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AUTOMATIC DEVICE FOR COUNTERBALANCING REACTION FORCES OF A BORE MINE MACHINE

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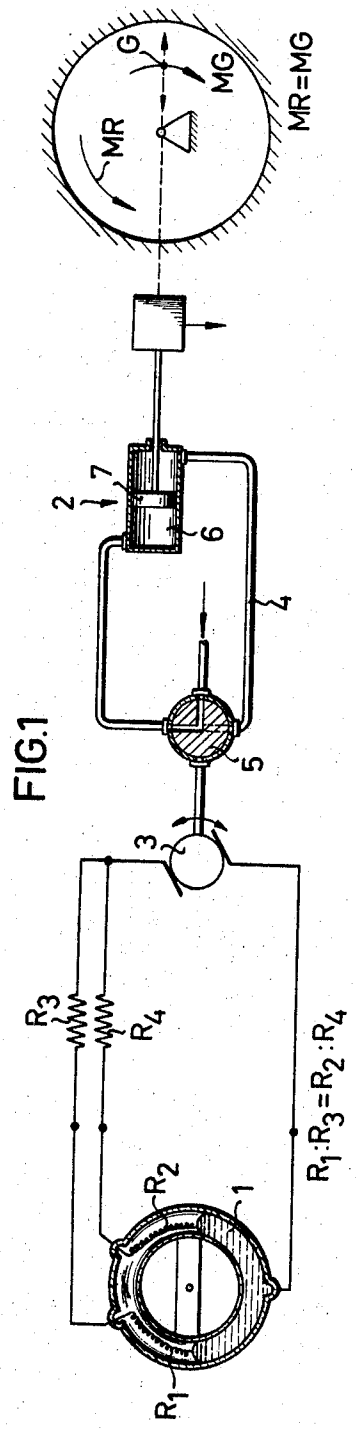


FIG.1

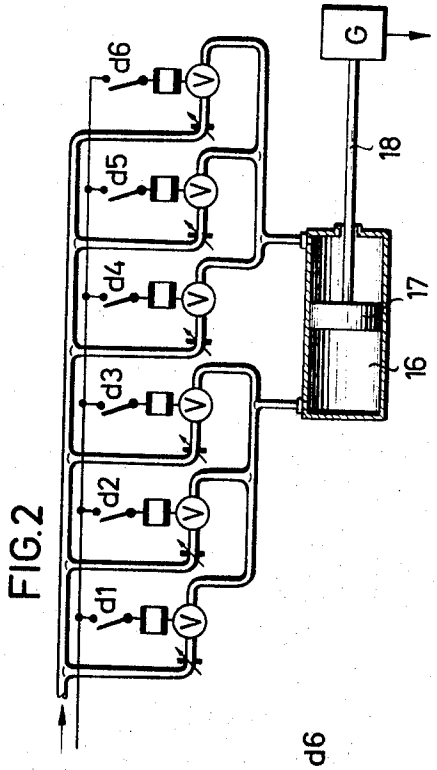


FIG.2

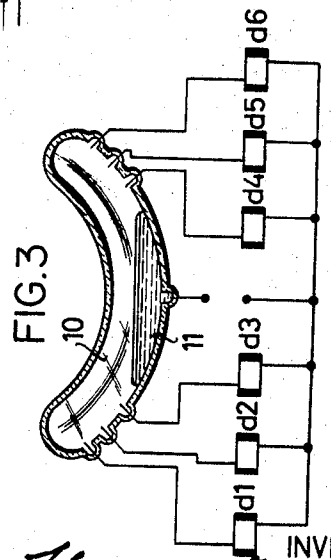


FIG.3

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AUTOMATIC DEVICE FOR COUNTERBALANCING REACTION FORCES OF A BORE MINE MACHINE

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5 Claims

ABSTRACT OF THE DISCLOSURE

In a bore mining machine a device for counteracting twisting torque of the machine created by the operation of the boring instrumentality. A weight associated with the machine is shiftable in directions transverse to the longitudinal axis thereof by automatic means responsive to the twisting action of the machine, so that the center of gravity is altered to effect a torque equal to and opposite that imposed by the machine. The automatic weight shifting means may comprise a hydraulic motor rendered operative by a measuring instrument, such as a ring potentiometer or a mercury switch, which is electrically connected for causing the hydraulic motor to shift the weight in one direction or the other in accordance with the demands of service.

The present invention relates more particularly but not exclusively to a method of controlling or preventing the inclination about an axis in a horizontal plane of a mining apparatus such as a boring machine of the type known as a "bore miner" for forming bores in earth formations such as coal seams in underground coal mines.

One particular object of the invention is to provide a control system for such a bore miner adapted to compensate for the twisting action on the body of the miner exerted by rotating or other tools forming part of the mining apparatus.

Such a twisting or canting action occurs especially with bore miners adapted to produce cylindrical excavations since the torque exerted by rotating boring tools be opposed by an equal and opposite torque from the body if the body is not to tilt about its longitudinal axis. This torque or twisting moment is particularly disadvantageous with modern bore miners, especially those mounted on crawler tracks, because the center of gravity is usually above the point at which the machine is attached to the tracks or other propulsion means, and as a result the machine is in any case in a state of unstable equilibrium.

A further object of the present invention is to provide a counter balancing system for such bore miners which produces an equal and oppositely acting force to compensate for the twisting or tilting action of the boring tools and thus prevent tipping of the body of the bore miner about its longitudinal axis, and thus to overcome the disadvantages in supporting the bore miner body by contacting the cylindrically curved walls of the bore. A disadvantage of methods of stabilizing the bore miner body by engaging the walls of the bore is that such methods do not allow for the forward movement of the bore miner to a sufficient extent, that is to say they provide a static rather than a dynamic supporting action.

A further object of the invention is to provide for the balancing of a bore miner so as to compensate for reaction forces of the type described by displacing the center of gravity of the machine from the geometrical center in a downward and lateral direction from the vertical median plane of the machine so as to produce a gravity moment

equal and opposite to the twisting or tilting action exerted by the boring tools.

A still further object of the invention is to insure that such a balancing force about the longitudinal axis of the machine is continuously varied in accordance with variations in the tilting force exerted by the boring tools as they pass from one type of rock or coal to another, so that the net resulting tilting force tending to upset the bore miner is zero. As a result the horizontal cross section of the machine remains in its preselected position.

A yet further object of the instant invention is to provide such a compensating system which is able to allow for changes in boring torque caused by variations in the rock or other material in which the machine is operated.

Another object of the invention is to provide a bore miner having known means such as trimming weights or a trimming tank for changing the position of the center of gravity of the bore miner in order to prevent it being tilted by the torque of the boring tools.

In accordance with one of its aspects, the invention consists in a bore miner or similar tunneling machine provided with a measuring instrument for detecting tilting of the bore miner body about its longitudinal axis, and means responsive to the instrument for moving a weight forming part of the bore miner so as to change the position of the center of gravity of the bore miner and thus compensate for or balance any tilting of the bore miner about the axis. This therefore provides for a regulating system which is completely independent from the sensitivity of the operator of the machine to tilting.

Preferably the means for causing displacement of the weight include an electrical circuit operating a hydraulic motor for moving the weight.

The measuring instrument can be in the form of a ring potentiometer, though it is also possible to use a mercury switch or similar device.

Two embodiments of the invention are now described with reference to the attached drawing. Only the essential parts are shown in order to make the description more readily intelligible to those skilled in the art.

FIG. 1 shows a first embodiment of the invention.

FIGS. 2 and 3 show the second embodiment of it.

In the right-hand part of FIG. 1 the mathematical expression defining the balance or equilibrium condition of the bore miner is illustrated. M_R denotes the torque exerted by the boring elements of the drum of the machine and to a lesser extent by the chiselling or scraping tools of the machine. M_G denotes the torque due to gravity which is to be maintained equal and opposite to the torque due to the boring tools, i.e.

$$M_R = M_G$$

In the embodiment shown in FIG. 1, the torque due to gravity is produced by a balancing weight G which can be moved in a direction as indicated by the arrows in the right-hand part of the figure.

The tilting of the boring machine body about its longitudinal axis is determined or detected by a measuring instrument 1 which produces control signals for a motor 2 which in turn moves the weight in the direction indicated by the arrows. The measuring instrument is shown in the particular form of a ring potentiometer with two corresponding resistances R_1 and R_2 which are connected with the two further resistances R_3 and R_4 to form a bridge circuit. When the balance of the bridge is upset, a motor 3 is actuated to operate a control element 5 in a hydraulic circuit 4 connected for driving the motor 2. The element 5 can be in the form of a twin slide valve, that is to say a valve which allows oil to flow into the space on the right-hand or the left-hand side of the piston 7 of the motor cylinder 6 in accordance with which the motor 3 is turned so that the weight is moved either to

the right or to the left in accordance with the direction of rotation of motor **3** which in turn depends upon the direction in which the ring potentiometer **1** is tilted.

The embodiment of the invention shown in FIGS. 2 and 3 comprises a mercury switch **10** with several contacts **11** to make electrical contact with the mercury so as to operate control motors d_1–d_6 in accordance with the direction and angle of tilt of the switch **10**. The control motors operate blocking parts or valves of which each is associated with an upstream throttle. The blocking valves operate on parallel branches of a hydraulic circuit duct having three branches on each side of piston **17** in a cylinder **16**. The unit **16, 17** constitutes a control motor for moving the weight G by means of the piston rod **18**. It is apparent that, in accordance with the number of control elements d_1–d_3 and d_4–d_6, a greater or lesser response to tilting of the motor **16, 17** can be produced.

The described method and device enable the position of a bore miner about its longitudinal axis during the boring of a cylindrical hole to be controlled automatically as the hole is extended. Thus, long drifts and tunnels can be produced through various different rocks without causing tipping of the bore miner as it passes from one rock to another with a different resistance to the boring tools.

I claim:

1. Device for automatically controlling the position of a bore mining machine about a longitudinal axis by counterbalancing reaction forces created by the working of such machine which tend to turn the machine about such axis, said device comprising a weight associated with said machine shiftable transversely to the longitudinal axis thereof to alter the center of gravity for producing a torque equal and opposite to the twisting torque created by the working of such machine, and means automatically responsive to a longitudinal twisting action of such machine for shifting said weight in one direction or the other for effecting a counterbalancing reaction torque.

2. An automatic control device as claimed in claim **1**, in which said weight shifting means comprises a measuring instrument responsive to twisting of such machine, electrical means energized by actuation of said instrument, and weight connected means activated by said electrical means for moving same.

3. An automatic control device as claimed in claim **2**, in which said measuring instrument comprises a tiltable switch, a hydraulic motor operatively connected to said weight, and means including an electrical circuit responsive to said switch for causing predetermined hydraulic pressure to be delivered to said hydraulic motor for imparting appropriate movement to said weight.

4. An automatic control device as claimed in claim **3**, in which said tiltable switch comprises a ring potentiometer, a reversible electric motor controlled by said potentiometer, and a valve for said hydraulic motor actuated by said electric motor.

5. An automatic control device as claimed in claim **3**, in which said tiltable switch comprises a mercury switch having a plurality of contacts, a plurality of control motors connected respectively to said contacts in accordance with the direction and angle of tilt of said switch, branch ducts leading to said hydraulic motor, and valves controlling said ducts respectively and blocked respectively by said control motors, thereby to control the liquid flow to said hydraulic motor.

References Cited

UNITED STATES PATENTS

2,761,666	9/1956	Heimaster et al.	299—1
2,917,126	12/1959	Phillips	180—104
3,160,284	12/1964	Moore	280—6.1 X
3,233,909	2/1966	Boone	180—41 X

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