Sept. 3, 1968 F. J. FUELL ETAL 3,399,601

HYDRAULIC SEQUENTIAL CONTROL SYSTEMS

Filed March 24, 1965 3 Sheets-Sheet 1

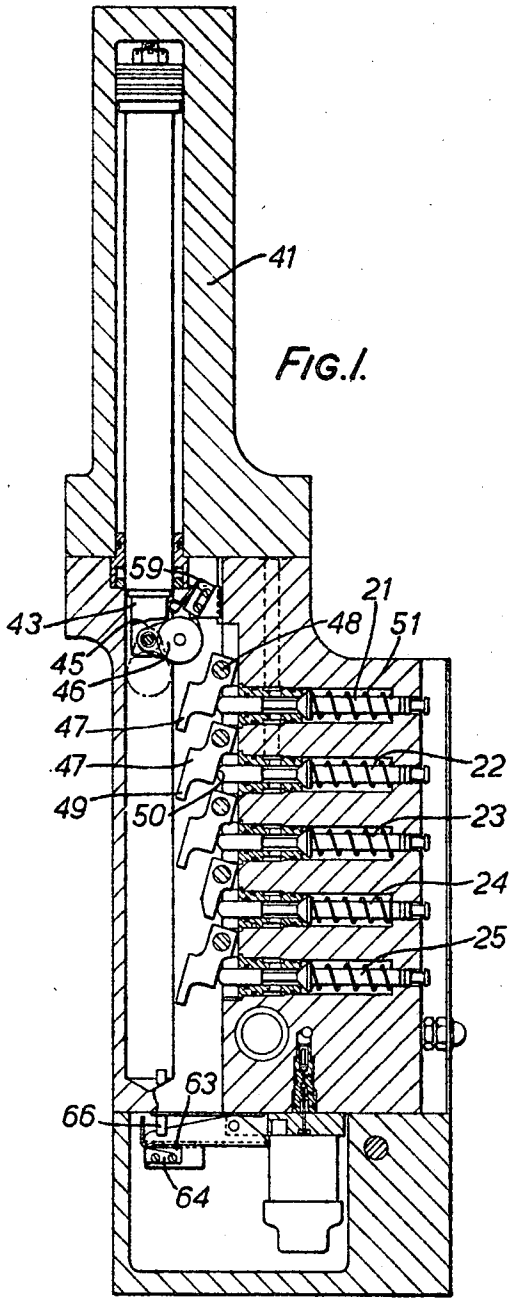


FIG. 1.

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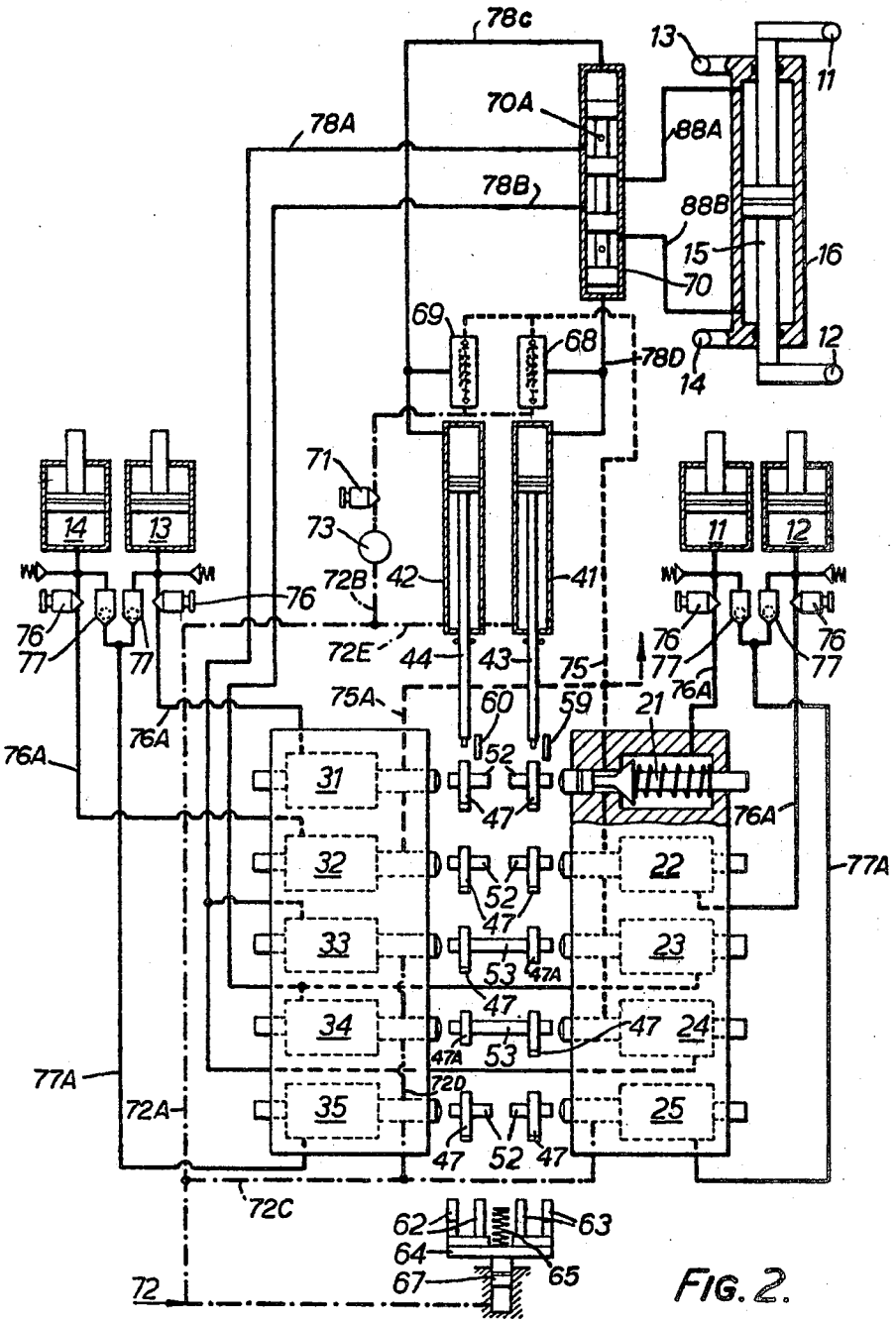


FIG. 2.

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HYDRAULIC SEQUENTIAL CONTROL SYSTEMS

Filed March 24, 1965 3 Sheets-Sheet 3

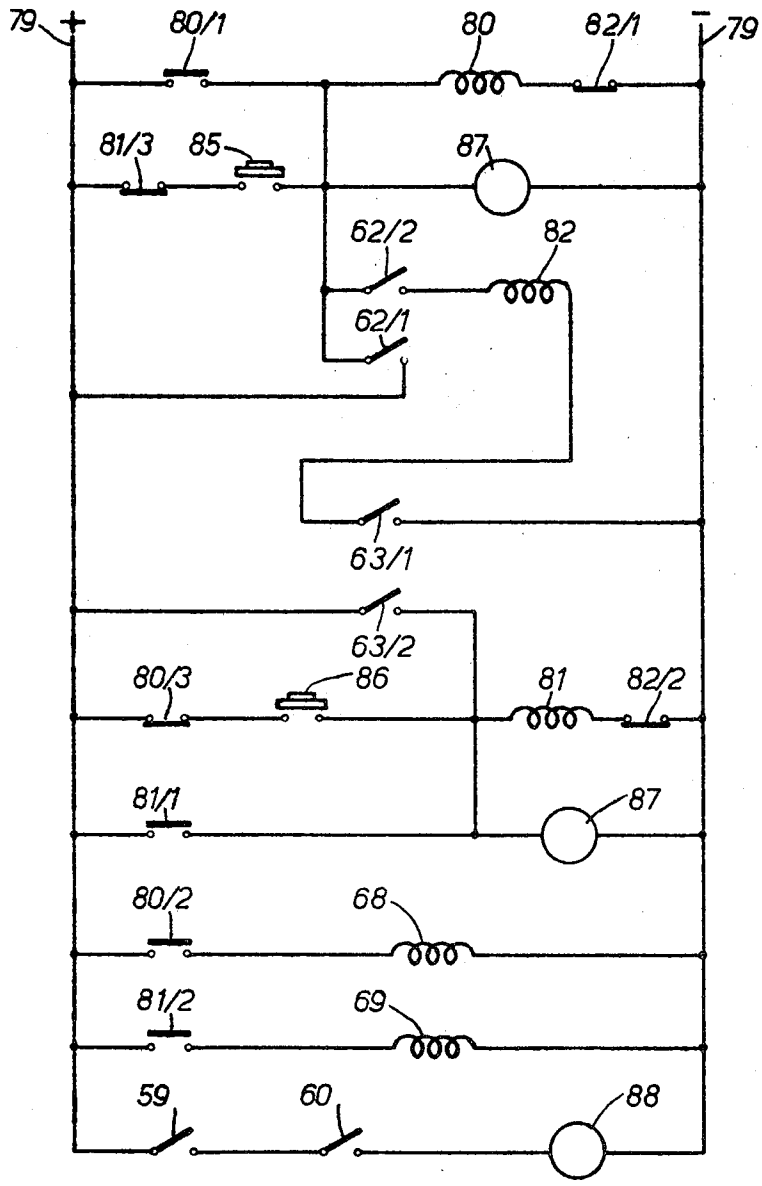


FIG. 3.

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3,399,601

HYDRAULIC SEQUENTIAL CONTROL SYSTEMS

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16 Claims. (Cl. 91—36)

This invention relates to hydraulic systems for automatically performing a cycle of operations. The invention is particularly, though not exclusively, concerned with a semi-automatic system of walking pit props.

Such systems have in general either been manually controlled, in which case it is necessary for a man to actuate a number of valves in succession in order to cause a set of pit props to move a step forward or backward, or have involved a costly and complicated fully automatic system. The present invention provides a system which saves almost as much time as the automatic system but is very much simpler.

According to one aspect of the present invention a hydraulic system for automatically performing a series of at least six operations, of which the first and third, the second and fifth, and the fourth and sixth are reversals of each other, includes two sequence controllers respectively serving to initiate the first three operations and the second three operations in sequence, and a reversing device for reversing the second and fifth operations, and means for actuating the first sequence controller and then the second sequence controller, with the reversing device in one position to initiate the operations in one sequence, and to actuate the second sequence controller and then the first sequence controller with the reversing device in the other position to initiate the operations in a different sequence.

Where the invention is applied to walking pit props various arrangements of props are possible. The simplest arrangement would be merely a front prop ram and a rear prop ram connected by a double-acting horizontal ram. In general, however, it will be preferable to employ front and rear left-hand prop rams connected to opposite ends of the piston rod of a double-acting horizontal ram, and front and rear right-hand prop rams connected to opposite ends of the cylinder.

In the former case the sequence of operations for a step forward would comprise lowering the front prop ram, extending the horizontal ram, raising the front prop ram, lowering the rear prop ram, contracting the horizontal ram and raising the rear prop ram. In order to take a step backwards it will be appreciated that the sequence of operations is not merely reversed. Thus it is necessary to lower the rear prop ram, extend the horizontal ram, raise the rear prop ram, lower the front prop ram, contract the horizontal ram and raise the front prop ram.

Similarly in the case of the latter arrangement a forward step may comprise lowering the left-hand prop rams, actuating the horizontal ram to advance the left-hand props, raising the left-hand prop rams, lowering the right-hand prop rams, actuating the horizontal ram to advance the right-hand props, and raising the right-hand prop rams. Similarly to take a step backwards the sequence of operations in not merely the reverse of that required for a forward step.

In one form of the invention each sequence controller comprises a number of operating valves arranged in a row and a cam actuated by a hydraulic ram, which will be referred to as a sequence ram, to move along the row and actuate the valves in succession. Conveniently the valves

are poppet valves which may be actuated by means of rocking tappets mounted in the path of the cam. The cam, which may be in the form of a roller, is conveniently mounted on a trigger lever so as to be retracted clear of the tappets during the return movement of the ram.

Conveniently the two sequence controllers are mounted alongside one another and they may be arranged so that during a complete cycle one first moves to its fully extended position in which it remains whilst the other then moves to its fully extended position, whereupon both sequence controllers return to their initial position. The arrival of the first sequence controller in its final position may actuate means, such as a microswitch, for initiating the movement of the second sequence controller.

It may be convenient, more especially for manual operation, to provide separate valves for independently lowering the two prop rams which normally move together, for example the two left-hand prop rams or the two right-hand prop rams. Similarly for actuating the double-acting horizontal ram two poppet valves may be required. Accordingly each row of valves may comprise five valves of which the first two are connected respectively to the two prop rams associated with that sequence controller, the third and fourth are shared between the two controllers for actuating the horizontal ram, both the third valves being actuated by one sequence controller whilst both the fourth valves are actuated by the other, and the fifth valve being connected to both of the associated prop rams.

Means are preferably provided for ensuring that if the pressure should fail, so that one pair of prop rams is not fully raised at the end of one half cycle, the ensuing half cycle will not occur and hence the other pair of prop rams will not be lowered. Such means may conveniently include microswitches mounted so as normally to be actuated by the sequence controllers at the end of their travel but arranged to be retracted to an inoperative position by a spring or the like if the system pressure should fail.

The invention may be put into practice in various ways but one specific embodiment will now be described by way of example with reference to the accompanying drawing, in which

FIGURE 1 is a somewhat diagrammatic side elevation of a double sequence controller with parts broken away to show its mechanism,

FIGURE 2 is a hydraulic circuit diagram, and

FIGURE 3 is an electrical circuit diagram.

The invention is illustrated as applied to a hydraulic system for automatically controlling a single cycle of operation of a set of walking pit props. Each set of pit props comprises a right-hand pair **11** and **12** one in front of the other connected to opposite ends of the piston rod **15** of a horizntal duble-acting ram, and a left-hand pair **13** and **14** connected to opposite ends of the cylinder **16**.

The operator is provided with a pair of control panels each controlling a group of twenty-five sets of pit props one group extending one way from him and the other group extending the other way from him along the coal face. The control panel is provided with a selector switch for selecting a particular set, and sections for individual sets each comprising an advance button, a retreat button and indicating lamps. The operator selects each set of props in turn and presses the advance button whereupon the system automatically performs one cycle consisting of six or eight operations required to take one step forward, without further action on the part of the operator.

The control apparatus for each set comprises a double sequence controller, which may conveniently be strapped to one of the walking unit ram bodies. The control unit comprises two rows of poppet valves each including five valves **21** to **25** and **31** to **35** which in normal operation are arranged vertically one above the other with their axes horizontal. Each sequence controller compries a sequence ram **41** or **42** the plunger **43** or **44** of which actuates the valves. At its end the plunger has a slot accommodating a pair of link plates **45** carrying a roller cam **46**. Thus the link plates can rock about a transverse axis through that of the plunger, so that the roller can swing from a retracted position (shown in chain lines) in line with the plunger, to a projecting position (shown in full lines) in which it projects sideways from the plunger to actuate the valves.

Each valve is provided with a rocking tappet **47** or **47A** mounted on a transverse shaft and having an actuating surface **50** bearing on the end of the poppet valve rod to open the poppet valve, against the action of a spring **51** tending to keep it closed. Each of the tappets **47** has a ramp surface **49** for engagement by the associated roller cam **46**, but the tappets **47A** have no ramp surface and are always clear of the path of the roller cam. As indicated diagrammatically in FIGURE 2, most of the rocking tappets **47** with individual stub shafts **52** one of which extends through the outside of the casing and is provided with a hexagonal recess to be engaged by a key for manual opening of the individual valve. In the two cases of the third and fourth valves, however, the tappets **47** and **47A** of the two sequence controllers are mounted on a comon shaft **53** so as both to rock together, their arrangement being such that both the third valves **23** and **33** will be opened simultaneously by the sequence ram **42** but not by the other sequence ram **41**, whilst both the fourth valves **24** and **34** will be opened by the sequence ram **41** but not by the sequence ram **42**.

Above the first pair of rocking tappets **47** microswitches **59** and **60** are mounted so as to be respectively engaged by a step on each of the plungers **43**, **44** to indicate that that plunger has started its outward travel. Similarly a pair of microswitches **62** are mounted so as to be both actuated by the end of the plunger **44** when it reaches the end of its outward travel, and a second pair of microswitches **63** are similarly mounted for actuation by the end of the other plunger **43** at the end of its outward stroke. Both these pairs of microswitches **62** and **63**, one pair for each sequence controller, are mounted on a common rocking lever **64** acted upon by a spring **65** tending to retract the microswitches clear of a dowel **66** which normally transmits movement from the plunger to the microswitches. A small piston **67**, subjected to the hydraulic system pressure, acts on the rocking lever to overcome the spring **65** and hold the lever **64** against the dowel **66** with the microswitches in their operative position. Should the system pressure fail, the microswitches will be retracted to an inoperative position by the spring **65**.

The unit also includes a pair of solenoid-controlled valves **68** and **69**, and a reversing valve **70** which may conveniently be described in connection with the hydraulic system shown in FIGURE 2.

The hydraulic system

Hydraulic presure fluid (for example at 3000 p.s.i.), is fed through conduits **72A**, **72B** indicated in chain lines from a supply **72** through a filter **73** and a variable restrictor valve **71** to the two solenoid-controlled valves **68** and **69**, and is fed direct to the piston **67** which holds the microswitches in their operative position. The same supply of pressure fluid, by-pasing the filter **73**, is connected by conduits **72C**, **72D** to the valves **33**, **34**, **35** and **25** by a conduit **72E** and to the return sides of the two sequence rams **41** and **42** where it acts on a reduced piston area, tending to withdraw the plungers **43**, **44** inwardly. A low-pressure return or exhaust **75**, **75A**, indicated in broken lines, is also connected to the solenoid valves **68** and **69** and to the poppet valves **21**, **22**, **23**, **24**, **31** and **32**.

Each of the poppet valves **21** and **22** is connected through a conduit **76A** and a variable restrictor **76** to one of the associated prop rams **11** or **12**, whilst both of the associated prop rams are connected through non-return valves **77** and a common conduit **77A** to the poppet valve **25**. The other two prop rams **13** and **14** are similarly connected to the poppet valves **31**, **32** and **35**. The poppet valves **33** and **24** are connected by a common conduit **78A** through the reversing valve **70** to one end of the horizontal ram **16**, whilst the poppet valves **23** and **34** are connected via a common conduit **78B** through the reversing valve **70** to the opposite end of the horizontal ram **16**. The reversing valve **70** is operated by pressure fluid delivered to opposite ends of it by conduits **78C**, **78D**. Thus one end is connected by the conduit **78D** to one solenoid-controlled valve **68** which is also connected to the operating cylinder of the associated sequence ram **41**. The other end of the reversing valve **70** is connected by the conduit **78C** to the other solenoid controlled valve **69** which is also connected to the operating cylinder of the other sequence control ram **41**.

Operation of the hydraulic system

In order to effect a step forward the solenoid-controlled valve **68** associated with the right-hand prop rams **11** and **12**, which are connected to the valves **21** to **25**, is opened.

This admits pressure fluid from supply **72** via conduits **72A**, **72B** and **78D** to one end of the reversing valve **70**, moving it to what will be termed its advance position (upwards in FIGURE 2), and at the same time it admits pressure fluid to the advance sequence control ram **41** to cause it to move steadily outwards. The roller cam **46** carried by the ram plunger **43** first opens the valve **21** so as to release fluid from it and lower the associated prop **11**. As the roller cam **16** passes on, the valve **21** closes and the valve **22** is opened the roller cam opens so as to lower the associated prop **12**. When the roller cam **46** reaches the valve **23** nothing happens since the associated rocking tappet **47A** has no cam ramp **49**. On reaching the valve **24** the roller cam **46** opens both the valve **24** and the valve **34** whose rocking tappets **47** and **47A** are mounted on the common shaft **53**. The valve **24** when opened connects one end of the horizontal ram **16** through the reversing valve **70** via conduits **88A** and **78A** and **75** to exhaust, whilst the valve **34** when opened connects the other end of the ram **16** through the reversing valve **70** via conduits **88B**, **78B** and **72C** to pressure fluid source **72**. Accordingly the horizontal ram **16** moves so as to advance the right-hand props **11** and **12** (the props **13** and **14** being held stationary between the floor and roof). The roller cam **46** then allows the valves **24** and **34** to close, and opens the valve **25** admitting pressure fluid through conduits **72C** and **77A** to both the prop rams **11** and **12** so that they are raised again into contact with the roof.

At the end of its travel the sequencer ram plunger **43** actuates the microswitches **63** which, in a manner to be described below, initiate the movement of the second sequence ram **42** by opening the second solenoid controlled valve **69**. This admits pressure fluid to the uppermost end of the reversing valve **70** (as seen in FIGURE 2) but as pressure fluid is already admitted to its other end the valve **70** is balanced and stays where it is in the advance position. Small relative pressure fluctuations may tend to move the valve **70** from the selected advance position, but these are neutralised by a friction device inherent in the piston proper.

In addition pressure fluid is admitted by the second solenoid valve **69** to the second sequence ram **42** which advances in a similar manner to the first. Its roller cam **46** first lowers the left hand props **13** and **14** successively by

opening the valves **31** and **32**. On arriving at the valve **33** it opens both the valves **33** and **23** so as to reverse the ends of the horizontal ram **16** to which pressure and exhaust are applied respectively. Accordingly the horizontal ram is moved in the opposite direction so as to advance the left hand props **13** and **14**. The valves **23** and **33** are then allowed to close, the roller cam **46** passes the valves **24** and **34** without actuating them, since the tappet **47A** of the valve **34** has no cam follower ramp, and finally opens the valve **35** so as to raise the left hand prop rams **13** and **14** into contact with the roof again. On arriving at the end of its travel the plunger **44** actuates the microswitches **62** and the fact that the pairs of microswitches **62** and **63** of both sequence rams **41** and **42** are then simultaneously actuated indicates that the cycle is complete, whereupon both solenoid valves switch over to exhaust and the sequence rams return to their initial positions.

The electric circuit

As indicated in FIGURE 3 the electric circuit comprises three relays **80**, **81** and **82** for ensuring that the cycle of operations described will occur automatically. The relays may be termed an "advance relay" **80**, a "retreat relay" **81** and a "stop relay" **82**. The advance relay coil **80** is connected across supply terminals **79** in series with holding contacts **80/1** of itself and normally-closed contacts **82/1** of the stop relay **82**. The holding contacts **80/1** are shunted by an advance button **85** in series with normally-closed contacts **81/3** of the retreat relay **81** and by microswitch contacts **62/1** closed by the plunger of the second ram **42** at the end of its travel which may be referred to as its finish microswitch contacts **62/1**. Connected across the supply in series with this microswitch are the other finish microswitch contacts **62/2** of the second ram plunger **44**, the stop relay **82** and finish microswitch contacts **63/1** of the first ram **41**.

Similarly the retreat relay **81** is connected in series with normally-closed contacts **82/2** of the stop relay and with its own holding contacts **81/1**. The latter are shunted by finish microswitch contacts **63/2** of the first ram **41** and by a retreat button **86** in series with normally-closed contacts **80/3** of the advance relay **80**. Each of the advance and retreat relays **80** and **81**, with its stop contacts in series with it, is shunted by a red lamp **87**, whilst a green lamp **88** is connected across the supply in series with the start microswitches **59** and **60** respectively; contacts which open when the plungers of their associated rams start to move and are connected in series so that the green lamp when illuminated indicates that neither ram **41** or **42** has moved. The advance relay **80** has contacts **80/2** connected across the supply in series with the advance solenoid-operated valve **68** whilst the retreat relay **81** has contacts **81/2** connected in series with the retreat solenoid operated valve **69**.

Accordingly it is thought that the operation will be clear.

Operation

When the advance button **85** is pressed it illuminates the advance red lamp **87** and energises the advance relay **80**, which closes its holding contacts **80/1** and also opens its contacts **80/3** in series with the retract button so that that button is ineffective. In addition its contacts **80/2** energise the advance solenoid valve **68**. As soon as the first sequence control ram **41** starts to move it extinguishes the green lamp.

At the end of its travel the first sequence ram **41** closes the finish microswitch contacts **63/2** shunting the retreat button **86** which illuminates the retreat red lamp **87** and energises the retreat relay **81**. This closes its own holding contact **81/1**, opens the normally-closed contacts **81/3** in series with the advance button **85** so that the advance button is ineffective, and its contacts **81/2** energise the retreat solenoid controlled valve **69**, to start the second sequence ram **42**.

When the second sequence ram **42** reaches the end of its travel both the microswitch contacts **62/2** and **63/1** in series with the stop relay **82** are closed and hence the stop relay **82** is energised, opening contacts **82/1** and **82/2** in series with both the advance and retreat relays so that both these relays are de-energised and both solenoid controlled valves **68** and **69** switch over to exhaust.

In order to make a retreating step it is only necessary to press the retreat button. This produces an analogous cycle of operations, but their sequence, though not accurately reversed, is modified so as to effect a retreating step.

Depression of the retreat button **86** illuminates the retreat red lamp **87** and energises the retreat relay **81**, which closes its holding contacts **81/1** and also opens its contacts **81/3** in series with the retreat button so that that button is ineffecive. In addition its contacts **81/2** energise the retreat solenoid control valve **69**, which is associated with the left-hand prop rams **13** and **14**, which are connected to the valves **31** and **32**, so that the valve is thus opened.

The opening of the control valve **69** admits pressure fluid from supply **72** via conduits **72A**, **72B** and **72C** to one end of the reversing valve **70**, moving it downwards, a sseen in FIGURE 2, and at the same time it admits pressure fluid to the retreat sequence control ram **42** to cause it to move steadily outwards. As soon as the lrst sequence control ram (which for a retreating step is ram **42**) starts to move it extinguishes the green lamp by opening the contacts of the start microswitch **60**. The roller cam **46** carried by the ram plunger **44** first opens the valves **31** and **32** so as to release fluid from them and lower the left-hand props **13** and **14**. When the roller cam **46** reaches the valve **33** it opens both the valve **33** and the valve **23** whose rouking tappets **47** and **47A** are mounted on a common shaft **53**. The valve **33**, when opened, connects one end of the horizontal ram **16** through the reversing valve **70** via conduits **88B**, **70A**, **78A**, **72D** and **72C** to the pressure fluid source **72**, whilst the valve **23** when opened connects the other end of the ram **16** through the reversing valve **70** via conduits **88A**, **78B** and **75** to exhaust. Accordingly, the horizontal ram **16** moves so as to move the left-hand props **13** and **14** in a retreating direction (the props **11** and **12** being held stationary between the floor and roof). The roller cam **46** then allows the valves **33** and **23** to close, and opens the valve **35** admitting pressure fluid through conduits **72C** and **77A** to both the prop rams **13** and **14** so that they are raised again into contact with the roof.

In similar manner to that for the advancing step procedure, at the end of its travel the first sequence ram **42** closes its finish microswitch contacts **62/2** and thereby automatically energises the other solenoid valve **68** which when opened admits pressure fluid to the second sequence ram **41**, and to the lowermost end of the reversing valve **70** (as seen in FIGURE 2). Since the pressure fluid is still admitted to the uppermost end via conduit **78C** the valve member is balanced and stays in the lower position as shown in FIGURE 2.

The second sequence will proceed automatically as the ram plunger **44** moves outwardly in analogous fashion to that for the second sequence of the advancing step procedure, that is, the right-hand props will first be lowered when the roller cam **46** opens the valves **21** and **22**, nothing happens when the roller cam **46** reaches the valve **23** since the associated rocking tappet **47A** has no cam ramp **49**, and then on reaching the valve **24** the roller cam **46** opens both the valve **24** and the valve **34** thereby reversing the pressure and exhaust connections to the horizontal ram **16**.

Accordingly the horizontal ram moves so as to move the right-hand props in a retreating direction, i.e. towards props **13** and **14** which are held stationary between the floor and roof. The props **11** and **12** are thereafter raised into contact with the roof when valve **25** is opened by the roller cam **46** of the ram plunger **44**.

As with the "advancing" step, at the end of the travel of the ram **41** both microswitch contacts **62/1** and **63/1** are closed thereby energising the stop relay **82**, and de-energising both the relays of the solenoid control valves **68** and **69** which are thus switched over to exhaust.

It will be appreciated that the invention is not restricted to the details of the specific embodiment described nor to the specific purpose of the latter. Thus the general principles of the invention may be employed for purposes other than walking pit props. For example for the control of machine tools.

What we claim as our invention and desire to secure by Letters Patent is:

1. A hydraulic system for automatically performing a series of at least six operations, comprising first and second sequence controllers to initiate the first three operations and the second three operations in sequence, a reversing device for reversing a number of operations, and means for actuating the first sequence controller and then the second sequence controller, with the reversing device in one position, to initiate the operations in one sequence, and to actuate the second sequence controller and then the first sequence controller, with the reversing device in another position, to initiate the operations in a different sequence.

2. A system as claimed in claim **1** which comprises a front prop ram and a rear prop ram connected by a double-acting horizontal ram, and the sequence of operations for a step forward comprises lowering the front prop ram, extending the horizontal ram, raising the front prop ram, lowering the rear prop ram, contracting the horizontal ram and raising the rear prop ram, whilst the sequence for a step backwards comprises lowering the rear prop ram, extending the horizontal ram, raising the rear prop ram, lowering the front prop ram, contracting the horizontal ram and raising the front prop ram.

3. A system as claimed in claim **1** which comprises front and rear left-hand prop rams and front and rear right-hand prop rams, the prop rams on one side being connected to opposite ends of a piston rod of a double-acting horizontal ram, and those on the other side being connected to opposite ends of a cylinder, and the sequence of operations for a forward step comprises lowering the prop rams on the one side, actuating the horizontal ram to advance the lowered props, raising those prop rams, lowering the prop rams on the other side, actuating the horizontal ram to advance the lowered props, and raising those prop rams, whilst for a step backwards the sequence comprises lowering the prop rams on one side, actuating the horizontal ram to retreat the lowered props, raising those prop rams, lowering the prop rams on the other side, actuating the horizontal ram to retreat the lowered props and raising those prop rams.

4. A system as claimed in claim **1**, in which each sequence controller comprises a plurality of operating valves arranged in a row and a cam actuated by a hydraulic ram as a sequence ram, to move along the row and actuate the valves in succession.

5. A system as claimed in claim **1**, in which each sequence controller comprises a plurality of operating valves arranged in a row and a cam actuated by a hydraulic ram as a sequence ram, to move along the row and actuate the valves in succession, the fluid fed to the sequence ram through flow restricting means to control its rate of movement.

6. A system as claimed in claim **1**, in which each sequence controller comprises a plurality of operating valves arranged in a row and a cam actuated by a hydraulic ram as a sequence ram, to move along the row and actuate the valves in succession, the valves being poppet valves and are actuated by means of rocking tappets mounted in the path of the cam.

7. A system as claimed in claim **1**, in which each sequence controller comprises a plurality of operating valves arranged in a row and a cam actuated by a hydraulic ram as a sequence ram, to move along the row and actuate the valves in succession, the cam being mounted on a trigger lever so as to be retracted clear of the tappets during the return movement of the cam.

8. A system as claimed in claim **1**, in which each sequence controller comprises a plurality of operating valves arranged in a row and a cam actuated by a hydraulic ram as a sequence ram, to move along the row and actuate the valves in succession, the cam being in the form of a roller.

9. A system as claimed in claim **1**, in which each sequence controller comprises a plurality of operating valves arranged in a row and a cam actuated by a hydraulic ram as a sequence ram, to move along the row and actuate the valves in succession, the two sequence controllers being mounted alongside one another.

10. A system as claimed in claim **1**, in which each sequence controller comprises a plurality of operating valves arranged in a row and a cam actuated by a hydraulic ram as a sequence ram, to move along the row and actuate the valves in succession, in which means are provided whereby the two sequence controllers are arranged so that during a complete cycle one first moves to its fully extended position, in which it remains whilst the other then moves to its fully extended position, whereupon both sequence controllers return to their initial position.

11. A system as claimed in claim **1**, in which each sequence controller comprises a plurality of operating valves arranged in a row and a cam actuated by a hydraulic ram as a sequence ram, to move along the row and actuate the valves in succession, the first sequence controller, in its final position, actuating means as a micro-switch for initiating the movement of the second sequence controller.

12. A system as claimed in claim **1**, in which each sequence controller comprises a plurality of operating valves arranged in a row and a cam actuated by a hydraulic ram as a sequence ram, to move along the row and actuate the valves in succession, and valves for independently lowering two prop rams which normally move together.

13. A system as claimed in claim **1**, in which each sequence controller comprises a plurality of operating valves arranged in a row and a cam actuated by a hydraulic ram as a sequence ram, to move along the row and actuate the valves in succession, and two poppet valves for actuating the double-acting horizontal ram.

14. A system as claimed in claim **1**, in which each sequence controller comprises a plurality of operating valves arranged in a row and a cam actuated by a hydraulic ram as a sequence ram, to move along the row and actuate the valves in succession, the row of valves comprises five valves of which the first two are connected respectively to the two prop rams associated with that sequence controller, the third and fourth are shared between the two controllers for actuating the horizontal ram, both the third valves being actuated by one sequence controller whilst both the fourth valves are actuated by the other, and the fifth valve being connected to both of the associated prop rams.

15. A system as claimed in claim **1**, in which each sequence controller comprises a plurality of operating valves arranged in a row and a cam actuated by a hydraulic ram as a sequence ram, to move along the row and actuate the valves in succession, and means for ensuring that if the pressure should fail, so that one pair of prop rams is not fully raised at the end of one half cycle, the ensuing half cycle will not occur and the other pair of prop rams will not be lowered.

16. A system as claimed in claim **1**, in which each sequence controller comprises a plurality of operating valves arranged in a row and a cam actuated by a hydraulic ram as a sequence ram, to move along the row

and actuate the valves in succession, and means for ensuring that if the pressure should fail, so that one pair of prop rams is not fully raised at the end of one half cycle, the ensuing half cycle will not occur and the other pair of prop rams will not be lowered, the means referred to include micro-switches mounted so as normally to be actuated by the sequence controllers at the end of their travel by arranged to be retracted to an inoperative position by a spring or the like if the system pressure should fail.

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3,097,829	7/1963	Seddon	91—170
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