United States Patent

[11] **3,578,807**

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[21] Appl. No. **773,584**
[22] Filed **Nov. 5, 1968**
Division of Ser. No. 570,109, July 11, 1966, Pat. No. 3,421,796 which is a continuation-in-part of application Ser. No. 202,642, June 11, 1962, now abandoned, which is a continuation-in-part of application Ser. No. 751,316, June 28, 1958, now abandoned.
[45] Patented **May 18, 1971**

[54] **METHOD OF STEERING**
10 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **299/1,** 175/26, 250/106
[51] **Int. Cl.** **E21c 35/08**
[50] **Field of Search** ..... 299/1; 175/24, 41, 26; 250/83,6 (W), 106(V.C.)

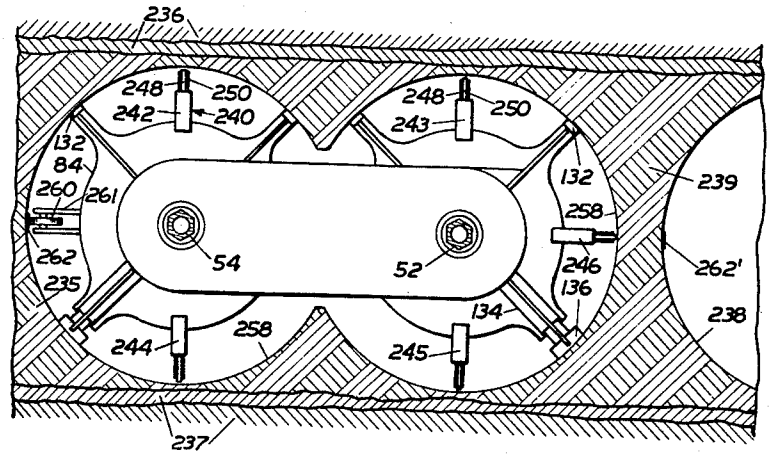
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ABSTRACT: A method of maintaining a desired distance between a steerable earth strata mining means and a laterally adjacent bore. A signal-reflecting means is placed at a known location along the bore. The mining means includes means to emit signals toward the reflecting means and another means to receive a portion of the original signal which is reflected by the reflecting means. The mining means is steered in response to the reflected signal received by the receiving means.



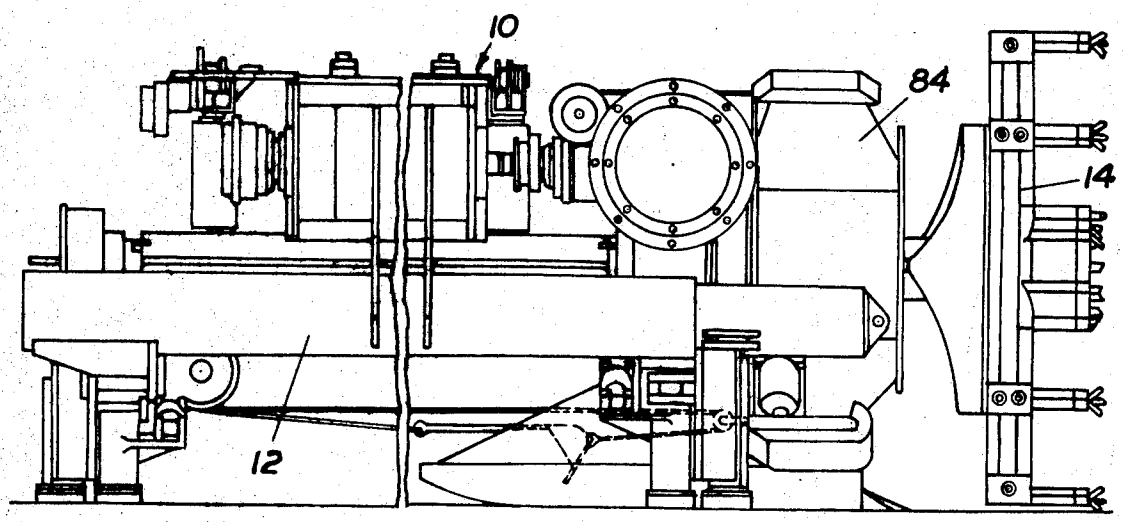


Fig. 1.

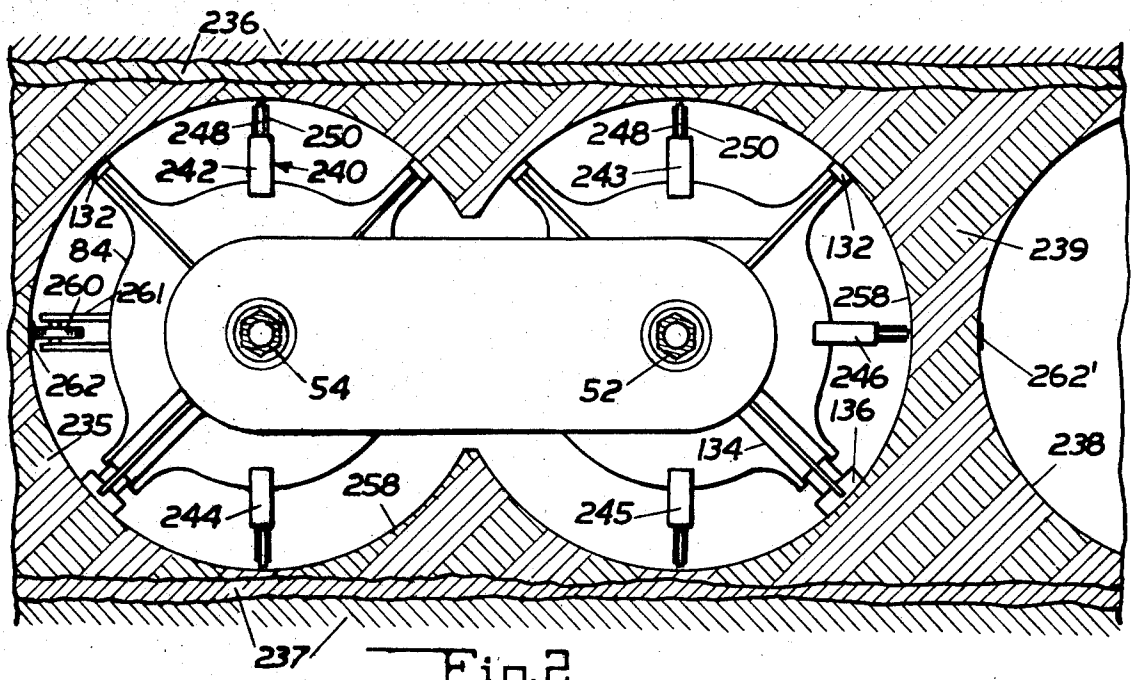


Fig. 2.

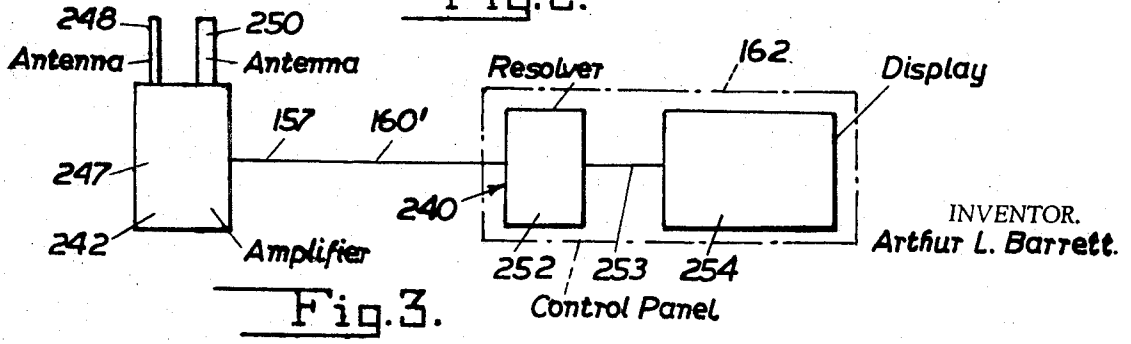


Fig. 3.

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METHOD OF STEERING

This application is a division of my application Ser. No. 570,109 filed July 11, 1966, now U.S. Pat. No. 3,421,796 which is a continuation-in-part of my application Ser. No. 202,642, filed June 11, 1962 (now abandoned) which is in turn a continuation-in-part of my earlier application Ser. No. 751,316, filed June 28, 1958 (now abandoned).

Some mining methods presently in sue utilize mining mineral laterally adjacent a previously mined area and for various reasons, such as subjacent support, a mineral pillar of a sufficient lateral width must be maintained between such mined areas. The present day mining methods have difficulty in maintaining the desired distance between a mining head and a laterally adjacent mined area due to a number of factors as the mining machine is advanced deeper into the mineral seam.

By the method of the present invention the desired distance between mining means and a laterally adjacent mined area is maintained by signal generating and receiving means which relay information necessary for any required correction in the mining machine direction.

These and objects and advantages of this invention will become more readily apparent from the following description and drawings in which:

FIG. 1 is a side elevational view of a mining machine embodying the principles of this invention;

FIG. 2 is a front elevational view partly in section of an auger head support frame having a bore location sensing means thereon constructed in accordance with the principles of this invention; and

FIG 3 is a schematic representation of a location sensing means connected to a remotely located bore locating indicating means.

For purposes of this invention any suitable mining machine which is capable of mining laterally adjacent passageways in a mineral seam can be used and as shown such a machine comprises a full face auger drilling head type machine, generally indicated at **10**, which includes an elongated main body portion **12**; a boring head support guide frame structure **84** located forward of portion **12**; and boring heads generally indicated at **14** located forwardly of portion **84** and mounted thereto at drive shafts **52** and **54** respectively.

In use machine **10** initially bores a passageway **238** (FIG. 2) in a mineral seam, such as a seam of coal **235** bounded on the upper and lower sides thereof by layers of rock **236** and **237** respectively, and after such initial boring withdraws from passageway **238** and thereafter bores a passageway **258** laterally adjacent passageway **238** while simultaneously forming a mineral pillar **239** between such passageways. For a variety of reasons, for example subjacent support, it is desirable to maintain a minimum lateral distance between passageways **238** and **258** (i.e. a minimum width of pillar **239**) and to this end any suitable directional adjusting means can be used such as those illustrated in my copending application Ser. No. 570,109, filed July 11, 1966, which controls the boring direction by means fully described therein, including adjusting means carried by structure **84** which comprise power cylinders and attached lower skids, **134** and **136**, respectively, and upper skids **132**. In a manner hereinafter described in detail, sensing devices of this invention relay required information as to the location of the guide frame structure **84** and boring heads **14** within vein **235** thereby enabling the maintenance of a desired boring direction.

The location of the boring head **14** within the passageway **258** is indicated by means of locating sensing devices, generally shown at **240** which include five electronic sensing units numbered **242** through **246** inclusive. Units **242** through **246** are secured to different portions of the guide frame structure **84** adjacent the outer periphery thereof, and comprise, respectively, an electronic amplifier **247** (see FIG. 3) and two spaced antennas **248** and **250**, emitting and receiving antennas, respectively, for electromagnetic radiation. Antennas **248** and **250** are suitably shielded and insulated from one another in any manner well known in the art. The sensing units **242** and **244** are a diametrically opposed pair in the vertical plane containing the axis of the drive shaft unit **54** and having the antennas thereof vertically upwardly and vertically downwardly directed, respectively. The sensing units **243** and **245** are similar pair in a vertical plane containing the axis of drive shaft unit **52** being upwardly and downwardly units, respectively. The sensing unit **246** is mounted in the plane of the axes of the two drive shaft units **52** and **54** and has the antenna thereof horizontally directed towards the previously developed passageway **238** at, as shown, substantially the thinnest portion of the pillar **239**.

Any suitable means can be used to detect and display bore position indicating signals generated by sensing units **242** through **246** such as the means shown in FIG. 3 with reference to unit **242** which include a power supply and signal conducting electrical conductor **157** which connects unit **242** through a line connection **160'** to a suitable control panel **162**, which in turn is connected to a source of power (not shown). As shown the control panel **162** includes a suitable signal resolver **252** which receives the signals of unit **242** through conductor cable **160** and passes such signals to a suitable display unit **254** such as multiple trace oscilloscope. The control panel **162** is suitably mounted on main portion **12** to enable a mining operator to visually observe signals to display unit **254** and make proper alignment adjustment to correct any undesirous deviations in boring progress through the seam **235**.

In FIG. 2 there is also shown a material-depositing means or paint wheel **260** pivotably mounted in brackets **261** which are rigidly secured on a portion of the frame structure **84** opposite to the mounting of the horizontally extending sensing unit **246** and substantially in the plane of the axis of the drive shaft units **52** and **54**. The paint wheel **260** is suitably supplied with a fast-drying paint, containing radioactive material for a purpose hereinafter described by paint supply means (not shown) and continuously contacts a portion of the passageway **258** farthest removed from the passageway **238** to deposit a continuous paint stripe **262** similar to a paint stripe **262'** shown as having been deposited in the passageway **238** along the central part of the pillar **239** during the previous passage of the guide structure **84** and boring heads **14** in the mining operation which produced passageway **238**.

In operation of the sending device **240** shown in FIGS. **2** and **3** a substance which is a good emitter of gamma radiation or neutrons is mounted within the emitter antenna **248** of the sensing units **242** through **245** so that gamma radiation or neutrons are directed upon the portions of the mineral vein most nearly adjacent to the sensing units. Since different rates of back scattering of the gamma radiation or neutrons are assignable to coal and rock, the receiver antennas **250** will receive signals of different strength according to the thickness of the layer of coal between the emitter **248** and the layer of rock upwardly or downwardly adjacent the mineral vein **235**. Such signals through the action of the resolver **252** are translated into thickness indications and exhibited in the indicator devices of the display unit **254**. In the case of the sensing unit **246** the gamma radiation emitting material may be omitted from the emitter antenna **248** because the signal from the radioactive material in the paint stripe **262'** received by the antenna **250** of the sensing unit **246** is inversely proportional to the thickness of the pillar **239** and is used in the appropriate indicating units of the display **254** to show the thickness of coal remaining in the pillar **239** after the boring head **58** has passed. Thus a complete set of bore location indications are available to an operator stationed at the control panel **162** to determine his actions in steering the guide structure **84** and boring heads **14** to follow undulations of the vein **235** and to correct any misalignment of the passageway **258** within the mineral vein **235**.

Unit **246** can additionally be used in a manner similar to units **242** through **245** as hereinabove described by substituting reflecting or reradiating stripes of metal or the like for paint stripes **262** and **262'**. With such a substitution: emitter antenna **248** is provided with a substance which is a good

emitter of gamma radiation or neutrons; such radiation is directed toward such reflecting stripes, respectively; such radiation is reflected back towards receiving antenna **250** of unit **246**; and receiving antenna **250** receives the radiation signal which indicates the width of the pillar **239** in a manner hereinbefore described.

It is to be appreciated that gamma ray or neutron emission which back scattering as hereinabove described in only one of several means which can be used with the sensing device **240** to give bore location information. For instance, other types of radiation such as radio frequency waves can be applied by the emitter to the coal and rock layers with reflected energy picked up by the receiver antenna **250** giving the desired information. When using a radio frequency emitter the paint stripes **262** and **262'** instead of being radioactive would consist of tuned elements such as discreet lengths of electrically conductive paint deposited upon the wall of the passageway **238** in the same position shown for the stripes **262** and **262'** or if necessary could consist of metallic rods of a suitable length to be tuned to the radio frequency radiation hereinabove mentioned. Such metallic rods could take the form of nails driven into the walls of the passageways **238** and **258** by an appropriate mechanism (not shown) during successive passes of the boring heads **56** and **58** in forming of the passageways **238** and **258**.

Instead of the radioactive paint stripes **262** and **262'** a continuous stripe of electrically conductive paint or electrical conductors (not shown) fastened to the respective walls of passageways **238** and **258** can be used. The electrical conductor in the passageway **238**, being independently supplied with an alternating potential serves as a source of electromagnetic radiation to be picked up by the receiver antenna **250** of the sensing unit **246**. It is to be realized that the particular type of radiation or particle emission used is in no sense a limitative feature of this invention.

Although preferred embodiments of this invention have been described and illustrated herein one skilled in the art can readily embody the principles of this invention without departing from the invention as defined by the scope of the claims set forth hereinafter.

I claim:

1. A method of maintaining a desired distance between a steerable earth strata mining means and a laterally adjacent passageway comprising: placing signal reflecting means at a known location in a first passageway formed in an earth strata; advancing a mining means into said earth strata adjacent and spaced from said first passageway; emitting signals having at least a component directed toward said reflecting means with at least a portion thereof being reflected by said reflecting means; sensing at least a portion of said reflected portion at a known location with respect to said mining means; and controlling the subsequent coarse of said mining means in response to such sensed portion.

2. A method as set forth in claim **1** wherein said emitting is of radioactive radiation and said sensing is of radioactive radiation.

3. A method as set forth in claim **1** wherein said placing is during formation of said first passageway.

4. A method as set forth in claim **1** wherein said sensing is of the intensity of at least a portion of said reflected portion.

5. A method as set forth in claim **1** wherein said placing of signal reflecting means is along a wall of said first passageway; said emitting is by means carried by said mining means; and said sensing is by means carried by said mining means.

6. A method of maintaining a desired distance between steerable earth strata mining means and a laterally adjacent passageway, comprising: placing a signal-emitting means at a known location in a first passageway formed in an earth strata; advancing a mining means into said earth strata adjacent and spaced from said first passageway; emitting from said signal-emitting means signals having at least a portion directed towards the path of advance of said mining means; sensing at least a portion of said emitted signal portion at a known location with respect to said mining means; and controlling the subsequent course of said mining means in response to such sensed portion.

7. A method as set forth in claim **6** wherein said emitting is of radioactive radiation and said sensing is of radioactive radiation.

8. A method as set forth in claim **6** wherein said placing is during formation of said first passageway.

9. A method as set forth in claim **6** wherein said sensing is of the intensity of at least a portion of said emitted portion.

10. A method as set forth in claim **6** wherein said placing of said radiation emitting means is along a wall of said passageway; and said sensing in by means carried by said mining means.