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Ewing

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[54] **REMOTELY CONTROLLED MINING MACHINE**

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[52] **U.S. Cl.** **299/1,** 299/30, 299/56, 299/75

[51] **Int. Cl.** **E21c 35/24**

[58] **Field of Search** 299/1, 18, 30, 56, 299/57, 64, 67, 75

[56] **References Cited**

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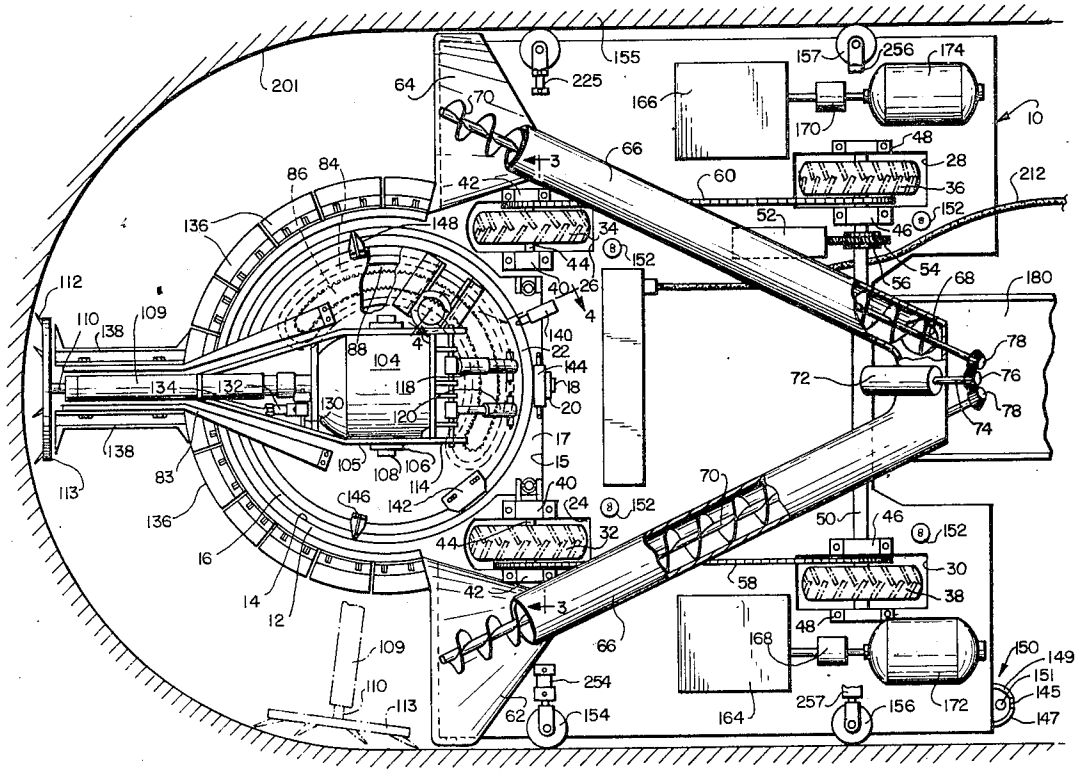
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Primary Examiner—Ernest R. Purser
Attorney—D. C. Roylance et al.

[57] **ABSTRACT**

A coal mining machine operated by remote control to cut coal lying in thick or thin seams and to convey the cut coal out of the shaft cut thereby. The machine can be manipulated to move forward or rearward and can be directed to the left and right. Cutter bits in a cutting assembly mounted on the machine frame are moved in a predetermined path through an angle of 180° as they cut a first cut and are then elevated and moved back along 180° in the opposite direction from the first cut to cut a second cut higher than the first cut. The cutter bits are then lowered to the original level completing their predetermined path. Both the upper and lower limits of the cuts can be adjusted and the base upon which the cutting assembly is connected can be tilted to allow the cutter bits to follow the contour of the coal seam and have its predetermined path varied. The machine comprises a main machine frame mounted on power-driven wheels for movement in forward and rearward directions; a base pivotably mounted to the frame so that it can be tilted relative thereto; a turntable rotatably mounted on the base and carrying a cutting assembly thereon for rotation through 180°, the cutting assembly having cutting bits at one end capable of being moved upwards and downwards; and a control system for actuating a motor for rotating the turntable through a cycle consisting of two opposite and coincident 180° reciprocations, for actuating a hydraulic cylinder to allow the cutting assembly to be pivoted so that the cutting bits are moved to a higher or lower elevation at the end of a 180° reciprocation, and for actuating the wheels to move the frame forward after the turntable and cutting assembly have moved through a complete cycle. Two ammeters measure the current magnitude in the cutter motor along each half of the cycle and indicate to the operator on increases of the load imposed on the cutter motor that the machine is cutting into substances other than coal and that, therefore, some adjustment is necessary to the path of the cutting bits at the end of a shaft mounted on the cutter motor.

16 Claims, 8 Drawing Figures



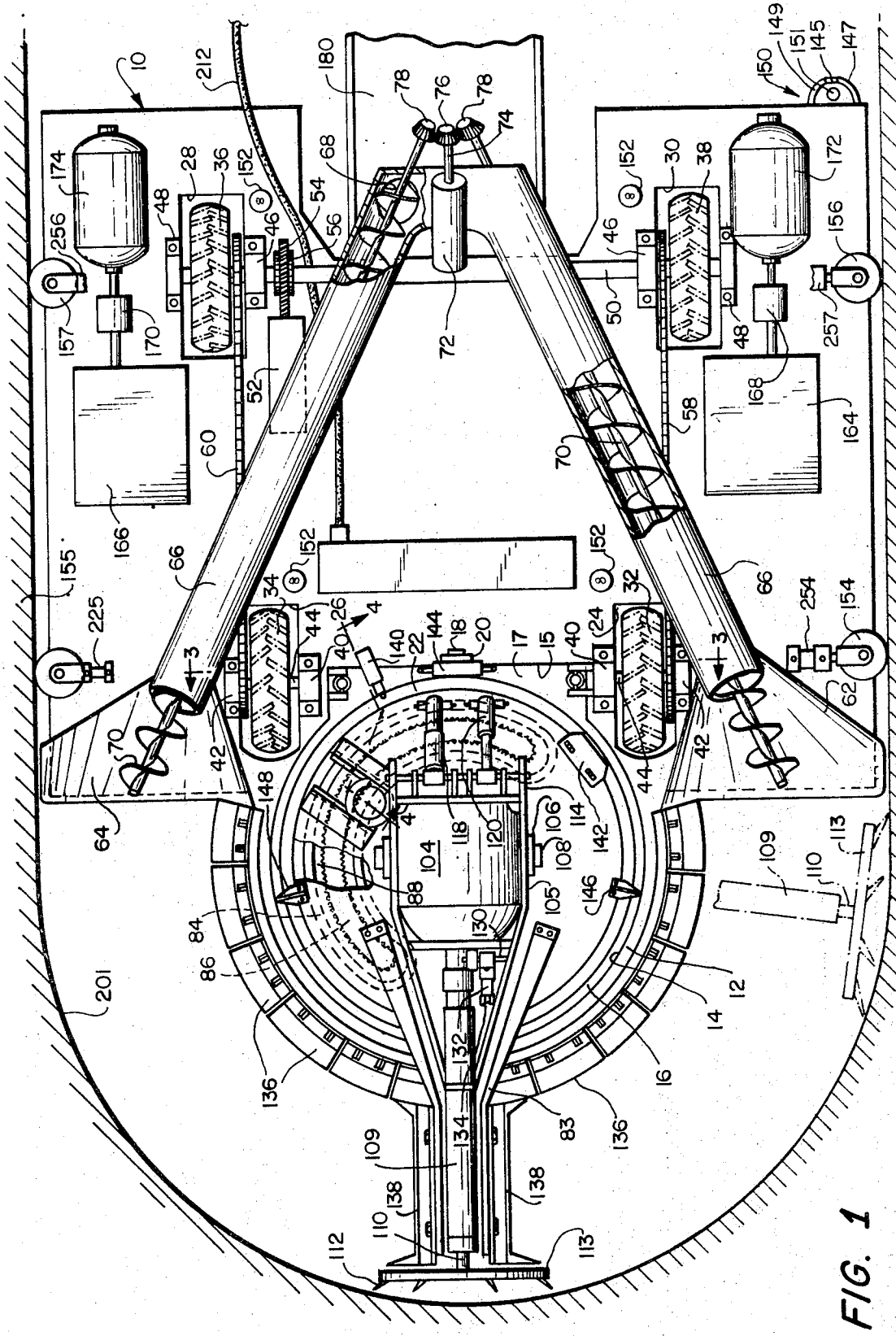


FIG. 1

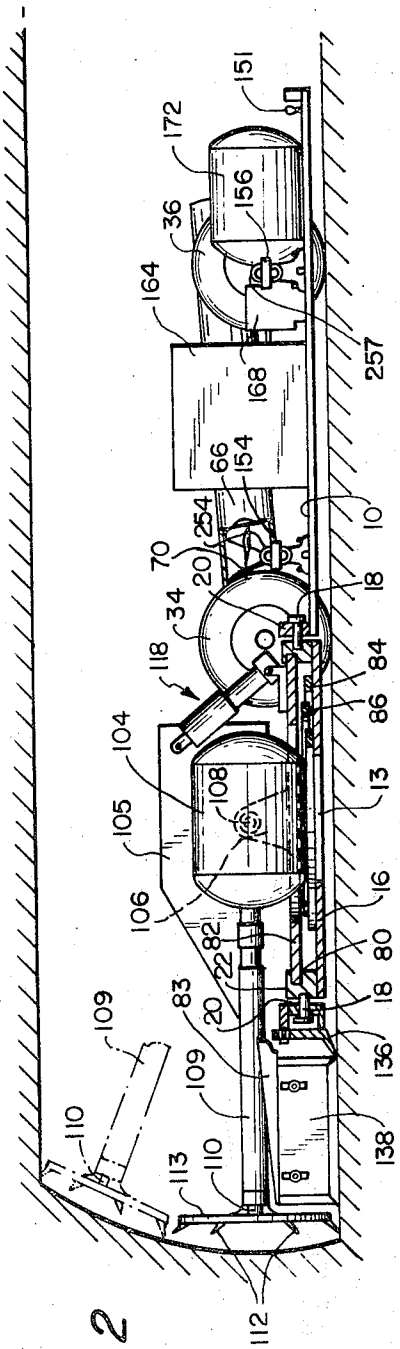


FIG. 2

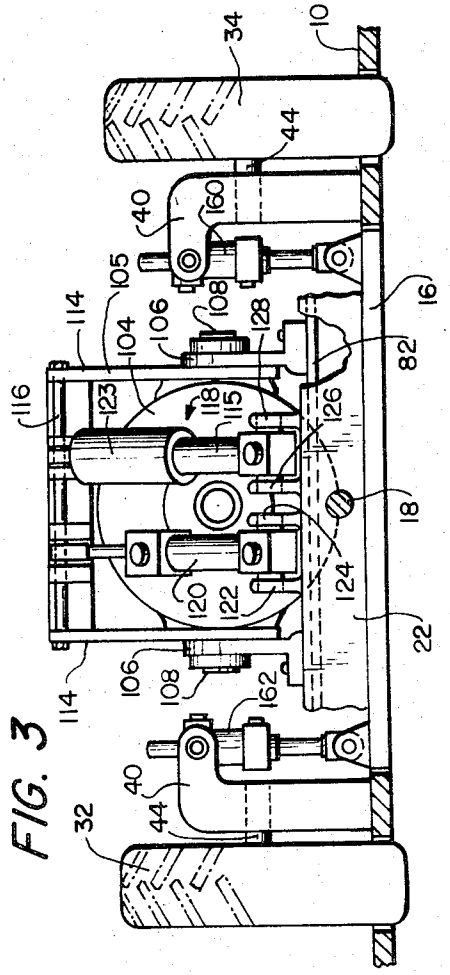


FIG. 3

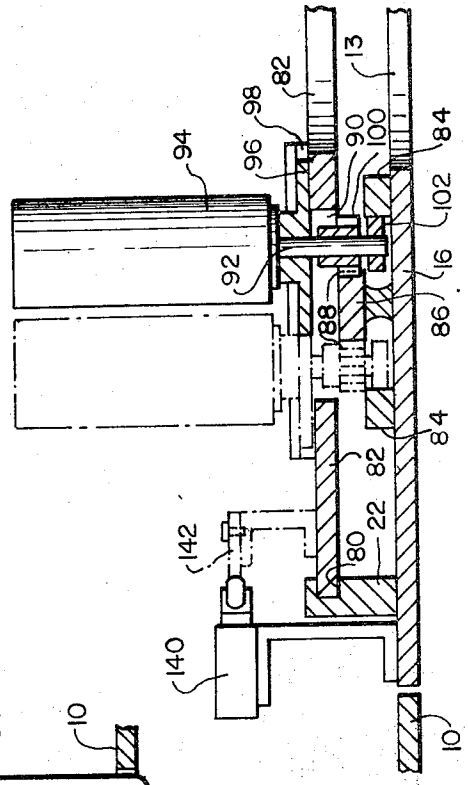


FIG. 4

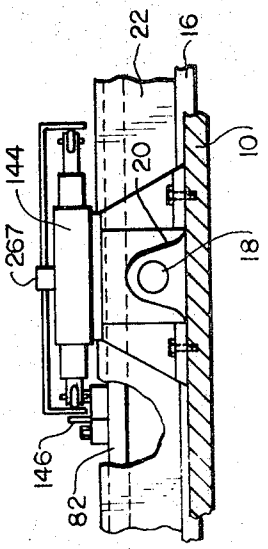


FIG. 5

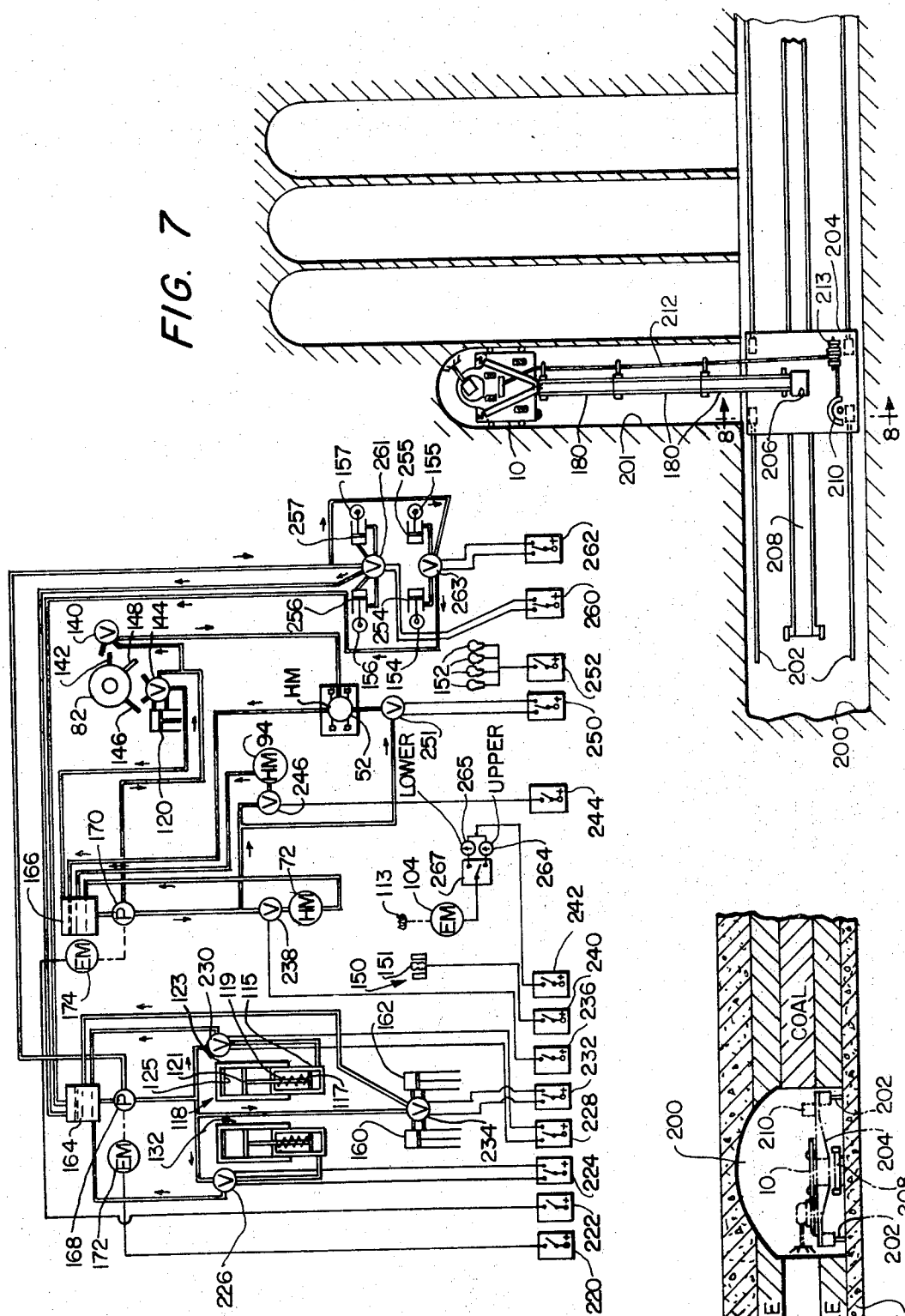


FIG. 6

FIG. 7

FIG. 8

REMOTELY CONTROLLED MINING MACHINE

This invention relates to a machine for mining coal and more particularly to a remotely controlled continuous mining machine which is capable of cutting coal lying in thick or thin seams by utilizing a control system which can remotely adjust the movement of the machine and the path of a cutting assembly to follow the coal seam.

Machines for mining coal are well-known in the prior art. However, they have proved to be unsatisfactory with regard to safety for the miners and efficiency of operation. The prior art mining machines, while being partially automatic, have nonetheless necessitated the presence of a miner in the proximity of the coal cutting site. This proximity increases the hazards to the miner because of the possibilities of explosions or cave-ins. Additionally, the miner's proximity to the actual cutting site has increased the chances of the miner breathing in harmful coal dust. While other mining machines have been remotely controlled, they have not had the capability of following a relatively thin seam of coal with any degree of precision and, therefore, unwanted rock, slate and shale are cut with the coal and from which the coal must later be separated. This cutting of material other than coal can also be dangerous due to the fact that sparks are emitted from such cutting and thereby increases the possibility of a coal dust or gaseous explosion in the mine. Finally, many of the prior art mining machines cut a large area of the coal face at one time and require a large degree of maneuvering to keep them in the cut. This results in an excessive use of unnecessary power and a reduced efficiency of operation.

With the above in mind, it is therefore an object of the present invention to provide a mining machine which will overcome the drawbacks of the aforesaid prior art machines and to provide a safer and more efficient coal mining machine.

Another object of the present invention is to provide a coal mining machine which is completely remotely controlled and wherein the operator of the machine is a safe distance from the cutting site.

Another object of the present invention is to provide a remotely controllable coal mining machine which can follow a thin seam of coal and cut only the coal while avoiding the surrounding rock, slate and shale.

Another object of the present invention is to provide a coal mining machine which has the cutting bits continuously in contact with the material it is cutting, and therefore operates efficiently.

Another object of the present invention is to provide a coal mining machine which can be controlled to cut only coal and not the surrounding rock and to therefore eliminate the generation of sparks which might ignite coal dust or mine gases.

Yet another object of the present invention is to provide a coal mining machine which may cut a thin seam of coal lying diagonally to the floor of the mine.

Other objects, advantages and salient features of the present invention will become apparent from the following detailed description, which, taken in conjunction with the annexed drawings, discloses a preferred embodiment of the present invention.

In general, the coal mining machine of the present invention comprises a main machine frame which is supported on hydraulically driven wheels; a base pivotably mounted on the front of the frame and tiltable relative thereto by hydraulic cylinders; a turntable rotatably mounted on the base and reciprocable relative thereto, by means of a unidirectional motor, through 180° in a first direction and back through 180° in an opposite direction; a cutting assembly pivotably mounted to the turntable and carrying cutter bits at one end, which cutter bits are pivoted in a vertical direction after each 180° of reciprocation of the turntable; and a control system for coordinating all of the various movements of the frame, the base, the turntable, and the cutting assembly.

Referring now to the drawings, which form a part of this original disclosure:

FIG. 1 is a plan view of a machine in accordance with the present invention;

FIG. 2 is a side elevation in partial section of the machine of FIG. 1;

FIG. 3 is a sectional view, taken substantially along lines 3—3 of FIG. 1, showing the base pivotably mounted to the frame;

FIG. 4 is a sectional view, taken substantially along lines 4—4 of FIG. 1, showing the unidirectional motor for rotating the turntable and the valve for actuating the wheel drive at the end of each cycle of reciprocation of the turntable;

FIG. 5 is a fragmentary elevational view of the valve which controls the movement of the cutter assembly upwards and downwards at the end of one-half of the cycle of reciprocation of the turntable;

FIG. 6 is a schematic diagram of the overall control system of the present invention;

FIG. 7 is a schematic representation, in plan, of a mining operation utilizing the present invention; and

FIG. 8 is a sectional view of a typical coal formation, the main tunnel and the operating tunnel, taken substantially along lines 8—8 in FIG. 7.

Referring to the drawings in detail, in FIG. 1, the main machine frame is designated 10 and is in the form of a planar rectangle having a substantially semicircular extension 12 along the front side with the mid point of the semicircle coincident with the longitudinal axis of the rectangular frame 10 and spaced slightly forward of that side and a diameter substantially equal to one-half the length of that side. A circular cutout 14 is provided in the frame 10 having a midpoint coincident with the midpoint of the semicircular extension 12 and a diameter slightly less than the diameter of that extension. Located at the rear of the circular cutout 14 is a rectangular cutout 15 having a length in a direction transverse to the longitudinal axis of the frame 10 equal to approximately two-thirds the diameter of the circular cutout 14 and a width in a direction parallel to the longitudinal axis of the frame equal to approximately one-third the radius of the circular cutout 14. Receivable in the circular and rectangular cutouts is a base 16 having a portion in the shape of a disc having a diameter slightly smaller than the diameter of the circular cutout 14 and having a portion in the shape of a rectangular extension 17 slightly smaller than the rectangular cutout 15. The base is pivotably mounted to the main machine frame 10 along the longitudinal axis of that frame by means of two shafts 18, 18 which pass respectively through two diametrically opposed upstanding supports 20 and into suitably drilled bores in an annular collar 22 mounted concentrically to the top of the disc portion of the base 16 along the perimeter thereof, the supports

20 being located on the longitudinal axis of the main machine frame 10 as seen in FIGS. 1 and 2. Hydraulic cylinders suitably mounted cause the base to pivot relative to the frame, as will be described hereinafter. Additionally, the base 16 has a central circular cutout 13 in the disc portion.

Four substantially rectangularly shaped openings 24, 26, 28 and 30 are provided in the machine frame 10, two just rear of the base 16 and two at the rear of the frame, for partially receiving, respectively, four driving wheels 32, 34, 36 and 38. The forward wheels 32 and 34 are supported in their respective cutout openings 24 and 26 by means of upstanding supports 40 and 42 mounted on the top of the frame on opposite sides of each opening having an axle or shaft rotatably supported therebetween and rigidly engaging each wheel. The rear wheels 36 and 38 are supported in their respective rear cutout openings 28 and 30 by means of two upstanding spaced supports 46 and 48, each of which is mounted to the top of the main machine frame adjacent the edges of each rear opening and which rotatably receive a shaft 50 which is connected at each end to one of the rear wheels. The wheels support the frame only a few inches off the ground.Resting on the top of the main machine frame 10 adjacent rear wheel 36 is a first hydraulic motor 52 having a worm 54 connected thereto and engageable with a corresponding wormgear 56 rigidly connected to the rear shaft 50. Actuation of the first hydraulic motor 52 results in a rotation of the rear shaft 50 and a concomitant rotation of the rear wheels 36 and 38. A chain belt 58 interconnects two sprockets, one mounted on the rear axle 50 and the other mounted on the left front shaft 44 of the left front wheel 32 for transmitting rotation of the rear axle to the front axle and wheel 32. Similarly, right front wheel 34 is connected to the rear axle or shaft 50 by means of a chain belt 60 suitably connected to sprockets on the rear shaft and on the right front shaft 44.

On the front side of the main machine frame adjacent to and on each side of the connection of the semicircular extension 12 with the main machine frame 10 are two hoppers 62 and 64. Each hopper has a leading edge located just below the plane of the bottom of the main machine frame extending from the extension 12 to the side edge of the frame and perpendicular to the longitudinal axis thereof. From that leading edge each hopper extends rearwardly and upwardly and converges into and communicates with an elongate conduit 66, the conduits converging at the rear end of the machine frame 10 with rear openings 68 therein slightly spaced from each other and facing downwards. Extending throughout each conduit 66 is an auger 70 having a forward end substantially coincident with the leading edge of each hopper and a rear end extending slightly out of the rear openings 68. Interposed between those rear openings is a second hydraulic motor 72 having a shaft 74 connected thereto with a beveled gear 76 at its end and facing towards the rear of the frame. Each auger 70 has a beveled gear 78 on an extension, each of those beveled gears 78 corresponding to and meshing with the beveled gear 76. Rotation of the second hydraulic motor shaft 74 results in a rotation of the beveled gear 76 connected thereto and a concomitant rotation of the beveled gears 78 and the augers 70.

As best seen in FIG. 2, received in a circular slot 80 in the interior of the collar 22 on the base is a turntable 82 in the form of an annulus. The turntable 82 is located in the collar 22 parallel to the base 16 such that there is a space defined between the turntable and the base 16 which supports the collar. As best seen in FIGS. 1, 2 and 4, mounted on the base 16 and having a height less than the space defined between the turntable 82 and that base 16 is a semicircular cam track 84 having a semicircular cutout therein formed from two concentric semicircular runs joined at each end by two small radius curves. The cam track 84 is defined by the locus of the center of a circle rolling on a 180° arcuate surface having a thickness. One end of the cam track is located about 15° to the left of the longitudinal axis of the frame 10 and the other end is located about 15° to the right of that longitudinal axis as viewed in FIG. 1. Mounted on the base 16 within the cutout portion of the cam track 84 and at a height slightly above that of the cam track is a semicircular geared track 86 having teeth 88 on the outer surface. An elongated slot 90 in the turntable, elongated in the radial direction and having a length equal to substantially one-half the outer radius of the turntable, receives the shaft 92 of an upstanding unidirectional hydraulic motor 94 which can slide along the elongated slot 90 along the top of the turntable by means of a circular plate 96 thereon receivable in two channels 98 supported on and parallel to the surface of the turntable and also parallel to the sides of the elongated slot 90. Rigidly mounted to the shaft 92 of the motor 94 is a gear 100 which engages the teeth 88 in the gear track 86. On the shaft 92 below the gear 100 is a cam follower 102 in the form of a disc, which cam follower is in contact with and moves along the cam track 84 as gear 100 rotates in engagement with track 86. Rotation of shaft 92 in the motor 94 causes the gear 100 to move along the gear track 86 and, because the motor 94 is rigidly connected to the turntable in an arcuate direction and capable only of movement in a radial direction thereto, causes a rotation of the turntable. When the gear 100 reaches the end of one of the semicircular runs along the gear track 86, the cam follower 102 follows one of the small radius curves of the cam track 84 and causes the motor 94 to move along the slot 90 and then the gear 100 continues its run on the opposite side of the geared track 86 and moves the turntable in the opposite direction.

As seen in FIGS. 1, 2 and 3, an electrical cutter motor 104 is pivotally mounted for movement in a vertical plane in the center of the annular turntable 82 on two upstanding supports 106 mounted thereto having shafts 108 passing therethrough and connected to the cutter motor frame 105 upon which the cutter is rigidly mounted. When the turntable rotates, the cutter motor rotates with it. The cutter motor frame 105 has a cutter shaft housing 109 integrally formed therewith at one end which rotatably receives the cutter shaft 110 therein, the shaft having a cutting head 113 and cutter bits 112 at its end. The cutter motor, the cutter shaft housing, the cutter shaft, the cutting head and the cutter bits comprise the cutting assembly.

On each side of the cutter motor 104 the cutter motor frame 105 has extensions 114 oriented perpendicular to the turntable 82 and extending rearwardly of the cutter motor on the side opposite the cutter shaft 110. Connected between the two extensions 114 is a rod 116 rotatably mounted therein and receiving the piston shaft associated with the hydraulic cylinder 120. The end of the hydraulic cylinder 120 opposite the pis-

ton shaft is mounted to the top surface of the turntable 82 by means of suitable plates 122 and 124.

As best seen in FIGS. 1, 3 and 6, a limit assembly 118 is mounted between the rod 116 mounted on the frame 105 and the supports 126 and 128 mounted on the top surface of the turntable 82. The assembly 118 is formed from a hydraulic cylinder 115 pivotally mounted at one end to supports 126 and 128 having a piston 117 contained and movable therein, a piston shaft 119 passing through the free end of the cylinder and mounted at one end to the piston and at the other end to a second piston or circular stop 121; and a cylindrical guide sleeve 123 pivotally mounted at a closed end to the rod 116 with the other open end movable along the exterior of the hydraulic cylinder and receiving the circular stop therein. The circular stop has a seal around its periphery to provide a tight fit between it and the guide sleeve. The piston inside the cylinder is spring biased downwards. A replaceable strike plate 125 is provided at the top of the interior of the guide sleeve at its closed end for receiving the circular stop when the guide sleeve is moved downwards.

On a portion of the cutter motor frame 105 extending forward of the cutter motor 104 at the side thereof is mounted a shaft 130 which is parallel to the plane of the turntable and which receives the guide sleeve associated with another, similar limit assembly 132. The end of the hydraulic cylinder associated with the assembly 132 is supported on the surface of the turntable 82 by means of support bracket 134.

Actuation of cylinder 120 causes the cutter motor to pivot and the cutter bits thereon to move upwards or downwards. The assemblies 118 and 132 provide an upper and lower limit, respectively, to the pivoting movement when the strike plate in each contacts the stop in each, and also provides a cushioning to the pivoting by means of air trapped in each guide sleeve between the strike and the stop. These limits are adjustable, as will be described hereinafter.

As seen in FIGS. 1 and 2, two scoops 138 extend along each side of the cutter shaft housing 109, which scoops are supported on the turntable by supports 83 and extend from the semicircular extension 12 as far as the cutter bits 112 which are at the end of the cutter shaft 110. The bottoms of the scoops rest on the floor of the cut shaft and float thereon because the scoops are loosely mounted to the supports 83 in a vertical direction by means of elongated vertical slots therein and bolts loosely fitting into the slots and securely fitting into the supports 83. Mounted on the front of the extension 12 and extending around the periphery thereof are a series of scrapers 136, the bottoms of which also float on the floor of the cut shaft. The scrapers are mounted the same way as the scoops.

As seen in FIG. 4, a valve 140 which is connected to the drive motor 52 is located on the base 16 adjacent the turntable and is actuatable by an extension 142 which is mounted to the turntable 82. The extension 142 is an elongated plate which is adjustable in the angular direction and will actuate the valve 140 each time the turntable is reciprocated through one complete cycle and cause the frame to move forward a predetermined amount.

As seen in FIGS. 1 and 5, a double-acting valve 144, connected to the pivoting cylinder 120, is mounted to the base 16 on the rear support 20 and corresponds to two extensions 146 and 148 rigidly secured to the turntable 82 and spaced approximately 195° from each other thereon. Each time the turntable completes a 180° reciprocation, this valve 144 is actuated and causes the motor 104 to pivot. An on-off switch 267 is mounted on the valve 144 for actuating ammeters as will be described below.

Located on the rear end of the main machine 10 is a guide light assembly 150. The assembly comprises a bulb 151 and a semicircular plate partically covering one side of the bulb and having a slit 145 in the middle and two translucent portions, one on each side of the slit. One portion 149 is colored red and the other, 147, green. The slit is in a plane parallel to a vertical plane containing the longitudinal axis of the frame and the plate is perpendicular to the plane of the frame. If the machine veers to the left or right, light from the bulb is transmitted through one of the colored plates to indicate this. If the machine proceeds on a straight path, only a white light from the bulb is transmitted through the slit.

Located along the surface of the main machine frame in various suitable locations are four trouble lights 152 which can illuminate the entire machine for inspection.

As seen in FIG. 3, mounted to each of the two supports 40 is a hydraulic cylinder 160, 162, having pistons movable therethrough and connected to the rectangular extension of the base 16. Activation of these cylinders tilts the base relative to the frame.

Mounted on the frame 10 on the piston shafts of four hydraulic cylinders 254, 255, 256 and 257, are four guide rollers. On the left side the left front roller 154 is adjacent the rear of the hopper 62 and the left rear roller 156 is adjacent the rear of the frame. On the right side the right front roller 155 and the right rear roller 157 are located opposite the corresponding left side rollers. These rollers engage the sides of the tunnel cut by the machine and can be extended to steer the machine to the left or right as will be described below.

Supported on each side of the main machine frame 10 and outboard of the conduits 66 are two hydraulic fluid tanks 164 and 166. Connected respectively thereto and also mounted on the main machine frame 10 are two pumps 168 and 170 which are driven by electric motors 172 and 174, respectively.

As seen in FIG. 1, an endless conveyor belt 180 is positioned beneath the openings 68 of the augers 70.

As seen in FIG. 7, a main mining tunnel designated 200 has along the sides thereof a rail or track system 202. Movable therealong is a launching platform 204 having a centrally located opening 206 therein communicating with a main conveyor 208 located below the platform 204 and extending along the center of the main tunnel 200. A control console 210 is located on the launching platform 204, which console is connected to the machine by an umbilical cord 212 wound on a reel 213 resting on the platform. The mining machine which cuts an operating tunnel 201 at right angles to the main tunnel is connected to the main conveyor 208 by a series of endless conveyors 180.

As seen in FIG. 6, the control console 210, located on the launching platform 204 is shown in schematic form, and illustrates the various switches on the console and the valves and motors to which they are connected, those valves and motors being located on the mining machine itself in suitable positions.

A conventional single-pole, single-throw on and off switch 220 is connected to the electrical motor 172

which runs the hydraulic fluid pump **168** which is further connected to the hydraulic fluid tank **164.** Similarly, a conventional single-pole, single-throw on and off switch **222** is connected to the electrical motor **174** which runs the hydraulic fluid pump **170** which is connected to the hydraulic fluid tank **166.**

A single-pole, double-throw on and off switch **224** is connected to the two-way solenoid valve **226** which valve is connected between the hydraulic pump **168** and the hydraulic cylinder **115** associated with the limit assembly **132** so that the hydraulic cylinder **115** may be activated by the valve **226** to cause the piston therein to move upwardly under the force of inflowing hydraulic fluid and downwardly by the force of the compression spring interposed between the top of the cylinder and the piston as the valve **226** allows fluid to flow from the cylinder. Similarly, single-pole, double-throw on and off switch **228** is connected to a two-way solenoid valve **230** which is in turn connected between the hydraulic pump **168** and the hydraulic cylinder associated with the limit assembly **118** to activate the piston therein in a similar manner as assembly **132.** As mentioned above, these two assemblies **118** and **132** set the upper and lower elevational limits of the pivoting action of the cutter assembly as actuated by hydraulic cylinder **120,** which operation will be described hereinafter. Thus, valves **226** and **230** provide for the adjustment of the elevation of the cutter bits.

A single-pole, double-throw on and off switch **232** is connected to a four-way solenoid valve **234** which has an inlet from the hydraulic pump **168** and various outlets to respectively move suitable pistons in the hydraulic cylinders **160** and **162** to change the pitch of the base **16.**

A single-pole, single-throw on and off switch **236** is connected to a one-way solenoid valve **238** which has an input from the hydraulic pump **170** and an output to the hydraulic motor **72** which runs the augers **70.**

A single-pole, single-throw on and off switch **240** is connected to the guide assembly bulb **151.** A single-pole, single-throw on and off switch **242** is connected to the electrical cutter motor **104.** Located between the electrical motor **104** and the switch **242** are two ammeters **264** and **265** which are selectively actuated by the energizing of switch **267** by extensions **146** and **148** on the turntable. A single-pole, single-throw on and off switch **244** is connected to a one-way solenoid valve **246** which has an input from the hydraulic pump **170** and an outlet to the hydraulic motor **94** mounted to and capable of rotating the turntable **82.**

A single-pole, double-throw switch **250** is connected to a solenoid valve **251** which is in turn connected between the hydraulic pump **170** and the hydraulic motor **52** running the wheels on the frame and can provide for forward and reverse movement of the frame by operating the motor **52** in two directions. This operation is independent of valve **140.**

A single-pole, single-throw on and off switch **252** is connected to the four trouble lights **152** mounted on the main machine frame **10** to illuminate the machine.

Connected to the hydraulic cylinder **120** is a double-acting mechanically actuated valve **144** which is connected to the hydraulic fluid line leading from the hydraulic fluid pump **170** and which is actuatable by movement of extensions **146** and **148** located on the turntable to pivot the cutting assembly to which cylinder **120** is connected.

Connected to the hydraulic pump **170** is the mechanically actuated valve **140** which is actuatable by movement of the extension **140** located on the turntable to cause the hydraulic motor **52** to rotate the wheels supporting the frame.

A single-pole, double-throw switch **260** is connected to a four-way solenoid valve **261** which is connected between the hydraulic cylinders **256** and **257,** which move the rear guide rolls **156** and **157,** and the hydraulic pump **168.**

Similarly, a single-pole, double-throw switch **262** is connected to a four-way solenoid valve **263** which is connected between the hydraulic cylinders **254** and **255,** which move forward guide rolls **154** and **155,** and the hydraulic pump **168.**

In a preferred embodiment, the cutter bits **112** are located on the periphery of the cutting head **113** having a 16-inch diameter, the cutter shaft **110** has a length of approximately 4 feet and the frame is 12 feet long and 7½ feet wide. The forward speed of the frame is approximately 1 foot per minute and the reverse speed is approximately 10 feet per minute. With these dimensions, a seam of coal from 18 inches to approximately 36 inches thick could be mined. With larger dimensions, a larger seam may be cut.

In order to use the mining machine of the present invention, the main mine tunnel **200,** as shown in FIGS. **7** and **8,** is bored to a width of approximately 20 feet with the floor of the tunnel being about one foot below the bottom of the coal seam. The rails **202** are placed along the side of the main tunnel for receiving the launching platform **204** which is movable therealong. Preferably, the top of the platform is in the same plane as the bottom of the coal seam. The mining machine initially is mounted on the top of the launching platform with the front of the machine facing one of the side walls of the main tunnel and the cutter shaft oriented parallel to the longitudinal axis of the main machine tunnel and therefore at right angles to the front of the mining machine. In this position, the gear **100** on the shaft of the motor **94** is located at one end of the geared track **86** and the cam follower **102** is located at the corresponding end of the cam track **84.**

The operator takes his place on the launching platform **204** in front of the control console **210** and starts the machine by turning on switches **220** and **222** which energize the electrical motors **172** and **174** which in turn cause the hydraulic fluid pumps **168** and **170** to pump fluid from the tanks **164** and **166** into the hydraulic lines and up to the desired pressure.

Switches **224** and **228** are then manipulated to trigger solenoid valves **226** and **230** which are connected respectively to the hydraulic cylinders associated with the limit assemblies **132** and **118.** These cylinders, in conjunction with their associated pistons, as mentioned above, provide an upper and lower limit to the pivoting of the cutter motor **104.** In beginning the cutting of a tunnel the upper and lower limits can be set as desired and usually are set to provide a lower limit such that the bottom of the cutter head **113** is parallel to the bottom of the coal seam and the top of the cutter head is, on being elevated, parallel to the top of the coal seam.

Switch **232** is then manipulated to activate solenoid valve **234** which establishes the desired pitch to the base **16** by selectively admitting hydraulic fluid to the hydraulic cylinders **162** and **160** located on opposite

sides of that base. Initially, the base can be oriented parallel to the machine frame.

After these adjustments have been made, switch **236** is turned to the on position which activates the one-way solenoid valve **238** which activates the hydraulic motor **72** to begin rotation of the augers **70.**

Switch **240** is then turned on and activates the guide light **151.**

Switch **242** is turned on and activates the electrical cutter motor **104** which rotates the cutter bits **112.**

The machine is now ready to begin cutting a shaft perpendicular to the main tunnel **200.** The actual cutting is instigated by actuating the switch **244** which actuates the one-way solenoid valve **246** to transmit hydraulic fluid to the hydraulic motor **94** which rotates the turntable carrying the cutter motor and cutter bits relative to the base **16** by engagement of the gear **100** mounted on the motor shaft **92** with the geared track **86.**

Initially, as stated above, the cutter shaft is oriented parallel to the longitudinal axis of the main tunnel **200** and, on actuation of the hydraulic motor **94,** the cutter bits begin to cut a predetermined path by rotating in a clockwise direction as viewed in FIGS. **1** and **7.** As the turntable rotates, the cutter bits in the cutting assembly engage the wall of the main tunnel and cut a layer of small thickness therefrom as it rotates through 180° in a first direction. When the cutter shaft and bits reach the end of the 180° rotation the extension **148** on the turntable engages and actuates the valve **144** which allows hydraulic fluid to flow into the hydraulic cylinder **120** which results in an upward movement of the cutter bits limited by the assembly **118** which has been set as described above. Since the hydraulic motor **94** is a unidirectional rotating motor, the gear **100** on the shaft **92** which has moved along one side of the geared track **86** moves around the end of the gear track and engages the other side of the geared track and causes the motor to move along the other side of that track. This causes the turntable to rotate or reciprocate in a second reverse direction through the same 180°. This will also cause the cutter bits to move therealong and cut through the coal in the wall adjacent the tunnel along the same 180° but slightly above the previous path. At the end of the second 180° rotation, the bits move downwards on actuation of hydraulic cylinder **120** by actuation of the valve **144** by extension **146** mounted on the turntable **82.** This ends the movement of the cutting assembly through its predetermined path.

As the cutting assembly completes its predetermined path consisting of a cycle of two 180° reciprocations and two movements vertically, one upward and the other downward, the extension **142** mounted to the turntable engages and actuates the valve **140** which triggers the hydraulic motor **52** connected to the wheels supporting the frame. This actuation can be continued for as long as the extension **142** remains in contact with the valve. This is adjustable by means of moving the extension along the periphery of the base. The actuation of the hydraulic motor **52** causes the entire machine to move forward slightly at which time a new cycle begins and the cutter bits once again cut coal from the shaft wall. This continues until a predetermined depth of cut has been reached. If for any reason the operator of the machine wants to move the entire machine forward a distance more than that provided by the automatic actuation by valve **140,** switch **250** can be actuated to in turn actuate the solenoid valve **251** which runs the hydraulic motor **52** forward. Also, since switch **250** can be actuated to reverse the hydraulic motor **52,** actuation of that switch **250** in that manner moves the mining machine in reverse and out the tunnel back onto the launching platform **204.**

Since the coal is usually lying in a thin seam between slate, shale and rock on the top and the bottom, as seen in FIG. **8,** it is preferable for the cutting bits **112** to only cut the coal lying therebetween. If the coal seam is lying parallel to the horizontal plane of the main machine frame, then the base is not tilted in either direction and the cutter bits rotate right through the coal seam. If the coal seam is not lying in the same horizontal plane as the mining machine frame, then the path of the bits on the cutting assembly can be tilted by actuation of switch **232** to provide for a pivoting of the turntable into a plane coincident with that of the coal seam by suitable actuation of cylinders **160** and **162.** The thickness of the seam itself is taken into consideration by the upper and lower limits provided to the pivoting of the cutter motor by the limit assemblies **118** and **132.**

In order to ascertain exactly where the plane of the coal seam is located the ammeters **264** and **265** which are connected to the electrical cutter motor **104,** display on the control console **210** a change in the amperage across the motor when the cutter bits are hitting hard shale, slate or rock. At this time the operator can vary the upper or lower assemblies **118** and **132** by providing or removing hydraulic fluid therefrom as described above to regulate the vertical pitch of the cutter shaft or vary the pitch of the base **16** so that the cutter bits follow the thin coal seam. The ammeters **264** and **265** are selectively actuated by extensions **146** and **148** on the turntable and switch **267** on the base so that only one is working on each of the upper or lower runs of the cutter bits. This allows the operator to known on which run, either upper or lower, the machine has encountered shale or rock, and therefore allows him to adjust the machine accordingly. If either of the ammeters registers a reading higher than normal during an entire run, the operator knows he must either raise or lower the path of the cutting bits. If either of the ammeters registers a higher than normal reading during only a portion of the run, the operator knows he must tilt the base to follow a diagonal seam of coal.

As the cutter shaft and cutter bits are reciprocating through their 180° of movement, the coal cut from the wall of the coal shaft falls to the bottom of the cut shaft and is moved to the left or the right by the scoops **138** mounted on the turntable adjacent the cutter shaft housing **109.** The reciprocation of the turntable and the scoop moves the cut coal into the hoppers **62** and **64** and into the augers **70** along which they are conveyed through conduits **66** and back to the endless belt **180.** Additionally, the scrapers **136** mounted along the semicircular extension **12** push any coal lying in front of the machine forward as the machine is activated in the forward direction at which time the scoops **138** move the coal to the hoppers.

As the mining machine proceeds forward into the operating tunnel a plurality of endless belt conveyors **180** are connected behind it which lead from it to the launching platform **204.** Coal moving from the augers **70** is deposited on the series of conveyors belts **180,** is conveyed to the opening **206** in the launching platform,

falls therethrough, is deposited on the main conveyor **208** in the main tunnel **200** and is conveyed out the tunnel. The conveyors **180** can have self-contained motors which can be connected to each other and a main power source fed to the machine frame from the console. The conveyor sections **180** are added between the launching platform and the machine as the machine moves forward until it reaches the limit of the predetermined depth of the cut. That depth can vary from 100–300 feet as desired.

If during the cutting operation, the machine is veering off to the left or to the right this will be indicated by a red or green signal from the guide light **150** and observed by the operator through a telescope mounted on the console. Hydraulic cylinders **254, 255, 256** and **257** can be activated to vary the position of rollers **154, 155, 156** and **157** to in turn straighten the course of the mining machine. Movement of the front rollers to the left and the rear rollers to the right causes the machine to move to the right. Movement of the front rollers to the right and the rear rollers to the left causes the machine to move to the left.

After each operating tunnel is cut and the coal removed therefrom, the mining machine is moved further along the main tunnel **200** to cut successive tunnels. Each of the previously cut tunnels can be filled with rock and debris from the main tunnel to prevent the possibility of a cave-in.

While one advantageous embodiment has been chosen to illustrate the invention, it will be understood by those skilled in the art that various changes and modifications can be made therein without departing from the scope of the invention as defined in the appended claims.

I claim:

1. An apparatus for cutting coal, the combination comprising:
- a machine frame;
- driving means for moving said frame in a forward direction;
- a base pivotally mounted to said frame;
- first means for pivoting said base relative to said frame;
- a turntable rotatably mounted on said base;
- second means for rotating said turntable relative to said base;
- a cutting assembly means pivotally mounted to said turntable for cutting coal;
- third means for pivoting said cutting assembly means to an upper and lower position;
- first control means for actuating said second means to rotate said turntable in a first and second direction through a cycle consisting of two opposite reciprocations;
- second control means for actuating said third means for pivoting said cutting assembly means after each reciprocation so said assembly means cuts in said lower position when said turntable is rotating in said first direction and in said upper position when said turntable is rotating in said second direction;
- third control means for actuating said driving means for moving said frame forward after said turntable has moved through a complete cycle; and
- fourth control means for actuating said first means to tilt the base so the cutting assembly means can cut on a course diagonal to the plane of the machine frame.

2. An apparatus according to claim **1** and further including
- conveyor means mounted to said machine frame for moving cut coal from said cutting assembly means to the rear of said machine frame.

3. An apparatus according to claim **2,** wherein said first, second, third and fourth control means are located remotely from said machine frame.

4. An apparatus according to claim **3,** wherein said second means includes
- a unidirectional rotating motor slidably mounted to said turntable and having a shaft thereon passing through said turntable;
- a gear rigidly mounted to said shaft, and a cam follower rigidly mounted to said shaft;
- cam track means rigidly mounted to said base for receiving said cam follower; and
- a geared track mounted to said base for receiving said gear.

5. An apparatus according to claim **4** wherein said third control means includes
- a valve means mounted on said base and connected to said driving means; and
- an actuating extension means mounted to said turntable and operative to actuate said valve means on reciprocation of said turntable through a complete cycle.

6. An apparatus according to claim **5** wherein said second control means includes
- a second valve means mounted to said base and connected to said third means; and
- a second actuating extension means mounted on said turntable and operative to actuate said second valve means on rotation of said turntable through one reciprocation.

7. An apparatus according to claim **6** and further including
- scoop means mounted to said turntable and extending on both sides of a portion of said cutting assembly means for pushing coal cut by said assembly means to said conveyor means; and
- sectional conveyor means communicating with said conveyor means for transferring coal received therefrom to a location remote from said machine frame.

8. An apparatus according to claim **7** and further including
- guide light means mounted on said frame for indicating the direction of travel of said frame; and
- steering means mounted on said frame for altering the forward direction of travel of said frame.

9. An apparatus according to claim **8** and further including
- indicating means connected to said cutter assembly means for indicating when the cutting assembly means is cutting substances harder than coal.

10. An apparatus for mining coal, the combination comprising:
- a substantially planar machine frame;
- a base pivotally mounted to said frame along the longitudinal axis of said frame;
- a turntable rotatably mounted on said base;
- means for rotating said turntable relative to said base through a predetermined cycle consisting of two opposite reciprocations;

cutting assembly means, mounted to said turntable and rotatable therewith, for cutting coal along a predetermined path; and

means for pivoting said base so said predetermined path is diagonal to the plane of said machine frame.

11. An apparatus according to claim **10**, further including:

means, coupled to said machine frame and responsive to rotation of said turntable, for advancing said machine frame at the completion of said predetermined cycle.

12. An apparatus for mining coal, the combination comprising:

a machine frame;

a turntable rotatably coupled to said machine frame;

means for rotating said turntable relative to said machine frame in first and second directions through a cycle consisting of two opposite reciprocations;

cutting assembly means, pivotally mounted to said turntable and rotatable therewith, for cutting coal; and

means, responsive to rotation of said turntable, for pivoting said cutting assembly means after each reciprocation so said cutting assembly means cuts in a first path when said turntable is rotating in said first direction and in a second path when said turntable is rotating in said second direction, said first path being parallel to said second path.

13. An apparatus according to claim **12** and further including:

indicating means, connected to said cutting assembly means, for indicating when said cutting assembly means is cutting substances harder than coal along said predetermined paths; and

means, connected to said cutting assembly means, for varying said predetermined paths when said indicating means indicates that said cutting assembly means is cutting substances harder than coal.

14. An apparatus for mining coal, the combination comprising:

a machine frame;

a base pivotally mounted to said frame along the longitudinal axis of said frame;

a turntable rotatably coupled to said base;

cutting assembly means, coupled to said turn-table, for cutting coal along a predetermined path;

means, coupled to said machine frame, for varying the path of said cutting assembly means;

indicating means, connected to said cutting assembly means, for indicating when said cutting assembly means is cutting substances harder than coal along said predetermined path; and

control means for actuating said means to vary said predetermined path when said indicating means indicates that said cutting assembly means is cutting substances harder than coal.

15. An apparatus according to claim **14** wherein:

said cutting assembly means includes an electrical motor; and

said indicating means includes means for detecting variation in the amperage across said electrical motor.

16. An apparatus according to claim **14** wherein said means for varying includes means, coupled to said machine frame, for pivoting said base.

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