

W. M. THOMAS.
COAL CUTTING MACHINE.
APPLICATION FILED JULY 14, 1915.

1,226,412.

Patented May 15, 1917.

4 SHEETS—SHEET 1.

Fig. 1.

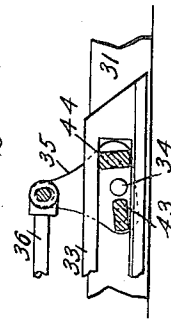
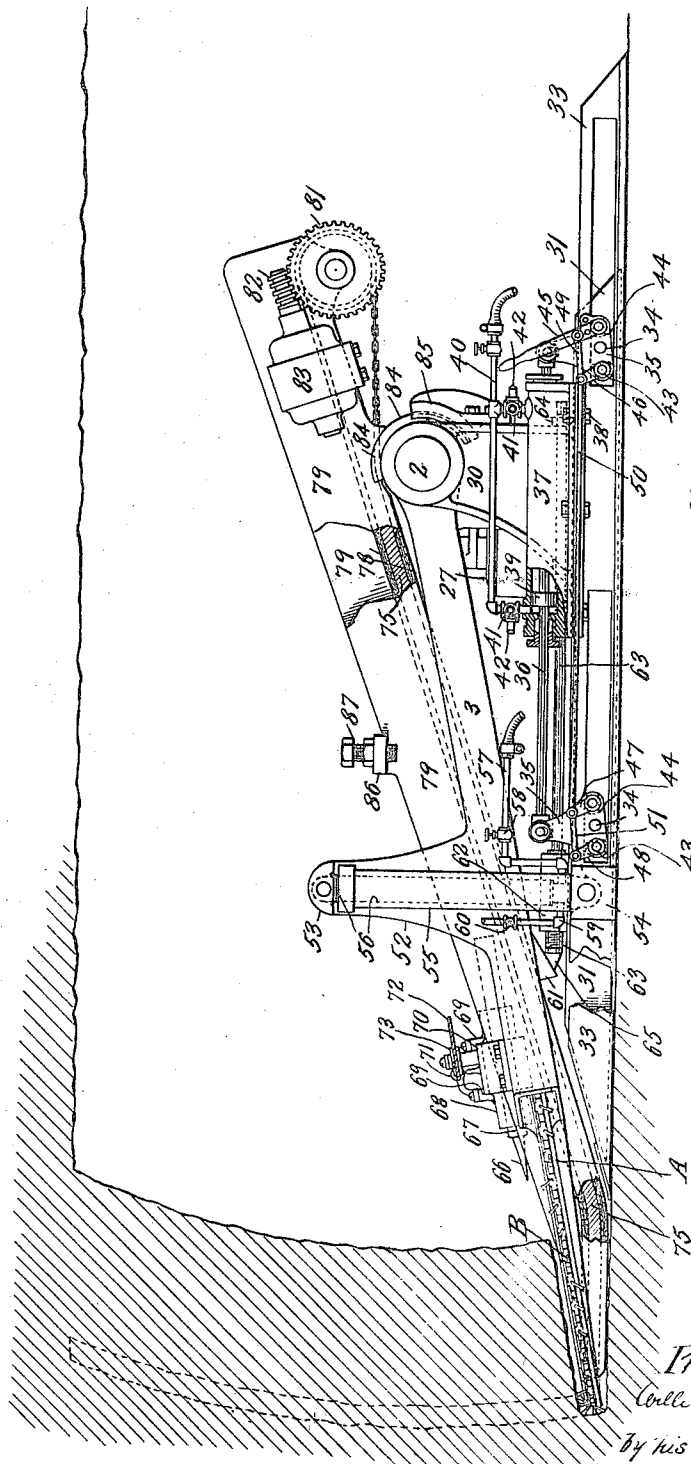


Fig. 1a.

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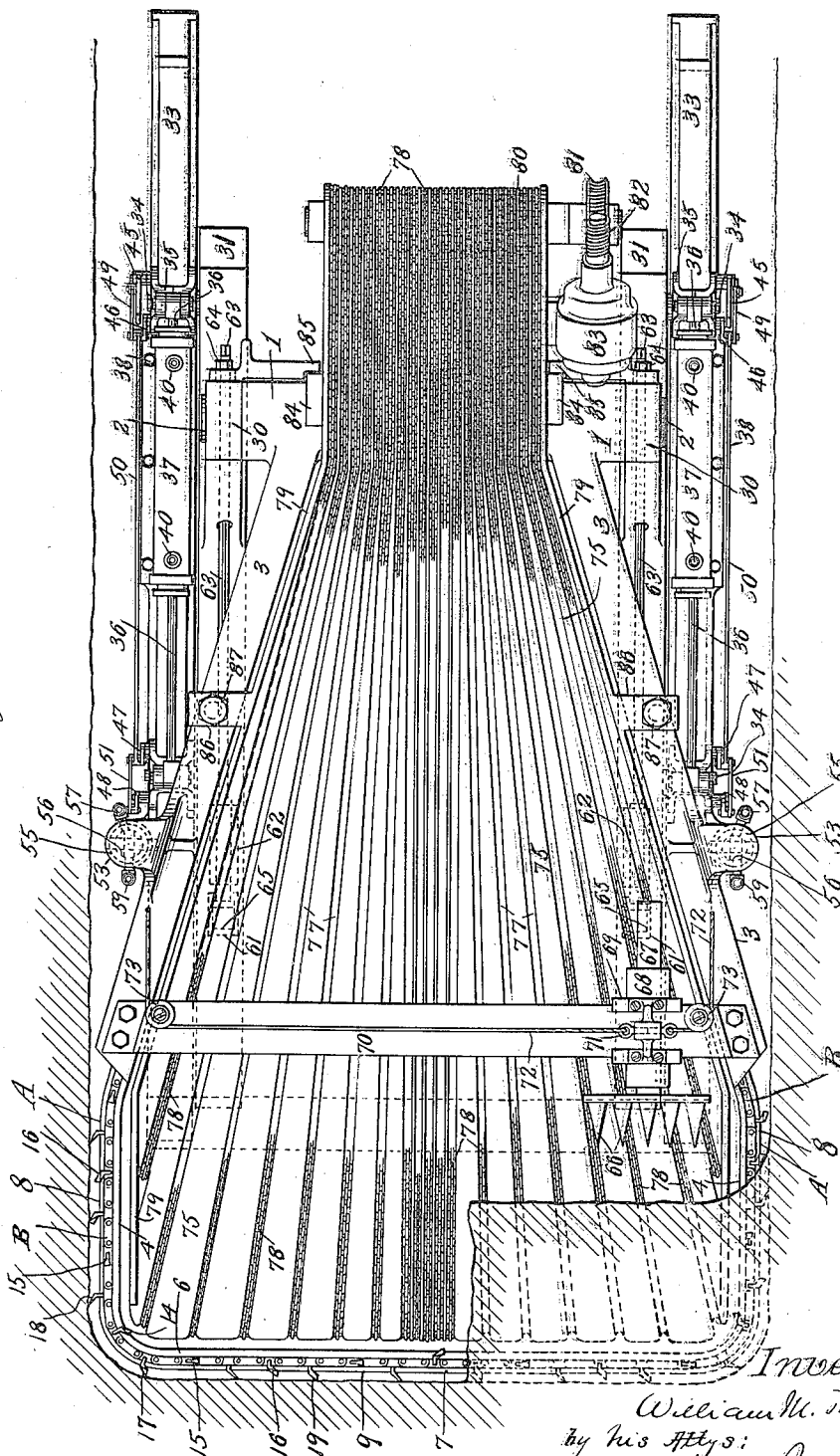
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4 SHEETS—SHEET 2.

Fig. 2.



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4 SHEETS—SHEET 3.

Fig. 3.

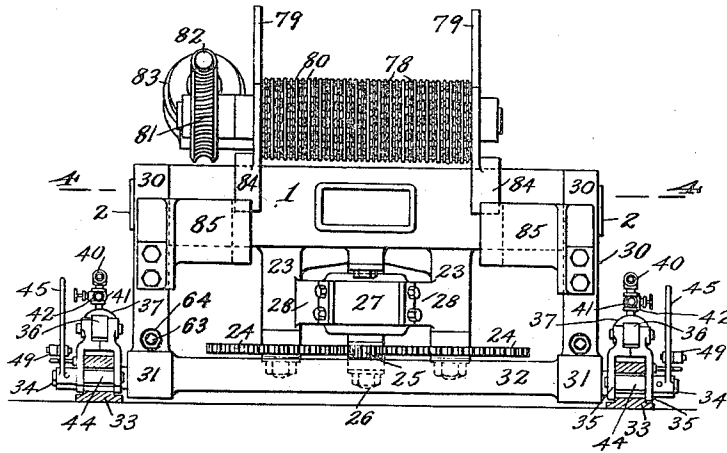
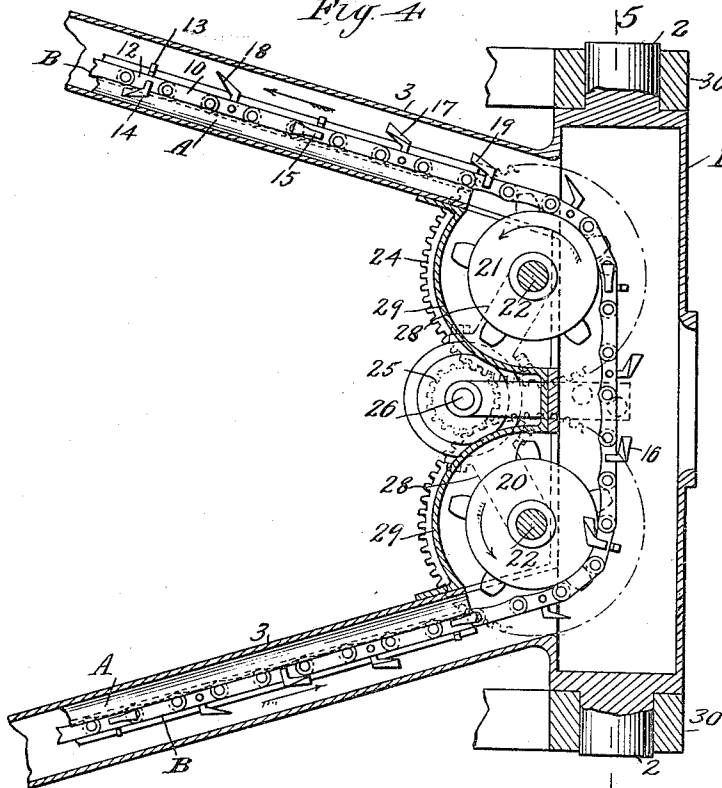


Fig. 4.

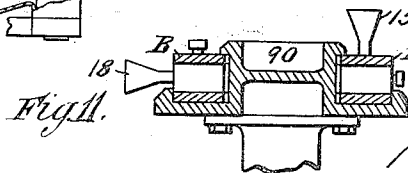
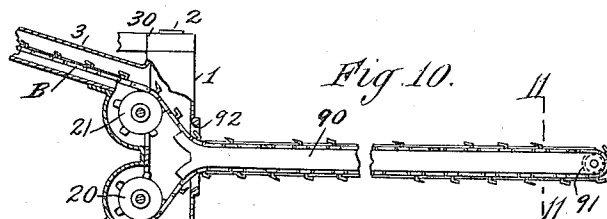
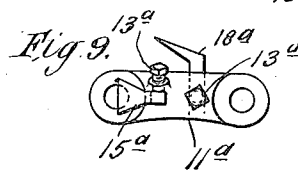
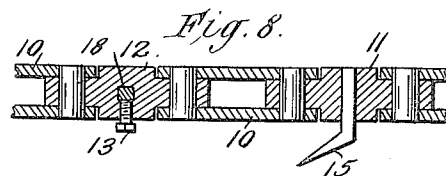
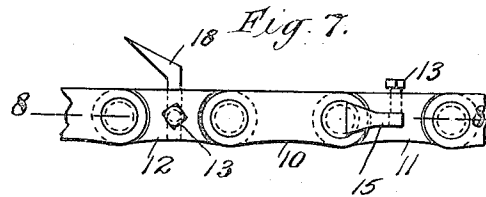
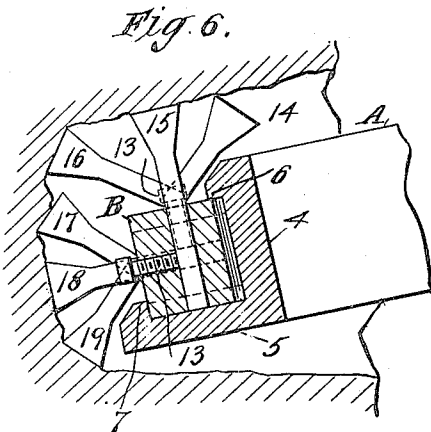
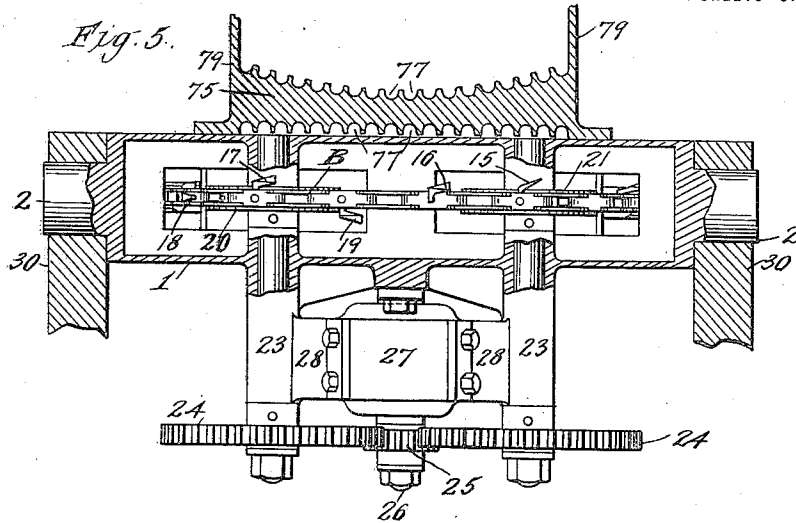


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4 SHEETS—SHEET 4.



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UNITED STATES PATENT OFFICE.

WILLIAM M. THOMAS, OF NEW YORK, N. Y., ASSIGNOR OF FIFTY AND ONE-HALF ONE-HUNDREDTHS TO FRANK OBERKIRCH, OF NEW YORK, N. Y.

COAL-CUTTING MACHINE.

1,226,412.

Specification of Letters Patent.

Patented May 15, 1917.

Application filed July 14, 1915. Serial No. 39,760.

To all whom it may concern:

Be it known that I, WILLIAM M. THOMAS, a citizen of the United States, residing at New York, county of New York, and State of New York, have invented certain new and useful Improvements in Coal-Cutting Machines, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to improvements in coal cutting apparatus.

The object of the invention is to provide a readily controllable and durable machine for mining coal, which will enable the coal to be mined in large and solid lumps, with a relatively small amount of slack, and also will permit a selective mining of the coal so that different grades in different strata may be kept separate from each other and slate or clay strata may be kept out of the coal.

With these general objects in view, my invention consists in the features, details of construction and combinations of parts which will first be described in connection with the accompanying drawings and then particularly pointed out.

In the drawings:—

Figure 1 is a side elevation, partly in section, of a mining machine constituting one embodiment of my invention.

Fig. 1^a is a detail view of the rocker and cam.

Fig. 2 is a plan of the apparatus shown in Fig. 1.

Fig. 3 is a rear elevation, partly in section.

Fig. 4 an enlarged detail view illustrating the means for driving the cutting chain.

Fig. 5 is a transverse section on the line 5—5, of Fig. 4, parts being shown in elevation.

Figs. 6, 7, 8 and 9 are detail views of the cutter chains and cutters.

Fig. 10 is a plan view of a cutter chain interchanging device attached to the machine.

Fig. 11 a detail sectional view on the line 11—11, Fig. 10.

Referring to the drawings, A is an open frame constituting a track for an endless cutting chain which is provided with cutters projecting outward from the frame and also

having cutters projecting upward, as will be explained more fully hereinafter.

The frame is so mounted that its front end may be pushed forward whereby the cutters which project outward as they pass the front of the frame will cut a path for the frame; and then the frame may be moved in a generally upward direction, that is to say in a direction from the floor toward the roof of the room or entry, whereby the cutters which project upward from the frame will cut a kerf in an upward direction, this kerf being wide enough to allow the frame to enter it.

The open frame is so constructed that it will surround the downward hanging mass of coal, which can be broken loose from time to time.

In the particular embodiment of the invention illustrated the open cutter-frame narrows toward the rear and is provided with suitable trunnions on which it may be swung angularly about a generally horizontal axis.

As shown, the frame consists of a hollow rear portion 1 having trunnions at each end, as indicated at 2, Fig. 4. To this rear portion 1 are connected two sloping side portions 3 each of which is advantageously tubular and provided with a track portion which carries the chain. This track portion has a generally L-shaped cross-section, the horizontal leg projecting outward. Each leg is provided with a rib projecting at right angles to the leg. The cross-section of this track will be apparent from Fig. 6 in which 4 is the vertical leg, 5 the horizontal leg, 6 the rib on the vertical leg and 7 the rib on the horizontal leg. The terms vertical and horizontal refer to their positions when the frame A is lifted to a horizontal plane.

The track portion of the frame is extended beyond the tubular portions to form the cutting sections of the frame. In the present example, this comprises two side portions 8 and a front portion 9, Fig. 2. The corners where the front portion and the two side portions meet are curved suitably as indicated in Fig. 2.

The cutting chain indicated generally at B, Fig. 1, consists of sprocket links 10, Fig. 7, connected by cutter-carrying links. In

the preferred construction shown particularly in Figs. 7 and 8 the cutter-carrying links are of two kinds, viz: one kind provided with vertical sockets arranged to carry a cutter which extends upward from the chain, such a link being shown at 11, while the other type of cutter-carrying links, one of which is indicated at 12, has a substantially horizontal socket arranged to carry a cutter extending outward from the chain.

The cutters are secured in their respective links in any suitable way, as, for example, by set screws 13. In order that the cutters may form kerfs of a width sufficient to allow the frame to enter the respective kerfs either in a forward or in an upward direction, the cutters are in sets, each set comprising a plurality of cutters arranged to cut in echelon.

This will be clear from Fig. 6 in which is shown a set of cutters extending upward from the frame and comprising three cutters, one inclined toward the right in Fig. 6, as indicated at 14, the other extending straight upward, as indicated at 15, and the other inclined toward the left, as indicated at 16. Fig. 6 also shows a set of cutters extending outward from the frame, this set comprising cutters, 17, 18 and 19, arranged to cut in echelon.

The links are rectangular in cross section and arranged to slide along the L-shaped track, being retained in said track by the ribs 6 and 7.

The inside face of each link is curved to conform to the sprocket wheels around which it passes, as will be explained hereinafter.

Instead of providing the chain with cutter-carrying links of two kinds as hereinbefore explained, each cutter-carrying link may have two sockets, one for an upward extending cutter and the other for an outward extending cutter, as will be clear from Fig. 9 where 11^a is the link, 15^a the upward extending cutter and 18^a the outward extending cutter. The set screws are indicated at 13^a, one being put at an incline, as shown, in order to give access to the screws.

At the rear end of the frame means are provided for driving the chain. In the present embodiment of the invention, the chain passes around two sprocket wheels, indicated at 20 and 21, these being mounted on shafts 22 carried in suitable journals 23, Fig. 5, carried by the rear portion or axle 1 of the frame. Each shaft projects below its journal and is furnished with a gear wheel 24, these gear wheels meshing with a gear pinion 25 fixed on the shaft 26 of a motor 27 whose casing is secured to the axis or rear portion 1 of the frame in any suitable way, as, for example, by providing the journals 23 with arms 28 to which the motor casing is bolted.

The sprocket wheels 20 and 21 are inclosed in part by a casing 29, Fig. 4.

It will be seen that in this construction the motor and the gearing for driving the chain swing with the frame and chain.

The trunnions 2 of the open frame are mounted in journal stands 30 carried by sills 31 extending in a longitudinal direction, these sills being connected at suitable intervals by cross-braces 32, one of which is shown in Fig. 3. The sills and braces constitute a base for the apparatus.

Suitable means are provided for moving the machine base, and with it the cutting apparatus, in a forward direction, whereby the cutting apparatus may be fed forward to the coal during the time it is cutting the horizontal kerf. In addition, means are provided for moving the machine backward, so that it may be withdrawn at any time from the face of the coal. In the preferred embodiment of the invention the means for moving the machine forward and backward is duplex, that is to say is in two sets, one set at each side of the central longitudinal axis of the machine, so that by putting one set in operation to move its side of the machine forward and the other set to move its side of the machine backward, the machine may be caused to turn in the corresponding direction.

In the present embodiment of the invention the moving means comprise shoes at each side of the machine base, mechanism for first lifting the base so that its weight will rest on the shoes and then moving the base either forward or backward according to the setting of the mechanism, then lowering the base, then lifting the shoes and moving them in the proper direction either forward or backward and then lowering the shoes, after which the action above described is repeated.

As the two sets of apparatus for moving the machine are alike, it will be necessary to describe only one.

Referring to Fig. 1, a shoe 33 is shown outside its corresponding machine sill, this shoe having two long slots. The sill is provided with two outwardly projecting studs 34, each of which extends through its respective slot in the shoe. On each stud is mounted a rocker or double bell-crank, bifurcated to straddle the shoe, as indicated at 35, Figs. 1 and 3.

The upper ends of the pair of rockers are suitably connected to a piston rod, 36, which extends through and projects from each end of a cylinder 37 suitably secured to the shoe, as, for example, by bolts 38, Fig. 1. The piston rod is provided with a piston as indicated at 39, Fig. 1, and any suitable means is provided for supplying each end of the cylinder with fluid under pressure. For the purpose of illustration, I

have shown a pipe 40, leading from a suitable source of fluid under pressure, this pipe being connected to each end of its respective cylinder by branches provided with valves,

41. The valves are illustrated as three-way cocks arranged to discharge through suitable outlets, as, for example, the outlet branches indicated at 42. By suitable manipulation of the valves 41 the piston and with it the piston rod can be forced longitudinally in either direction.

Each rocker is provided with means for engaging the inner walls of the shoe. In the present example, this means comprises a pair of cam blocks, one serving for use during the forward movement of the machine, and the other for use during the backward movement of the machine. Each cam block is arranged so that it may be thrown into and out of action.

In the present example, the cam blocks which act during the forward movement of the machine are indicated at 43 and those which act during the backward movement of the machine are indicated at 44. Each cam block is fixed on a shaft journaled in the bifurcated portion of its rocker, as shown in Fig. 3, each shaft projecting outside its rocker and carrying a crank arm, one of which, 45, is extended to form a hand lever to which the other crank arms 46, 47 and 48 are connected by links 49, 50 and 51, so that by swinging the hand lever 45, all the cam blocks will be rotated.

The cam blocks 43 are fixed in their shafts so that they will be at right angles relatively to the other pair of cam blocks 44. Hence, when the hand lever 45 is pushed forward, the cam blocks 43 will be swung to a generally horizontal position, while the cam blocks 44 will be swung to a generally vertical position, as shown in Fig. 1^a. In this condition when the rocker is swung, the upper and lower surfaces of the cam blocks 44 may engage the upper and lower walls of the slots in the shoes while the cam blocks 43 cannot engage the shoe, but are out of action. When the hand lever 45 is swung backward, the condition of the cam blocks is reversed, that is to say the cam blocks 44 are put in a generally horizontal position and are out of action, while the cam blocks 43 are moved into a generally vertical position and are ready for action.

The operation of this moving mechanism is as follows:—

Assuming that the hand lever 45 is swung backward, the cam blocks 43 are thereby brought into operative position, while the cam blocks 44 are swung out of action. If now the piston be at the forward end of the cylinder, and fluid pressure be admitted to the forward end of the cylinder while the rear end of the cylinder is open to the exhaust, the first action will be to force the

piston rod rearward, thereby swinging the rocker arms so that the top surfaces of the cam blocks 43 contact with the top walls of their respective slots and lift the shoe clear of the ground. There is sufficient play in the points of connection of the piston rod and rocker arms to permit this upward movement of the shoe and its attached cylinder. As the machine base is now on the ground, the piston rod is held against further movement relative to the ground. The piston then serves as a stationary abutment against which the fluid pressure reacts to push the cylinder forward, carrying with it the shoe. When the cylinder has completed its forward movement the piston is at its rear end. By then admitting fluid pressure to the rear end of the cylinder while opening the front end to the exhaust, the first action is to move the piston forward, thus swinging the rockers so that the bottom faces of the cam blocks 43 contact with the bottom walls of the slots in the shoe. These points of contact become fulcrums, so that the continued forward movement of the piston and its consequent swinging of the rockers lifts the machine base. This throws the whole load of the apparatus on the shoes, and as the friction of these against the ground is far greater than that between the bottom faces of the cam blocks 43 and the bottom walls of the slots, the said walls act as a track along which the machine may be pulled by the forward movement of the piston. When the machine base has been carried forward to an extent equal to the stroke of the piston, the fluid pressure is reversed in the cylinder. The first effect of this action is to move the rockers in a direction to lower the machine base and then lift the shoes, whereupon the load of the machine is carried by the base directly to the ground. Therefore, as before described, the cylinders are moved forward carrying the shoes with them to a new position. By repeating the operations above described the machine will continue to move forward.

It is obvious that if the hand lever 45 be swung in the opposite direction the cam blocks 43 will be swung out of action while the cam blocks 44 will be put into position for operation. Thereafter by suitably supplying fluid pressure to first one end of the cylinder and then the other, the machine will be moved backward in an obvious manner.

If the cam blocks 43 at the left side of the machine be put in position for operation, while at the right side the cam blocks 44 are in operative position, the machine may be advanced on the left side and withdrawn on the right side, so that the machine will turn around in a right handed direction. By a reversal of the cam blocks the

machine may be caused to rotate in a left handed direction. If the moving apparatus at one side be actuated while that at the other side is inoperative the machine may be caused to move on an arc either forward or backward, according to the direction of movement of one side caused by the moving apparatus then in operation.

Suitable means is provided for swinging the cutting mechanism about its trunnions in an up and down direction. In the present example the open frame is provided with upward extending posts 52 whose upper ends are flanged outward to form lugs, indicated at 53. The sills of the machine are provided with outward extending step-blocks 54, and between each step-block and the corresponding lug 53 over it is mounted a hydraulic ram device comprising a cylinder 55 and a plunger 56, the bottom of the cylinder being pivoted or hinged to the corresponding step-block 54 while the upper end of the plunger is pivoted or hinged to the corresponding lug 53.

Suitable means is provided for admitting fluid pressure to and exhausting it from the lower end of each cylinder. In the present example the lower end of the cylinder is provided with an inlet pipe 57 controlled by a valve 58 and with an outlet pipe 59 controlled by a valve 60.

For the purpose of adjustably limiting the downward movement of the swinging cutting mechanism, a suitable adjustable stop device may be provided. In the present example, the lower faces of the side members of the open frame are provided with stop-blocks 61 having inclined abutment faces, and on the machine support are mounted adjustable devices for engagement with these abutment faces. In the present construction each sill is provided with a stationary nut, as indicated at 62. Through each nut passes the threaded portion of a long rod 63 extending to the rear of the machine when it is guided in an opening in the respective journal stand, as shown in Fig. 2. The rear end, back of such journal stand, is threaded to receive a check or lock nut 64 and has its projecting end squared to receive a wrench. The front end of the rod 62 is made conical, as indicated at 65, Fig. 1. The conical head of each rod engages its respective stop-block 61. By gradually screwing the rods 63 forward as the machine is undercutting the coal, the cut or kerf may be made to slope upward. By gradually screwing the rods 63 backward during the undercutting the kerf may be made to slope downward. By this means it becomes possible to let the machine follow the dip or inclination of a coal seam while it is undercutting its way into the coal.

With the apparatus hereinbefore de-

scribed it is possible to undercut the coal and then back-cut it, that is to say cut a face body loose from the seam so that a depending pillar of coal is left hanging from above, this pillar having substantially the same stratification as the body of coal from which it has been severed. The height of this depending pillar is determined by the height to which the back-cutting has been done.

The pillar is readily broken loose for removal from the mine in any suitable way. Since its stratification is transverse to the height of the pillar, that is to say generally horizontal, a suitable pick device working in the direction of the stratification will readily sever the pillar transversely to its height.

I may provide the swinging frame with suitable means for thus severing the pillar. In the present example, I have shown an apparatus comprising a pick head 66 advantageously provided with a plurality of points, this head being formed on the front end of a solenoid plunger 67, capable of being reciprocated in a solenoid coil 68 to which current may be supplied from any suitable source. The solenoid is fixed to a sliding carriage 69 arranged to slide along a track 70 secured at each end to the open frame and extending transversely thereto. This track is generally parallel to the face of the coal.

For convenience of operation the carriage is provided with eyes 71 to each of which is connected a wire cable or rope 72 each rope passing around a pulley 73 and leading rearward to any convenient point. By pulling one rope and letting out the other the carriage and with it the pick device may be traversed across the coal face. By supplying a suitable current to the solenoid coil the plunger will be reciprocated in a well known way and the pick points will be caused to pick the coal in the general direction of its stratification.

The pillar of coal will break easily along the plane of its strata when picked and will drop down. In practice the back-cutting is not carried entirely to the roof of the entry or drift as the large depending pillar thus formed would be difficult to handle. Usually the back-cutting is carried upward to a point where the depending pillar is of manageable size. Then the pick device is operated to break off the desired portion, and the latter is removed. The back-cutting is then carried farther until another suitable depending pillar is formed, whereupon this is picked loose and removed.

While the machine as thus far described will have many advantages over machines heretofore known, I prefer to combine with this cutting machine a mechanism for moving the coal as soon as it has been separated.

Furthermore, this removing mechanism is arranged to follow up the cutting mecha-

nism at any desired interval below the cutters so that when the coal is picked loose it will not drop very far and hence will not be seriously shattered.

5 In the present example the coal removing mechanism consists of a conveying mechanism which can follow the cutters into the undercutting and can convey the coal as it falls, to cars at the rear of the machine.

10 In the best embodiment of the invention the conveying mechanism comprises an apron with side walls and endless conveyor mechanism traveling over the apron from the front edge of the apron toward its rear end, the apron with its side walls being so shaped that it may occupy the open space inclosed by the open frame of the coal cutting mechanism. This conveying mechanism is mounted so that the front end of the apron may be moved up and down.

In the example illustrated the conveying mechanism is angularly movable about a transverse axis near the rear of the machine.

Referring more specifically to the details of construction of the example shown in the drawings, 75 indicates an apron whose outline conforms generally to the outline of the open frame, as will be clear from Fig. 2. That is, the apron is wide at the front end and narrows toward the rear in order that coal collected across substantially the entire front of the machine may be brought to a central point at the rear of the machine so as to be discharged readily into cars.

35 The rear portion of the apron is advantageously extended beyond the cutting mechanism, as shown in Fig. 2, and this portion may be rectangular in plan. An important feature of the invention consists in making the apron generally trough shaped at its intermediate portion, that is, the apron is concave on its upper surface along its intermediate portion.

45 The curvature of the concave portion is greatest about where the narrowed end of the intermediate portion joins the rectangular rear portion, this concavity transversely of the apron being illustrated in Fig. 5. From this cross-section the concavity flattens out toward the front and the rear ends so that most advantageously the front end of the apron is a flat surface. Also the rear end of the apron may be a flat surface. The upper face of the apron is advantageously provided with a plurality of grooves 77 to form guiding means for guiding a plurality of endless chains 78, Fig. 2.

55 If desired the lower face of the apron may be correspondingly grooved, as will be clear from Figs. 1 and 5.

The apron is provided with side walls, as indicated at 79.

60 At the rear end of the apron is arranged a chain drum 80 journaled in hangers carried by the side walls.

The upper surface of the drum may be tangential to the upper surface of the rear end of the apron.

70 The endless chains pass around the drum, thence forward under the apron, then up around the front edge of the apron, as shown in Fig. 2, and back along the upper surface of the apron to the drum. By rotating the drum the chains will be moved in such a direction that coal falling on the chains at the front of the apron will be moved toward the rear of the machine and discharged over the top of the drum. Owing to the concavity of the intermediate portion of the apron those chains at each side of the central chain, which as shown in Fig. 1 do not travel in a straight line from the front of the apron to the drum, will be prevented from jumping out of the guiding channels.

85 Any suitable means for driving the chain drum 80 may be employed. In the drawing, I have shown one journal of the drum provided with a worm wheel 81 engaged by a worm 82 on the shaft of an electric motor 83 which is secured to one of the side walls of the apron.

90 In order to mount the apron so that it can be given an angular movement up and down it is provided with curved saddles 84, Figs. 1 and 2, which rest on the curved surface of the hollow rear portion 1 of the cutting mechanism. The curvature of the saddles and the surfaces which support them may be concentric with the axis of the trunnions of the coal cutting mechanism. To hold the saddles against accidental displacement, suitable curved caps, 85, may be placed outside them, as indicated in Figs. 1 and 3, these caps being bolted to the journal stands 30 of the cutting mechanism.

100 In order that the conveying mechanism may be swung upward and downward with the coal cutting mechanism, after the latter has passed above a certain height, any suitable mechanism for causing the open frame to move the apron may be employed. In the present example the side walls of the apron are provided with outward extending lugs 86 which project over the open frame. Each lug is provided with an adjustable means for contacting with the open frame, as for example, the set screws 87, Figs. 1 and 2, each of which is threaded through the corresponding lug and may be provided with a lock nut, as shown.

110 When the coal cutting mechanism is down to its lowest position, the front end of the apron rests upon the floor, this end being suitably shaped for this purpose, as will be clear from Fig. 1. From the flat front end the apron rises to a point where its rear end is higher than the usual mine car.

120 As the cutters undercut the coal, the latter falls to the apron and will be withdrawn 130

from the undercutting by the rearward movement of the chains along the upper face of the apron.

When the undercutting has been completed, the cutting mechanism is swung upward gradually by fluid pressure in the ram cylinders, 55, so that the cutters at the top of the chain cut a back kerf with the corresponding side kerfs so as to isolate a depending pillar of coal from the coal mass. The chains in the apron carry off this coal.

When the cutting mechanism has been swung upward until its open frame contacts with the adjustable set screws 87 the cutting chain may be stopped and the pick device brought into operation to break loose the depending pillar of coal. This drops onto the front end of the apron, and is removed by the chains, which carry the coal up the incline and deposit it in the car.

It will be noted that the mass of coal which drops to the apron has only a short distance to fall and hence does not injure the apron. This distance may be varied by adjusting the set screws 87.

As soon as the chains have removed the coal, the cutting chains are again started in operation and the open frame is swung upward farther thus continuing the back cutting and isolating another depending pillar of coal. But as at the commencement of this back-cutting operation the open frame was in contact with the set screws 87, the upward movement of the cutting mechanism causes the conveying mechanism also to swing upward, following the cutting mechanism and below it.

The distance between the front end of the open frame and the front end of the apron below it, is also determined by the set screws 87 and is so limited that when, after further back-cutting, the depending pillar of coal is broken off by the pick device, the coal will not fall far enough to injure the apron.

It is an important advantage of the present invention that the machine is so constructed as first to undercut in the coal body itself, and then back-cut as well as side-cut the coal in a direction substantially transverse to the strata of the isolated depending pillar thus formed, because in this way a selective mining of the coal is possible.

That is to say, the back-cutting mechanism can be stopped at any height where the quality of the coal changes, or where it reaches an intervening strata of shale, clay or the like. The depending pillar may be broken off by the pick device and removed by the conveyer to a mine car. Then the back cutting of the poorer coal, shale or clay may be proceeded with and this may be picked loose and removed by the conveyer separately from the coal and may be dis-

charged either to a separate car or, in the case of slate or clay, may be deflected by a chute or board to the side of the mine tracks. So far as I am aware, no machine heretofore employed has permitted this selective mining of coal.

A further important advantage is that as the coal can be readily picked loose along its cleavage planes; no necessity exists for blasting and therefore the coal is not shattered, but is solid and can be mined in large lumps so that it can be shipped long distances and still will reach its destination in the condition of high grade coal, instead of in the form of low priced slack, as occurs with shattered blocks of coal mined with explosives.

An important feature of the coal cutting machine illustrated is that instead of removing and replacing the cutters one by one from the chain while the latter is in the machine, as for example for sharpening the cutters, I may readily uncouple and withdraw the chain with its attached cutters, insert another chain with cutters, couple the same and allow the machine to proceed with its operation. As it requires considerable time to remove and replace the cutters in a cutting chain, if this be done with the chain in the machine, the idleness of the latter would constitute a great loss.

In the machine illustrated in the drawing, the chain is removed by uncoupling the chain at a point within the hollow rear portion 1 intermediate the two sprocket wheels, where all the slack of the chain exists.

The substitute chain may have one end coupled to the right hand end of the uncoupled chain to be replaced while the other end of the substitute chain is connected to the left hand end of the chain.

The sprocket wheels may now be slowly rotated, whereby the substitute chain will be drawn into place in the tracks of the open frame and the old chain will be pulled out of the machine. Thereupon the ends of the substitute chain may be coupled together and the machine is ready for use.

For the purpose of enabling this operation to be performed quickly and conveniently, I provide an extension piece 90 which has a chain track in each side of it, as shown in Fig. 11. The front ends of these tracks diverge to the left and right respectively as shown in Fig. 10 and are arranged to enter the opening in the rear wall of the hollow rear portion 1 of the cutting machine.

The rear end of the extension piece is provided with a chain wheel 91 around which the chain may turn.

Suitable means is provided for detachably connecting the extension piece to the rear of the machine. In the example shown the rear of the machine has a bracket 92 on which the front portion of the extension

piece may rest and to which it may be secured by screws.

The rear end of the extension piece may be suitably supported. For example it may rest on the floor of the mine, in which case the open frame is swung up to a position where its tracks are in one inclined plane with the tracks of the extension piece or the extension piece may be brought up into place and supported on a car whose height is suitable, in which case the open frame may be brought to about a horizontal position.

When it is desired to substitute one chain for another the extension piece is provided with the substitute chain which is fed into place by hand until the two ends of the substitute chain project from the front end of the extension piece.

Then the old chain is uncoupled, the ends thereof coupled to the corresponding ends of the substitute chain and the sprocket wheels 21 slowly rotated. In this way the old chain is drawn out onto the tracks of the extension piece and the substitute chain is drawn into the tracks of the open frame.

The ends of the old chain will now be projecting from the front ends of the extension piece. They are uncoupled and the extension piece with the old chain is removed from the machine. The ends of the substitute chain are coupled together and the machine is ready for operation. The old chain may be repaired at leisure and replaced in the extension piece ready for the next substitution.

What I claim is:—

1. In a mining machine, the combination, with cutters arranged to cut a kerf in a substantially horizontal direction, of cutters arranged to cut in an upward direction from said horizontal kerf, a pair of separated side kerfs and a back kerf connecting said side kerfs, means for moving said last mentioned cutters upward during the cutting operation whereby a depending pillar of mineral is formed, and means for operating said cutters.

2. In a mining machine, the combination, with cutters arranged to cut a kerf in a substantially horizontal direction, of cutters arranged to cut in an upward direction from said horizontal kerf and simultaneously, a pair of separated side kerfs and a back kerf connecting said side kerfs, means for moving said last mentioned cutters upward during the cutting operation whereby a depending pillar of mineral is formed, and means for operating said cutters.

3. In a mining machine, the combination, with cutters arranged to cut a kerf in a substantially horizontal direction, of cutters arranged to cut in an upward direction from said horizontal kerf, a pair of separated side kerfs, and a back kerf connect-

ing said side kerfs, an open frame carrying said last mentioned cutters and of such dimensions as to enter the upward kerfs, means for raising said frame into the upward kerfs during the cutting operation, whereby a depending pillar of mineral extending through the frame is formed, and means for operating said cutters.

4. In a mining machine, the combination, with cutters arranged to cut a kerf in a substantially horizontal direction, of cutters arranged to cut in an upward direction from said horizontal kerf and simultaneously, a pair of separated side kerfs, and a back kerf connecting said side kerfs, an open frame carrying said last mentioned cutters and of such dimensions as to enter the upward kerfs, means for raising said frame into the upward kerfs during the cutting operation, whereby a depending pillar of mineral extending through the frame is formed, and means for operating said cutters.

5. In a mining machine, the combination, with an open frame, of two sets of cutters, carried by said frame, one set being arranged to cut a kerf into which the front portion of the frame can enter in generally horizontal direction and the other set being arranged to cut a kerf into which the front portion of the frame can enter in an upward direction, means for operating the cutters, means for moving the frame forward and means for moving the front portion of the frame upward.

6. In a mining machine, the combination, with cutters arranged to cut a kerf in a substantially horizontal direction, of cutters arranged to cut in an upward direction from said horizontal kerf, a pair of side kerfs and a back kerf inclosing a pillar of mineral substantially as described, and removing means arranged to be located in the horizontal kerf while the side and back kerfs are being cut, to catch and carry off the falling mineral.

7. In a mining machine, the combination, with cutters arranged to cut a kerf in a substantially horizontal direction, of cutters arranged to cut simultaneously in an upward direction from said horizontal kerf, a pair of side kerfs and a back kerf inclosing a depending pillar of mineral substantially as described, and removing means arranged to be located in the horizontal kerf while the side and back kerfs are being cut, to catch and carry off the falling mineral.

8. In a mining machine, the combination, with an open frame, and two sets of cutters carried by said frame, one set being arranged to cut a kerf into which the front portion of the frame may enter in a generally horizontal direction, the other set being arranged to cut a kerf into which the front portion of the frame can enter in an

upward direction, of a mineral removing means arranged to occupy the space inclosed by the open frame to catch and carry off the mineral, means for moving the frame and mineral removing means forward and means for moving the front portion of the frame upward.

9. In a mining machine, the combination, with means for cutting a kerf in a substantially horizontal direction, and cutters arranged to cut, in an upward direction, a pair of side kerfs and a back kerf inclosing a depending pillar of mineral substantially as described, of removing means arranged to enter beneath the pillar of mineral to catch and carry off the mineral, and means for breaking the depending pillar of mineral whereby the separated portion may be caught and removed by the removing means.

10. In a mining machine, the combination, with cutters arranged to cut a kerf in a substantially horizontal direction, cutters arranged to cut simultaneously, in an upward direction, a pair of side kerfs and a back kerf communicating therewith, and mineral removing means arranged to enter the horizontal kerf, of means for separating the mineral between said kerfs along its cleavage planes, whereby it is dropped into the removing means.

11. In a mining machine, the combination, with an open frame and two sets of cutters carried by said frame, one set being arranged to cut a kerf into which the front portion of the frame may enter in a generally horizontal direction, the other set being arranged to cut a kerf into which the front portion of the frame can enter in an upward direction, of a mineral removing means arranged to occupy the space inclosed by the open frame to catch and carry off the mineral, means above said removing means for separating the mineral between the kerfs along its cleavage planes, whereby it is dropped to the mineral removing means, means for moving the frame and the mineral removing means forward, and means for moving the front portion of the frame upward.

12. In a mining machine, the combination, with cutters arranged to cut a kerf in the general direction of the floor of the mine to form an undercut, and cutters arranged to cut, in an upward direction, a pair of side kerfs and a back kerf communicating therewith, of a conveyer mechanism whose front is arranged to enter the undercut, and means for moving the front of the conveyer mechanism upward with the cutting mechanism at an interval below the same.

13. In a mining machine, the combination, with a frame having two track surfaces at an angle to each other, of a cutting mechanism comprising a plurality of connected links arranged to run in contact with both

track surfaces and carrying two sets of cutters, one set being opposite one track surface and the other set opposite the other track surface.

14. In a mining machine, the combination, with a frame having two track surfaces at an angle to each other, each track surface carrying a rib projecting transversely to the respective track-surface, of a cutting mechanism comprising a plurality of connected links arranged to run in contact with both track surfaces beneath said ribs, and carrying two sets of cutters, one set being opposite one track-surface and the other set opposite the other track-surface.

15. In a mining machine, the combination, with a chain comprising a plurality of cutter-carrying links connected by chain wheel links, cutters secured in the cutter carrying links and arranged in two sets, one set of cutters being arranged to cut in a direction transverse to the direction in which the other set cuts, of chain wheels engaging the chain wheel links, means for supporting and guiding the chain, and means for driving the chain wheels.

16. In a mining machine, the combination, with an open frame pivoted to swing about an axis transverse to the vertical and longitudinal axes of the machine, of means for cutting upward and means for cutting forward carried by said frame, and means for swinging the frame about its axis.

17. In a mining machine, the combination, with an open frame pivoted to swing about an axis transverse to the vertical and longitudinal axes of the machine, of means for cutting upward and means for cutting forward carried by said frame, fluid-pressure means for moving the frame forward and fluid pressure means for swinging the frame in an upward direction.

18. In a mining machine, the combination, with an open frame pivoted to swing about an axis transverse to the vertical and longitudinal axes of the machine, of means for cutting upward and means for cutting forward carried by said frame, means for swinging the frame about its axis, and adjustable means for limiting the downward movement of the frame.

19. In a mining machine, the combination, with a cutting mechanism arranged to swing about an axis transverse to the vertical and longitudinal axes of the machine, of a conveying mechanism arranged to be located below the cutting mechanism, said conveying mechanism being arranged to swing about an axis transverse to the vertical and longitudinal axes of the machine at a distance above the floor of the mine.

20. In a mining machine, the combination, with a cutting mechanism and a conveying mechanism, both of which are angularly movable in an up and down direction, of

means for swinging the cutting mechanism and means whereby the cutting mechanism may swing the conveying mechanism.

21. A device of the character described
5 comprising a supporting frame, standards carried by said supporting frame, a cutter frame pivotally mounted in said standards,
a cutter chain carried by said cutter frame,
10 a plurality of cutters carried by said cutter chain and arranged to cut in horizontal and vertical planes, means for actuating said cutter chain, fluid means for forcing the cutter
frame to cut an underkerf in a horizontal
plane, fluid means arranged to force said
15 cutter frame to cut a back and side sheer wall kerf from said underkerf to the roof of an entry, a conveyer frame carried by said standards, a platform carried by said conveyer frame, a plurality of grooves

formed in said platform, a plurality of con- 20
veyer chains operative in said grooves, means for actuating said conveyer chains, means arranged to cause said conveyer to travel in horizontal and vertical planes in the path of
the cutter frame, a supporting plate carried 25
by said cutter frame, a tool mounted on said supporting plate, adjustable transversely of said cutter frame and arranged to break down the freed material as passed by said
cutter frame, and means for actuating said 30
tool.

In testimony whereof, I have hereunto set my hand in the presence of two subscribing witnesses.

WILLIAM M. THOMAS.

Witnesses:

PHILIP N. TILDEN,
JAMES F. DONOVAN.