United States Patent

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[72] Inventor George T. Addison
Burton-on-Trent, England

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[73] Assignee Coal Industry Patents Limited
London, England
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[54] CUTTERS FOR MINERAL-MINING MACHINES
14 Claims, 5 Drawing Figs.

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[51] Int. Cl. E21c 35/08, E21c 25/08
[50] Field of Search 175/41; 299/1

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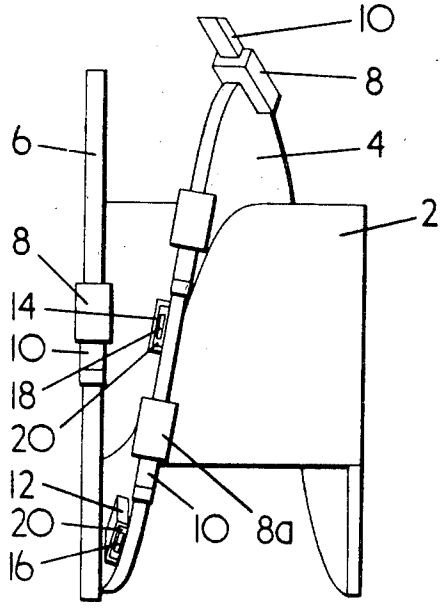
Primary Examiner—Ernest R. Purser
Attorney—Stevens, Davis, Miller & Mosher

ABSTRACT: A cutterhead for a mineral-mining machine, particularly a shearer-loader, comprises a rotary cutter equipped with fixed cutter tools distributed around the head. Adjacent to the periphery of the head but spaced from one another are mounted a source and a detector of electromagnetic radiation, the detector deriving an output signal dependent upon the amount of radiation detected by backscatter from the strata adjacent to the cutter and gives a measure as to the thickness of coal remaining after cutting. Means are also provided on the cutter for relating the output signal from the detector to the angular position of the source or detector about the axis of rotation of the cutter so that when the signal is fed from the detector to responsive control means for steering the machine positioned on the machine body, the cutting horizon of the cutter is controlled in relation to a coal/stone interface at a boundary of the seam.



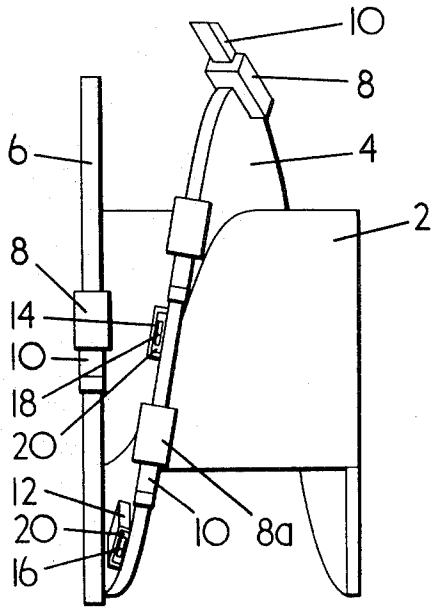


FIG. 1

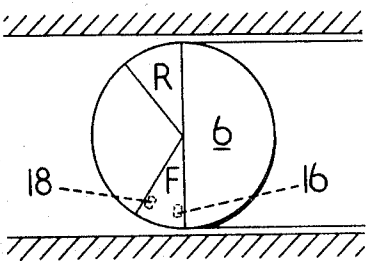


FIG. 2

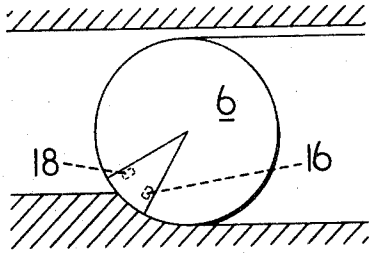


FIG. 3

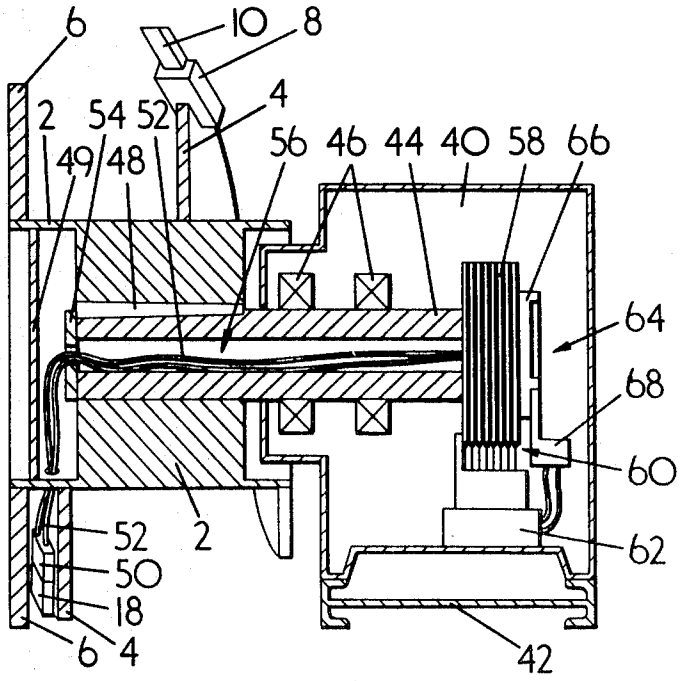


FIG. 4

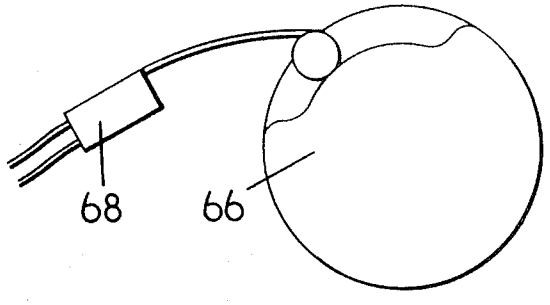


FIG. 5

CUTTERS FOR MINERAL-MINING MACHINES

This invention relates to cutterheads for mineral-mining machines and in particular to a cutterhead having means for determining the position of the cutter relative to a boundary of a mineral seam.

It is well known for a cutter tool to be held in a holder resiliently mounted on a rotary cutterhead of a coal-mining machine, 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 an arrangement the signal derived from the said 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 signal due to a change in the type of mineral being cut by the tool may be masked. Another disadvantage of this known cutterhead is that it is necessary for the tool to cut rock mineral beyond the coal seam boundary before any variation in signal occurs.

It is also known for a rotary cutterhead to be mounted on a coal-mining machine having means comprising a source and a detector of electromagnetic radiation mounted on a part of the machine at the rear of the cutterhead, to measure the thickness of coal remaining at the floor or roof after cutting and to control the steering mechanism of the machine so as to maintain this thickness at a predetermined level. A disadvantage of having the means at the rear of the cutterhead is that a delay occurs between when the position of the cutterhead relative to the coal seem boundary changes and when the corresponding signal is derived from the detector. A further disadvantage of this known arrangement is that should the cutterhead cut into rock mineral beyond the coal seam boundary so that the source and the detector are adjacent to a rock face, the means is incapable of determining the position of the cutterhead relative to the coal seam boundary.

When the said mining machine is a shearer-type machine which has the source and detector mounted in a loading manner such as a plough towed behind the cutter and which traverses along the coal face, it is necessary, because of the presence of the plough, to limit the cutting to one direction. Also, the presence of the plough requires a stable hold to be formed at the end of the face to accommodate the plough.

An object of the invention is to provide a cutterhead for a mineral-mining machine which overcomes the above-mentioned disadvantages.

According to the invention a cutterhead for a mineral-mining machine comprises holders for cutter tools mounted on said head a source of electromagnetic radiation mounted on the cutterhead, a detector also mounted on the cutterhead but spaced from the said source the detector being adapted to receive backscattered radiation from said source, said detector having associated electrical means adapted to derive an output signal dependent upon the amount of radiation detected, and electrical means for feeding the output signal from the detector.

Preferably, the cutterhead is rotary cutter comprising holders for cutter tools distributed around said head, a source of electromagnetic radiation mounted adjacent to the periphery of the said head, a detector of said radiation also mounted adjacent to the periphery of said head but spaced from said source, said detector deriving an output signal dependent upon the amount of said radiation detected, and electrical means for feeding the output signal from the detector.

The electrical means may comprise commutator means for relating the output signal from said detector to the angular position of said source or detector about the axis of rotation of the cutterhead.

Preferably, the rotary cutterhead comprises a hub adapted to be mounted on the machine drive shaft, a helical loading vane extending along, and secured to, the hub, a plate secure onto one end of the hub, holders for cutter tools secured around the outer portion of the vane and the plate, a source of electromagnetic radiation mounted adjacent to the periphery of said head, a detector of said radiation also mounted adjacent to the periphery of said head but spaced from said source, said detector deriving an output signal dependent upon the amount of said radiation detected, electrical means for feeding the output signal from the detector.

A cutter toolholder may be mounted intermediate said source and said detector.

By way of example only one embodiment of the invention will be described with reference to the accompanying drawings, in which:

FIG. 1 is a diagrammatic front view of a rotary cutter;

FIG. 2 is a diagrammatic side view of the cutter in an operation position;

FIG. 3 is a diagrammatic side view of the cutter in an alternative operational position;

FIG. 4 is a diagrammatic section through a mineral-mining machine; and

FIG. 5 is a detail of FIG. 4.

FIG. 1 shown a rotary cutter suitable for mounting on a well-known shearer-type coal-mining machine (not shown).

The cutterhead comprises a hub 2 adapted to be mounted on the machine drive shaft and a helical loading vane 4 extending along and secured to the hub 2. A circular end plate 6 is secured onto one end of the hub 2, Both the vane 4 and the plate 6 have holders 8 for cutter tools 10 secured around their outer portions.

The cutterhead also comprises two holders 12 and 14 secured to the rear of outer portions of vane 4, the holder 12 being adjacent to the circular end plate 6. The holders 12 and 14 are positioned on opposite sides of a toolholder 8*a*.

Secured within the holders 12 and 14 respectively, is a source 16 and a detector 18 of electromagnetic radiation, the detector 18 deriving an output signal dependent upon the amount of radiation detected. The radiation detected is that backscattered from the strata adjacent to the detector 12. The source 16 can be for example of Americium 241, Caesium 137 or Caesium 134 and the detector can be for example a scintillation counter with a thallium-activated sodium iodide crystal, a scintillation counter with a sodium-activated Caesium iodide crystal, a gas-filled proportional counter, a germanium avalanche detector or a silican avalanche detector.

Both the source 16 and the detector 18 are embedded in an elastomeric material 20 so as to minimize the effects of shock and vibration during operation. A protective window made of nylon or any other tough material having a low atomic weight is placed over the detector 18.

The output connector of the detector 18 is connected by associated means (not shown) to responsive control means positioned on the machine which are sensitive to the output signal and which accordingly control the steering mechanism of the machine. The steering mechanism controls the cutting horizon of the head. Alternatively, the responsive control means may convert the output signal into a visual signal which can be seen by the machine operator who may then operate the steering mechanism.

The associated means may comprise a pulse shaper and/or an amplifier for the output signal from the detector.

The means may further comprise commutator means for gating the output signal from the detector 18 so that only the portion of the signal derived when the detector is within a predetermined arc or arcs of cutter revolution is fed to the control means. It is thus possible to feed to the control means only the portions of the output signal derived when the detector 18 is adjacent to the coal seam boundaries at the roof or floor. As for example when the detector 18 is within the arcs of cutter revolution indicated at R or F in FIG. 2. The The commutator means may be a cam-operated switch mounted on the machine side of the cutter and actuated by a cam positioned on the machine body. The position and extent of the cam are adjustable to permit resetting of the predetermined arc. Alternatively, the commutator means can include for ex-

ample a photoelectric cell, a magnetically operated reed switch or a proximity switch responsive to change of capacitance or inductance. In each case suitable means for actuating the switch would be mounted on the machine.

The output signal from the detector is fed to the responsive control means which includes either a ratemeter circuit, which operates only when being fed by the gated signal and converts the signal to DC, or to a scaling circuit, which will give the average gated signal over a number of cutter revolutions.

The signal from the ratemeter circuit or from the scaling circuit is used to control the steering mechanism of the machine and thus keep the cutter operating within the coal seam.

The output signal from the detector **18** can be suitably gated by the commutator means so as to represent two fractions, one fraction being derived when the detector **18** is adjacent to the roof, and the other fraction being derived when the detector **18** is adjacent to the floor.

Alternatively, the cutterhead comprises two detectors, the gated signal from one corresponding to when the first detector is adjacent to the roof and the gated signal from the other corresponding to when the second detector is adjacent to the floor.

In operation as the machine travels along the face electromagnetic radiation is emitted from the source **16** towards the coal being cut by the cutter. The holder **8***a* and its associated tool **10** shield the detector **18** from direct radiation and only an amount of backscattered radiation from the coal or from the coal and surrounding rock mineral is detected by the detector **18**. Thus the amount of radiation detected by the detector **18** when adjacent to the roof or floor of the seam depends upon the thickness of coal left by the cutter at the roof or floor. Should the thickness of coal left at the roof or floor change from the predetermined level the gated detector output signal will vary, accordingly, and the responsive control means on the machine will cause the machine-steering mechanism to be operated so as to correct the position of the machine within the seam. The correction is applied either automatically or manually depending upon which type of control means are used.

As the source **16** and the detector **18** are mounted on the cutter adjacent to the cutter tolls **10** there is little or no delay between when the coal thickness changes and when the corrective measures are applied.

By suitable adjustment of the commutator means it is possible to vary the angular position of the arc of cutter revolution for which the detector output signal is fed to the control means. It is, therefore, possible for the cutter to cut a constant thickness of rock material, the detector output signal being gated over an arc of cutter revolution adjacent to the coal seam boundary. FIG. **3** shows the cutter operation in one such installation.

It will be appreciated that because the source **16** and detector **18** are mounted on the cutterhead it is not necessary to have suitable mountings behind the cutter, and, therefore, if desired the loading member which usually provided these mountings can be dispensed with. This enables the shearer to cut coal during traverse along the face in both directions as well as removing the requirement for a stable hold to accommodate the loading member.

FIG. **4** shows a second embodiment of the invention in which the detector **18** of electromagnetic radiation is located adjacent to the face side of the cutter. The source of the said radiation is not shown in FIG. **4**.

FIG. **4** shows the body **40** of a shearer-type mineral machine travelling along a longwall face conveyor **42**. The machine has a drive shaft **44** supported in bearings **46**. The driving gears for the shaft **44** and the supports for the bearings **46** are not shown.

Mounted on the free end of the shaft **44** is a rotary cutter having a hub **2** retained in position by a key **48**. A helical loading vane **4** extends along and is secured to the hub **2** and an annular plate **6** is secured onto the end of the hub **2**. A cover plate **49** is secured in position to protect the electrical means.

The detector **18** is secured adjacent to the periphery of the vane **4**. The electrical means provided on the cutter comprise a rate meter circuit **50** connected to the detector **18**, and a cable **52** which extends from the rate meter circuit **50** through the hub **2** and a cap **54** located on the end of the shaft **44**. The cable **52** then passes along an axial bore **56** in the shaft **44** and is electrically connected to sliprings **58** which are located around the shaft **44** within the body **40** and which have contacts **60**. The output signal from the detector **18** is fed through the rate meter circuit **50** here the signal is converted to DC, along the cable **52** and through the sliprings **58** and the contacts **60** to responsive control means **62** which control the steering mechanism (not shown) of the machine.

Commutator means **64** positioned at the end of the shaft **44** comprise a cam **66** secured onto the shaft **44** and a spring-loaded switch **68** which is actuated by the cam **66** as it rotates. The commutator means is shown more clearly in FIG. **5**. The signal from the switch **68** is fed to the control means **62**.

The rate meter circuit **50** may be replaced by a scaling circuit which will give the average gated signal over a number of cutter revolutions.

In modifications of this embodiment of the invention the responsive control means comprises the pulse shaper and/or the amplifier for the output signal from the detector.

In a further modified cutterhead the detector is mounted in the same angular plane as the source **16** but is spaced from the source **16** in a direction along the cutter. This can be achieved by mounting the detector on a second helical loading vane arranged parallel to the vane **4**, or by mounting the source on the circular plate **6**.

In one further modified embodiment of the invention the cutter comprises at least two detectors, one being mounted adjacent to the machine side of the cutter and the other being mounted adjacent to the face side of the cutter so that by comparing the two output signals the inclination of the cutter can be determined.

Further embodiments of the invention are applicable to nonrotary cutterheads, such as coal plough cutterheads.

I claim:

1. A cutterhead for a mineral-mining machine, comprising holders for cutter tools mounted on said head, a source of electromagnetic radiation mounted on the cutterhead, a backscattered radiation detector also mounted on the cutterhead but spaced from said source, electrical means associated with said detector and adapted to derive an output signal dependent upon the amount of radiation detected.

2. A rotary cutterhead for a mineral-mining machine comprising holders for cutter tools distributed around said head, a source of electromagnetic radiation mounted adjacent to the periphery of said head, a detector of said radiation also mounted adjacent to the periphery of said head but spaced from said source, said detector deriving an output signal dependent upon the amount of said radiation detected, and electrical means for feeding the output signal from the detector.

3. A cutterhead as claimed in claim **2**, in which the electrical means comprise commutator means for relating the output signal from said detector to the angular position of said source or detector about the axis of rotation of the cutterhead.

4. A cutterhead as claimed in claim **2**, in which the electrical means comprise a rate meter circuit.

5. A cutterhead as claimed in claim **2**, in which the electrical means comprise a scaling circuit.

6. A rotary cutterhead for a mineral-mining machine comprising a hub adapted to be mounted on the machine drive shaft, a helical loading vane extending along, and secured to, the hub, a plate secured onto one end of the hub, holders for cutter tools secured around the outer portions of the vane and the plate, a source of electromagnetic radiation mounted adjacent to the periphery of said head, a detector of said radiation also mounted adjacent to the periphery of said head but spaced from said source, said detector deriving an output signal dependent upon the amount of said radiation detected, and electrical means for feeding the output signal from the detector.

7. A cutterhead as claimed in claim 6 in which a cutter toolholder is mounted intermediate said source and said detector.

8. A cutterhead as claimed in claim 6 in which said source and said detector are embedded in an elastomeric material.

9. A cutterhead as claimed in claim 6 in which a protective window of tough material having a low atomic weight is placed over said detector.

10. A rotary cutterhead for a mineral-mining machine operating a hub adapted to be mounted on the machine drive shaft, a helical loading vane extending along, and secured to, the hub, a plate secured onto one end of the hub, holders for cutter tools secured around the outer portions of the vane and the plate, a source of electromagnetic radiation mounted adjacent to the periphery of said head, a first detector of said radiation mounted on the vane adjacent to the periphery of the machine side of said head, a second detector of said radiation mounted on thy plate adjacent to the periphery of the face side of said head, each of said detectors being spaced from said source and deriving an output signal dependent upon the amount of said radiation detected, and electrical means for feeding the output signal from said detectors.

11. A rotary cutterhead for a mineral-mining machine comprising holders for cutter tools distributed around said head, a source of electromagnetic radiation mounted adjacent to the periphery of said head, a detector of said radiation also mounted adjacent to the periphery of said head but spaced from said source, said detector deriving an output signal dependent upon the amount of said radiation detected, and electrical means for feeding the output from the detector and for gating said output signal so as to represent two fractions, one fraction being derived when said detector is adjacent to the roof of the seam, and the other fraction being derived when the detector is adjacent to the floor of the seam.

12. A rotary cutterhead for a mineral-mining machine comprising holders for cutter tools distributed around said head, a source of electromagnetic radiation mounted adjacent to the periphery of said head, first and second detectors of said radiation also mounted adjacent to the periphery of said head but spaced from said source, said first detector deriving an output signal when adjacent to the roof of the seam and said second detector deriving an output signal when adjacent to the floor of the seam, and electrical means for feeding the output signal from said detectors.

13. In a mineral-mining machine, a rotary cutterhead, a vane on the head, a plurality of pick holders spaced along the vane, a source of electromagnetic radiation, an electromagnetic radiation detector, the said source and the said detector being spaced along the vane and separated by at least one of said pick holders, electrical means associated with the said detector, steering means for the machine adapted to control the position of the machine, the electrical means being connected to the steering means whereby steering of the machine is achieved by an electrical signal, dependent in value on the amount of radiation from the said source, backscattered onto the said detector, being generated by the said electrical means and fed to the steering means.

14. In a mining machine according to claim 13, a further associated detector, said source and detectors being connected with said steering means through said electrical means, and commutator means connected with aid electrical means.