March 29, 1932. B. A. CHUBBUCK 1,851,037

MINING MACHINE

Filed Dec. 27, 1928 7 Sheets-Sheet 1

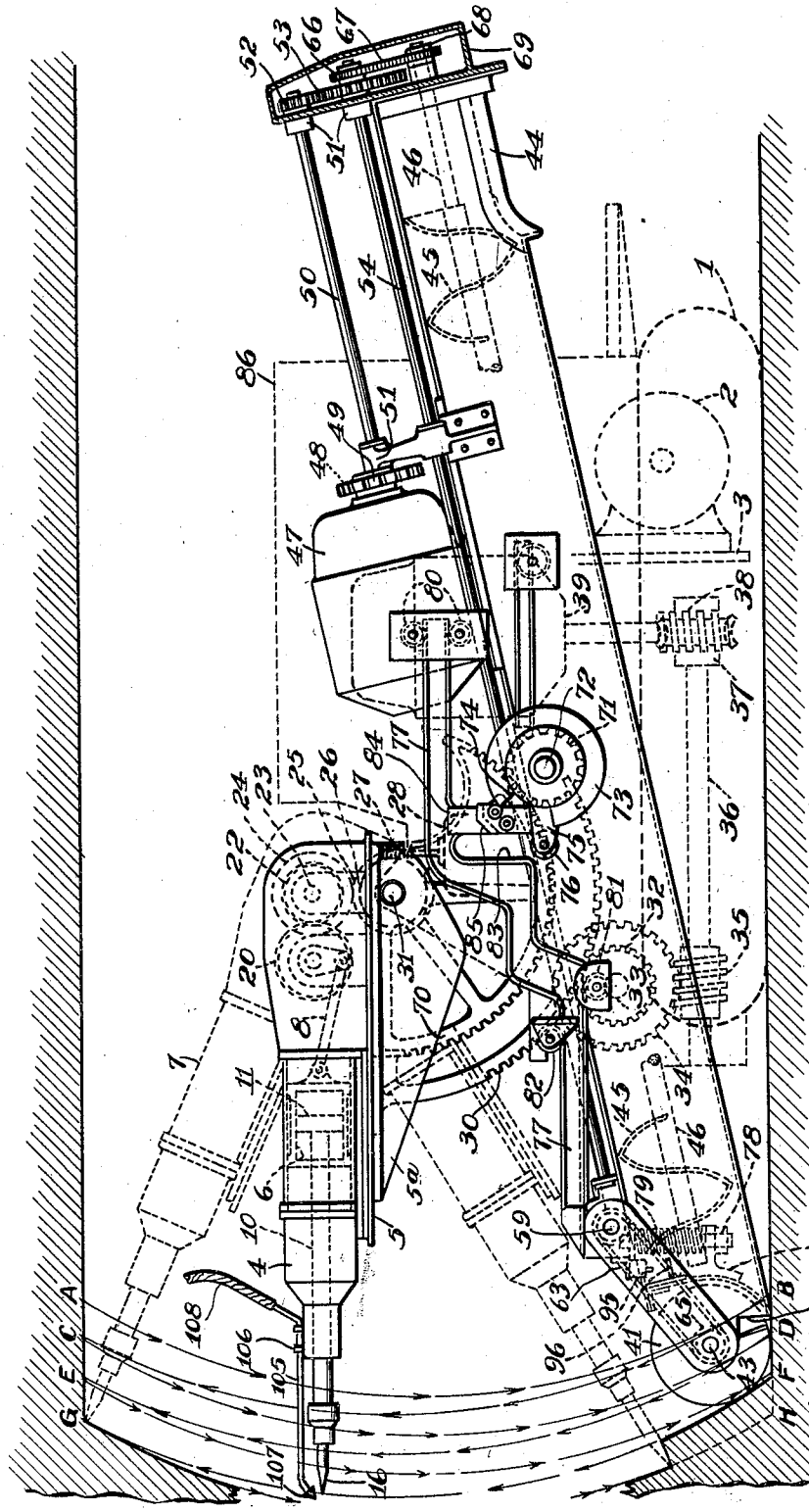

Fig. 1.

INVENTOR:
BURT A. CHUBBUCK,
DECEASED,
BY ERMA M. CHUBBUCK,
ADMINISTRATRIX.
by Brown & Critchlow
attorneys.

March 29, 1932. B. A. CHUBBUCK 1,851,037

MINING MACHINE

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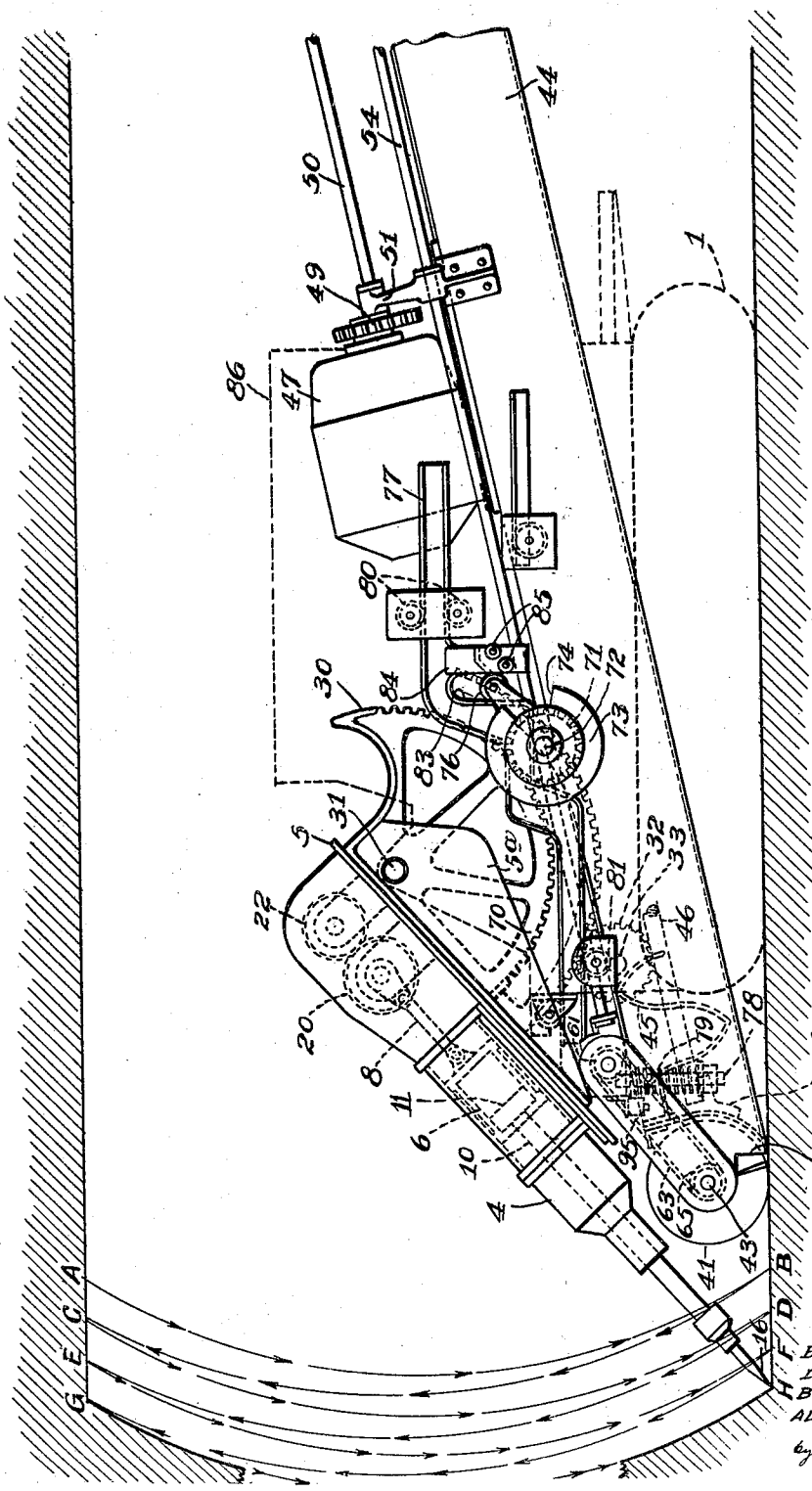

Fig. 2.

INVENTOR:
BURT A. CHUBBUCK,
DECEASED,
BY ERMA M. CHUBBUCK,
ADMINISTRATRIX.
by Brown & Critchlow
attorneys.

March 29, 1932. B. A. CHUBBUCK 1,851,037

MINING MACHINE

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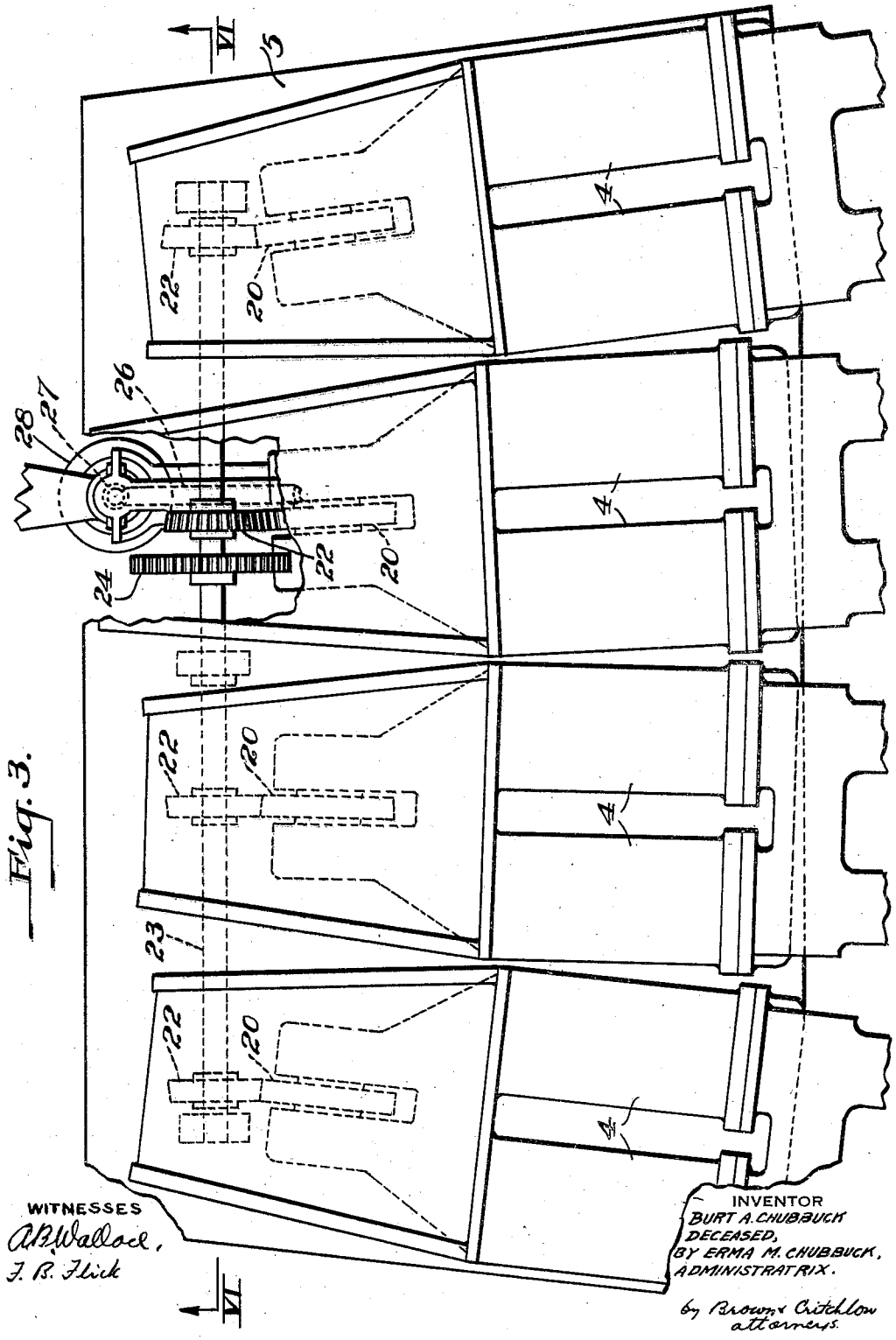

Fig. 3.

WITNESSES
A. B. Wallock,
F. B. Flick

INVENTOR
BURT A. CHUBBUCK
DECEASED,
BY ERMA M. CHUBBUCK,
ADMINISTRATRIX.
by Brown & Critchlow
attorneys.

March 29, 1932. B. A. CHUBBUCK 1,851,037

MINING MACHINE

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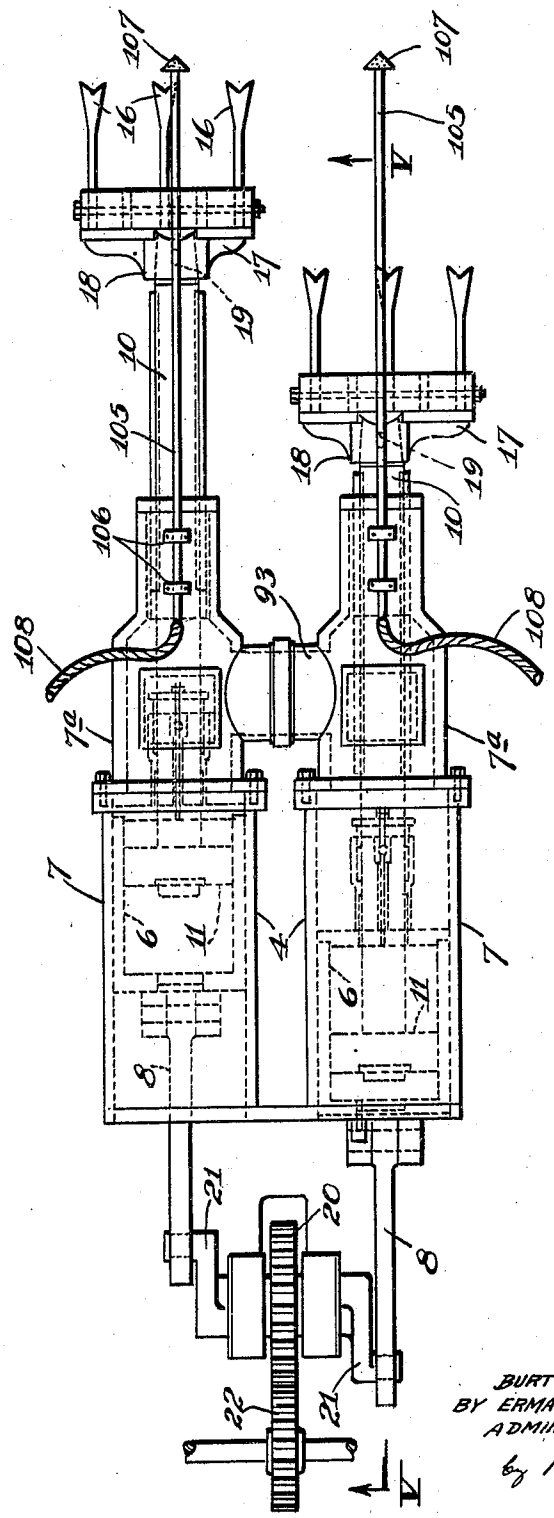

Fig. 4.

WITNESSES

A. B. Wallace

F. B. Flick

INVENTOR

BURT A. CHUBBUCK, DECEASED

BY ERMA M. CHUBBUCK,

ADMINISTRATRIX.

by Brown & Critchlow

attorneys.

March 29, 1932. B. A. CHUBBUCK 1,851,037

MINING MACHINE

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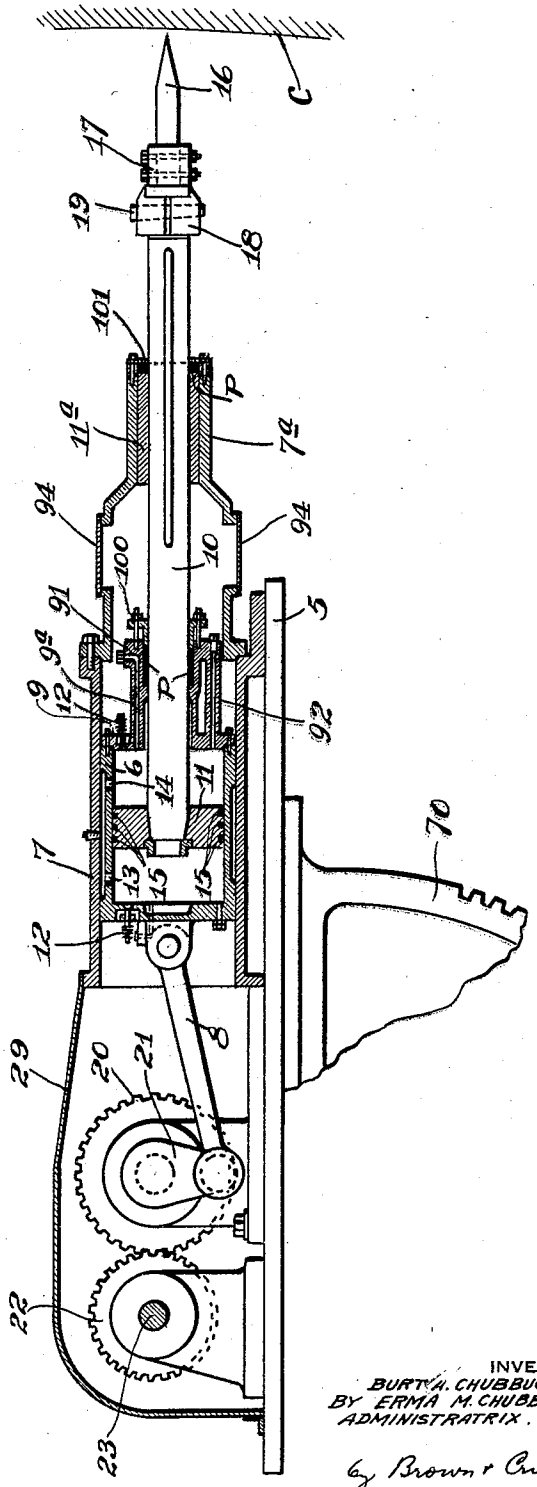

Fig. 5.

WITNESSES

A. B. Wallace.

I. B. Flick.

INVENTOR

BURT A. CHUBBUCK, DECEASED

BY ERMA M. CHUBBUCK,

ADMINISTRATRIX.

by Brown & Critchlow

attorneys.

March 29, 1932. B. A. CHUBBUCK 1,851,037

MINING MACHINE

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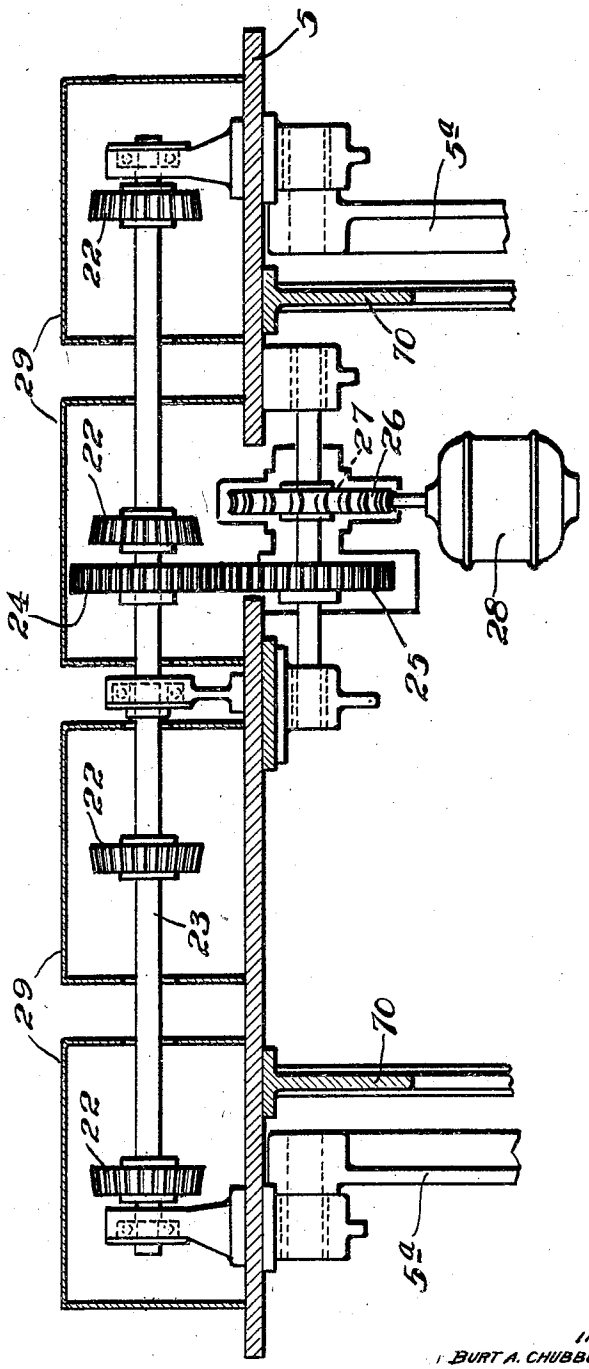

Fig. 6.

WITNESSES

A. B. Wallace.

F. B. Flick.

INVENTOR:

BURT A. CHUBBUCK, DECEASED,
BY ERMA M. CHUBBUCK,
ADMINISTRATRIX.

by Brown & Critchlow
attorneys.

March 29, 1932. B. A. CHUBBUCK 1,851,037

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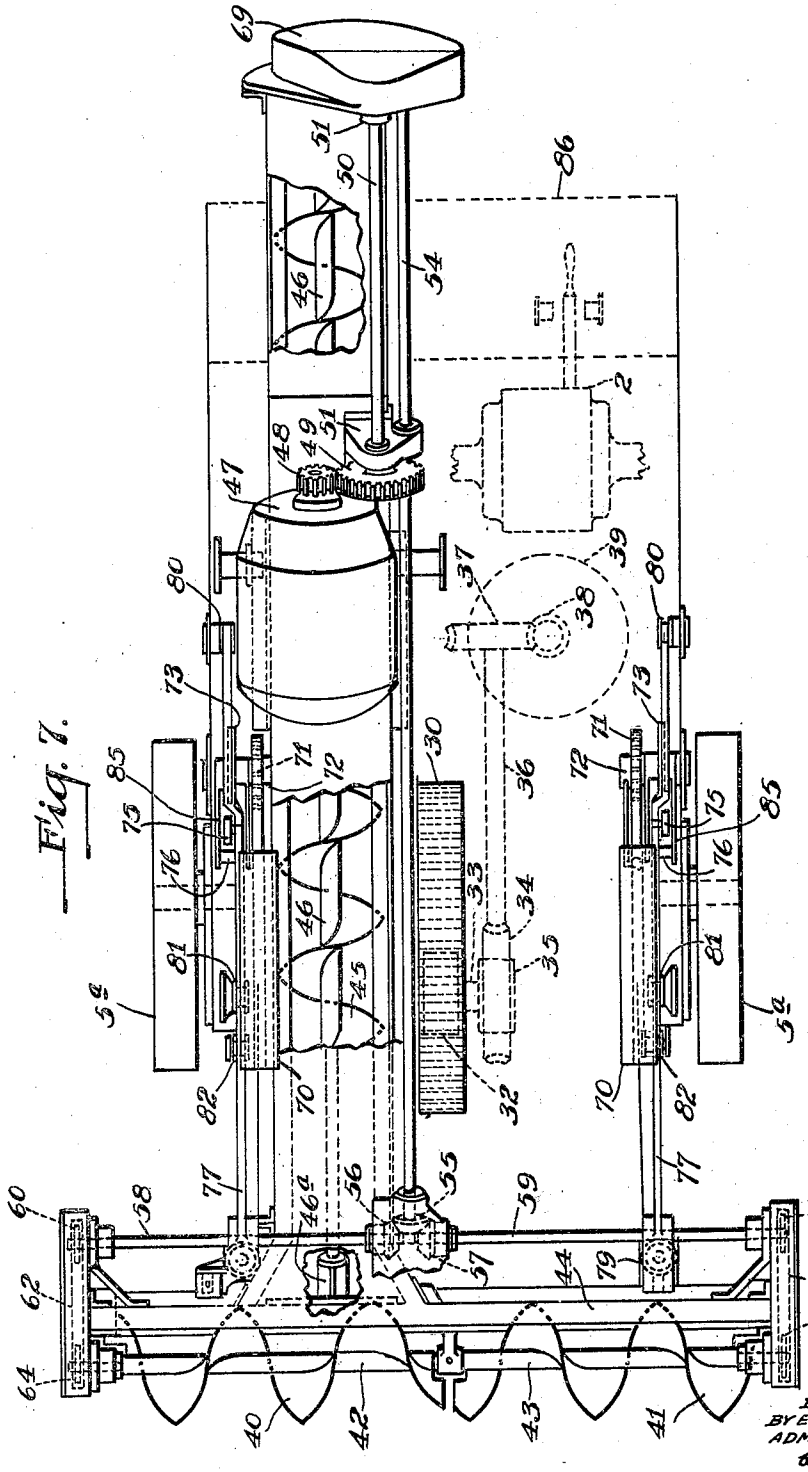
Fig. 7.



INVENTOR

BURT A. CHUBBUCK, DECEASED, BY ERMA M. CHUBBUCK, ADMINISTRATRIX.

by Brown & Critchlow attorneys.

Patented Mar. 29, 1932 1,851,037

UNITED STATES PATENT OFFICE

BURT A. CHUBBUCK, DECEASED, LATE OF PITTSBURGH, PENNSYLVANIA, BY ERMA M. CHUBBUCK, ADMINISTRATRIX, OF MEDINA, NEW YORK, ASSIGNOR TO THE U. S. COAL MACHINERY COMPANY, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF DELAWARE

MINING MACHINE

Application filed December 27, 1928. Serial No. 328,805.

The invention relates to machines for mining, tunnelling, and the like, and especially to those for digging coal and similar frangible materials.

An object of the invention is to provide a machine for cutting coal and the like which embodies paired reciprocating cutters which are automatically oscillated with respect to the face being cut, are resiliently actuated by operation of a prime mover and are cushioned at both ends of their strokes to absorb shock due to both normal and abnormal cutter impact, and which machine embodies the advantages of, while being of simpler construction and higher efficiency than, the cutter mechanism disclosed in the United States Patent No. 1,651,672, issued December 6, 1927.

Another object is to provide a machine embodying a plurality of paired chipping cutters mounted on a self-propelled truck, which is adapted to move forward progressively to advance the cutters into the face at a uniform, predetermined rate.

A further object is to provide a machine of the type referred to, in which the sweep of the cutter is regulable to cut the entire face down to floor level or to cut any desired portion of the face, which is provided with conveying mechanism for collecting, and loading the coal or other material brought down, and with means for automatically retracting the conveying mechanism in coordination with downward movement of the cutters to permit them to cut to the floor level.

In the accompanying drawings, Figs. 1 and 2 are side elevational views of a machine embodying the invention, showing two different operating positions; Fig. 3 is a fragmentary plan view showing the disposition of and driving means for the cutter battery; Fig. 4 a detail plan view of one pair of cutters; Fig. 5 a vertical sectional view through a cutter mechanism, taken on line V—V, Fig. 4; Fig. 6 is a vertical section of the table taken on line VI—VI, Fig. 3, showing the cutter drive; and Fig. 7 is a plan view of the conveying mechanism together with its driving elements.

Stated briefly, the machine according to the invention embodies cutter mechanisms disposed in cooperating pairs, each mechanism including a prime mover comprising a closed reciprocable cylinder, a floating piston enclosed therein, a cutter shaft connected to said piston, and means to reciprocate the cylinders, and by reason of fluid trapped in the cylinder by the piston the cutters are moved in response to movement of the cylinder and the cutter impact is cushioned or absorbed in compression of that fluid. The cutter battery is carried by a table pivotally mounted on a truck adapted to advance at a uniform rate, and means are provided to oscillate the table to move the cutters vertically with respect to the face being cut. Conveyors are also provided to gather and transport the material removed, and means associated with the conveyors and cutter table withdraw the conveyors after the cutters pass below a horizontal position to permit them to cut down to the floor level.

Referring to the illustrative embodiment shown in the drawings, from which all parts not essential to an understanding of the invention have been eliminated, the machine comprises a truck of suitable construction provided with means for propelling it along the tunnel or other place of use, and most suitably this comprises caterpillar tractor mechanism indicated generally by the numeral 1, Figs. 1 and 2, the construction of which forms no part of my invention and is well understood. Preferably the tractor tread is driven by means of an electric motor 2, carried on a frame structure 3, suitable shafts, driving gears and selective speed and reversing mechanism of the usual type, not shown, being provided for that purpose.

The cutter assembly comprises a plurality of cutter mechanisms indicated generally by the numeral 4, Fig. 3, disposed in cooperating pairs on a table 5 pivotally mounted on hangers 5*a*, Fig. 6. Each cutter mechanism comprises a cylinder 6, Figs. 4 and 5, preferably provided with bearing flanges at each end, and reciprocated in a guide casing 7 by a connecting rod 8 attached to the rear end of the cylinder. The forward end of the cylinder is closed by a head 9 formed to provide a bearing sleeve 9*a* for a cutter shaft

10 connected to and extending forwardly from a piston 11, floating in cylinder 6. The shaft is supported at its extended end in a bushing 11*a* held in an extension 7*a* of the guide casing. All of the bearing contacts are designed to be fluid-tight, and to this end packing P disposed in member 9*a* is held in place by a packing gland 100, and in bushing 11*a* by a cap 101. Also, piston 11 is provided with piston rings 15, and the bearing surfaces between the casing and cylinder are adapted to provide a fluid-tight fit. Each end of the cylinder is provided with a one-way spring-impelled check valve 12, which acts to admit air to compensate for that lost by leakage. The cylinder may be, and preferably is, further supplied with lateral ports or openings 13 and 14, Fig. 5, connecting the cylinder on opposite sides of the piston through the space between the cylinder and casing intermediate of the end flanges.

Cutting tools are provided on the forward ends of the shafts 10, the form shown embodying a plurality of chisel-like cutters 16 removably held in a tool holder 17 provided with a shaft-receiving socket 18 and held on the shaft by a key 19. These cutters are preferably of the chisel-like fish tail form seen in Figs. 4 and 5. Their form adapts the cutters to chip out fragments of the wall which they strike, and for that reason the form illustrated is at present preferred.

The cutter mechanisms are disposed in cooperating pairs, each pair of cylinders being reciprocated by a gear 20 and cranks 21 connected to connecting rods 8, the cranks being arranged to reciprocate the cylinders of each pair in opposite directions, as shown in Fig. 4. Gears 20 mesh with pinions 22 carried on a common shaft 23, to which is keyed a gear 24 driven by a pinion 25, spiral gear 26, and spiral pinion 27 connected to the shaft of a motor 28, Figs. 3 and 6. Housings 29 may be provided for these drives.

As previously described, it is characteristic of the invention that the cutter mechanisms are disposed in cooperating pairs. The machines according to the invention may be equipped with one such pair, or with a plurality, depending on the width of cut. When a battery of pairs are used, it will generally be desirable to dispose them in fanwise fashion, as shown in Fig. 3.

The cutters are moved vertically over the wall of coal being cut, and to this end hoisting mechanism associated with table 5 is provided. This includes a segmental gear 30, Figs. 1 and 7, secured to table 5 and supported on a shaft 31. Gear 30 meshes with a pinion 32 on a shaft 33 driven by a worm gear 34, worm 35, shaft 36, worm gear 37, and a worm 38, connected to the shaft of a reversing motor 39. The segmental gear is designed to provide the maximum cutter sweep desired, and any suitable means are employed for regulating the swing of the table and cutters to move over the face fully to the floor level, or to cut any desired portion of the face and to automatically reverse the movement at the end of the throw.

Associated with the truck is conveyor and loading mechanism adapted to remove the coal brought down through the action of the cutter. This mechanism comprises right and left hand screw conveyors 40 and 41, Fig. 7, carried at the forward, or cutting, end of the machine by shafts 42 and 43 respectively, which operate in bearings supported by a frame structure indicated generally at 44. These conveyors gather the material as it falls to the floor and deliver it to an inclined screw conveyor 45 on a shaft 46 (Figs. 1 and 7), also carried in frame 44, which extends to the rear of the truck, so that the material can be discharged into a following truck or car.

The conveyors are driven by an electric motor 47 carried on frame 44, through a pinion 48 on the motor shaft which meshes with a gear 49 on a shaft 50 journalled in bearings 51 and provided at the other end with a pinion 52, Fig. 1. Pinion 52 meshes with a gear 53 on a shaft 54 provided with a bevel pinion 55 at its forward end which meshes on opposite sides with two bevel gears 56 and 57 mounted on separate horizontal shafts 58 and 59, suitably journalled and carrying on their outside ends sprocket wheels 60 and 61, Fig. 7, which drive the forward conveyors through sprocket chains 62 and 63 and sprockets 64 and 65 carried by shafts 42 and 43, respectively. The longitudinal or rearwardly moving conveyor 45 is driven by a sprocket 66 on shaft 54, sprocket chain 67 and sprocket 68 mounted on shaft 46. This driving mechanism may be enclosed within a housing 69, as shown in Fig. 1.

Referring to the lower dotted line position of the cutters in Fig. 1, it will be seen that the forward conveyors when in normal position would interfere with the downward progress of the cutters and prevent cutting entirely to the floor level. A special feature of the invention resides in means for retracting the conveyor mechanism as the cutters approach the lower dotted line position of Fig. 1, to permit the cutter to work to the floor level. To this end, similar gear sectors 70, Figs. 1, 2, 6 and 7, mounted on each side of table 5 mesh with pinions 71 on shafts 72 carried on frame 44. Keyed to shafts 72 to turn with pinion 71 are circular cams 73 each having a segmental notched portion 74. Arms 75 each provided at its end with a roller 76 are also mounted on shafts 72. Conveyor shifting arms 77 on each side of frame 44 are resiliently connected to the forward end thereof by bolts 78 and heavy duty coiled springs 79 interposed between the arms and the frame, as shown in Fig. 1, and the rear

ends of these arms are supported between guide rollers 80 carried by the truck frame. Rollers 81 and 82 also carried by the truck frame support and guide the shifting arms at intermediate points. Each arm 77 is provided with a vertical slot 83 which lies above rollers 76 when roller arms 75 are in their forward horizontal position, and connected to the rear side of these slots are bearing plates 84, which with the corresponding portion of the arms carry a pair of rollers 85, to form a roller bearing surface for the periphery of cam 73. The motor drives and other mechanism on the rear of the truck are preferably enclosed within a cover 86.

Assuming the machine to be in position adjacent the face of coal to be cut, motors 28, 39 and 47 are started to set the cutters, hoisting mechanism and conveyors in motion, and tractor-drive motor 2 is started and run in gear to advance the machine at a constant and uniform rate, this rate being equal to the desired progress of the cutters into the coal and being adaptable to suit conditions by means of suitable selective gear mechanism.

The cutter-actuating motor drives pinions 22, and these in turn actuate the cutters of each pair through gears 20 and connecting rods 8, to reciprocate the cylinders in opposite directions, as seen in Fig. 4. Referring to Figs. 4 and 5, the action of the cutters is as follows: When crank 8, Fig. 5 is advancing, the cylinder 6 will be driven forwardly, and piston 11 and shaft 10 will simultaneously be advanced. The drive used is selected to reciprocate the cylinders with relatively great rapidity, so that when the cylinder has been advanced sufficiently to bring cutters 16 into contact with the face of the coal, the impact thereagainst is sudden and sharp, causing a small amount of coal to be chipped out. The cylinder is, of course, advancing at this moment, and it is positively actuated by the connecting rod, but the cutter, cutter shaft and piston are actuated by the air cushion in the cylinder, and consequently the impact of the cutter against the coal is resiliently absorbed. This is an important feature of the invention, because the machine suffers no impact shock, and thus there is no danger of damage to the machine due to the repeated impact, or to impact with slate, rock or other material harder or less frangible than that being cut. In either case the action will be as follows: The impact will tend to move the piston rearwardly in the cylinder, and since the rings 15 prevent leakage of air past the piston, the air trapped behind the piston will be compressed, this compression being resisted more the further the piston moves rearwardly, and the result is that all of the shock is resiliently taken up thereby. Where the ports 13 and 14 are not provided in the cylinder, this action will be confined to the space behind the piston; but where the ports are provided, the compression will force air to the forward end of the cylinder through ports 13 and 14 and the conduit formed between the cylinder and the guide casing. In this case, as the piston moves back, the air will be displaced until the piston reaches and closes port 13, after which the air remaining will be compressed between the piston and the portion of the cylinder beyond the port, and contact of the piston with the rear of the cylinder will thereby be prevented.

Continued rotation of gear 20 retracts the cylinder, releasing the pressure on the cutters, and the air compressed behind the piston expands and returns the piston to a point where the pressure on each side is equalized, this action being assisted to some extent by the inertia of the piston and shaft. The most favorable position for the piston during the non-impact periods of the cycle is substantially in the middle of the cylinder. If the ports 13 and 14 are not provided, valves 12 will act to maintain it substantially in that position. This, however, is accomplished more readily and quickly through the use of the ports, the interchange of air between the two sides upon movement of the piston in either direction tending to maintain the piston in its mid position.

Cylinder 6 is fitted in guide casing 7, and shaft 10 in bearing member 9*a* in such manner as to make fluid-tight bearing surfaces, but nevertheless there may be gradual loss of air from the cylinder. Such loss of air is fully compensated by the one-way valves 12, which, when the pressure in the cylinder falls below atmospheric, will open to supply the air lost in compression. Oil supply and drain openings 91 and 92 are also provided in the cylinder head. The guide casing extension 7*a* is connected to casing 7 to make a fluid-tight connection, and the extensions 7*a* of each pair are connected by a coupling 93, Fig. 4, whereby when one cylinder moves forwardly the air ahead of it is applied to the head of the retreating cylinder, and thus the air in the casing is circulated, assuring clean air free from mine dust and other material detrimental to preservation of bearing surfaces. The casings 7*a* are also provided with bolted caps or hand holes 94. This cutter construction thus provides full and positive cushioning of the cutter, the construction is simple, repairs are easily made and no auxiliary air compressing equipment is required, the actuation being positive by virtue of the piston floating within the cylinder itself.

When motor 39 is started the hoisting pinion 32 actuates segmental gear 30, to oscillate the hoisting table (and the cutters) vertically with respect to the wall being cut, suitable automatic reversing mechanism being used to reverse the gear drive when the

cutters have reached the roof and floor of the cut. The progressive path of the cutters into a face of coal is represented by the arrowed lines AB, BC, etc., Figs. 1 and 2, and the oscillating movement with respect to the wall results in the production of parallel grooves in the coal face, and the pillars thus formed are intermittently broken down.

The material thus cut falls to the floor, where the right and left hand screw conveyors 40 and 41 pick it up and pass it to the longitudinal conveyor 45, which discharges it into a car or other receptacle. It will be seen from Fig. 1 that, in moving downwardly along the line GH, progress of the cutters would be barred by the conveyors, and the machine could not move forward. This is taken care of by the special conveyor moving mechanism, which operates as follows: The conveyors are carried by arms 77, and as long as the cutters are above horizontal, rollers 85 bear against the periphery of cam 73, and no movement of the conveyor arms is possible. Sector gears 70, mounted with the hoisting table rotate pinions 71, and consequently cams 73 and arms 75. As the table moves downwardly from its uppermost position rollers 85 will ride on the circular surface of the cam until rotation thereof brings notch 74 of the cams up to the rollers. At this moment, arms 75 have moved to slots 83 in conveyor arms 77, and as the table continues to move downwardly pinions 71 will continue to rotate, causing arms 75 and rollers 76 to move upwardly, and rollers 76 move along slots 83, thus moving conveyor arms 77 and the entire conveyor mechanism backwardly, permitting the cutters to operate to the floor level. The fully retracted position is shown in Fig. 2.

In this conveyor-moving mechanism it will generally be desirable to have rollers 85 leave the cam surface and enter its notch as the table reaches a position about 12½ degrees below horizontal in its downward movement. The conveyors will then be fully retracted by the time the cutters reach the floor. When the table begins to move upwardly, pinion 32 is driven in the reverse direction, arms 75 then urging the conveyor mechanism forwardly until rollers 85 again bear on the periphery of the cam. Through the use of this mechanism the conveyor is automatically and positively actuated in response to cutter movement, and the conveyor assembly is held in fixed relation to the machine at all times and cannot move except as actuated by the cutter mechanism.

The machine is preferably provided with means for preventing dust formation during its operation, and this is most suitably accomplished by means of a water spray directed against the coal. In the machine shown, a pipe 105 connected to extension 7*a* of the guide casing, as by straps 106 bolted to the casing, extend forwardly therefrom alongside the cutter shaft. The forward end is provided with a spray nozzle 107, and the pipe is preferably bent to direct the spray close to the point of contact of the cutting tool with the coal. The pipe is connected to a water line by a flexible conduit 108, and the nozzle preferably distributes the water in the form of a very fine mist. In this manner the spray moves with the cutters, and dust formed by the cutting is at once wet and thus prevented from floating into the air.

As mentioned previously, automatic means reverse the cutter hoisting mechanism, and since the machine, when in operation, is driven in gear its operation is fully automatic. The various drives are all under the control of the operator. However, to prevent undue stress arising from contact with objects which the conveyors cannot handle, means may be, and preferably are, provided to automatically stop the machine under such circumstances. For this purpose the forward end of each of the conveyor arms 77 is provided with a push button switch 95, Figs. 1 and 2, inserted in the circuit of tread motor 2, and disposed below each button on the conveyor framework, is a stop 96. Should the front conveyors meet a lump of coal, or a rock or other object which they cannot handle, the conveyors will tend to climb over it. When this happens, the conveyor structure moves upwardly against spring 79, and continued movement brings stop 96 against the button, shutting off the tread motor. The operator then reverses the machine, the obstruction is removed, switch 95 reset, and the machine advanced to operate as before.

The machine according to the invention possesses numerous advantages. It can be built in units of any size, to cut any desired width, and through the use of rapidly repeated, high speed cushioned impact blows, the coal struck by the cutters is chipped out instead of being gouged or scraped out as in prior cutting systems. The construction permits maximum impact blows without recoil or shock in the machine, so as to insure complete protection to the machine together with substantial freedom from breakdowns due to parts broken as the result of impact stresses. The product is uniform in size, a minimum amount of coal is cut in bringing the main portion down in the form of lumps, thus producing a minimum of fines, and the machine automatically gathers and delivers the coal. It is capable of high output, and owing to the cutter construction, a minimum of power is required. Numerous other advantages may be seen by those skilled in the art.

Although in the specification and appended claims the machine is referred to as for digging coal, it will be understood that it can equally be applied for use with other materials, whose nature is such that they are

readily chipped or shattered, and such use is fully comprehended and intended to be within the scope of the expression used. It will also be understood that it is not limited to the use of air as the fluid used in the cylinders.

Claims:

1. In a coal digging machine, the combination of a truck provided with a pivotally supported cutter table, motor-actuated means for oscillating said table, cutter means disposed on said table and adapted upon oscillation thereof to cut a plurality of substantially parallel vertical grooves in the coal, screw conveyors adapted to remove the coal brought down by said cutters, and means for retracting said conveyors when the cutters move toward the floor, said conveyors being supported by a pair of arms slidably carried by the truck.

2. A coal digging machine according to claim 1, said conveyor-retracting means comprising a sector gear carried by said table, a pinion meshing therewith, and an arm and roller actuated by rotation of said gear and pinion and adapted when the table passes below its horizontal position to engage said conveyor arms to urge the arms and conveyor mechanism rearwardly of the machine.

3. In a coal digging machine, the combination of a truck, motor-actuated caterpillar tread mechanism to propel said truck, a table pivotally carried at the forward end of said truck, motor-actuated means for oscillating said table vertically with respect to the face to be cut, a plurality of motor-actuated cutter mechanisms disposed in cooperating pairs on said table, each mechanism comprising a guide casing, a cylinder reciprocable therein, a piston slidably enclosed in said cylinder and air-cushioned from its ends, a tool-carrying shaft connected to said piston and extending forwardly therefrom, a cutter connected to the extended end of said shaft, ports in said cylinder on each side of the piston for passing air from one side of the piston to the other, and means for positively reciprocating the cylinders of each pair in opposite directions whereby the pistons are actuated by pressure created in the air trapped in said cylinder by said piston, motor-actuated screw conveyors carried by said truck, and means cooperating between said table and conveyor mechanism for retracting the conveyors when the table passes below its horizontal position.

4. In a coal digging machine, a motor-operated truck, a motor-operated hoisting table pivotally carried by said truck, and paired cutting mechanism disposed on said table, each mechanism comprising a guiding casing, a cylinder reciprocable therein, a floating piston elastically cushioned within said cylinder, and a shaft extending forwardly from said piston and carrying a cutter tool, the cylinders of each pair being reciprocated in opposite directions, motor-operated conveyor mechanism for gathering and removing the coal brought down by said cutters, and means for retracting said conveyors to permit the cutters to operate to floor level comprising conveyor-supporting members slidably borne by said truck, a common shaft carrying a cam, a pinion and an oscillating power-applying arm, and a rack carried by said table engaging said pinion, said cam normally preventing movement of said conveyor-supporting members and adapted upon rotation by said rack and pinion to permit engagement of said arm and conveyor-supporting members when the table reaches 12½° below horizontal in its downward travel.

5. In a coal digging machine, the combination of a truck, means for propelling said truck, vertically oscillable reciprocating cutters carried in cooperating pairs by said truck, means for collecting and conveying rearward of the truck the coal brought down by said cutters, and mechanism operatively connected to said collecting means for retracting it in response to downward movement of said cutters to permit the cutters to move to floor level.

6. In a coal digging machine, the combination of a motor-operated truck, a motor-operated hoisting table pivotally carried by said truck mechanism including a motor operatively connected to said table for oscillating it vertically with respect to the face to be cut, a plurality of motor-actuated cutter mechanisms disposed in cooperating pairs on said table, each cutter mechanism comprising a guide casing, a cylinder reciprocable therein, a piston slidably enclosed in said cylinder and air-cushioned from its ends, a shaft extending forwardly from said piston, a cutter tool connected to the extended end of said shaft, ports in said cylinder on each side of the piston connected to pass air from one side of the piston to the other, and means for positively reciprocating the cylinders of each pair in opposite directions whereby the pistons are actuated by pressure created in the air trapped in said cylinder by said piston, motor-operated conveyor mechanism for gathering and removing the coal brought down by said cutting mechanism, and means associated with said conveyor mechanism for retracting it in response to downward movement of the cutters to permit the cutters to work to floor level.

In testimony whereof I sign my name.

ERMA M. CHUBBUCK,
Administratrix of the Estate of Burt A. Chubbuck, Deceased.