United States Patent

[11] 3,550,959

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[21] Appl. No. 845,194
[22] Filed July 28, 1969
[45] Patented Dec. 29, 1970
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[32] Priority Aug. 6, 1968
[33] Great Britain
[31] No. 37466/68

[54] **HARDNESS SENSING ROTARY CUTTERS FOR MINERAL MINING MACHINES**
9 Claims, 3 Drawing Figs.

[52] U.S. Cl. 299/1, 175/39, 175/50
[51] Int. Cl. E21c 39/00
[50] Field of Search 299/1, 85; 175/39, 50

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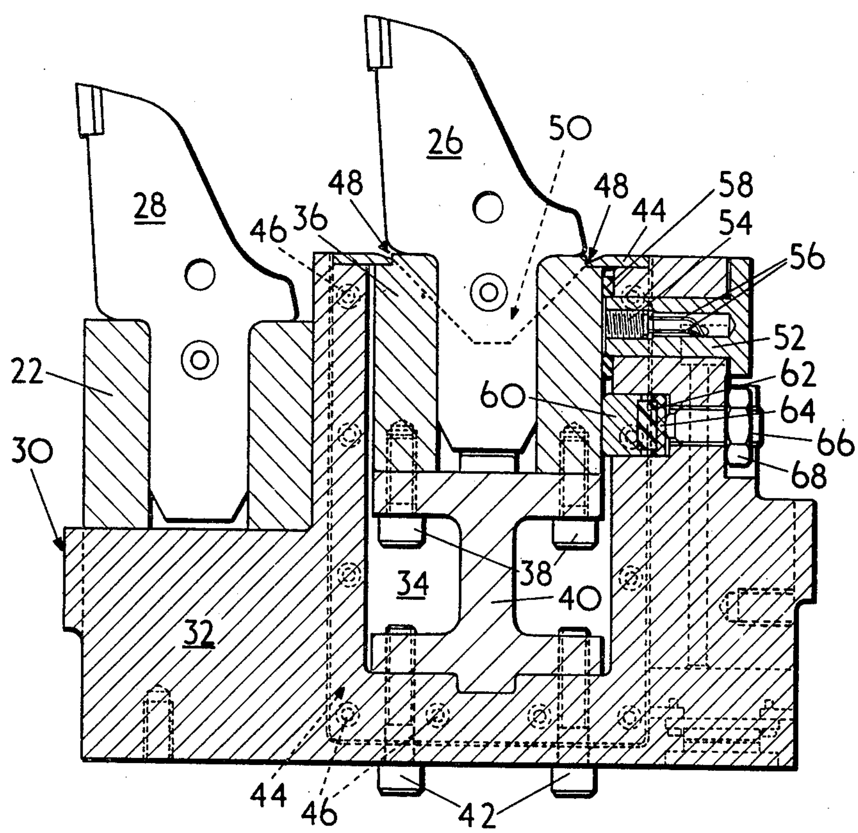
ABSTRACT: A rotary cutter for a mineral mining machine particularly a shearer loader or trepanner. The cutter comprises a cutter head equipped with fixed cutter tools distributed around the head. Immediately behind and adjacent one fixed tool there is a resiliently mounted tool which extends in the direction of its length slightly beyond the adjacent fixed tool. This ensures a constant shallow penetration for the resiliently mounted tool during cutting. A position sensitive transducer is mounted in the head to give a signal indicative of movement of the resiliently mounted tool under varying load so that change in mineral hardness at a seam boundary can be detected and the machine steered accordingly.



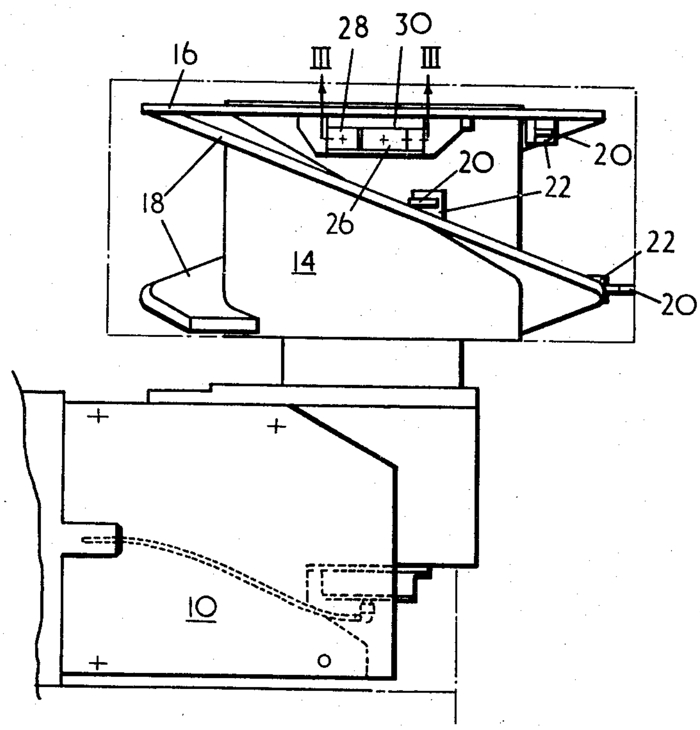

28
30
III
III
16
20
20
22
18
26
22
14
20
10

FIG. 1.

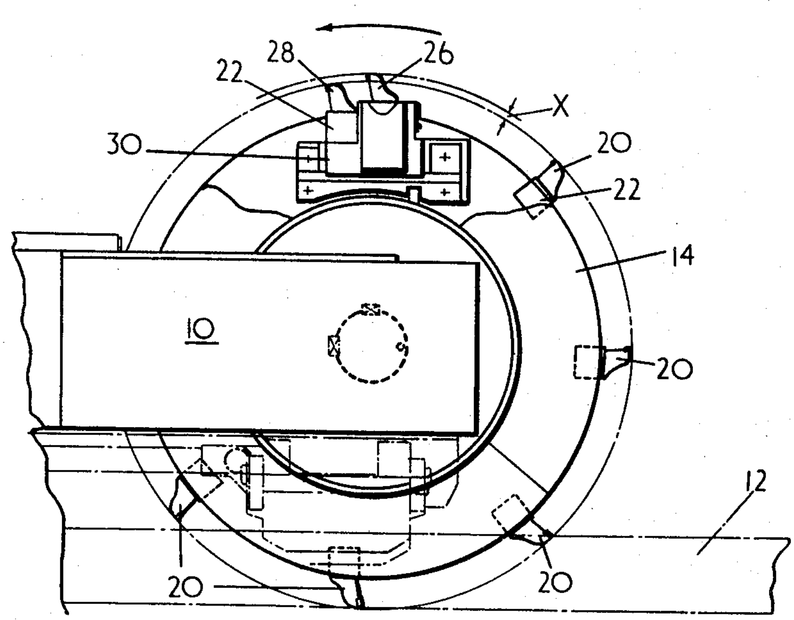

28
26
22
X
30
20
22
14
10
20
12
20
20

FIG. 2.

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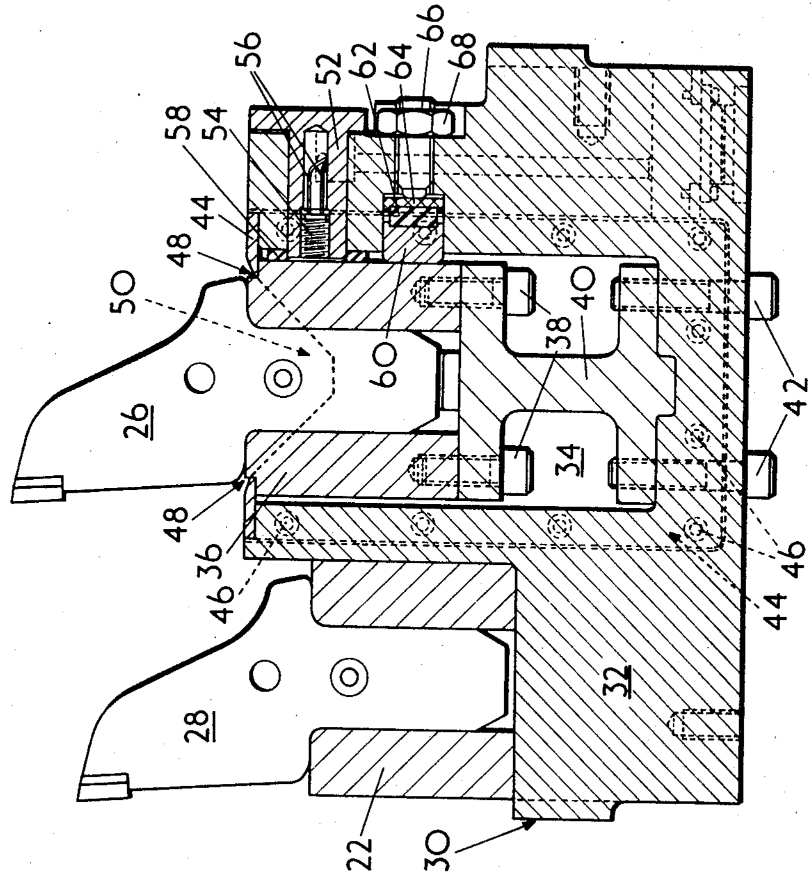

FIG. 3

HARDNESS SENSING ROTARY CUTTERS FOR MINERAL MINING MACHINES

It is well known for a cutter tool to be held in a holder resiliently mounted on the head of a rotary cutter, and to provide means sensitive to the movement of the holder relative to the head which derive a signal indicative of said movement. With such a cutter the signal derived from the means varies according to the type of mineral being cut by the tool and also according to the tool penetration into the mineral. Unfortunately, if the tool penetration is not constant, as is usually the case, a varying signal will be derived and a change in the signal due to a change in the type of mineral being cut by the tool may be masked.

An object of this invention is to provide a rotary cutter which overcomes the above-mentioned disadvantage.

According to the present invention a rotary cutter for a mineral mining machine comprises a rotary head, cutter tools fixedly mounted on, and distributed around, said head, a resilient mounting member mounted on said head, a further tool mounted on said resilient mounting member so as to be movable relative to said head, said further tool being so positioned relative to one of said fixedly mounted tools that the penetration of said further tool over at least a substantial part of the cutting path of said further tool is shallow and constant, and means mounted on said head which are sensitive to relative movement between said further tool and said one of said fixedly mounted tools, said means being adapted to derive a signal indicative of said relative movement.

Said further tool is preferably located behind, and adjacent, said one fixedly mounted tool and said further tool preferably extends, in the direction of its length, beyond said one fixedly mounted tool.

Said one fixedly mounted tool thus acts as a shield tool to cut the major portion of mineral in front of said further tool which thus has a shallow constant penetration in the mineral over a substantial portion of its cutting path. This enables a very clear indication to be obtained of the boundary of a mineral seam in a manner suitable for a mineral mining machine to be properly steered by manual adjustment or equally well by automatic adjustment.

One embodiment of the invention will now be described by way of example, with reference to the accompanying drawings in which:

FIG. **1** is a plan of the end of a shearer-loader machine showing the rotary cutter drum;

FIG. **2** is a side elevation of the same end of the machine shown in FIG. **1**; and

FIG. **3** is a vertical section on an enlarged scale on the line III–III in FIG. **1**.

The drawings show the invention applied to a shearer-loader machine **10** which can move along the upper flanges of a longwall coalface armored conveyor **12**. The machine **10** has a rotary cutter which comprises a rotary cutter head in the form of a drum **14** equipped with a backplate **16** and helical loading vanes **18**.

The drum **14** when ready for use is equipped with fixedly mounted cutter tools **20** each mounted in a mounting box **22**. The boxes are secured to the inner side of the backplate **16** and to the rear sides of the vanes **18**. The drum **14** rotates in the direction of the arrow in FIG. **2**.

The drum **14** also has a resiliently mounted tool **26** which is located immediately behind one tool **28** of the fixed tools and which extends, in the direction of its length, beyond the fixed tool **28**. The amount of extension beyond the fixed tool **28** is the amount shown as X, in the radial sense, in FIG. **2**.

The tools **26** and **28** are mounted in a mounting assembly **30** supported on the backplate **16**.

FIG. **3** shows the assembly **30** in more detail. It comprises a housing **32** to which is welded a mounting box **22** for the tool **28** and in which there which there is a cross-channel **34**. The channel **34** accommodates a mounting box **36** for the tool **26**, which box is secured by bolts **38** to the upper end of a short I section cantilever **40**. The lower end of the beam **40** is secured by bolts **42** to the housing **32** at the base of the channel **34**. The ends and top of the channel **34** are closed by an inverted U-shaped cover plate **44** held by screws **46**. Clearance (not shown) is provided at **48** between the inner edge of a cutout **50** in the cover plate and the upper edge of the mounting box **36**.

The housing **32** has a cylindrical insert **52** having a bore **54** to receive an electromagnetic movement transducer **55** connected by leads **56** to a control circuit described below. A dirt seal **58** surrounds the inner end of the insert **52** and engages the side of the box **36**. There is a small clearance between the inner end of the inert **52** and the box **36**.

The housing **32** also has a cylindrical plug **60** slidable in a bore in the housing which engages the box **36** and is backed by a rubber block **62** and by a cylindrical backing disc **64**. A screw **66** adjustable in the housing **32** has its inner end engaging the backing disc **64** and has a locknut **68**.

The cantilever beam **40** is resilient and allows the tool **26** to move back relative to the housing **32** and relative to the drum **14** under cutting load. Such movement causes inductive changes in the electromagnetic flux across the airgap between the transducer in the bore **54** and the box **36**, and the transducer produces a corresponding electrical signal for the control circuit.

If the screw **66** is screwed into the housing **32**, a preload is applied to the cantilever beam **40** through the rubber block **62** which is deformed and acts as a spring to apply the preload to the beam **40**. This preload enables the effective zero-force level at the tip of the tool **26** to be varied to suit the external electrical circuit. This is, below a certain value of force applied to the tip of the tool **26** there is no deflection of the beam **40** and no signal from the transducer **55** in the bore **54**. This preload facility is entirely optional in many applications can be dispensed with.

The assembly **30** is readily mounted as a whole on the backplate **16** and can be removed as a whole for repair or adjustment. The assembly is very compact and robust. The beam **40** in particular is very short. The boxes **22, 36**, are very closely positioned so that the tools **28, 26** are as close as possible.

The close location of the tool **26** behind the tool **28** ensures that the tool **26** has effectively a constant shallow penetration by the amount X beyond the penetration of the tool **28**. In the case of tools on a drum of a shear-loader machine there is a very pronounced variation in depth of penetration during cutting, the depth varying from zero at the start of the 180° cutting and increasing to maximum at the middle of the arc and falling to zero at the end of the 180° arc. This variation would render any attempt at detecting a seam boundary quite ineffective. However, using the leading tool **28** according to the invention with the tool **26** extending slightly beyond the tool **28** the signal obtained from the transducer can be made to indicate changes of mineral hardness with sufficient accuracy for indication or control purposes.

By way of example the amount X may be one-half inch where the maximum penetration of the tool **28** is 2 inches.

In a modification, the first tool **28** may be wider than the tool **26**. This may be used particularly where the rotary cutter is the cutter head of a trepanner machine.

The inner end of the insert **52** acts as a stop for the box **36**, should the force on the tool **26** become excessive.

The signal from the transducer **55** passes to a receiving and display circuit (not shown) which may be positioned in a roadway remote from the machine and which converts the signal into any desired form.

This circuit also comprises further means which related the signal from the transducer **55** to the angular position of the tool **26** about the axis of rotation of the drum **14**. The further means could comprise three microswitches actuated by cams mounted on the cutter head drive shaft. One microswitch is actuated for the time the tool **26** is cutting and thus enables the receiving circuit to determine the amplitude of the average signal derived from the transducer **55**. By comparing the actual signal derived from the transducer **55** with the average signal it is possible to determine if any peak signals occur. The invention particularly enables a very pronounced peak signal to be obtained. If the type of coal being cut gives rise to a fluctuating signal it may be found beneficial to compare the actual signal from the transducer with a signal equal to one and five-tenths times the average signal. Even then, very pronounced peak signals can be achieved.

Any peak signal which may occur is fed via a Schmitt trigger unit to two AND gate units arranged in parallel. One of the AND gate units is electrically connected to the second microswitch which is actuated by its associated cam when the tool **26** is cutting adjacent the roof of the seam. The second AND gate unit is connected with the third microswitch which is actuated by its associated cam when the tool **26** is cutting adjacent the floor of the seam.

Each AND gate unit has, therefore, two inputs which, when suitably matched, cause a signal to be transmitted from the AND gate unit to a display circuit. The display circuit may comprise two pilot lights, one of which lights up when a signal is transmitted from its associated AND gate unit.

As the shearer-loader moves along the mineral face, the cutter head moves towards a boundary of the coal seam, the tool **26** starts to cut the different, usually harder, mineral adjacent the coal seam and a signal is derived from the transducer **55** which causes a signal to be transmitted from one of the AND gate units as previously described. This latter signal is related to the angular position of the tool **26** and thus to the seam boundary at which the hard mineral is being cut and, therefore, indicates what steering action should be applied to correct the position of the cutter head.

The steering action may be applied manually or automatically, i.e., the signal is transmitted from the AND gate unit to means arranged to actuate the shearer steering mechanism.

In alternative embodiments, the further means which relate the signal to the angular position of the tool **26** may comprise a magslip arrangement or a wiper moving around an impedence bridge. With these embodiments the signal derived from the transducer **55** could be continuously displayed on an oscilloscope having a circular time-base.

Although the specific embodiment is described above in relation to a shearer type of machine, the invention is equally applicable to other types of machine, for example a trepanner.

In a modification, the radial pick type of tools shown could be replaced by point-attack type tools for example. Also, in general, the resiliently mounted tool may differ in one or more respects (in addition to length) from the adjacent fixed tool.

I claim:

1. A rotary cutter for a mineral mining machine comprising a rotary head, cutter tools fixedly mounted on, and distributed around, said head, a resilient mounting member mounted on said head, a further tool mounted on said resilient mounting member so as to be movable relative to said head, said further tool being so positioned relative to one of said fixedly mounted tools that the penetration of said further tool over at least a substantial part of the cutting path of said further tool is shallow and constant, and means mounted on said head which are sensitive to relative movement between said further tool and said one of said fixedly mounted tools, said means being adapted to derive a signal indicative of said relative movement.

2. A rotary cutter as claimed in claim **1**, in which said further tool is located behind, and adjacent, said one fixedly mounted tool and in which said further tool extends, in the direction of its length, beyond said one fixedly mounted tool.

3. A rotary cutter as claimed in claim **2**, in which said one fixedly mounted tool is wider than said further tool.

4. A rotary cutter as claimed in claim **1**, in which said rotary head is a head suitable for a shearer-loader type of mineral mining machine.

5. A rotary cutter as claimed in claim **4**, in which said rotary head has at one end a backplate, and in which said one fixedly mounted tool and said further tool are mounted on said backplate.

6. A rotary cutter as claimed in claim **1**, in which said rotary head is a trepanning head suitable for a trepanner-type mining machine.

7. A rotary cutter for a shearer-type mineral mining machine comprising a rotary head, said rotary head having at one end a backplate, cutter tools fixedly mounted on, and distributed around, some of said fixedly mounted tools being mounted on and distributed around said backplate, a resilient mounting member mounted on said backplate, a further tool mounted on said resilient mounting member so as to be movable relative to said head, said further tool being located behind, and adjacent, one of said fixedly mounted tools on said backplate and said further tool extending, in the direction of its length, beyond said one fixedly mounted tool on said backplate, and means mounted on said backplate which are sensitive to relative movement between said further tool and said one fixedly mounted tool on said backplate, said means being adapted to derive a signal indicative of said relative movement.

8. A rotary cutter for a mineral mining machine, comprising a rotary head, cutter tools fixedly mounted on, and distributed around, said head, a housing mounted on said head, a first tool-receiving box carried by said housing in fixed relation thereto, one of said fixedly mounted tools being mounted in said first box, a resilient member carried by said housing, a second tool-receiving box carried by said resilient member, a further tool mounted in said second box so as to be movable relative to said head, said second box and said further tool being positioned behind, and adjacent, said first box and said one fixedly mounted tool, respectively, and said further tool extending, in the direction of its length, beyond said one fixedly mounted tool, and means mounted on said housing which are sensitive to relative movement between said further tool and said one fixedly mounted tool, said means being adapted to derive a signal indicative of said relative movement.

9. A rotary cutter as claimed in claim **8**, comprising a preload plug slidably mounted relative to said housing, one end of said plug engaging said second box, a resilient element located behind said plug, a disc located behind said element, and a screw adjustably mounted in screwed relationship with said housing behind said disc, one end of said screw engaging said disc.