July 16, 1968 O. JACOBI 3,392,532

COAL FACE SUPPORT SYSTEMS

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FIG. 1

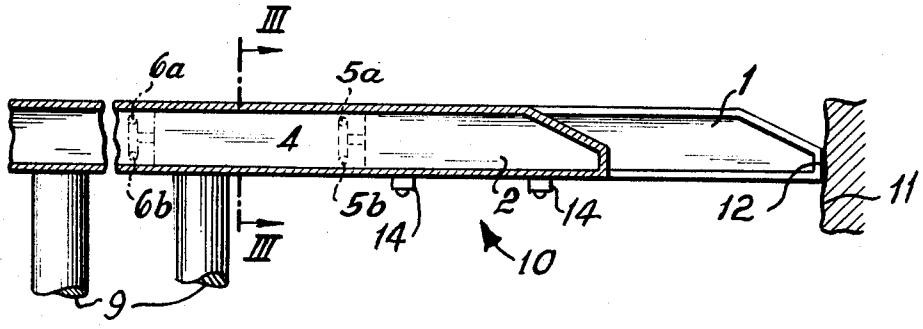


FIG. 2

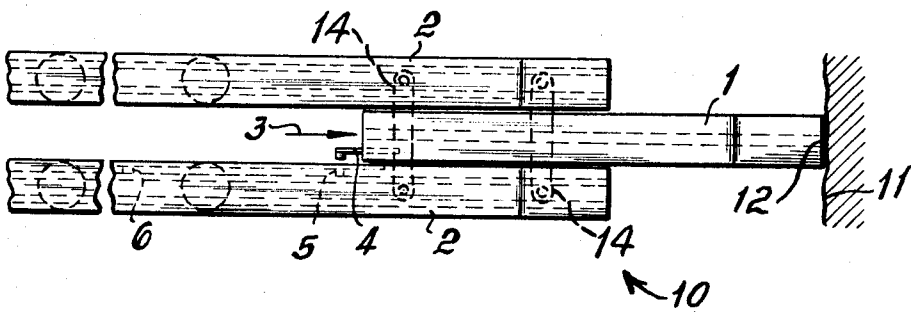
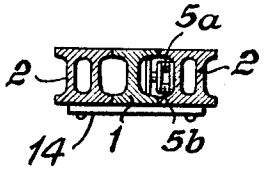


FIG. 3



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COAL FACE SUPPORT SYSTEMS

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FIG. 4

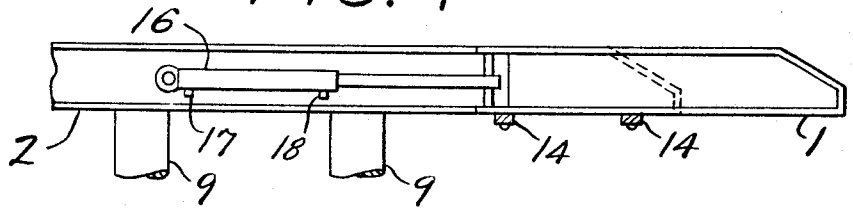
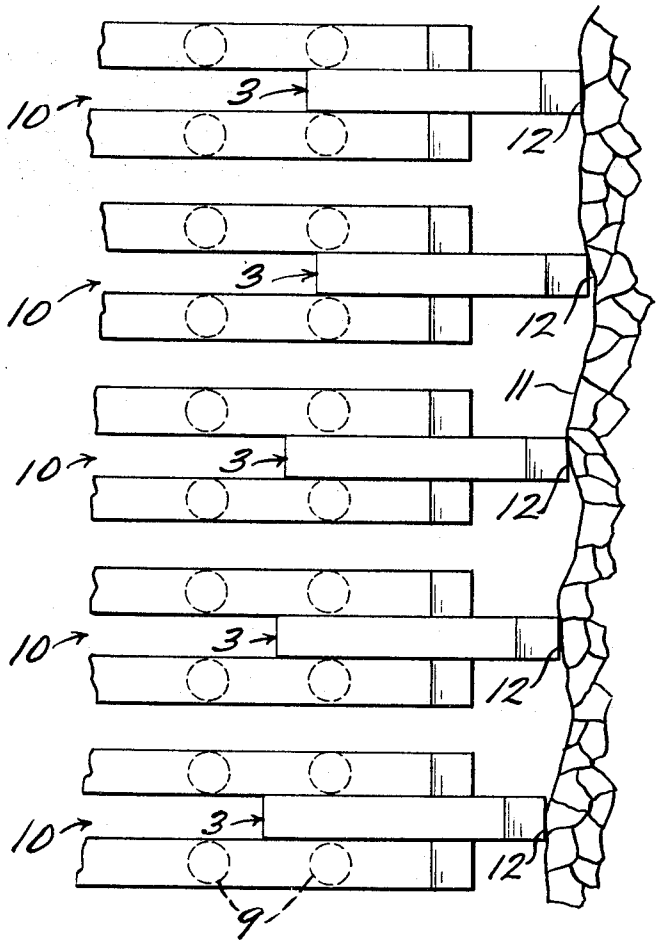
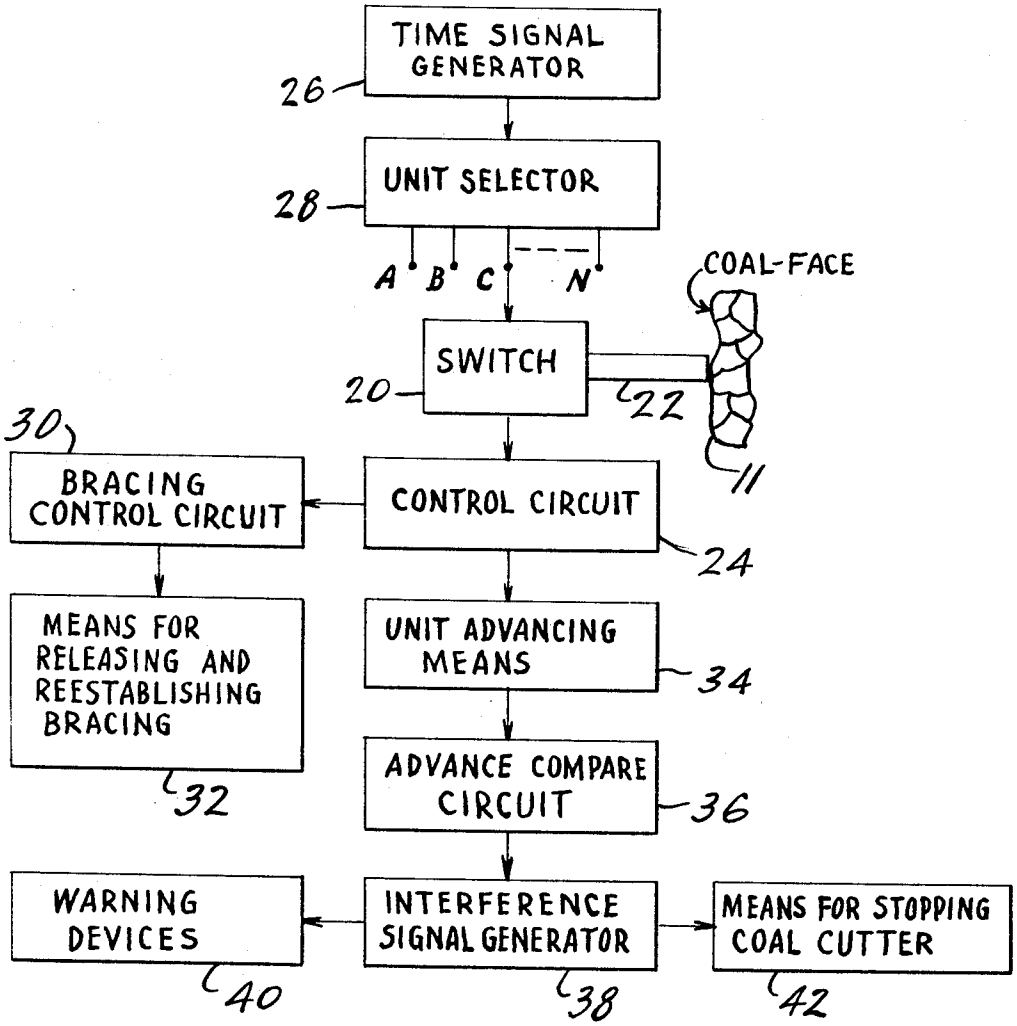


FIG. 5



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FIG. 6



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United States Patent Office 3,392,532
Patented July 16, 1968

3,392,532

COAL FACE SUPPORT SYSTEMS

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Continuation-in-part of application Ser. No. 432,556, Feb. 15, 1965. This application Dec. 27, 1965, Ser. No. 516,524
Claims priority, application Germany, Dec. 30, 1964, B 79,947
18 Claims. (Cl. 61—45)

ABSTRACT OF THE DISCLOSURE

An improved automatic control system for groups of sliding roof bars used in supporting a coal face within a coal mine. Each group has a number of support units, each including a sliding roof bar, two fixed roof bars and a unit control. A source of timing signals periodically cycles each group. When a particular group receives the timing signal, a unit selector cyclically distributes it to each unit within the group. If the control circuit for a unit has previously been prepared, the time signal causes the unit to advance. The control circuit is prepared only when there is room for the unit to advance a predetermined distance. If the predetermined advancing distance is not achieved because of a fault or an obstruction, an interference signal is generated which operates warning devices and preferably stops the coal cutter.

This application is a continuation-in-part of my copending application Ser. No. 432,556, filed Feb. 15, 1965, now Patent No. 3,348,381, issued Oct. 24, 1967.

This invention relates to an improvement method and apparatus, for successively shifting and setting the individual units of a hydraulic coal face support system.

In the parent application (Ser. No. 432,556 now Patent No. 3,348,381, issued Oct. 24, 1967), one of the embodiments disclosed is a method of automatically shifting and setting individual support units which are associated together in groups in the support system. While the support units remain set or fixed, contact is continually made with the working face in the region where the group is located and a control signal is transmitted to initiate the relief of the bracing pressure; the advance of the units; and the re-setting of the support units. In this method, contact is made with the working face only in front of one support unit in the group and a control signal is triggered as soon as there is sufficient room for shifting. The support unit at which contact is made remains set until the control signal is given. A feeler device maintains constant contact with the working face for sensing purposes and for triggering the control signal.

In carrying this method into effect, in the system as a whole, only one unit at a time is in motion in each group. The individual units of the group successively take over from one another while the progress of the shifting process as a whole is a relay-like advance in which many groups take part.

In the above described method, the initiation of the shifting operation depends only on the state of the working face in the region of the unit carrying the feeler device. This means that the other units of the group can be shifted only when the working face has been cut away sufficiently far in front of the unit carrying the feeler device. Even if the unit carrying the feeler device has triggered the control signal, the shifting action ceases within the group if one of the following units has no room to shift. In that case, in fact, all the remaining units must wait until the obstacle, which prevents the advance of this unit, has been removed. As will be understood, it may thereby happen that a portion of roof surface which may be exposed will not be supported immediately.

It is an object of the present invention to provide an improved method and apparatus wherein the roof can be supported in the region of each unit of the group as soon as the receding coal face permits shifting of such unit, regardless of the conditions at the region of each of the remaining units.

It is another object of the present invention to provide a method and apparatus for sensing an obstacle in the path of advance of a support unit.

Further objects of this invention will become apparent from the following specification and drawings, in which:

FIG. 1 is a longitudinal cross section taken through a roof bar of a support unit, which is used in the method according to the present invention;

FIG. 2 is a plan view of the roof bar shown in FIG. 1;

FIG. 3 is a vertical sectional view taken along the line III—III of FIG. 1;

FIG. 4 is a diagrammatic cross-sectional view of a support unit showing a hydraulic piston for advancing the sliding roof bar;

FIG. 5 is a plan view of a group of individual roof support units; and

FIG. 6 is a block diagram of the coal-face support system.

According to the present invention, contact is made with the working coal face **11** at the front **12** of each support unit **10**. Control signals are transmitted in this way. However, such control signals are blocked and, in order to initiate the relief of the constant bracing pressure which is applied to each unit when it is not being advanced; the advance of each unit; and re-setting of each unit, the blocking is suspended by a time signal delivered to all the units **10** in the group at fixed intervals of time.

Thus, according to the present invention, the control signal only puts the relevant unit into its state of readiness for shifting, but the shifting action is not initiated thereby. Rather, it is the time signal that serves to initiate the shifting action. On the other hand, the time signal cannot alone initiate the shifting action as that occurs only if there is readiness for shifting. In this way, all of the units **10** of the group in the region where the roof is exposed, and must therefore be supported, are shifted on delivery of the time signal. If none of the units has room to shift, all the units remain set or fixed when the time signal is delivered, because the roof is fully supported. If the roof is sufficiently exposed only at one unit, and contact has already been achieved between the other units and the working face, then only that unit is shifted on delivery of the time signal and the remaining units remain braced.

The advantages which are obtained by the present invention are many, for examples, any possibility of dangerous exposed portions of the roof not being immediately supported is eliminated and on the other hand, the advantage of the method of the parent application which includes the relay-like advancing of the groups of support units is retained.

The re-setting of each unit after the initiation of the shifting process may take place after completion of an advancing movement of a predetermined size. However, this dependence on distance may be disadvantageous. For example, if the advancing unit encounters an obstacle, say a fault in the roof, during its advance, it cannot cover the predetermined distance of advance and therefore stops in an unbraced condition. In certain circumstances, this may result in considerable impairment of safety.

According to a preferred embodiment of the present invention, this drawback is removed in that the time signal

is given a predetermined duration during which the blocking of the control signal is suspended and, at the end of this time, irrespective of the presence of the control signal, any unbraced unit of the group in question is reset. In this embodiment, each unit is allowed a given period of time within which it may advance through the prescribed distance. If this does not happen, each unit again becomes fully braced and therefore does not fail to support the roof.

It is essential that any obstacle to advance which prevents any unit from covering its full shifting distance shall be perceivable and that steps be instituted to dispose of the dangerous condition which has possibly been created.

According to the present invention, this is achieved in that the distance of advance actually covered during the predetermined duration of the time signal is measured and compared with the prescribed or predetermined distance of advance. If such prescribed distance of advance is not achieved, an interference signal is transmitted. This is, therefore, a third signal, which is triggered in addition to the control signal and the time signal. The third signal is triggered as soon as the unit concerned does not advance for any reason in spite of its readiness to advance due to the control signal having been transmitted and in spite of the delivery of the time signal.

The interference signal may be utilized in any desired manner. According to one embodiment of the invention, an acoustic warning system, such as a bell, a whistle or a horn, or an optical warning system, such as a light is rendered operative by the interference signal. In another embodiment, a combination acoustic-optical warning system is utilized. In this way, the attention of a service gang, in readiness at the coal face, is drawn by the warning system to the support unit concerned. The service gang can then remove the obstacle which is preventing advance of the unit. In still another embodiment of the invention, the interference signal operates a switch or valve to stop the coal cutter.

Preferably, the interference signal is initiated only when the difference between the actual advance covered and the prescribed distance exceed a certain predetermined limit. Slight differences between the actual advance and the prescribed distance are disregarded.

In another embodiment, the interference signal is used to produce a further lowering of the roof bar of the blocked unit to permit advance and re-setting of the unit in question. This is of special value where the obstacle preventing advance is in the roof, for examples in the form of a fault or in the form of partly burnt coal. The roof bar of the support unit moves below the obstacle and stopping of the unit advance is prevented.

According to a still further embodiment of the invention, the interference signal is used to operate a switch or valve for stopping the cutting of coal and the conveyor at the coal face.

The present invention also relates to apparatus for carrying the improved method into effect. In one embodiment, the apparatus consists of a time-signal transmitter associated with the groups of units of the system. It comprises successively switchable time contacts and time-signal leads respectively associated with the support units. In its simplest constructional form, the time-signal transmitter may be at a time clock. Of course, other forms of time-signal transmitter, such as a cyclic valve in a pneumatic system, may also be used. If, in accordance with the above-described preferred way of carrying the method into effect, the time signal is to have a certain duration, this is achieved in that the time contacts of the time-signal transmitter are rendered switchable for given periods of time.

One embodiment of the present invention is shown in FIGS. 1–5 of the accompanying drawing. Two roof bars **2** for each unit **10** are fixed to supports **9**, which can be raised or lowered by any known method, for example by hydraulic cylinders. A sliding roof bar **1** is guided between the two fixed roof bars **2** over two connecting members **14** and is urged mechanically, pneumatically, or hydraulically, as indicated by the arrow **3** in FIGS. 1, 2 and 5 and by the pneumatic or hydraulic cylinder **16** in FIG. 4, against the working face. The cylinder **16** in FIG. 4 has fluid line connectors **17** and **18** for extending and retracting the sliding roof bar **1**. At the end or most advanced position of the sliding roof bar **1**, shown in FIGURE 1, a circuit is closed, such circuit producing the relief of the roof bar bracing pressure and the advancing movement of the unit. With the sliding roof bar **1** abutting against the face, the unit is pneumatically or hydraulically advanced with the roof bars **2** sliding forwardly along the now stationary sliding roof bar **1**, until a contact bar **4** touches contacts **6***a* and **6***b* and causes the re-setting of the unit.

Thus, the arrangement which has been described constitutes apparatus by means of which the control signal, which results in the relief of bracing pressure, the advance of the unit, and the re-setting of the unit concerned, can be triggered at each unit.

The contacts **5***a* and **5***b* only initiate the readiness to advance, and the actual process of advance is not initiated thereby. Thus, these contacts only supply a control signal, which is at first blocked. The blocking is suspended only when a circuit (not shown) containing the switch **5**, receives a time signal which causes the circuit to be closed. The time signal is delivered successively to the units in a group.

In a preferred way of carrying the invention into effect, in which a time signal of predetermined duration is delivered, that is in which the circuit containing the switch **5** is closed only during the period from the beginning to the end of the time signal, the contacts **6***a*, **6***b* may be dispensed with.

As will be apparent, the sliding room bar **1** has the advantage, as compared with a simple feeler switch between the tips of the roof bars **2**, that the roof is always underpinned as far as the working face, in fact before initiation of the advancing action by the time signal. The sliding roof bar can therefore alternatively constitute the advancing support unit, it being possible to effect the triggering of the control signal by means of a feeler switch, such as that shown in parent application Ser. No. 432,556, which is not shown in the drawing, but which carries out, for example, a measurement of distance between the roof bar and a conveying means, which is usually installed at the coal face. In that case, of course, the contacts **5** and **6** on the sliding advance securing roof bar can be dispensed with.

If, after the control signal has been transmitted and after the time signal has been delivered, the unit does not cover a prescribed advance distance, an interference signal can be transmitted. The triggering of this interference signal can be effected by means of an arrangement corresponding substantially to the apparatus illustrated in FIGURES 1 to 3, but which is advantageously designed as a feeler switch, the latter being suitably arranged between the unit and the conveyor. In the event that the control signal is triggered by such a feeler switch, the arrangement for triggering the interference signal may be installed in the same feeler switch.

FIGURE 6 is a block diagram of the coal face support system. The circuits in each block are well known to those skilled in the art. Each support unit within a group of N units has a switch or valve **20** which is actuated by a coal-face sensor **22**. Whenever the sensor **22** fails to sense the coal face **11**, switch **20** is closed to prepare the control circuit **24** for advance. When the coal-face **11** is sensed, there is insufficient space for the support unit to advance and switch **20** is opened to block the control circuit **24**.

The overall support system may include a number of groups of supports units. A time signal generator **26** controls the system by sending periodic time signals to the different groups within the system. Whenever a particular

group receives a time signal, a unit selector **28** within the group distributes the time signal to the N different units within the group. If the switch **20** is closed when the unit (Unit C is shown) receives the time signal, the signal is transmitted to the control circuit **24** to begin the unit advance cycle. When the time signal is first applied to the control circuit **24**, it triggers bracing control circuit **30**, which operates the means **32** for releasing and re-establishing the bracing pressure. When the time signal is terminated, bracing control circuit **30** re-establishes the bracing pressure. The bracing control circuit may simply operate in a known manner a valve which controls the fluid pressure applied to a hydraulic or pneumatic brace.

After the bracing pressure is released, the control circuit **24** actuates a unit advancing means **34**, which can be a hydraulic or pneumatic cylinder, such as cylinder **16** in FIG. 4. If there is an obstruction or a fault in the coal surface which prevents the unit from advancing a predetermined distance, the advance compare circuit **36** actuates generator **38** to generate an interference signal. The interference signal can be used to operate a visual or acoustic warning device **40**, such as a steady or blinking light, a horn, or a bell, for warning the system operator. The interference signal can also operate a device **46** for stopping the coal cutter, which might be a switch for an electric cutter or a valve for a pneumatic cutter.

I claim:

1. In a hydraulic coal-face support system comprising individual support units associated in groups and mounted for advance in order to maintain support for the roof adjacent the coal-face as coal-cutting proceeds, apparatus for effecting the advance of the units automatically and comprising, for each group, means on each unit for continually sensing the portion of the coal-face in front of such unit, switching means controlled by the sensing means, first signal-generating means which are operable, in response to actuation of the switching means due to cutting-away of the coal faces in front of any support unit of the group, to generate a control signal, means for advancing each unit, a control circuit controlling the advancing means and closable to effect operation of the said advancing means, means responsive to generation of the control signal to prepare the control circuit for closure, second signal-generating means which are operable at predetermined time intervals to generate a time signal, means for delivering said time signal to the units of the group in succession, means responsive to generation of the time signal to complete closure of the previously prepared control circuit, thereby to cause advance of the support unit to which such time signal is delivered.

2. Control apparatus in a hydraulic coal-face support system, according to claim **1**, wherein the second signal-generating means acts to generate the time signal at intervals for a predetermined period on each occasion, and bracing control means are provided to control release and re-establishment of a braced condition of each support unit in which it supports the roof, such bracing control means being operable through the control circuit in response to initiation and termination of the time signal respectively to cause release and re-establishment of the braced condition of the support unit to which the time signal is delivered.

3. Control apparatus in a hydraulic coal-face support system, according to claim **2**, wherein the control circuit is so arranged that the bracing control means is operable, to re-established the braced condition of the support at the termination of the time signal, independently of the condition of the switching means at that time.

4. Control apparatus in a hydraulic coal-free support system, according to claim **1**, including means for comparing the distance advanced by any support unit of the group with a prescribed distance, and third signal generating means, operable if the prescribed distance is not at least substantially attained, to generate an interference signal.

5. In a hydraulic coal-face support system comprising individual support units associated in groups and mounted for advance in order to maintain support for the roof adjacent the coal-face as coal-cutting proceeds, apparatus for effecting the advance of the units automatically and comprising, for each group, means on each support unit for sensing the coal-face in front of such unit, a control circuit operatively connected to said sensing means, first switching means in said control circuit responsive to the sensing means for preparing said control circuit, timing means operatively connected to said control circuit for producing a time signal at predetermined time intervals such time signals being successively delivered to the support units of the group, and second switching means in said control circuit responsive to the time signal and operable to close the previously prepared control circuit to initiate advance of the support unit to which the time signal is delivered.

6. Control apparatus in a hydraulic coal-face support system, according to claim **5**, including means for comparing the distance advanced by any support unit of the group with a prescribed distance, and third switching means, operable in response to a blockage preventing advance of any unit through the prescribed distance, for producing an interference signal.

7. Control apparatus in a hydraulic coal-face support system, according to claim **6**, including means for stopping coal-cutting at the coal-face operable by the interference signal.

8. Control apparatus in a hydraulic coal-face support system, according to claim **5**, including a feeler switch wherein are combined the sensing means and the first switching means.

9. Control apparatus in a hydrualic coal-face support system, according to claim **5**, including means for comparing the distance advanced by any support unit of the group with a prescribed distance, and a feeler switch comprising the sensing means and the first switching means, together with third switching means, operable if the prescribed distance is not at least substantially attained, to generate an interference signal.

10. In a hydraulic coal-face support system comprising individual support units associated in groups and mounted for advance in order to maintain support for the roof adjacent the coal-face as coal-cutting proceeds, aparatus for effecting the advance of the units automatically and comprising, for each group, means for continually sensing the coal-face in front of each unit, means for advancing each unit, a circuit controlling operation of the advancing means, a plurality of switchable contacts in such control circuit, an electric current source connected to the control circuit, means whereby the control circuit is prepared for closure through its switchable contacts when the sensing means indicates that the coal-face has been cut-away in front of the unit carrying such sensing means, timing means for causing an intermittent time signal to be produced, and switching means for feeding the successive time signals to the units of the group in succession thereby to cause the control circuit to be successively closed to the unit to which the time signal is delivered, whereby said units is advanced.

11. In a hydraulic coal-face support system comprising individual support units associated in group and mounted for advance in order to maintain support for the roof adjacent the coal-face as coal-cutting proceeds, apparatus for effecting the advance of the units automatically and comprising, for each group, means for continually sensing the coal-face in front of each unit, means for advancing each unit, a circuit controlling operation of the advancing means, a plurality of switchable contacts in such control circuit, an electric current source connected to the control curcuit, means whereby the control circuit is prepared for closure through its switchable contacts when the

sensing means indicates that the coal-face has been cut-away in front of the unit carrying such sensing means, timing means for causing an intermittent time signal to be produced, switching means for feeding the successive time signals to the units of the group in succession thereby to cause the control circuit to be successively closed to the unit to which the time signal is delivered, whereby said unit is advanced, means for comparing the distance advanced by each unit with the distance prescribed for advance, and means whereby an interference signal is produced if the prescribed distance is not attained due to the presence of an obstacle blocking advance of the unit.

12. Control apparatus in a hydraulic coal-face support system, according to claim **11**, including an acoustic warning device rendered operable by the interference signal.

13. Control apparatus in a hydraulic coal-face support system, according to claim **11**, including a visual warning device rendered operable by the interference signal.

14. Control apparatus in a hydraulic coal-face support system, according to claim **11**, including a lowerable roof bar on top of each support unit, and means whereby, when the interference signal is produced, such roof bar is lowered to permit advance of the unit to continue in the event of the obstacle being in the roof.

15. Control apparatus in a hydraulic coal-face support system, according to claim **11**, wherein the time signal is produced on each occasion for a predetermined period, and bracing control means are provided to control release and re-establishment of a braced condition of each support unit in which it supports the roof, such bracing control means being operable through the control circuit in response to initiation and termination of the time signal respectively to cause release and re-establishment of the braced condition of the support unit to which the time signal is delivered.

16. A method of automatically advancing the individual support units of a hydraulic coal-face support system,

according to claim **18**, additionally comprising the steps of:

(e) generating the time signal on each occasion for a predetermined period of time,

(f) using the end of the time signal to rebrace the advanced support unit in position so that it again supports the roof.

17. A method of automatically advancing the individual support units of a hydraulic coal-face support system, according to claim **16**, additionally comprising the steps of:

(g) comparing the distance advanced by any unit of the group with a prescribed distance,

(h) producing an interference signal if this prescribed distance is not attained by the advancing unit.

18. A method of automatically advancing the individual support units of a hydraulic coal-face support system wherein the units are associated in groups, comprising the steps of:

(a) sensing the coal-face in front of each unit,

(b) preparing a control circuit in each unit in response to the sensed position of the coal-face in front of such unit,

(c) feeding a time signal at predetermined intervals of time to each unit of the group in succession, and

(d) using such time signal to initiate advance of the unit to which the time signal is delivered provided that such unit has been previously prepared for advance.

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JACOB SHAPIRO, *Primary Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,392,532 July 16, 1968

Oskar Jacobi

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 21, "The" should read -- This --. Column 4, line 36, "room" should read -- roof --. Column 5, line 71, "coal-free" should read -- coal-face --. Column 6, line 63, "units" should read -- unit --; line 65, "group" should read -- groups --.

Signed and sealed this 23rd day of December 1969.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents