Jan. 31, 1956 H. D. LETTS 2,733,057

CONTINUOUS MINING MACHINE HAVING ADJUSTABLE TUBULAR CUTTERS

Filed Oct. 8, 1952 6 Sheets-Sheet 1

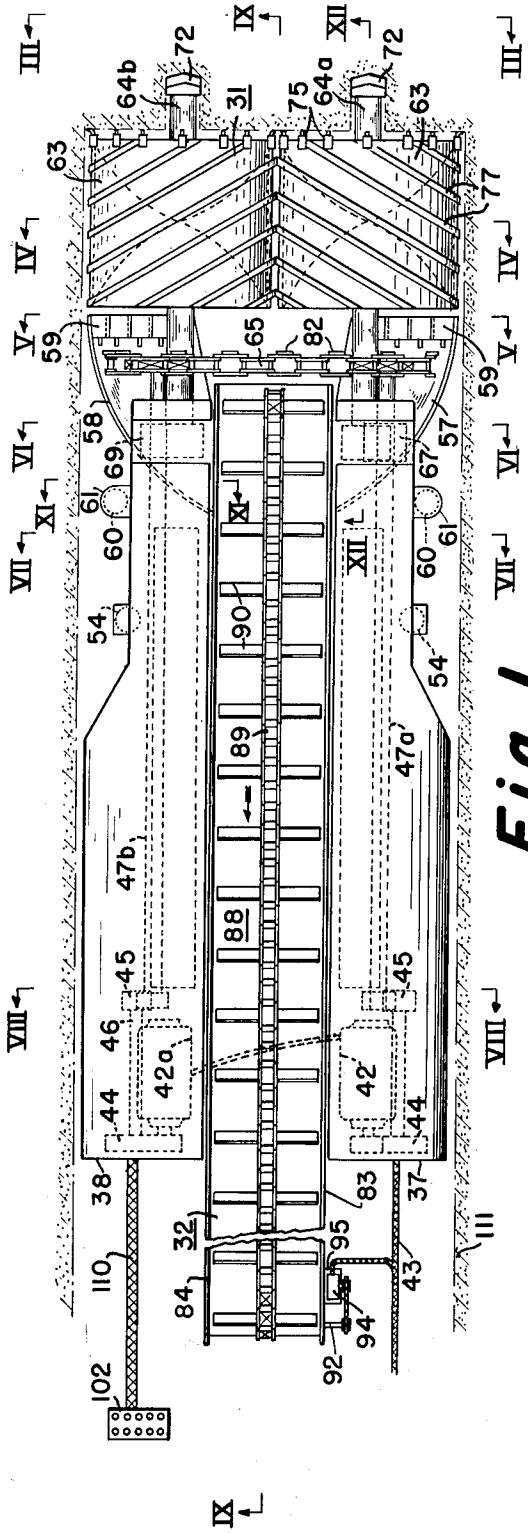

Fig. 1

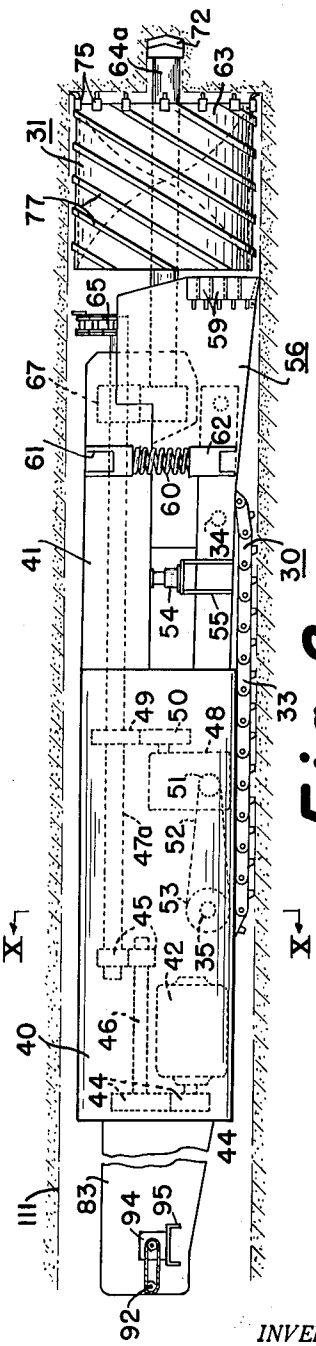

Fig. 2

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CONTINUOUS MINING MACHINE HAVING ADJUSTABLE TUBULAR CUTTERS

Filed Oct. 8, 1952 6 Sheets-Sheet 2

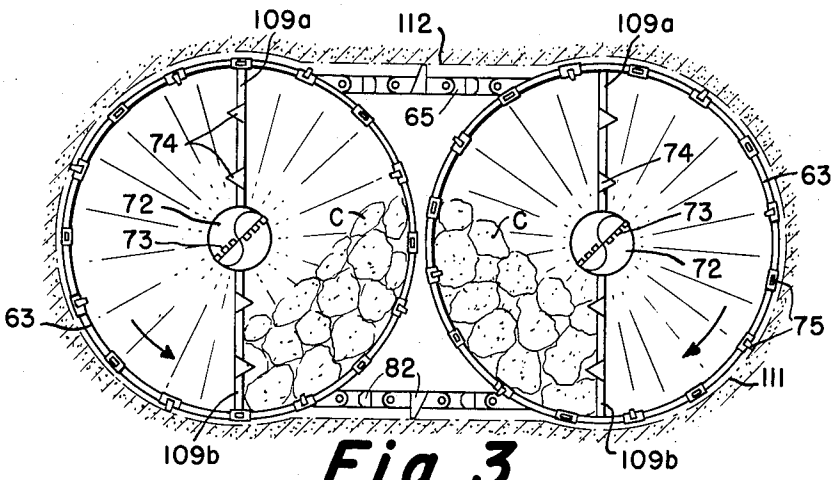

Fig. 3

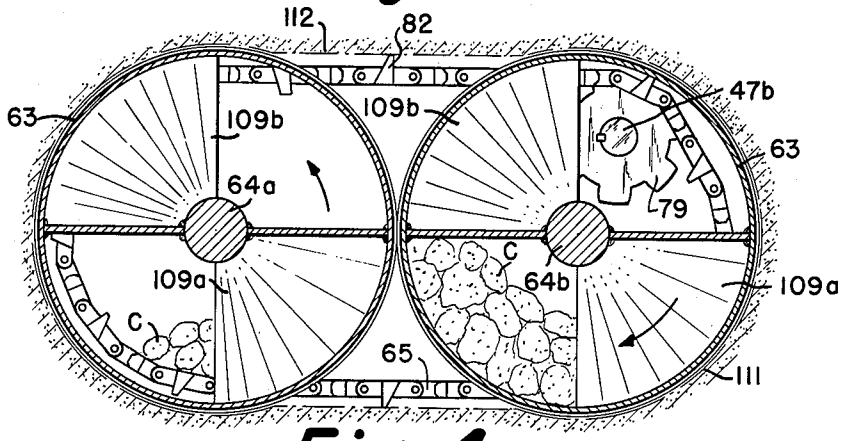

Fig. 4

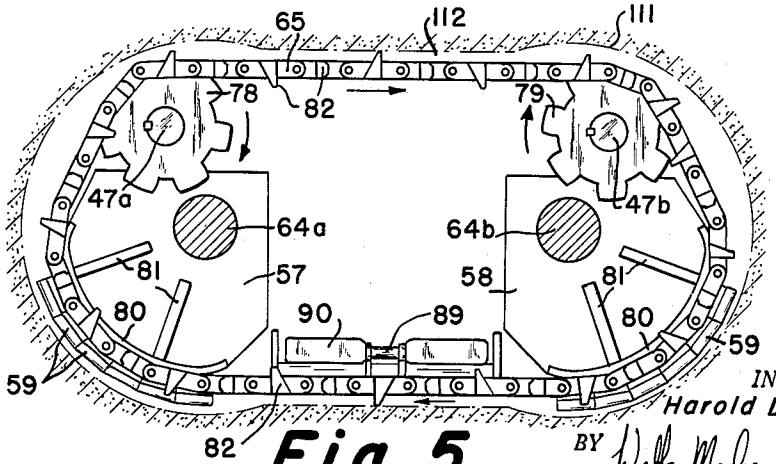

Fig. 5

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CONTINUOUS MINING MACHINE HAVING ADJUSTABLE TUBULAR CUTTERS

Filed Oct. 8, 1952 6 Sheets-Sheet 3

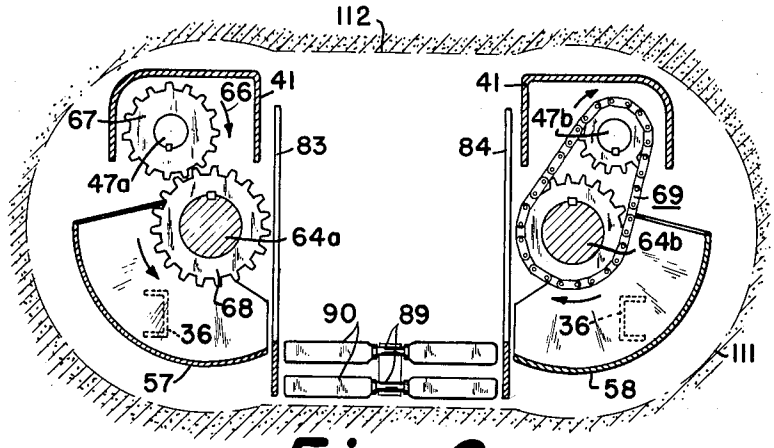

Fig. 6

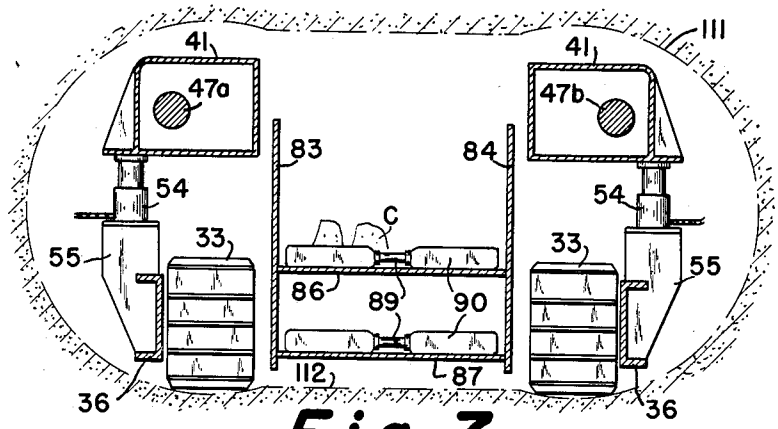

Fig. 7

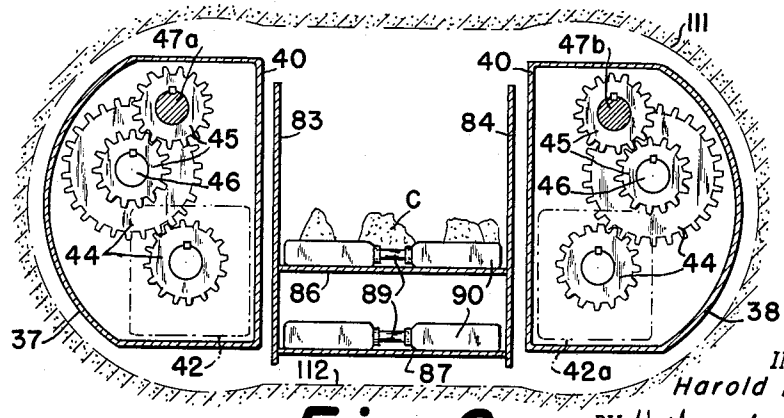

Fig. 8

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CONTINUOUS MINING MACHINE HAVING ADJUSTABLE TUBULAR CUTTERS

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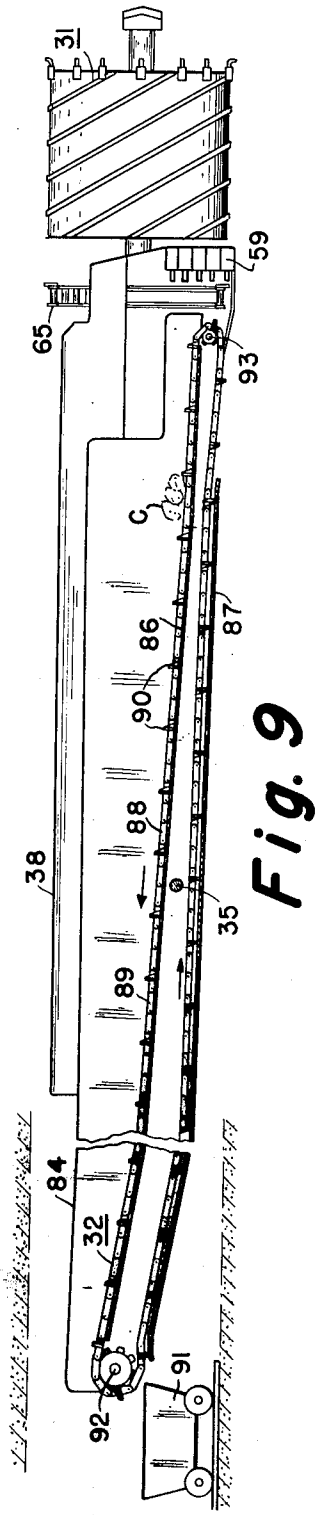

Fig. 9

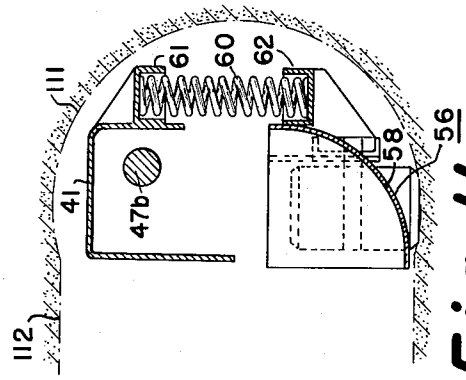

Fig. 11

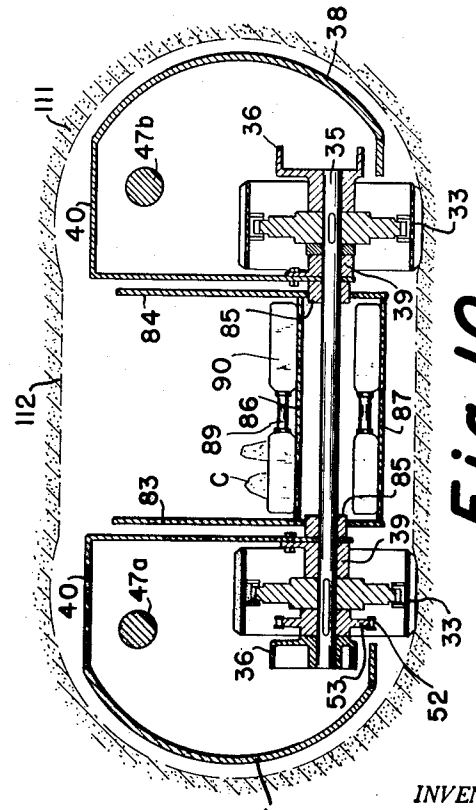

Fig. 10

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CONTINUOUS MINING MACHINE HAVING ADJUSTABLE TUBULAR CUTTERS

Filed Oct. 8, 1952 6 Sheets-Sheet 5

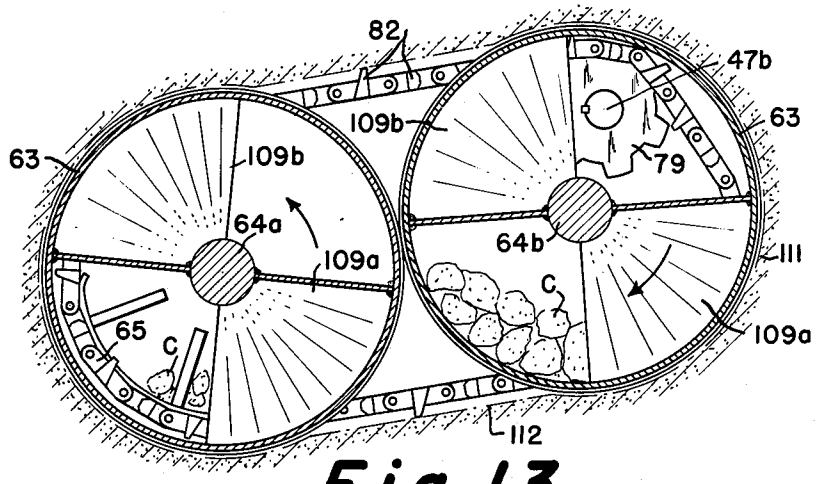

Fig. 13

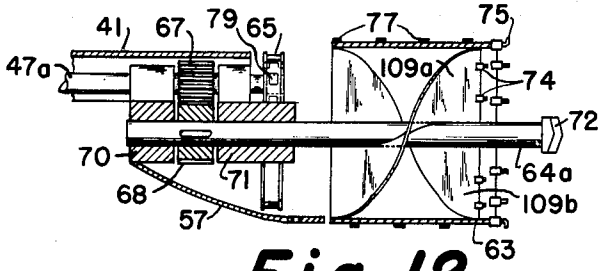

Fig. 12

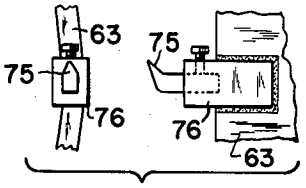

Fig. 14

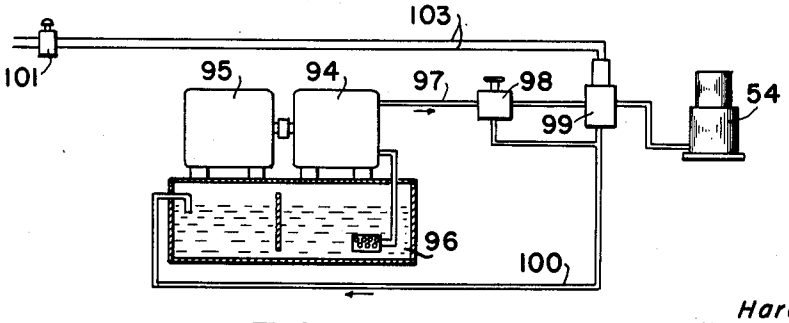

Fig. 15

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CONTINUOUS MINING MACHINE HAVING ADJUSTABLE TUBULAR CUTTERS

Filed Oct. 8, 1952 6 Sheets-Sheet 6

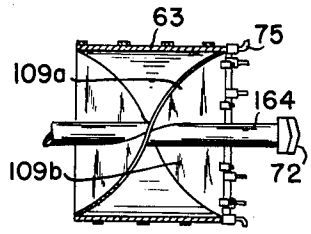

Fig. 16

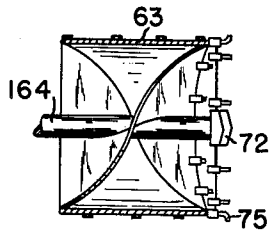

Fig. 17

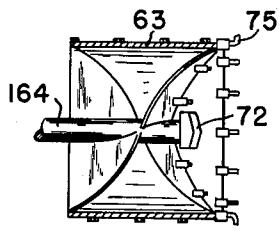

Fig. 18

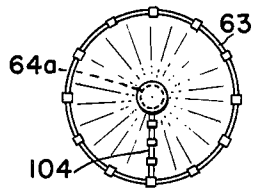

Fig. 19

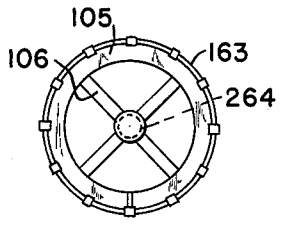

Fig. 20

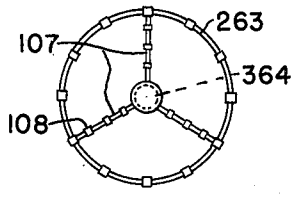

Fig. 21

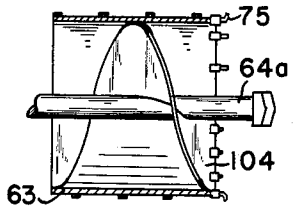

Fig. 22

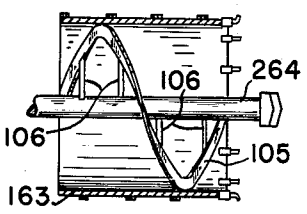

Fig. 23

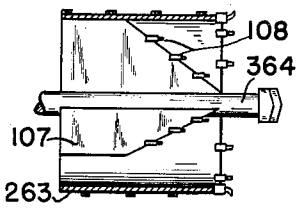

Fig. 24

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Patented Jan. 31, 1956

2,733,057

CONTINUOUS MINING MACHINE HAVING ADJUSTABLE TUBULAR CUTTERS

Harold D. Letts, Zelienople, Pa., assignor of one-half to Howard B. Salkeld, Zelienople, Pa.

Application October 8, 1952, Serial No. 315,874

8 Claims. (Cl. 262—7)

This invention relates to a machine for continuously mining coal and like minerals and particularly such a machine that is adapted to constant advance.

Ordinarily, a vein of coal is undercut or kerfed and then exploded into smaller portions which are relayed to the mouth of the mine. Such a technique is slow and cumbersome. Consequently, various machines have been suggested for continuously mining coal in order to avoid these intermittent and time-consuming steps. None, however, has been completely satisfactory. One objection is that the action of many of the prior so-called continuous mining machines is limited to a given position. That is, such machines are really stationary and therefore restricted to mining only an area within reach. Upon exhausting such an area, the prior art machines must be moved, often laboriously, to a new station where, with the machine once more stationary, the mining operation is resumed.

Another objection to prior mining machines is that they are incapable of adjusting lateral slopes in the direction of a vein of coal, that is, to an oblique direction which is neither horizontal nor vertical. It frequently happens that a vein being mined is horizontal for only a given distance after which it may turn vertically or tilt in such an oblique direction. Previous mining machines, due in many instances to their rigid and actually stationary operation, cannot be quickly adapted to follow a vertical change of direction of a coal vein. And in no instance is it known where any mining machine can be adapted to follow such an oblique or skewed path.

The present machine solves these problems and presents as well other novel features hereafter described. In particular, the present machine embodies in one form the cooperable action of a plurality of parallel, tubular cutters with a cutter chain. The tubular cutters are placed side-by-side, while the cutter chain traverses a path which is transverse to the tubular cutters and conforms substantially with their transverse outline. In this manner, the tubular cutters and cutting chain bore a hole which is substantially oblong in cross-section. Ordinarily, the machine contains a conveyor to receive the coal as it is discharged from the tubular cutters and then to transport the mined coal to the rear of the machine. In this manner, the operation of the machine is truly continuous since the cutters constantly advance and the coal is simultaneously carried away.

In another embodiment, the tubular cutters are supported at the leading ends of a pair of housings or frames mounted on the mining machine. The housings are individually pivotable so that the direction of mining may be changed either vertically or in an oblique direction depending on whether both or only one of the housings is pivoted.

Other advantages and novel features are apparent from the following description and drawings of a presently preferred embodiment wherein:

Figure 1 is a plan view showing a general arrangement of parts;

Figure 2 is a side elevation of Figure 1;

Figure 3 is an end view of Figure 1 taken on the line III—III;

Figures 4 through 9, Figure 11, and Figure 12 are sections of Figure 1 taken on lines having a Roman numeral which corresponds, respectively, to the Arabic numeral of the resulting figure;

Figure 10 is a section of Figure 2 taken on the line X—X;

Figure 13 is a section of Figure 1 corresponding to Figure 4 but showing one tubular cutter raised with respect to the other;

Figure 14 illustrates front and side elevations of the cutting means on the leading edges of the tubular cutters;

Figure 15 is a diagram schematically illustrating a hydraulic system used to pivot the housings or frames;

Figures 16, 17, and 18 are longitudinal sections of a tubular cutter illustrating various positions a pilot cutter may take;

Figures 19, 20, and 21 are end views of a tubular cutter showing modifications of means to support a tubular cutter about a mining shaft; and

Figures 22, 23, and 24 are vertical longitudinal sections of Figures 19, 20, and 21, respectively, with only the outer half shell of the tubular cutter removed.

Referring to the drawings, this embodiment includes, as generally shown, a continuously movable base **30**, a mining head **31**, and a conveying system **32**.

The movable base comprises endless tractor treads **33** having a front axle **34** and a rear axle **35**. The axles are held apart by side beams **36** outside the treads as shown in Figure 7. A pair of housings or frames **37** and **38** extend lengthwise of the base **30** along the sides and pivot about the rear axle on bearings **39** as illustrated in Figure 10. Each housing is constructed in the same manner and includes a rearward compartment **40** having an arm portion **41** projecting forwardly of the base. The rearward compartment contains the drive means for the tractor treads **33** and the mining head **31**. Electric motors **42** and **42***a* secured to the floors of the rear compartments **40** receive current through a flexible cable **43** which approaches motor **42** from one side and crosses between the flights of the conveying system **32** to service the other motor **42***a*. By means of conventional gearing **44** and **45**, each motor drives a rear shaft **46** and a main drive shaft **47***a* or **47***b* which extends past the leading end of its housing. The shafts **46**, **47***a*, and **47***b* are journaled in conventional bearings (not shown) which are secured to the sides of the housings. A medial portion of each main drive shaft operates a gear reduction box **48** by intermeshing gears **49** and **50**. A sprocket **51** of the gear box drives the rear axle **35** by a chain **52** and sprocket **53** fixed to that axle.

A hydraulic cylinder **54** supports each housing forwardly of the rear axle and pivots the housing thereabout. As illustrated in Figure 7, a standard **55** secured to the side beam **36** carries each hydraulic cylinder whose piston bears against the underside of the arm portion **41** of the housing. A scoop plate generally shown at **56** includes two arcuate wings **57** and **58** which curve outwardly away from the conveying system **32** at the side and inwardly toward the conveying system at the bottom. The forward ends of the wings terminate at a point adjacent the rear of the mining head **31** and have a plurality of hinged plates **59** arranged in "fish-scale" fashion. That is, the plates pivot about a common axis and adjacent plates partially overlap. The hinged plates enable the scoop to adapt itself to changing ground contours without snagging. A coiled spring **60** on each side of the machine pivots the scoop downwardly about the front axle **34** so that the scoop may readily receive all coal discharged by the mining head and direct it onto

the conveying system. As shown in Figure 11, each spring 60 bears against opposing pockets 61 and 62 which are secured, respectively, to a side of the projecting arm 41 and a side of a wing of the scoop 56.

Considering now the mining head, this apparatus includes tubular cutters 63 supported about mining shafts 64*a* and 64*b* and a cooperating cutting chain 65. The construction of each tubular cutter is the same, and they are preferably of equal diameter. The mining shafts 64*a* and 64*b* extend in parallel fashion from their corresponding housings 37 and 38 wherein they are rotated by the main drive shafts 47*a* and 47*b*, respectively. Since the main drive shafts must rotate in the same direction to propel the cutting chain 65 as hereafter described, and since the tubular cutters 63 are preferably driven in opposite directions to urge the mined coal toward the center of the machine, different drive arrangements are used to rotate the mining shafts from the main drive shafts. As shown in Figure 6, the main drive shaft 47*a* rotating in the direction of the arrow 66 drives the mining shaft 64*a* in an opposite direction by cooperating spur gears 67 and 68. On the other hand, the main drive shaft 47*b* rotating in the same direction as the main drive shaft 47*a* drives the mining shaft 64*b* in a similar direction by a silent chain drive shown generally at 69. As a result, the main drive shafts as between themselves rotate in the same direction, but the tubular cutters being supported over the mining shafts rotate in opposite directions with respect to each other. In either type of drive arrangement for the mining shafts, relatively large bearings 70 and 71 (Figure 12) straddle the spur gears or silent chain drive to support the mining shafts in cantilever fashion. The bearings in turn are supported by the sides of the housing. Each mining shaft terminates in suitable cutting means to form a pilot cutter. In Figure 3, this pilot cutter is shown as a conventional convolute boring surface 72 having carbide cutting teeth 73.

Each tubular cutter is supported concentrically about its mining shaft. Preferably, this support includes a helicoid sheet which spirals about the shaft and extends radially from the mining shaft to the tubular cutter. In this manner, in addition to supporting the tubular cutter about its shaft, the helicoid sheet helps to fracture the cylinder of coal cut by the tubular cutter and simultaneously advance the broken portions through the tubular cutter onto the conveying system as the cutter rotates. The leading edges of the helicoid sheet may have cutting teeth 74 as shown in Figures 3 and 12. More than a single helicoid sheet may also be used. The form illustrated in the drawings (except for Figures 19 through 24) includes, for example, two helicoid sheets 109*a* and 109*b* spaced substantially 180 degrees from each other to form a double-thread construction.

The leading edges of the tubular cutters may also have cutting teeth 75. The teeth have carbide tips and are removably inserted in receiving blocks 76 fixed to the shell of the tubular cutter as shown in Figure 14. Successive teeth preferably point in different directions so that the cut made by the tubular cutter exceeds the thickness of its shell. A circumferential ridge 77 spirals rearwardly on the exterior of each tubular cutter to force backwardly any coal chips or dust which becomes lodged between the outside of the tubular cutter and the hole it is boring. In this manner, clogging or fouling of the tubular cutters is prevented.

While the direction of the hole cut by the mining machine is solely dictated by the desired operation of the machine, it has been found that the present machine best follows the action of the mining head and in line with the hole thereby cut when the mining head shafts 64*a* and 64*b* are in substantially the same vertical plane as the corresponding tractor treads 33, and when a plane cotangent with the bottoms of the tubular cutters is substantially coplanar with the bottom flights of the tractor treads.

A cutting chain 65 is stationed behind the tubular cutters and travels a continuous path transverse to the mining shafts. As illustrated in Figure 5, sprockets 78 and 79 keyed to the main drive shafts 47*a* and 47*b*, respectively, propel the cutting chain which passes beneath guide strips 80 spaced from the wings 57 and 58 of the scoop 56 by supporting arms 81. In this connection, it will be noted that the spring 60 which urges the scoop 56 away from the projecting arm 41 also serves thereby to tension the cutting chain 65. The teeth 82 of the chain preferably point in different directions as in the case of the teeth on the leading edges of the tubular cutters. The cooperable action of the tubular cutters and the cutting chain provides substantially an oblong hole.

Referring principally to Figures 9 and 10, the conveying system, generally shown at 32, includes vertical guide walls 83 and 84 extending lengthwise of the movable base 30 of Figure 1. The walls have bearing inserts 85 which space and support the walls on the front and rear axles 34 and 35. Platforms 86 and 87 are fixed as by welding to adjacent sides of the walls 83 and 84. A scraper conveyor, shown generally at 88, includes a chain 89 and crossarms 90. The conveyor rides over the platforms pushing the coal before it on the upper flight to discharge the coal eventually into a shuttle car 91 or portable conveyor. The scraper conveyor turns about a rear axle 92 and a front axle 93. The motor 94 in Figure 1, carried by a ledge 95 secured to the guide wall 83, drives the rear axle by a conventional sprocket and chain arrangement. This motor may be energized by splicing to the flexible cable 43. The rear axle 92 is journaled in the guide walls 83 and 84 while the front axle 93 is journaled in the forward ends of the side beams 36. The platforms 86 and 87 cause the conveyor flights to straddle the front and rear axles of the movable base 30.

The hydraulic cylinder 54 may be operated by the system schematically shown in Figure 15. This apparatus may be housed between the vertical guide walls and preferably near the forward end of the machine to be sufficiently above the conveyor 88 to avoid interference. A pump 94 driven by a motor 95 draws hydraulic fluid from a reservoir 96 and discharges it through a line 97 to a relief valve 98 and then to a solenoid-operated, three-way valve 99. Ordinarily, the fluid flows through the return line 100 to the reservoir. When it is desired to pivot a housing, an operator depresses the push button 101 forming a part of the control panel 102 of Figure 1. This operates the solenoid valve through the electrical lead 103 thereby closing the return line 100 and opening the valve 99 to the hydraulic cylinder 54. The hydraulic pressure developed is conventionally used to pivot the housing about the rear axle as previously described. The mining machine may be horizontally steered by conventionally braking one of the tractor treads.

Various modifications are possible with the mining head. As shown in Figures 16, 17, and 18, the pilot cutter 72 at the leading end of the mining head shaft 164 may precede, be substantially flush with, or succeed the cutting teeth 75 on the leading edge of a tubular cutter 63. These variations are ordinarily dependent on the properties of the coal being mined. Further, the means for supporting a tubular cutter about a mining shaft may take many forms. Ordinarily, such supporting means need only permit the flow of the material mined through the tubular cutter since continued mining forces previously mined coal through the cutter. Accordingly, straight radial arms extending from the mining shaft to the cutter may be employed. However, it is much preferred to aid the flow of coal through the tubular cutter. To this end, helicoid sheets which spiral about the mining shafts are used. Either the previously described double-

thread construction 109*a* and 109*b* as shown in Figure 16 or the single-thread construction 104 illustrated in Figures 19 and 22, resembling an Archimedes screw, may be used. The former construction is preferred since it provides smoother and more efficient operation. For example, when the leading edges of the helicoid sheet have cutting teeth 74 as in Figure 3, twice as much cutting force is exerted by the helicoid sheets 109*a* and 109*b* of Figure 16 as compared to the helicoid sheet 104 of Figure 22. In any case, the helicoid sheets also have the added advantage of helping to fracture the coal as it is introduced into and tumbles through the tubular cutters.

When the properties of the coal are such that relatively large lumps are formed, any helicoid sheet construction can be changed to that of Figures 20 and 23. In this case, just a helicoid strip 105 is used. The outer edge of the strip bears against a tubular cutter 163, while the strip is rigidly spaced from the mining shaft 264 by radial arms 106. This arrangement facilitates the flow of larger lumps of coal. Figures 21 and 24 illustrate a still further type of supporting means for the tubular cutters. This type embodies a plurality of sheets 107 which extend radially from the shaft 364 to the tubular cutter 263. The leading edges of each sheet 107 slant rearwardly and contain cutting teeth 108. The advantage of this construction is that as the coal advances into the tubular cutter, it becomes wedged between the edges of the sheets 107 and the tubular cutter 263. Continued mining action aided by the teeth 108 fractures the coal into smaller portions which are thereby more easily processed by the machine.

In an overall operation, an operator walks behind the continuously advancing machine and controls the actions of the various parts through a control panel 102. The control circuits which are of standard design reach the machine through a flexible conduit 110. In the embodiment shown, the pilot cutters at the leading ends of the mining shafts 64*a* and 64*b* first bore into the coal or like mineral. The diameter of the pilot cutter exceeds that of its shaft so that an annular area is formed about the shaft. Accordingly, when the teeth 75 of the tubular cutters first bore into the coal, the cross sectional area of a tubular cutter around its mining shaft is somewhat greater than the cross sectional area of the cylinder of coal cut. This annular area provides room to which the coal may "break" and, coupled with the natural tendency of the mined coal to crumble, aids in reducing the coal to smaller portions. As the tubular cutters continue to rotate, the coal tumbles therethrough aided by the helicoid sheets which may also further fracture the coal as by striking one lump against another. The tubular cutters rotate toward each other at the bottom so that the coal C as in Figure 3 is urged toward the center. The cutting chain 65 removes the triangular portions between the tubular cutters left untouched by their action. This cooperable action between the cutters and chain provides a substantially oblong hole. Since the teeth 75 on adjacent tubular cutters overlap as the cutters rotate, the cutting chain 65 mounted as described serves the additional purpose of synchronizing the rotation of each cutter to prevent the teeth from striking against one another. The scoop 56 receives the coal from the cutters and cutting chain and directs it onto the conveyor 88. The coiled spring 60 maintains the scoop in a downward position and thereby also automatically tensions the cutting chain. The conveyor moves the coal to the rear of the machine where it is dumped into a shuttle car 91 or onto a portable conveyor and then carried away.

When it is desired to steer the machine vertically, the operator need only hydraulically apply pivoting pressure to both of the housings as previously explained. If, however, it is desired to follow an oblique direction that is neither horizontal nor vertical, only one housing is pivoted, or one housing is pivoted more than the other, to station the tubular cutters as shown in Figure 13. This position of the cutters aided by conventional horizontal steering means previously mentioned enables the direction of mining to proceed in the oblique or skewed path. Moreover, the machine can recover from an oblique change of direction and resume its former direction or veer off in still another direction. The compressibility of the coiled spring 60 and the natural play between the cantiliver mining shafts 64*a* and 64*b* permit elevation of one end of the cutting chain and of one housing with respect to the other without interfering with their cooperating functions.

As shown, for example, by Figures 5 through 8 and Figure 10, the balance of the machine behind the tubular cutters fits within the oblong hole 111 cut by the mining head. The tractor treads 33 move on the bottom 112 (Figure 7) of the hole cut and are substantially coplanar therewith. Accordingly, no matter in what direction an operator drives the machine, the hole cut will accommodate the size of the machine.

As used herein and in the claims, the terms "horizontal" and "vertical" have only relative meaning.

While the foregoing disclosure describes a presently preferred embodiment and some modifications thereof, it is understood that the present invention may be practiced in other forms and with still other modifications within the scope of the following claims.

I claim:

1. A mining machine including a movable base, frames supported by the base and having a shaft-driven rotatable tubular cutter extending forwardly of the base, means to move vertically the forward end of each frame individually with respect to the base whereby the tubular cutters may be placed at different vertical elevations causing the direction of boring to proceed in a skewed direction, the tubular cutters having an endless band drivingly connected with the tubular cutters and traveling in an encompassing path around the driving shafts for the tubular cutters preventing separation of the same whereby the cooperable action of the tubular cutters with the endless band cuts substantially an oblong hole.

2. A continuous mining machine adapted for constant advance including a movable base having front and rear axles, a continuous conveyor mounted over the base and extending longitudinally thereof, means to drive the conveyor, a housing mounted on the base on each side of the conveyor and extending forwardly of the base, each housing containing driving means including means to drive the movable base, means to pivot each housing about the rear axle, and a mining head supported by the leading ends of the housings including a mining shaft projecting from each housing in parallel relation and rotated in opposite directions by the driving means in the housings, each shaft terminating in cutting means to form a pilot cutter, a pair of closely spaced tubular cutters each concentric with a different shaft, means to support each tubular cutter about its concentric shaft, said supporting means being adapted both to assist in fracturing the material mined and to advance it through the tubular cutter onto the conveyor, a cutting chain stationed behind the tubular cutters and adapted to travel a continuous path transverse to the shafts, said chain having linear upper and lower flights conforming substantially to the perimeter of the associated tubular cutters, means to move the chain through said path, and a scoop pivotable about the front axle and extending beneath the cutting chain to the rear of the tubular cutters to guide the material discharged from the tubular cutters onto the conveyor.

3. A machine for continuously mining coal and like minerals that is adapted for constant advance including: a movable base having tractor treads traveling about front and rear axles, vertical guide walls extending longitudinally of the base and mounted thereon, a continuous conveyor stationed between the walls and mounted over the base for individual movement, means to drive the conveyor, a housing on each side of the conveyor pivotally

mounted about the rear axle and extending forwardly of the base, each housing containing electrical driving means including means to drive the tractor treads, means to support each housing forward of the rear axle and to pivot each housing separately thereabout, and a mining head supported by the leading ends of the housings including a mining shaft projecting from each housing in parallel relation, means to drive each mining shaft in opposite directions including a main drive shaft extending lengthwise of each housing and driven in turn by the electrical driving means, cutting means on the forward ends of the mining shafts to form pilot cutters, a pair of closely spaced tubular cutters having cutting means at their leading edges, each cutter having the same diameter and being concentric with a different shaft, a plane cotangent with the bottoms of the tubular cutters being substantially coplanar with the bottom flights of the tractor treads, means to support each tubular cutter about its concentric shaft including a helicoid sheet spiraling about the mining shaft, and extending radially from the shaft to the tubular cutter, an endless chain having cutting teeth stationed behind the tubular cutters and driven by the main drive shafts, said chain being adapted to travel a continuous path transverse to the mining shafts wherein the upper and lower flights of the chain are spaced apart a distance substantially equal to a diameter of a tubular cutter whereby the cooperable action of the pilot cutter, tubular cutters, and cutting chain results in substantially an oblong hole, a scoop pivotable about the front axle and extending beneath the cutting chain to a point adjacent the rear of the tubular cutters to guide the material discharged from the tubular cutters onto the conveyor, and resilient means urging the scoop downwardly.

4. A machine for continuously mining coal and like minerals that is adapted for constant advance and for allowing a winding vein thereof, including: a movable base having endless tractor treads traveling about front and rear axles, vertical guide walls extending longitudinally of the base and mounted thereon, a continuous conveyor stationed between the walls and mounted over the base for individual movement, means supported by a guide wall to drive the conveyor, a housing on each side of the conveyor pivotally mounted about the rear axle and extending forwardly of the base, each housing containing electrical driving means including means to drive the rear axle, hydraulic means to support each housing forward of the rear axle and to pivot each housing thereabout, whereby pivoting both housings equally changes the path of mining in a vertical direction and pivoting the housings unequally changes the path of mining in an oblique direction that is neither horizontal nor vertical, and a mining head supported by the leading ends of the housings including a mining head shaft projecting from each housing in parallel relation, each mining head shaft being in substantially the same vertical plane as a corresponding tractor tread, means to drive each mining head shaft comprising a main drive shaft extending lengthwise and forwardly of each housing and driven in turn in the same direction by the electrical driving means, means mechanically joining one main drive shaft to a mining head shaft to drive the latter in an opposite direction, means mechanically joining the remaining main drive shaft to the remaining mining head shaft to drive the latter in the same direction, cutting means on the forward ends of the mining head shafts to form pilot cutters, a pair of contacting tubular cutters having cutting means at their leading edges, each tubular cutter having the same diameter and being concentric with a different mining head shaft, a plane cotangent with the bottoms of the tubular cutters being substantially coplanar with the bottom flights of the tractor treads, means to support each tubular cutter about its concentric shaft including a helicoid sheet spiraling about the mining head shaft and extending radially from the shaft to the tubular cutter whereby said supporting means both assists in fracturing the cylinder of coal initially cut by each tubular cutter and to advance the resulting fractured portions through the tubular cutter, an endless cutting chain stationed behind the tubular cutters and driven by the portions of the main drive shafts extending forwardly of the housings, said chain being adapted to travel a continuous path transverse to the mining head shafts wherein the upper and lower flights of the chain are spaced apart a distance substantially equal to a diameter of a tubular cutter whereby the cooperable action of the pilot cutters, tubular cutters, and cutting chain results in substantially an oblong hole which is at least as large as the largest cross-section of the machine, a scoop pivotable about the front axle and extending beneath the conveyor and cutting chain to a point adjacent the rear of the tubular cutters to guide the material discharged from the tubular cutters and cutting chain onto the conveyor, and guide strips supported by the scoop to space the bottom flight of the cutting chain from the upper flight, and resilient means urging the scoop downwardly away from the housings to tension the cutting chain and maintain the scoop in a downward position.

5. A mining head adapted to be mounted forwardly of a mining machine including a plurality of drive shafts, a tubular cutter drivingly connected to each drive shaft, means for vertically moving the tubular cutters individually or together with one another with respect to the machine band receiving means on each drive shaft, and an endless band common to the band receiving means and traveling transversely around the shafts in engagement therewith whereby the vertically movable tubular cutters are maintained in a closely spaced cooperating relation preventing separation thereof.

6. A mining head adapted to be mounted forwardly of a mining machine including a plurality of substantially parallel drive shafts, a tubular cutter drivingly connected to each drive shaft, means for vertically independently tilting the drive shafts with respect to one another and to the machine, band receiving means on each shaft, and an endless band common to the band receiving means and having cutting means traveling in a path transversely around the drive shafts in engagement with the band receiving means whereby the cooperable action of the tubular cutters with the endless band cuts a hole and the band maintains the tubular cutters in closely held together cooperating relation so that the cutters are prevented from separating and the hole cut is uniformly substantially oblong.

7. A mining head adapted to be mounted forwardly of a mining machine and act as a directional control including: a pair of closely spaced tubular cutters arranged in parallel relation, a pair of shafts terminating in cutting means to form pilot cutters, means to support a tubular cutter about a shaft, driving means to rotate the shafts, vertically acting lift means for independently vertically tilting the forward end of each shaft with respect to the mining machine, sprockets drivingly connected to the shafts, a common cutting chain trained about the sprockets and mounted transversely of the shafts and propelled by said driving means, and means to space apart the upper and lower flights of the chain a distance substantially equal to a diameter of a tubular cutter whereby the cooperable action of the pilot cutters, tubular cutters, and cutting chain cuts a single hole and the engagement between the sprockets and the trained cutting chain maintains the tubular cutters in closely held together cooperating relation even during such vertical tilting so that the hole is substantially oblong and adapted to receive the mining machine.

8. In a machine for continuously mining coal and like minerals, a mining head adapted to act as a directional control, including: a pair of closely spaced tubular cutters of substantially equal diameters, said cutters being normally arranged in parallel relation and having cutting teeth at their leading edges, a pair of mining shafts, means to support each tubular cutter about a mining shaft, said

supporting means being adapted both to assist in fracturing the cylinder of coil initially cut by each tubular cutter and to advance the resulting fractured portions through the tubular cutter, cutting means on the leading end of each shaft to form a pilot cutter, driving shafts to rotate the mining shafts toward each other, independently tilting means to vertically tilt the forward end of each mining shaft with respect to the mining machine while the machine is advancing, and including separately operable jack means, sprockets on the driving shafts, an endless chain provided with cutting teeth, said chain engaging the sprockets and encompassing the driving and mining shafts in restrained relation, a coal scoop adapted to be carried by the mining machine below the cutting chain for gathering mined coal and guiding it rearwardly, guiding means on the scoop to receive the lower flight of the chain and space it from the upper flight a distance substantially equal to a diameter of a tubular cutter, and resilient means urging the scoop downwardly from the mining machine to tension the cutting chain whereby the cooperable action of the pilot cutters, tubular cutters, and cutting chain cuts a single hole and the cutting chain synchronizes the tubular cutters in adjacent cooperating relation even when the mining shafts are unequally vertically tilted so that the hole is substantially oblong and adapted to receive the mining machine as it advances regardless of the angle of advance.

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