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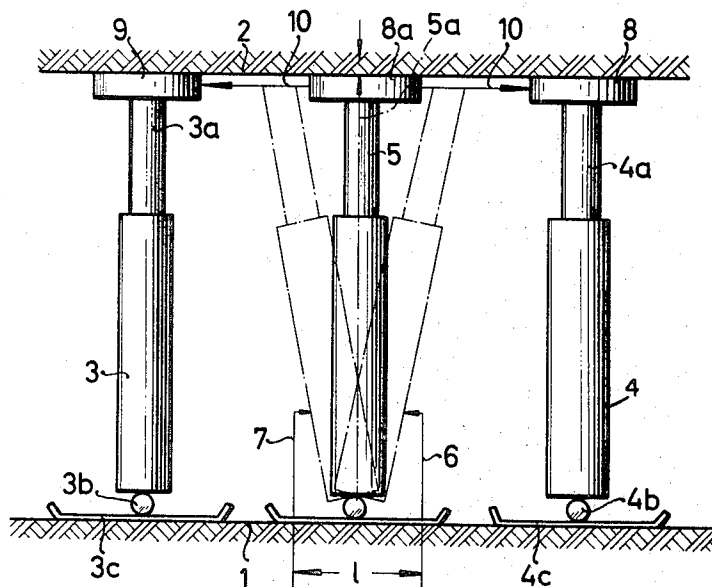
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MINE ROOF SUPPORT MEANS

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FIG. 1



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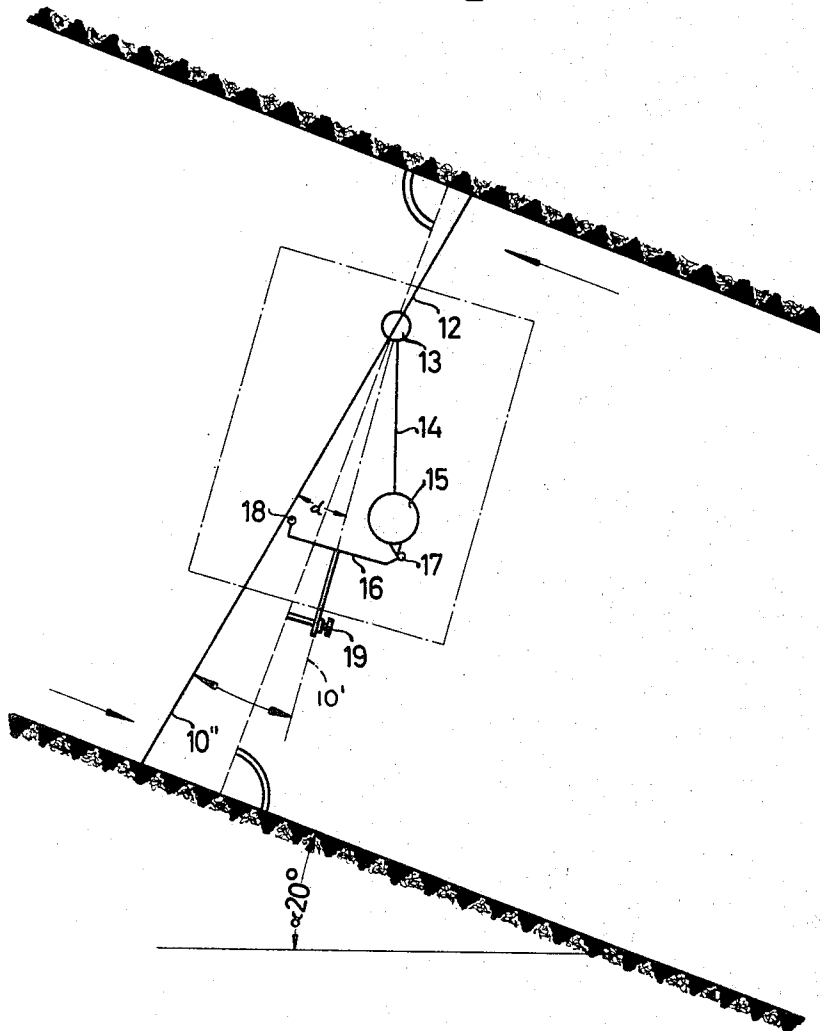
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**FIG. 2**



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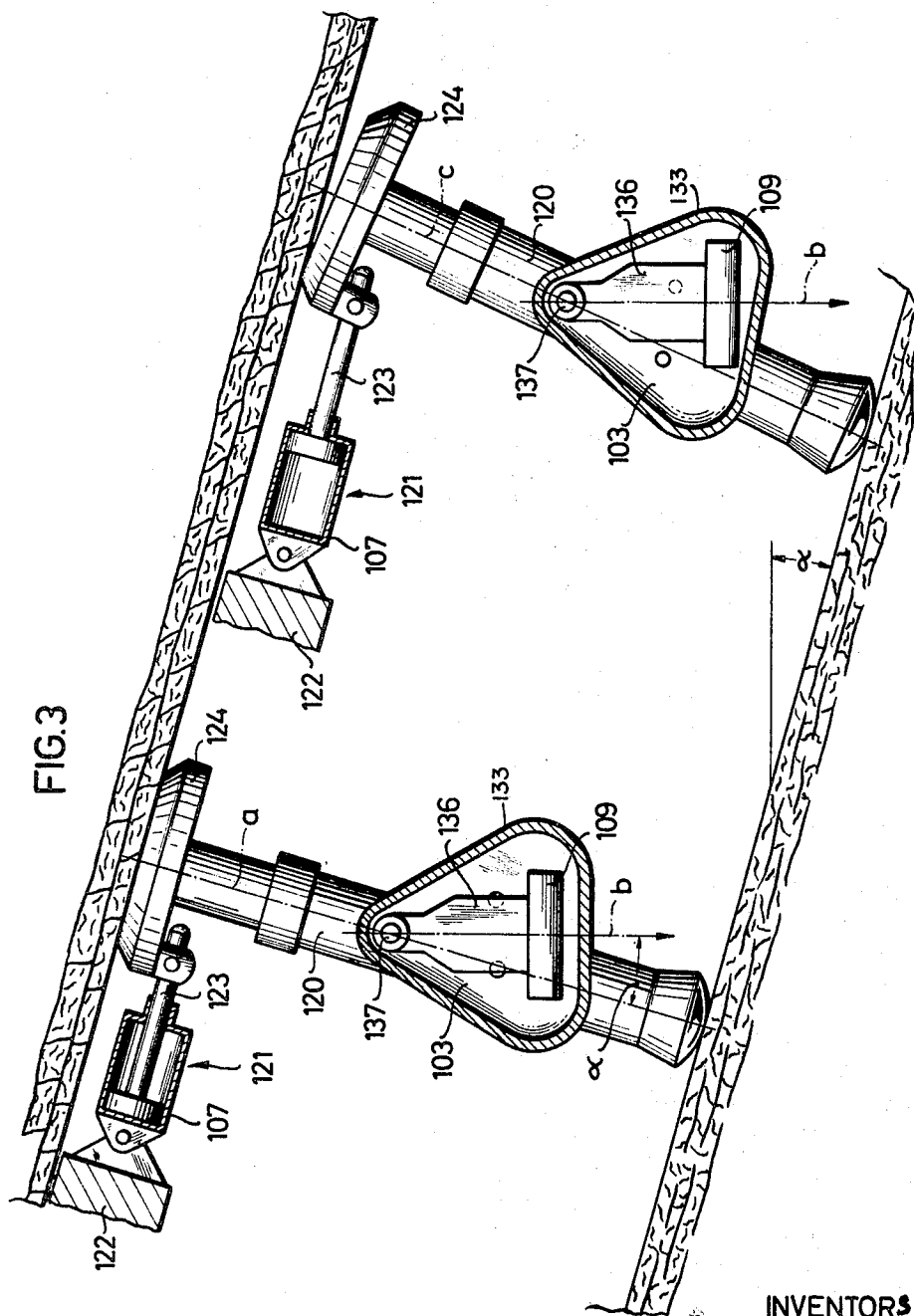
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Sheet 3 of 4



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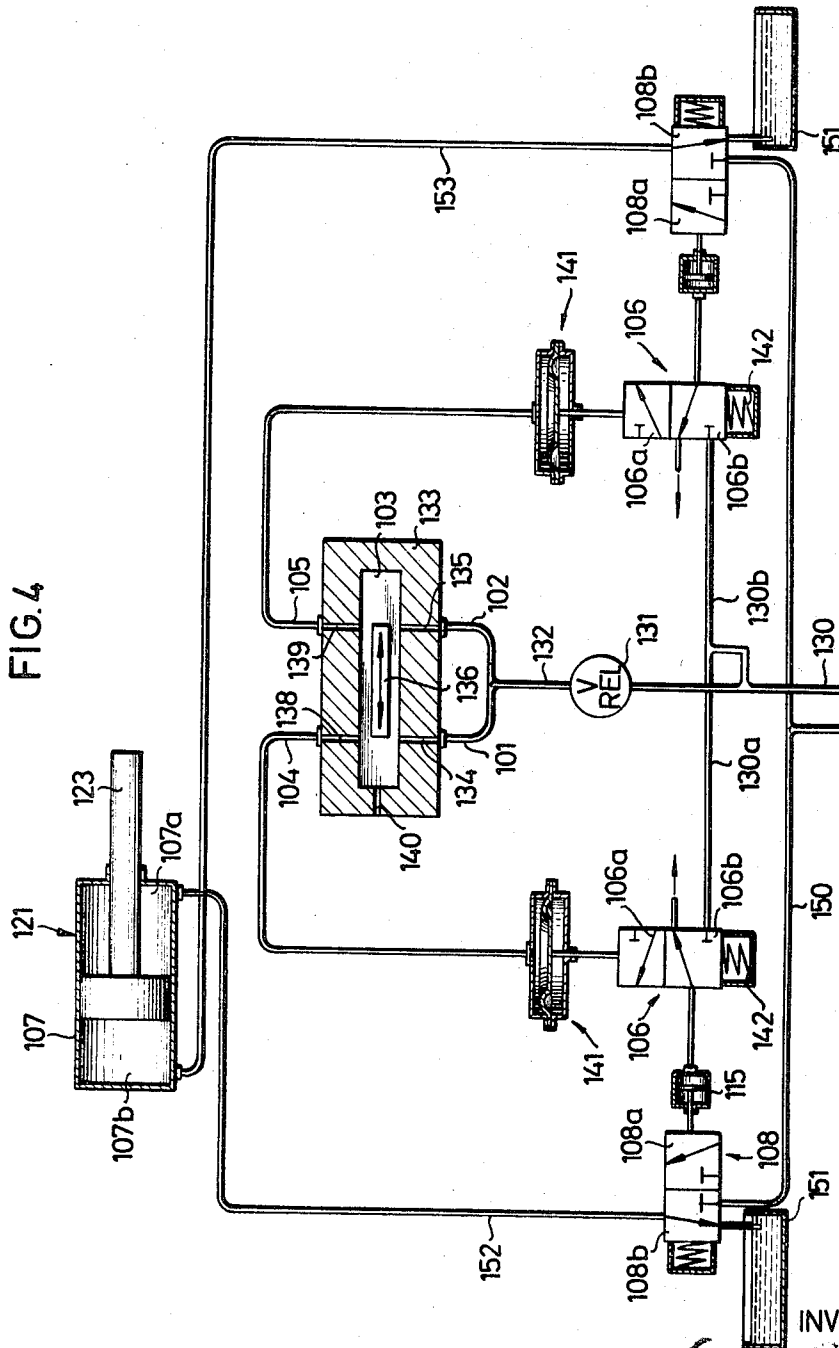
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FIG. 4



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3,437,010

## MINE ROOF SUPPORT MEANS

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6 Claims

### ABSTRACT OF THE DISCLOSURE

The specification describes automatic systems for controlling the angular settings of pit props. In one system feelers for sensing the inclination of the prop are mounted on a foot plate of the prop and control rams moving the top of the prop. In other systems pendulum-like devices are suspended from the prop and operate electrical contact when the angle changes, or control the flow of air jets operating a pneumo-hydraulic transducer which controls rams setting the angle of the prop.

The invention relates to the setting of pit props in mines, and more particularly to the setting of hydraulic pit props so that their axes are normal to the angle of dip of the excavation in which they are placed.

In mine roof support systems the angular position of each pit prop should be precisely set in order to ensure the roof supporting force provided by the pit props reaches its optimum value. The usual method of setting the pit props is by hand by the miner generally responsible for the arrangement of pit props.

The angular setting is particularly important in the case of pit props forming parts of hydraulically operated roof support frames and it is desirable that such frame systems should be completely mechanised, i.e. remotely controlled. The necessity of adjusting the angular settings of the props manually causes an amount of labor costs which is out of proportion with the actual time taken for setting. In other words, if the necessity for manual setting of the pit prop angles could be dispensed with, other improvements could be made which would reduce costs in addition to the actual saving in labor for setting. Pit props in support frames are commonly mounted on foot plates and connected with roof-engaging parts able to pivot, so that the props can tilt in accordance with relative movement between the mine roof and floor in a direction parallel to each other, so that bending of the props is avoided. After such relative movement it is then necessary to reset the angular positions of the pit props to their correct values.

Apart from relative movements between the overlying and underlying strata in mining excavations, another reason for the need for adjusting the angular positions of pit props is to be found in the case of self-advancing roof support frames coming into contact with the usual unevennesses in the floor or roof which move the pit props out of their correct angular positions. There is also the difficulty that the advance of the tops of the pit props may not be exactly in step with their bottom portions.

One object of the present invention is to provide means for automatically setting hydraulic or other pit props in their correct angular positions.

Accordingly the invention consists in a method of setting the axis of a pit prop in a position having a predetermined angular relation to the vertical, characterised by the use of feeler means for sensing inclination of the pit prop from the given angular setting in relation to the

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vertical, by the conversion of inclination values determined by the feeler means into control signals, and by the use of these signals to control means adjusting the angular position of the pit prop in relation to the vertical.

A further object is to apply the invention as defined in the last preceding paragraph so as to achieve an automatic setting of the axes of pit props in a self-advancing roof support system independently of the number and size of the advancing steps without manual control being required.

A further object is to enable the degree of error in the angular position of pit prop to be kept as small as may be required.

In accordance with one form of the invention to be described below, the feeler means for sensing departures from the correct angular positions of the pit props are fixed to head pieces or feet of the props, the positions of such head pieces or feet being dependent upon the lie of the mine roof or floor. This however has certain disadvantages. For instance, when the floor or roof is uneven the head pieces or feet do not correspond with the general lie of the excavation. In order to overcome such errors due to the presence of such unevenness, it is possible to provide a large head piece or foot piece for the pit prop, but this is expensive and makes the pit prop expensive.

Therefore, in accordance with a preferred embodiment of the invention, the feeler means include gravity responsive means for determining the vertical direction, and means for detecting the angular relation between the vertical direction and the direction of the pit prop axis.

The advantage of this construction is that measurement of the inclination of the pit-prop is independent of the nature of the mine roof or floor.

In accordance with a further feature of the invention, we provide a control system for adjusting the angular setting of a pit prop comprising feeler means responsive to the angular position of the pit prop, ram means connected with upper part of the pit prop for changing the angular position of the pit prop, and control circuit means for operating the ram means in accordance with signals produced by the feeler means.

The pit prop can form part of a mine roof support system of the self-advancing type and the ram means can comprise rams for adjusting the angular position of the pit prop in a vertical plane extending in the direction of advance of the support system and further rams for adjusting the angular setting of the pit prop in a vertical plane normal to the direction of advance.

It is possible to provide gravity responsive means for detecting the vertical direction, and means for giving a signal when the gravity responsive means detects a departure of the pit prop from an angular setting having a predetermined relation to the vertical. The gravity responsive means can comprise a freely hanging mass mounted near the top of the pit prop.

The control system can comprise compressed air supply duct means, two discharge orifice means connected with the latter, control parts of the hanging mass arranged to hinder air emerging from the discharge orifices, two air receiving orifices arranged respectively opposite the air discharge orifices, pneumo-hydraulic transducer means responsive to air pressure in the two receiving orifices, and duct means connecting the transducer means with the ram means for operating the latter hydraulically.

The control system in accordance with the invention can further comprise a housing containing the control parts of the hanging mass, the discharge and receiving orifices being arranged in walls of the housing. The controlling parts of the hanging mass can be in the form of edge portions of a plate forming part of the hanging mass, the housing having further orifice means for venting its interior to the atmosphere.

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The control system can further comprise air pressure operated motor means, pneumatic valves arranged to be opened and closed by the motor means, and duct means connecting the motor means with the two receiving orifices, hydraulic valve means arranged to be operated by the pneumatic valve means, and duct means connecting the latter with the ram means. The housing can be secured to the pit prop by means of a pivot means and scale means can be provided for indicating the inclination of the housing in relation to the pit prop, and releasable means to prevent pivoting of the housing in relation to the pit prop.

In order that the invention may be understood in detail, embodiments of it are now described with reference to the attached drawings.

FIG. 1 is a diagrammatic view of a first embodiment of the invention.

FIG. 2 is a diagram showing the operation of an electrical control circuit forming part of an embodiment of the invention.

FIG. 3 is a further diagrammatic view of pit props embodying the invention. The left-hand side shows a pit prop which is set at the required angle to the vertical, while the right-hand side shows a pit prop whose angle is to be changed in order to bring it into agreement with the required angle to the vertical.

FIG. 4 is a circuit diagram.

In FIG. 1 reference numeral 1 denotes the floor or underlying stratum of a mine excavation and reference numeral 2 denotes the roof. Two pit props 3 and 4 are in the required angular setting which in the particular case shown is normal to the dip of the excavation. The pit props are pivoted at joints 3b and 4b to foot plates 3c and 4c so that they can be set in different angular positions to those shown. These possible positions are shown in broken lines in the case of the central pit prop 5 in fig.

In the embodiment of the invention shown two feelers 6 and 7 spaced by a distance  $l$  are connected with the foot plate of the prop, though alternatively they could be connected with part of a conveyor running past the props in the case where the props form part of a support system in a longwall coal mining set-up. The feelers 6 and 7 generate signals when the pit prop 5 is inclined so far as to reach either of the positions indicated in broken lines. The signals produced by the feelers then operate means for tilting the pit prop 5 so that it is returned to a predetermined angular relationship to the vertical. For example, the intended position of the pit prop can be vertical. In the particular embodiment shown the means for adjusting the angular setting of the pit prop are in the form of rams 10 extending between the cap or head piece 8a of the pit prop 5 and the head pieces 8 and 9 of the pit props 4 and 3. The rams 10 act in the direction of the arrows. Instead of acting on the adjacent pit props of the roof support system, the rams 10 could be arranged at the bottom of the pit prop 5, in which case the latter would be pivoted at the top end while its bottom would be able to move in the plane of the drawing.

Further feelers similar to feelers 6 and 7 which detect movements of the prop in a plane parallel to the plane of the drawing could be provided to detect movements in a vertical plane perpendicular to this plane, appropriate rams being provided to shift the top of the prop in a direction normal to the plane of the drawing. That is to say, if the props 3, 4 and 5 form a roof support system for longwall coal mining, adjustment of the angular setting of the axes of the props in two mutually perpendicular vertical planes respectively parallel to and normal to the coal face can be provided for.

In the embodiment of the FIG. 2, a pit prop carries in its upper part 12 a freely hanging mass 15 suspended by a thread 14 attached to the prop at 13. The mass 15 can swing in the plane of the drawing and come to rest in a position which is vertical.

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Below the mass 15 hanging on the thread 14, there is a mark 16 which corresponds with a pointed part on the mass 15 when the pit prop is in the correct angular position in relation to the vertical direction. To the right and left of the mark 16 there are contacts or the like 17 and 18 which, when the mass 15 reaches them, generate signals which operate rams such as rams 10 shown in FIG. 1 to move the pit prop into its correct angular position, that is to say, the position in which the pointed part on the mass 15 is opposite the mark 16. The signals can conveniently be electrical.

The positions of the contacts or the like 17 and 18 and of the mark 16 can be adjusted by means of a screw 19. This enables the predetermined or desired position of the pit prop to be set so as not to correspond with the vertical by the angle  $d$  required; for instance, in FIG. 2 the angle  $d$  can be  $20^\circ$  so that the pit prop axis is normal to the dip of the excavation in which it is placed, the angle of dip of the excavation being  $20^\circ$ , when the ram has acted to move the prop axis 10" from its position marked with a solid line to its position 10' marked in broken lines. The angle through which the prop axis has to be moved to bring it into the correct position is denoted by  $\xi$ .

Both FIGS. 1 and 2 are purely diagrammatic and various features of design well known to those in the art, such as means for damping oscillations of the mass 15 can be incorporated.

The pit prop 120 shown in the left-hand side of FIG. 3 is set at an angle  $\alpha$  to the vertical in an inclined mining excavation from which, for instance, a seam of coal has been extracted. The desired position of the pit prop is normal to the dip of the excavation and is indicated by reference letter  $b$  denoting a line making the angle  $\alpha$  with the vertical line  $b$ .

Both the pit props 120 shown in FIG. 3 have means for adjusting their inclination in the form of double action rams 121 with cylinders 107. The cylinders are attached to fixed supports 122 while the piston rods 123 are attached to the head pieces or caps 124 of the pit props 120.

As soon as a pit prop, such as the right-hand one, comes into an angular position departing from the required angular position so that its axis  $c$  does not make an angle  $\alpha$  with the vertical direction  $b$ , a control system is operated to return the prop 120 to its required angular position. This control system causes movement of the piston rod 123 in the cylinder 107 of the double acting ram 121.

As shown in FIG. 4, the control system has a duct 130 which is connected with a compressed air supply as commonly used in mines. The compressed air passes along duct 130 to a pressure reducing valve 131 whose outlet is connected by duct 132 which leads to two ducts 101 and 102 connected with air discharge orifices 134 and 135 in the wall of a housing 133. The air passes through the orifices into the housing.

As can be seen from FIG. 3, the housing 133 is so large that it can contain the whole of suspended mass 109 with a plate 136 which is suspended freely at 137 and can move as indicated by the arrow in FIG. 4.

Opposite the air discharge orifices 134, 135 respectively there are two air receiving orifices 138 and 139 connected by ducts 104 and 105 leading to pneumo-hydraulic transducers, each of which comprises a chamber 141 with a membrane which moves in accordance with the pressure in the orifice 138 or 139 which is connected to it. The chambers 141 with the membranes act as motors for controlling valves 106 which are urged by springs 142 into the positions 106b. In the latter position the valves block the ducts 130a and 130b. In the positions 106b, air can flow along the latter ducts to pistons and cylinders 115 which move valves 108 from the closed positions 108b into the open positions 108a in which hydraulic liquid is allowed to flow along a main 150 through the respective

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valve 108 via duct 152 or 153 to one or other of spaces 107a or 107b on the two sides of the piston in the cylinder 107. When one valve 108 is moved into the position 108a and liquid flows to the cylinder 107 on one side of its piston, liquid from the space on the other side of the piston can escape via the other valve 108 which is in the position 108b and allows the liquid to pass back to the reservoir at 151.

The interior 103 of the housing 133 is vented to atmosphere via an orifice 140.

If the pit prop 120 is not at its correct angle of inclination, as shown on the right in FIG. 3, the plate 136 hinders the discharge of air from the orifice 135 with its edge portion, while allowing air from discharge orifice 134 to blow into the receiving orifice 138 so that air can pass to the pneumatic motor 141 with the result that the membrane in it is deflected and moves the two-way valve 106 into the position 106a. Consequently compressed air flows along duct 130a and moves the valve 108, by acting on piston 115, into the position 108a, with the result that liquid under pressure flows from duct 150, through valve 108, along duct 152, and then into the space 107a on the right-hand side of the piston of ram cylinder 107.

Since the valve 108 on the right of the circuit diagram remains in the position 108b, liquid under pressure can be discharged from the space 107b on the left-hand side of the ram piston through duct 153, through valve 108, and then to the reservoir at 151.

Owing to this operation of the pneumo-hydraulic circuit, the piston rod 123 of the ram moves to the left into the cylinder 107 until the pit prop 120 is moved into the correct angular position in relation to the vertical, as is the case with the pit prop shown on the left of FIG. 3.

In order to adjust the position to which the control device sets the pit prop, the housing 133 can be pivoted on the pit prop and a scale can be provided to show its position. Also releasable means can be provided for preventing unintended pivoting of the housing 133.

One advantages of the embodiment of the invention described with reference to FIGS. 3 and 4 is that it regulates the angular position of the pit prop in relation to the vertical precisely. Following a displacement of the prop from its correct angular position, there is usually only a single correcting movement of the piston rod 123 and no hunting.

What we claim is:

1. A control system for adjusting the angular disposition of a pit prop arranged between the floor and ceiling of a mine shaft where the prop is at an angle to a predetermined line between the floor and ceiling, the system comprising an extensible ram between an end portion of the prop and a fixed support, means for detecting such prop angularity, and means responsive to said detecting means for causing said ram to actuate the prop to such predetermined line.

2. A control system as claimed in claim 1, in which said detecting means comprises a gravity responsive device.

3. A control system as claimed in claim 2, in which said gravity responsive device comprises  
a housing on said prop,

a pendulum plate within said housing pivoted at its upper end and having a weight at its lower end,  
a pair of spaced air inlet orifices thru one wall of said housing,

a pair of spaced air outlet orifices through the opposite wall of said housing, and aligned with the respective inlet orifices,

the pendulum plate being disposed between said inlet and outlet orifices, so that in normal position of said plate air from the inlet orifices is baffled so as not to pass to said outlet orifices but swinging of said pendulum plate in one direction or the other enables air from one of the inlet orifices to flow directly to its respective outlet orifice,

means for supplying compressed air to both inlet orifices, and

a hydraulic system constituting said ram actuating means comprising parts energized by air from one or the other of said outlet orifices for causing liquid to be introduced under pressure to one end or the other of said ram, thereby to shift the prop in one direction or the other.

4. A control system as claimed in claim 3, comprising transducers communicating with said outlet orifices respectively, valves normally closed by said compressed air supply means and communicating with said transducers respectively to be opened thereby where same are energized by compressed air from said outlet orifices, pipes for the passage of hydraulic pressure fluid to opposite ends of said ram respectively, valves controlling said pipes respectively and communicating with said normally closed valves to be opened thereby to enable hydraulic fluid to flow to one end or the other of said ram.

5. A control system as claimed in claim 1, in which said detecting means comprises a feeler disposed on opposite sides of said prop, and means responsive to tilting of said prop for actuating said ram for returning said prop to said predetermined line.

6. A control system as claimed in claim 1, in which said detecting means comprises a freely hanging mass, a thread suspended from said prop for said mass, electric contacts on opposite sides of said mass engageable thereby, and means including an electric circuit to be energized upon engagement of said mass with one contact or the other for actuating said ram in one direction or the other to shift the prop to such predetermined line.

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