherein the plurality of bores in the plate lie on a common pitch circle with its centre at the rotational axis of the rotatable member, the further bore in the plate is aligned with the rotational axis of the member, and the plate has another bore disposed between said pitch circle and the further bore end communicating with an annular gap disposed between the rotatable member and an inner planar face of the plate.

13. A system according to claim 12, wherein said at least one bore in the rotatable member contains a sealed sleeve adapted to be urged into sealing relationship with said planar face of the plate by means of the pressure of the pressure medium conveyed therethrough.

14. A system according to claim 8, wherein there is provided detent means for causing the rotatable member to be indexed into various angular positions as the member rotates so that each of the plurality of bores in the plate is successively brought into communication with said at least one bore in the rotatable member.

15. A system according to claim 8, wherein the rotatable member is received in a housing attached to the plate, there being provided roller bearings located between the housing and the member.

16. In combination with a mine roof support installation having a plurality of roof support assemblies, each with hydraulically operated props, and at least one shifting ram for moving the assemblies in relation to one another, a hydraulic control system comprising: a source of pressure medium, valve devices, at least some of the valve devices each having two servo-pistons and associated working chambers, the pistons being adapted to operate the valve devices when pressure medium is conveyed to either working chamber, and pressure medium conduits connected to the props and the ram, a manually operable control device being settable to various operating positions to actuate selected valve devices to cause pressure medium to be fed to and from the props and the ram to effect various operating cycles including extension and retraction of certain of the props and shifting of certain of the assemblies, means operably connecting one of the working chambers of each valve device with the control device and means operably connecting the other of the working chambers of each valve device to part of the system for automatically effecting a sequence of operations, wherein the control device includes a setting which when adopted causes the retraction of the props of one assembly and the shifting of the assembly effected by the automatic ram to be initiated simultaneously.

17. An installation according to claim 16, wherein the control device comprises: a rotatable member and a fixed plate provided with a plurality of bores, and a further bore in the plate, the rotatable member having at least one bore therein which can be brought into sealed register with each of the plurality of bores in the plate as the member is rotated, the rotatable member also having a further bore which communicates with the further bore in the plate, there being further provided a shut-off valve operably disposed to open and close communication between the further bore in the member and the at least one bore in the member, at least some of the plurality of bores in the plate being in communication through suitable hydraulic lines with associated servo-control working chambers so that the manual operation of the control device causes an associated valve member to be actuated, each valve member further including a second servo-control working chamber, and means being provided to operably connect the second working chamber to part of the system for automatically effecting a sequence of operations on the appliances.

18. An installation according to claim 16, wherein the control device has settings whereat some of the props of one of the support assemblies are extended and retracted independently of the remaining props of the assembly.

19. An installation according to claim 16, wherein the control device has a setting whereat a sequence of operations composed of the retraction of the props of one of the assemblies, the shifting of said one assembly and the subsequent extension of the props is effected automatically.