C. O. & J. F. BEMIES.

MINING MACHINERY.

APPLICATION FILED NOV. 7, 1910.

1,127,395.

Patented Feb. 9, 1915.

4 SHEETS—SHEET 1.

FIG. 1.

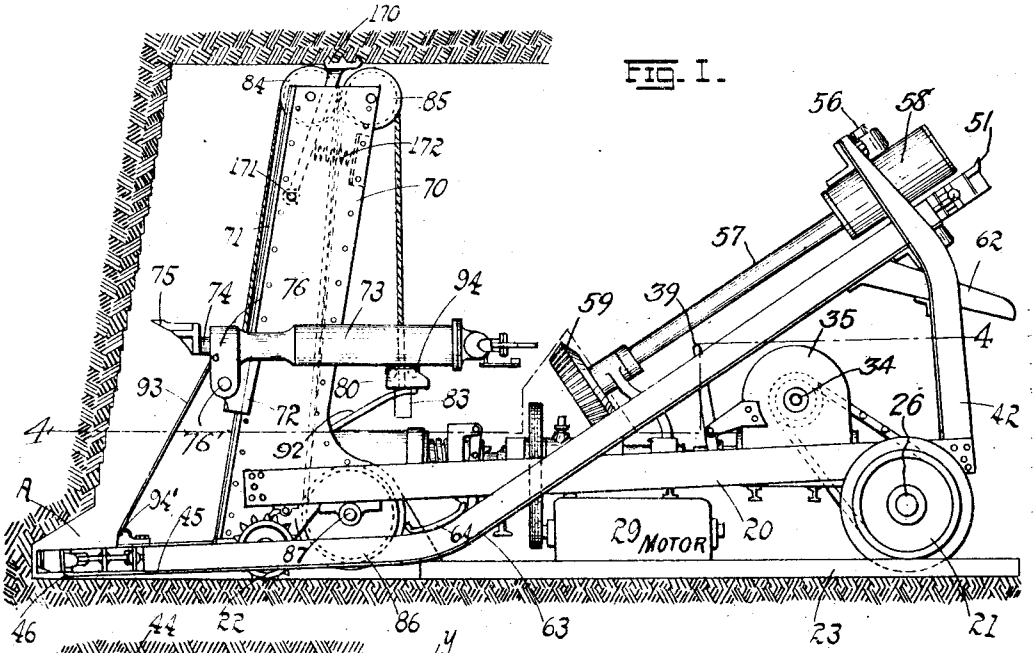


FIG. 2.

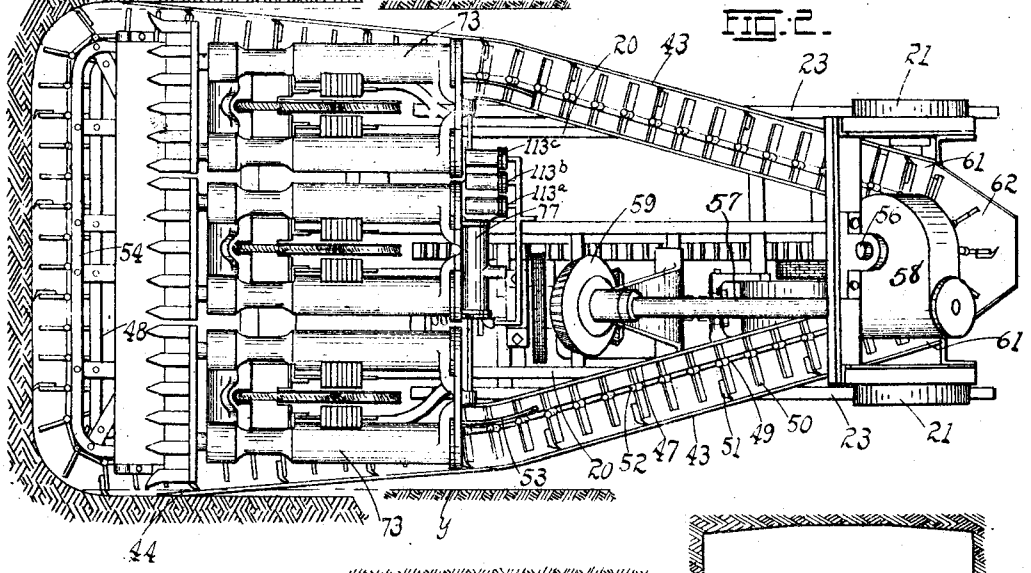


FIG. 13.

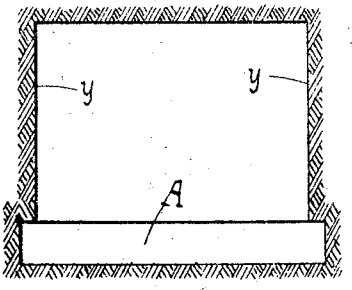


FIG. 14.



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4 SHEETS—SHEET 3.

FIG. 3.

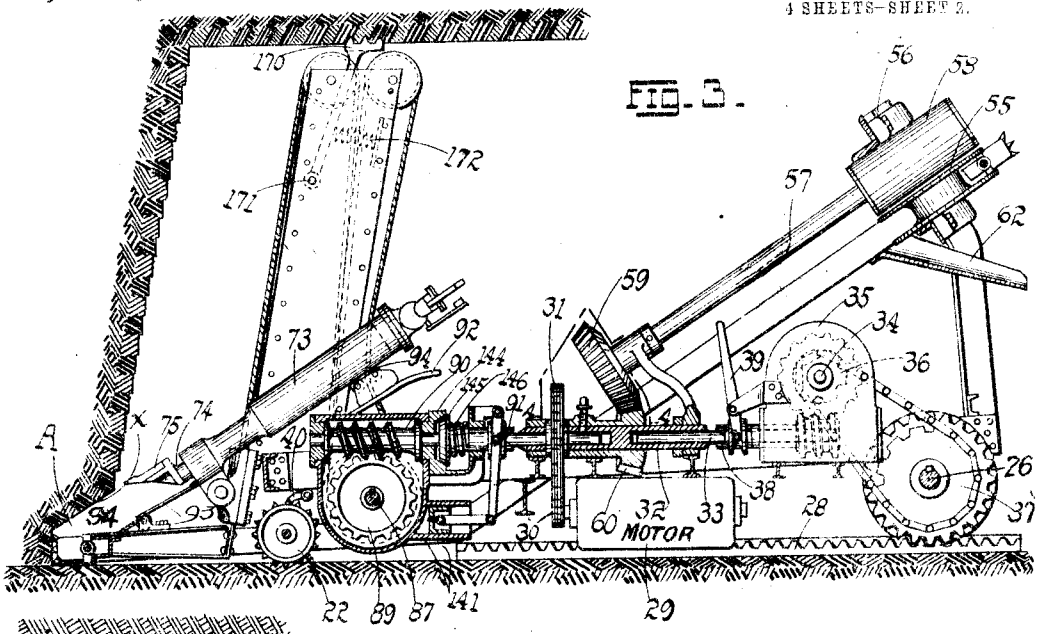
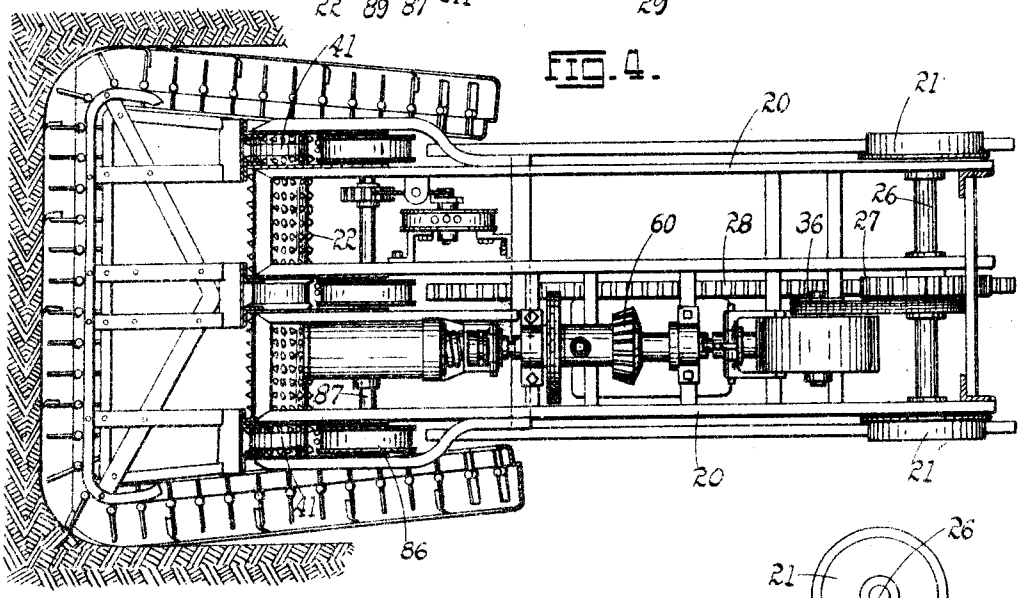


FIG. 4.



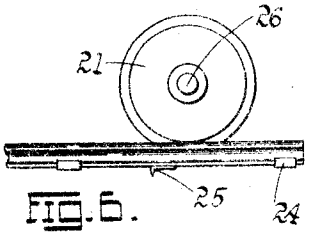


FIG. 6.

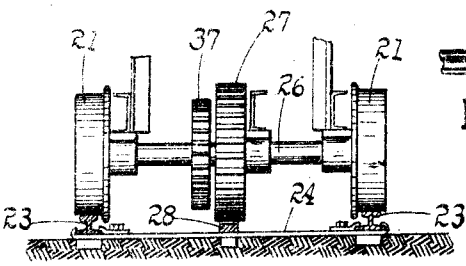


FIG. 5.

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4 SHEETS-SHEET 3

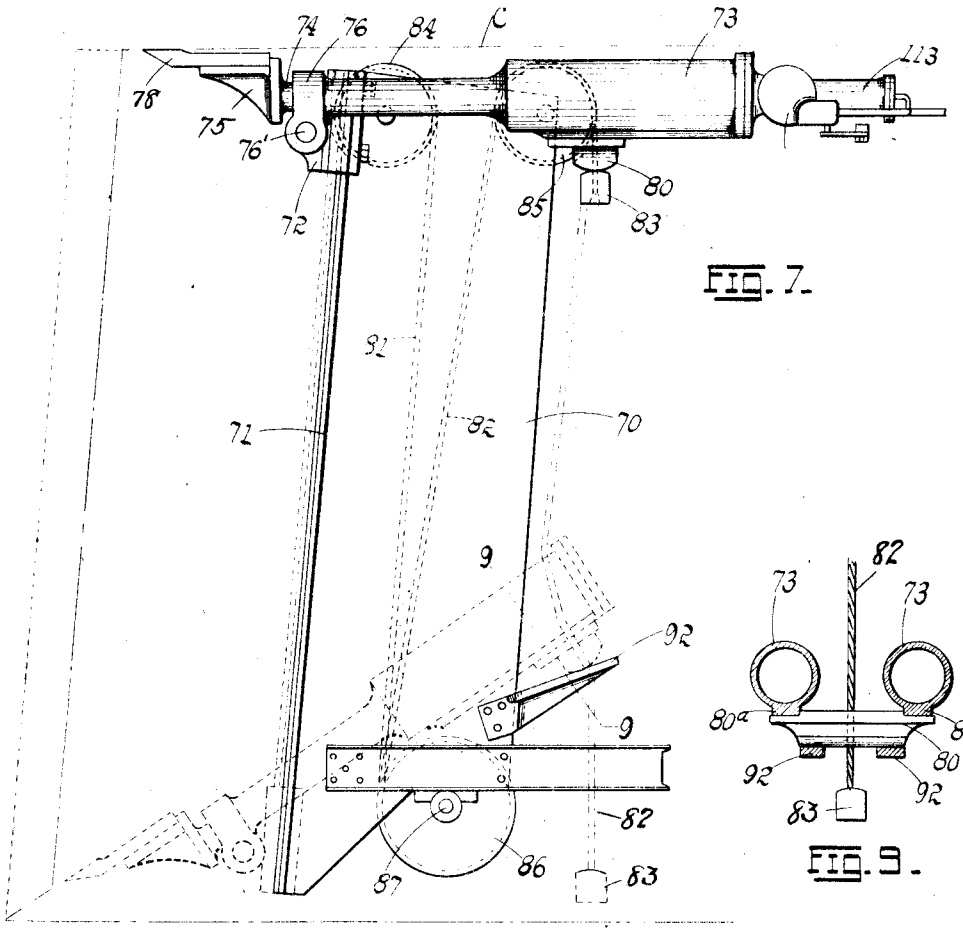


FIG. 7.

FIG. 9.

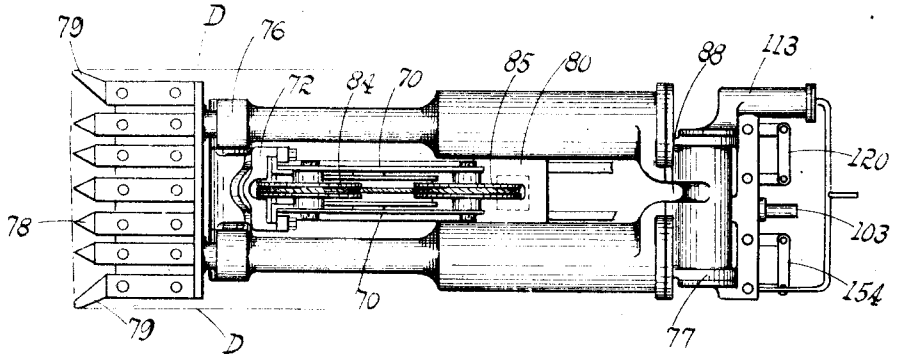


FIG. 8.

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APPLICATION FILED NOV. 7, 1910.

1,127,395.

Patented Feb. 9, 1915.

4 SHEETS—SHEET 4.

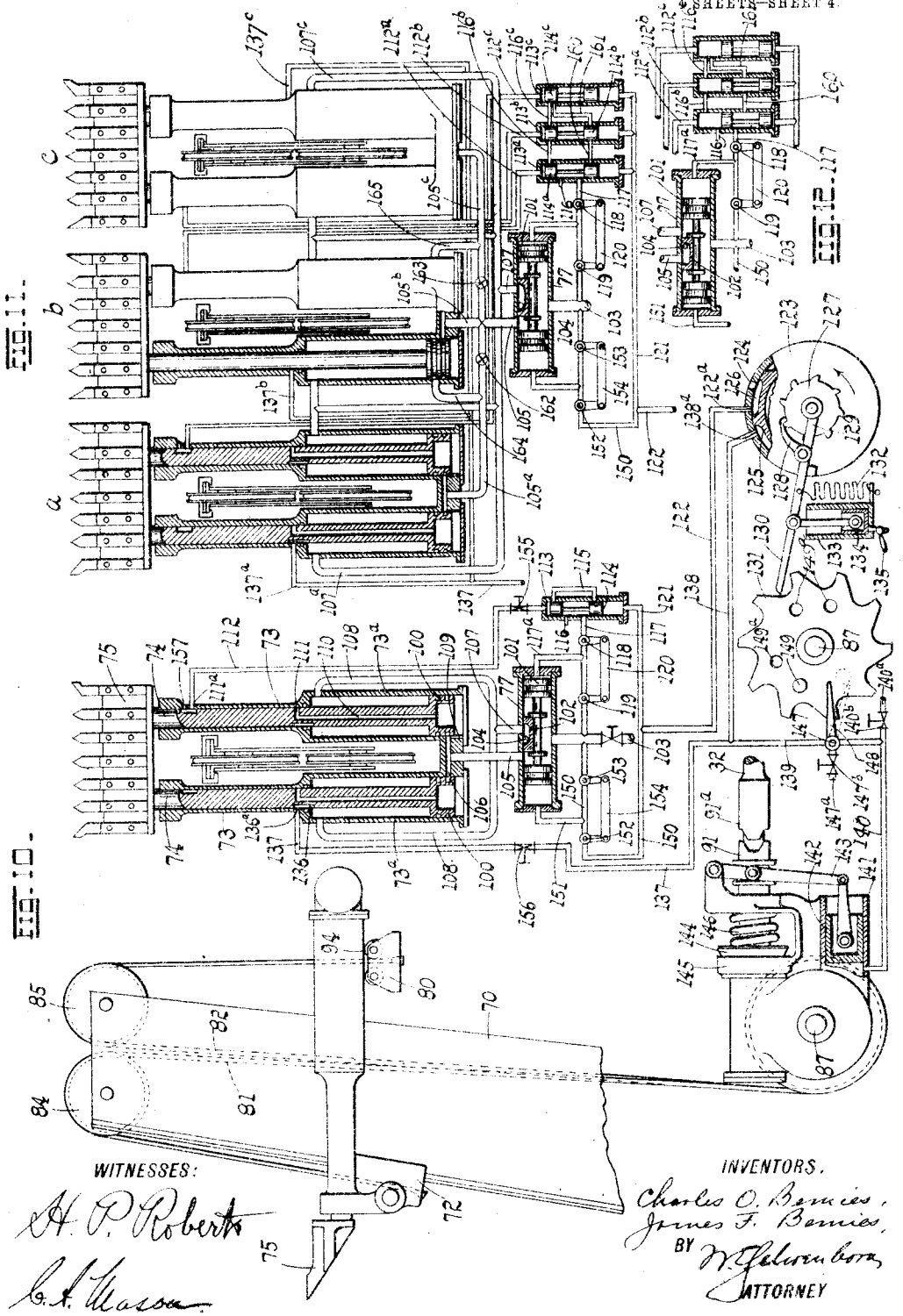


FIG. 11.

FIG. 12.

FIG. 10.

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MINING MACHINERY.

1,127,395. Specification of Letters Patent. Patented Feb. 9, 1915.

Application filed November 7, 1910. Serial No. 591,031.

To all whom it may concern:

Be it known that we, (1) CHARLES O. BEMIES and (2) JAMES F. BEMIES, citizens of the United States, residing at (1) McClellandtown and (2) New York, in the counties of (1) Fayette and (2) New York and States of (1) Pennsylvania and (2) New York, have invented certain new and useful Improvements in Mining Machinery, of which the following is a specification.

This invention relates to mining machines, and more particularly to the class of machines which are used for mining coal, and especially bituminous coal.

The objects of this invention are, to provide a mechanism that will undercut the coal the full width of the chamber, in one continuous operation and convey the coal cut to a point of discharge at the extreme rear of the machine, in one continuous and endless combined cutter and conveyer; to construct a machine which will undercut the coal so that it can be easily sheared or sliced down the full width of the chamber and combine with such undercutting and conveying mechanism a shearing down mechanism which will shear down the coal the full width of the chamber in one stroke of the piston; to construct a machine which will shear down the coal the full width of the chamber, in predetermined and uniform sections of regular thickness, width and length; to construct a machine in which the combined undercutting and conveying and shearing down mechanism is fed against the face of the coal at the same time, all parts remaining in the same relation to each other and always feeding in the cutting direction, and attached to the same frame or support; to construct a machine wherein no one mechanism has to be moved out of the way of another mechanism, all parts moving in the direction of the work at all times.

Further objects will appear from the detail description in connection with the accompanying drawings, in which:—

Figure 1 is a side elevation of a machine embodying this invention, Fig. 2 is a plan, Fig. 3 is a vertical longitudinal section, parts being shown in elevation, Fig. 4 is a section on line 4—4 Figs. 1 and 3 parts being shown in elevation and the shearing down mechanism being removed. Fig. 5 is a detail rear elevation showing the mechanism for feeding the machine against the face of the coal. Fig. 6 is a detail side elevation showing similar mechanism. Fig. 7 is a detail elevation of the shearing down mechanism the cutter being shown in different positions. Fig. 8 is a plan of Fig. 7. Fig. 9 is a detail section on line 9—9 Fig. 7. Fig. 10 is a diagrammatical view showing one of the cutters, its motor, feeding mechanism and controlling means. Fig. 11 is a diagrammatical view showing the multiple unit cutter and controlling mechanism. Fig. 12 is a detail showing the controller in a different position, and Figs. 13 and 14 are sections showing the forms of rooms which can be cut.

Previously in mining coal by machinery where the blasting is eliminated, the coal has to be undercut for a certain distance by some form of undercutting mechanism. The most common form being a cutter-chain, that is, a chain with cutters attached which travels across the face of the coal usually a section at a time, until the proper depth has been cut. This leaves the cut coal spread along the floor of the chamber and has to be removed by hand, and is a waste product. After undercutting the coal the undercutting mechanism has to be drawn back to make room for a conveyer to collect the coal broken down into it and the coal thus broken down is conveyed to a point of discharge by transferring once or twice, making two or more different conveyers necessary before it reaches a point of discharge. The conveyers also have to be shifted from side to side of the chamber as each section is cut. After undercutting, the coal is broken down into the conveyer by a breaking down mechanism, the most common form consisting of a drill or punch, although in some cases, a saw or a class of cutters similar to the undercutting chain is used. The method usually followed is to drill the coal full of holes, this being waste product, and then breaking the coal down by separate means in irregular and uneven shapes. In some cases the drilling is omitted, and the coal is punched down, which also leaves the coal uneven and irregular in shape. These methods consume considerable time in lost motions, by moving one device out of the way of another device, and produce a great amount of dust and waste product, and uneven shapes.

It is to overcome the objections of the previous machines that this new and novel mining machine is invented.

The machine herein described first undercuts the coal with a new combined cutter and conveyer, wherein the cutters are mounted upon conveyer flights, and to distinguish this new form of cutter from the common form of cutter-chain, we will call it a cutter conveyer and will so use the term in future explanation of the undercutting device. This cutter conveyer not only undercuts the coal but conveys the coal undercut to a point of discharge, on cars or other conveyances, at the extreme rear of the machine, in one continuous operation as the cutter conveyer is endless. The shearing down mechanism is decidedly novel in that it shears or slices the coal down in predetermined and uniform sections of regulated thickness, width and length, with a minimum amount of dust and waste product for the maximum amount of coal sheared down. The undercutting and shearing down mechanism are combined in one frame and the entire frame is fed forward. The machine being fed forward as a unit, obviates the necessity of one operation overlapping another or of moving one mechanism out of the way of another. The machine and all its different mechanisms always feeds in the direction of the cut or toward the face of the coal. This machine comprises many new and novel features over the previous forms of machines in that it mines the coal and conveys it to cars in a minimum number of operations, saving time, labor and material, besides mining the coal in desirable shapes. With these ends in view the machine will now be described so that any one skilled in the art can understand its operation.

The machine comprises a frame made up of structural steel the main side members of which are designated by 20, and which are suitably braced by cross tie and strut members as shown in the drawing. The frame is supported by a pair of flanged wheels 21 and a toothed roller 22. The wheels are supported by the rails 23 of a track which rest upon cross ties 24 on the floor of the room, the track being preferably provided with spurs 25 which prevent rearward movement of the track and the machine when in place thereon. The shaft 26 for the wheels has mounted thereon a spur wheel 27 which meshes with a rack 28 on the crossties 24 for the purpose of feeding the machine against the face of the coal. A driving motor 29 is supported on the frame so as to move therewith and transmits power by means of chain and pulleys 30, 31 to a main shaft 32. The motor is preferably an electric motor and takes its power from a trolley or third rail as is common in mining practice, but it may as well be another type of motor, for instance, internal combustion or compressed air or steam.

A shaft 33 is mounted for rotation in shaft 32 and has mounted on its right hand end a worm which meshes with a worm wheel on shaft 34. Both worm and worm wheel are mounted in the casing 35 on the frame. The shaft 34 has secured thereto a sprocket 36 which is connected to a sprocket 37 on shaft 26. A sliding clutch 38 operated by a handle 39 is arranged to connect shafts 32 and 33 so that the gear 27 is driven from the main shaft 32 to feed the entire frame and the parts connected thereto forward and backward, the reversal of direction being accomplished by simply reversing the motor. In this construction the gear 27 and sprocket 37 are rigid with shaft 26, it is obvious however that they may be mounted on a sleeve or bushing loosely on the shaft. The toothed roller 22 engages the floor of the room directly and is restrained against backward movement by a pawl 40 which engages the teeth. The roller is preferably in sections as shown and near each end a row of teeth are omitted so that the roller can engage the track the teeth on each side forming the flanges.

The undercutting mechanism.—A pair of conveyer troughs 43 extend rearwardly and upwardly and are supported at their front end on the main frame and at the rear by posts 42. These conveyer troughs comprise a bottom and sides the outer sides of which stop or are cut off at 44 and beveled as shown. The bottoms 45 also stop or are cut off at 46 near the front of the machine. The inside walls extend from the rear to the front and merge into a front wall 48 which extends across the front of the machine, the corners where the walls merge being rounded as shown in the drawings. A cutter conveyer 49 of the chain or link type slides in the trough and is provided with flights 50. Some of the flights are provided with cutters 51 for the purpose of undercutting the coal in a manner hereinafter to be described. Rollers 52 are mounted on the flights and bear against guides 53 and 54 on the frame, the guides 52 and 53 merging to form rounded corners as shown in the drawings. The conveyer is endless and passes over a sprocket or driving wheel 55 which is provided with teeth to engage the rollers 52 on the flights. This wheel is mounted upon a shaft 56 having a worm wheel which meshes with a worm on shaft 57, the worm and wheel being mounted in the casing 58. The shaft 57 is driven by bevel gears 59 and 60 on the shafts 57 and 32 respectively. The conveyer troughs discharge at the points 61, 61 into a chute 62 which delivers the coal to suitable vehicles or another conveyer. Since the troughs are cut off at the front end as shown at 44 and 46, the cutters project be-

yond the same, and the troughs and cutters extend to the floor level at the front end. If now the machine is moved against the face of the coal as shown in the drawings and the clutch 38 thrown in and motor 29 started, the conveyer and the cutters thereon will be moved along the face of the coal and the entire machine will be moved inward. This will cause the cutters 51 to undercut the coal as shown at A and the coal as cut is conveyed rearwardly and discharged into the chute 62. After the coal has been undercut, it can then be sheared down by the shearing down mechanism in the manner hereinafter to be described. At the point 63 where the conveyer trough curves upwardly, a guide 64 is provided which keeps the flights down on the bottom of the trough.

The shearing down mechanism.—A series of pairs of rearwardly inclined structural steel standards 70 are mounted on the main frame provided with guides 71 forming rearwardly inclined guideways. Since the construction of each unit is the same only one will be described in detail. The guideway 71 has mounted to slide thereon a crosshead 72 which supports the front end of a pair of cylinders 73 the piston rods 74 of which are rigidly secured to a single cutter head 75. The cylinders are rigidly connected at their front end by a cross member 76 which is pivotally mounted on the crosshead 72 at 76'. The rear ends of the cylinders are rigidly connected by a valve casing 77. By this construction the cylinders straddle the guiding standards and form a rigid unitary structure. The cutter head is also prevented from turning and no spline or the like is necessary. The cutter head is provided with a number of teeth 78, 79 forming a serrated edged cutter the teeth being secured to the head by bolts or riveting, but any other form of serrated cutter may also be used if so desired. The cutting face of the cutter extends outside of the outside limits of the cylinder when it is in horizontal position and the outside teeth 79 are curved outwardly for the same reason. This is shown in Figs. 7 and 8 where the outside limits of the cutter faces are indicated by lines C and D. In this way the cutters can cut close to the roof and walls of the room, and saves the labor of hand picking walls and roof to allow for free passage forward of whole machine. A cross member 80 extends across the rear ends of the cylinders and slides on ways 80^a thereon. Cables 81, 82 pass over pulleys 84, 85 mounted between the side members 70 and are connected to the cross-head 72 and cross member 80 respectively. The cable 81 is fixedly secured at its end to cross head 72, but cable 82 passes loosely through a hole in cross member 80 and has fastened at its end a weight and stop 83. The cables are fastened to and wind on a drum 86, the shaft 87 of which is mounted in the main frame and has secured to it a worm wheel 89 meshing with a worm 90 which is adapted to be clutched to shaft 32 by a clutch 91. A pair of stops 92 are mounted on the standards 70 and are adapted to be engaged by the cross members 80 on the rear ends of the cylinders.

By means of the above mechanism the cutter can be raised and lowered and when near its lowest position the cutter will incline as shown in Figs. 3 and 7. As the cutter is lowered, the cross member 80 will strike the stops 92 arresting the rear end of the cutter but its forward end is free to move down and preferably its weight is assisted by auxiliary tension means such as a cable 93 fastened to the crosshead 72 and secured to a small torsional drum 94', so that it will be wound up when the crosshead is raised. When the rear end of the cutter is arrested the weight 83 will cause the cable to pass on keeping it taut, and this weight or stop will not come into play again to raise the rear end until the front end is horizontal. A slot or groove 88 is provided for the cable 82 when the cutter is inclined. In the construction shown in Figs. 1 and 3 the cross member 80 is provided with antifriction rolls 94.

The motor and controlling mechanism.— The motor for driving the shearing down cutter is preferably of the fluid pressure type and the cutters are preferably of multiple unit construction, the units of which are however governed by a single controller. Fig. 10 shows diagrammatically a single unit construction, while Fig. 11 shows the preferred multiple unit construction. Referring first to Fig. 10, the cylinders 73^a have working therein pistons 100 connected to the piston rods 74. A main controller cylinder 77 is provided with a balanced piston valve 101 the stem of which carries an ordinary D slide valve 102 which is adapted to control the admission of motive fluid, as compressed air, from the main supply pipe 103, and the exhaust to the exhaust pipe 104. A pipe 105 leads from the controller 77 to the lower ends of the cylinders 73^a. The pistons when in their lowest position cover the ports 106 connected to pipe 105, but a groove 109 is formed in one or both cylinders to permit starting of the pistons in their forward stroke. A pipe 107 has branches 108 leading to the upper ends of the cylinders. The right piston and rod have formed therein a channel 110 leading to a port 111 which is adapted to aline with a port 111^a connected with pipe 112. This pipe is connected with the upper end of a supplemental controller cylinder 113 provided with a balanced piston 114. A by-pass pipe 115 connects two separated ports in the cylinder which ports are however normally closed by the heads of valve 114, and

116 is an exhaust pipe. A pipe 117 is connected with a cylinder 113 and the main 103 and is provided with two valves 118 and 119 the stems of which are connected by a link 120. A branch pipe 117ª connects 117 with the right hand end of cylinder 77, and valve 118 is normally open while 119 is normally closed, so that the right hand end of cylinder 77 is normally connected with cylinder 113 but normally disconnected from main 103. A pipe 121 is connected to the lower end of cylinder 113 and is connected by another pipe 122 to a valve casing 123. This valve casing is provided with an exhaust port 124 and a rotatable valve 125 provided with recesses 126. The shaft of this valve has mounted thereon a ratchet wheel 127 adapted to be engaged by a pawl 128 on a pawl carrier 129 swinging about the valve shaft as an axis. The tail 130 of the pawl carrier is adapted to be engaged by the teeth on a wheel 131 on shaft 87 to operate the pawl carrier in one direction, and a spring 132 moves the pawl carrier in the opposite direction. The return movement of the pawl carrier as its tail snaps past the teeth is steadied and dampened by a dash pot comprising a cylinder 133, a piston 134 connected to the pawl carrier and a regulating valve 135 in the cylinder. The left piston rod is provided with a groove or port adapted to aline with a port 136ª connected to pipe 137 and with the upper end of the cylinder when the pistons are in their lowest position. A branch pipe 138 leads from pipe 137 to a port 138ª in the valve casing 123. A second branch 139 connects with a pipe 140 leading to a cylinder 141 provided with a piston 142 which is connected to a lever 143 pivoted on the frame. The lever is adapted to shift the clutch member 91 into and out of engagement with the coöperating clutch member 91ª on shaft 32. The clutch member 91 is in the form of a sleeve splined on the shaft of the worm 90, and carries a brake cone 144 which is adapted to coöperate with a stationary brake cone 145 on the worm casing. A spring 146 normally throws the brake cones into engagement. A valve 147 is located in the branch 139 and the stem 148 of this valve is adapted to be struck by a pin 149 on the wheel 131 so as to move the valve to closed position when the wheel has been moved a predetermined number of steps. A main supply pipe 140ª is connected to pipe 140 and is provided with a valve 140ᵇ which is normally closed. A pipe 150 connects the pipe 122 with the main 103 and by a branch pipe 151 with the left hand end of the cylinder 77. Valves 152 and 153 are located in the pipe 150, and valve 152 is normally open while 153 is normally closed, so that pipe 122 is normally connected with the left end of cylinder 77, while both the left end of cylinder 77 and pipe 122 are normally disconnected from main 103. The valves 152 and 153 are connected by a link 154 so that they can be controlled in unison. The pipes 112 and 137 are provided with hand valves 155 and 156 for a purpose hereinafter to be described. The right cylinder is provided above port 111ª with an exhaust port 157. The ports and passages in both cylinders and pistons are preferably duplicated so that the parts will be interchangeable, but only one set need be provided for one cylinder. In this way the ports in one cylinder and piston control one mechanism while those in the other cylinder control another mechanism.

The operation will now be described.

Suppose the parts are in the position shown in Fig. 10, valves 118, 152, 147, 155 and 156 being open, and valves 119, 153, and 140ᵇ being closed. If now motive fluid such as compressed air is admitted to main 103, this air will flow into cylinder 77 between the heads of valve 101, and from thence to the lower ends of cylinders 73ª through pipe 105 driving the pistons outwardly on their working stroke. As the pistons come to the end of their working stroke, port 111 will aline with port 111ª so that the air will be admitted to pipe 112 and to the upper end of cylinder 113 driving the piston valve 114 down, the air below the valve exhausting through pipes 121 and 122 to exhaust 124. This movement of valve 114 will cause pipe 112 to be connected with the right end of cylinder 77 through pipes 115, 117 and 117ª, thereby driving the piston valve 101 to the extreme left as shown in Fig. 12, the air at the left of the piston exhausting through pipes 151, 150 and 122 to exhaust 124. This movement of piston valve 101 will connect the lower ends of the cylinders 73ª with the exhaust pipe 104 and the upper ends with the inlet main 103, so that air is admitted through pipes 107 and 108 to the upper ends of cylinders 73ª to drive the pistons 100 and the cutter head back. As the pistons near the end of their return stroke, the groove or port 136 will connect the port 136ª with the upper end of the left cylinder so that air is admitted to the rear of piston 142 through pipes 137, 139 and 140, port 138ª being at this time closed to the exhaust 124. This will cause the piston 142 to be driven outward to release brake 144 and clutch 91 with 91ª, against the tension of spring 146. The worm 90 will now be driven from shaft 32 thereby rotating shaft 87 and drums 86 to wind up cables 81 and 82 so as to raise or feed the cutting mechanism vertically. The rotation of shaft 87 and the toothed wheel 131 thereon will cause the teeth on the wheel to move the pawl carrier 129 and then allow it to snap over and be released so that the spring 132 pulls the pawl carrier down to rotate the valve one step. One step in this

case is a movement of the succeeding recess 126 in the valve disk 125 to the position occupied by the preceding one. During this movement the port 138[a] will be connected to the port 122[a] to connect pipe 137 with the left end of cylinder 77 through pipes 138, 122 and 151, and with the bottom of cylinder 113 through pipes 138, 122 and 121. Since the upper end of cylinder 113 is now connected with the exhaust port 157 piston 114 will be driven up. This movement of piston 114 will connect the right end of cylinder 77 with the exhaust pipe 116 so that the piston 101 is driven to the right to position shown in Fig. 10 by the pressure from pipe 151. This movement of the piston 101 will again connect the pipe 107 and the rear end of the cylinders 73[a] with the exhaust pipe 104. The cylinder 141 is then also connected with the exhaust so that the spring 144 will release clutch 91 and apply brake 144 to stop the feeding movement of the cutting mechanism. The parts are so timed that by the time the valve disk 125 has been moved to a new position the piston valve 101 has been moved back to its original position to connect the upper ends of cylinders 73[a], and cylinder 141 with the exhaust and the lower ends of cylinders 73[a] with the supply main, so that the parts are in position to start another series of operations, the cutting mechanism being fed step by step at the end of each backward stroke of the cutter head. After the cutting mechanism has been fed a predetermined number of steps, *i. e.*, has reached the roof the pin 149 engages the arm 148 to close the pipe 140 and cylinder 141 to the pipe 139 and open it to the exhaust pipe 147[a]. This pin 149 is preferably adjustable so that the position where the feeding is to be stopped can be varied. This can be accomplished by providing the wheel with a series of holes 149[a] in any one of which the pin can be inserted.

The cutting mechanism can be let down in the following manner: The valve 147 is placed in dotted position where it was left by the pin 149, valve 147[b] in exhaust pipe 147[a] is closed and pawl carrier 129 lifted so that the tail 130 will clear the teeth on the wheel. The pawl carrier can be held in raised position by closing valve 135. The valve 140[b] is then opened slowly so as to release brake 144 but not to close clutch 91. This will cause the cutting mechanism to be lowered by gravity the brake by a slight engagement preventing sudden movements. Or the valve in pipe 103 may be closed and valve 140[b] opened to release brake 144 and clutch 91 and the motor 29 may then be reversed to lower the cutting mechanism.

It is sometimes desirable to reciprocate the cutter without feeding it. This may be accomplished as follows:—Valves 155 and 156 are closed, and 147 is moved to dotted position. The valve in 103 is then opened so that air will be admitted to the lower ends of cylinders 73[a] to drive the pistons therein and the cutter head forward. Link 120 is then moved to open valve 119 and close 118 causing the piston 101 to be driven to the left thereby connecting the lower ends of cylinders 73[a] with the exhaust pipe 104 and the upper ends with the main 103 so as to drive the pistons and cutter head back. By again operating link 120 in the reverse direction the pistons are again driven outward. The pistons and cutter head can thus be reciprocated by reciprocating the link 120, whereby the reciprocation of the pistons and cutter head can be manually controlled without feeding the cutter mechanism. It will be readily seen that the same result can be accomplished by operating the link 154.

A single unit has been described above, but a multiple unit mechanism will now be described: The separate units are designated in Fig. 11, *a*, *b* and *c*. A single controller cylinder 77 is provided for all of the units but a separate supplemental controller cylinder 113[a], 113[b], 113[c] is provided for each unit. The connection between the main and supplemental controller cylinders and the power cylinders of the units will be obvious from Figs. 11 and 12, and similar parts have been designated by similar reference characters as in Fig. 10, and the parts of the separate units by similar reference characters distinguished by the exponents "a," "b," and "c." In order however to permit the center cutter head to start its cutting stroke before the others the branches 105[a] and 105[c] are provided with valves 162 and 163 and pipes 164 and 165 lead from the cylinders of the center unit and connect with pipes 105[a] and 105[c] beyond the valves 162 and 163. The ports of pipes 164 and 165 are so located in the cylinders of unit *b* that they are not uncovered until the pistons of the unit have moved a predetermined distance on their working stroke, when the air will flow to the cylinders of units *a* and *c* to operate the pistons therein. In this manner the cutter of the central unit is started on its working stroke in advance of the cutters of the units *a* and *c*. The controlling mechanism is so arranged that the piston valve 101 will not be shifted to position shown in Fig. 12, to reverse the cutter, until all the pistons and cutter heads of all the units are at the end of their forward or working stroke. This is accomplished in the following manner: The end supplemental cylinder 113[a] of the unit *a* only is connected with pipes 117 and 116, and the cylinders 113[a], 113[b], and 113[c] are connected by pipes 116[b], 116[c] and pipes 160 and 161 which are located as shown in Figs. 11 and 12. It will be seen that the pipe 117 is not open to the air pressure from pipe 112[a]

or any other pressure pipe until all the pistons 114^a, 114^b, 114^c are at the bottom of their strokes as shown in Fig. 12, and this will not happen until all the pistons in the main power cylinders are at the end of their forward or working strokes. Air cannot therefore be admitted to the right of cylinder 77 to move piston 101 to the left so as to reverse any of the main cutter pistons until all these cutter pistons are at the end of their cutting strokes. The above mechanism therefore provides means for insuring that all the cutter pistons shall be at the end of their cutting stroke before any of them are reversed. The above operation is accomplished by providing one main controller the reversing action of which is controlled by a series of supplemental controllers one for each and governed by each cutter motor. The feeding action of the cutter mechanism and the other detail operations of the mechanism will be the same as in the construction shown in Fig. 10 and further description will therefore be unnecessary. The pipe 137 may however in this case have only one branch 137^a for the left cylinder of unit *a*, or it may also have branches 137^b and 137^c leading to the left cylinders of units *b* and *c*.

In Figs. 11 and 12 the parts are shown diagrammatically in order to show the connections. In the actual machine however the cylinder 77 as well as the cylinders 113 are secured to and carried by the main or cutter cylinder 73^a. This is shown in the other figures.

In the complete operation, the cutters of the shearing down mechanism are placed in the position shown in Fig. 3 and the valve in the main 103 is closed to throw these cutters out of operation. The motor 29 is then started to drive the main shaft 32 and drive the combined conveyer and undercutting mechanism. The clutch 38 is then thrown in to feed the entire machine against the face of the coal to undercut the same as shown in Figs. 1 and 3, the cut coal being conveyed to the chute 62 by the conveyer flights. After the coal has been sufficiently undercut, the clutch 38 is disengaged to stop the feeding of the machine, the conveyer however being kept running. The valve in the main supply pipe 103 is now opened to start the shearing down mechanism in operation. The cutters will be driven against the face of the coal, and after each return stroke, the cutter is automatically fed or raised so as to be placed in position to shear down another layer. The coal as sheared down falls into the conveyer and is discharged into the chute 62. After a predetermined number of cuts have been taken, the feeding mechanism is automatically thrown out of operation. In this way the machine can be started and it will not stop until the entire face from floor to ceiling has been sheared down. During the shearing down operation the machine is restrained against backward movement by the engagement of the gear 37 with rack 28, the worm preventing reverse movement of gear 37, and by pawl locked roller 22 engaging the floor, and by a locking member engaging the roof. This locking member comprises a toothed member 170 pivoted at 171 on one of each of the standards 70, and pressed into engagement with the roof by a spring 172.

The guideways on the standards 70 incline rearwardly, so that the cut face of the coal will also incline. It is found that the shearing down operation is very much easier when the face is so cut. The outside limits of the shearing down cutters are located inside the limits of the undercutting mechanism. The material can therefore be more easily sheared down at its outside limit since it will overhang at the outside breaks. The relative limits are shown in Figs. 2 and 13 where the lines *y*, *y*, represent the outside limits of the shearing down mechanism. It will be seen that the first cuts are on a slant as shown at X Fig. 3. In this manner the shearing down of the first layer is rendered easier.

In the multiple unit construction the central cutter starts in advance of the cutters on either side. The entire multiple unit cutter will therefore act as a wedge, whereby the strain is thrown on the frame gradually instead of suddenly. The control mechanism is so constructed that the piston in one cutter cylinder of a unit controls the reversing or supplemental controller, while the piston of the other cylinder controls the step by step feeding mechanism.

The machine is entirely self contained as it carries its own power plant, and is so constructed that it can at any time be either automatically or manually controlled. The machine is very flexible in its operation and control which is of great advantage in mining work.

The units of the shearing down mechanism can be so arranged that it can cut either a flat roof as in Fig. 13, or a concave roof as in Fig. 14. This latter construction may be obtained by making the middle standards and guides higher than the outside standards. The construction of the cutter heads is such that the coal can be sheared down clear to the ceiling.

Although a multiple unit cutting mechanism is described, it will be obvious that a single unit cutter may be used. The shearing down cutters may also be used as an undercutting mechanism by placing the cutters in the position shown in Figs. 3 and 7 and then reciprocating the cutters back and forth without feeding the same by manipulating the links 120 or 154 as fully described. The strokes can be regulated so as to be

long or short in order to perform this undercutting operation, the timing being regulated by the timing of the operation of the links. In this way the coal can be undercut to prepare it for the shearing down operation. The undercutting mechanism may therefore be dispensed with, in which case it is however necessary to provide another form of conveyer or else remove the broken down coal by hand. It is preferable however to use the combined undercutter and conveyer in connection with the shearing down mechanism in the manner described.

The combined cutter and conveyer chain is shown, described, and claimed in our copending application Ser. No. 591032 filed Nov. 7, 1910.

Having thus described the invention what is claimed is as follows:—

1. In a mining machine the combination with a frame or support, an upright standard on said frame, a shearing down mechanism movable vertically as a whole on and guided by said standard, and a combined undercutter and conveyer projecting from the lower section of said standard for conveying away the coal cuttings, and the coal sheared down.

2. In a mining machine the combination with a frame or support, a standard on said frame, of shearing down mechanism thereon, means for feeding said frame toward the face of the coal, and a spring-pressed shoe attached to the standard engaging the roof at the front of said frame to prevent backward movement of said frame.

3. In a mining machine the combination with a frame or support, a rearwardly inclined standard on said frame, of shearing down mechanism movable on and guided by said frame, means for reciprocating said shearing down mechanism forwardly and rearwardly, a motor for moving said mechanism on said frame, a clutch for said motor whereby said mechanism may be stopped or started at intervals as it is raised, and means for feeding said shearing down mechanism upwardly at the end of each rearward stroke and made to travel rearwardly as it is raised.

4. In a mining machine the combination with a frame or support, of a guideway thereon, a cross-head on said guideway, and a shearing down mechanism supported by said cross-head, said shearing down mechanism comprising a cutter-head and a pair of pistons and cylinders arranged on opposite sides of said guideway, said cutter-head carried by and connecting said pistons.

5. In a mining machine the combination with a frame or support, of a guideway thereon, a cross-head on said guideway, and a shearing down mechanism supported by said cross-head, said shearing down mechanism comprising a pair of cylinders, pistons therein, and a cutter-head having its cutting edge above the cylinder, said cutter-head carried by and connecting said pistons.

6. In a mining machine the combination with a frame or support, of a guideway thereon, a cross-head on said guideway, and a shearing down mechanism supported by said cross-head, said shearing down mechanism comprising a pair of cylinders, pistons therein, and a toothed cutter-head having its cutting edge above the cylinder, said cutter-head carried by and connecting said pistons.

7. In a mining machine the combination with a frame or support, of a guideway thereon, a cross-head on said guideway, a shearing down cutter pivotally supported on said cross-head at its front end, said cutter to swing about a transverse axis thereon, and a stop for the rear end of said cutter on said cross-head.

8. In a mining machine the combination with a frame or support, of a guideway thereon, a cross-head on said guideway, a shearing down cutter pivotally supported on said cross-head at its front end, and means for supporting said cutter in a horizontal position for certain limits and in inclined positions for other limits.

9. In a mining machine the combination with a frame or support, of a guideway thereon, a cross-head on said guideway, a shearing down cutter pivotally supported on said cross-head at its front end, means for supporting said cutter in a horizontal position for certain limits, and a stop on said guideway to variably incline said cutter as it approaches its lower limit.

10. In a mining machine the combination with a frame or support, of a guideway thereon, a cross-head on said guideway, a shearing down cutter pivotally supported on said cross-head at its front end, means for adjustably supporting said cutter in a horizontal position on said guideway, and means for supporting said cutter in horizontal and inclined positions on said guideway.

11. In a mining machine the combination with a frame or support, of a guideway thereon, a cross-head on said guideway, a shearing down cutter pivotally supported on said cross-head at its front end, means for adjustably supporting said cross-head and the rear end of said cutter, and means on said guideway for supporting said cutter in a variably inclined position as it approaches its lower limit.

12. In a mining machine the combination with a frame or support, of a guideway thereon, a cross-head on said guideway, a shearing down cutter pivotally supported on said cross-head at its front end, supporting means connected to said cross-head and the rear end of said cutter, the latter being a

lost motion connection, and a stop on said guideway for the rear end of said cutter to variably incline said cutter as it approaches its lower limit.

13. In a mining machine the combination with a frame or support, of a guideway thereon, a cross-head on said guideway, a shearing down cutter pivotally supported on said cross-head at its front end, cables connected to said cross-head and the rear end of said cutter, the connection to the rear end of said cutter providing for a lost motion, and a stop on said guideway for the rear end of said cutter to variably incline said cutter as it approaches its lower limit.

14. In a mining machine the combination with a frame or support having an upright guideway, of a shearing down cutter mounted on said guideway, means for raising the cutter on said guideway, means for reciprocating said cutter forwardly and rearwardly, and means for feeding said cutter upwardly at the end of each rearward stroke.

15. In a mining machine the combination with a frame or support having a guideway, of a shearing down cutter mounted on said guideway, means for raising said cutter in the guideway, means for reciprocating said cutter forward and backward, braking means for holding said cutter in position, and means for releasing said braking means to permit feeding of said cutter upwardly at the end of each backward stroke.

16. In a mining machine the combination with a frame or support having an upright guideway, of a shearing down cutter mounted on said guideway, means for raising said cutter in the guideway, means for reciprocating said cutter forward and backward, means for operating said raising mechanism to feed said cutter along said guideway, and means operable at the end of each backward stroke of said cutter for setting said cutter raising means in operation.

17. In a mining machine the combination with a frame or support having an upright guideway, of a shearing down cutter mounted on said guideway, means for raising said cutter in the guideway, means for reciprocating said cutter, means for operating said raising mechanism to feed said cutter along said guideway, means for holding said cutter in position, and means operable at the end of each backward stroke of said cutter for releasing said holding means and for setting said cutter raising means in operation.

18. In a mining machine the combination with a frame or support having an upright guideway, of a shearing down cutter mounted on said guideway, a fluid operated motor for reciprocating said cutter forward and backward, fluid controlled means for raising said cutter in said guideway, fluid controlled devices for holding said cutter in position on said guideway, and means for releasing said holding devices and for setting said raising means in operation at the end of each backward stroke of said cutter.

19. In a mining machine the combination with a frame or support having a guideway, of a shearing down cutter mounted on said guideway, means for reciprocating said cutter, means for feeding said cutter step by step and means for throwing said feeding means out of operation after a predetermined number of feed movements.

20. In a mining machine the combination with a frame or support having a guideway, of a shearing down cutter mounted on said guideway, means for reciprocating said cutter, means for feeding said cutter, means for holding said cutter in position on said guideway, and intermittently operable controlling means for said feeding and holding means to release said cutter and feed it step by step, and means for throwing said controlling means out of operation after a predetermined number of steps.

21. In a mining machine the combination with a plurality of shearing down cutters, of motors for operating said cutters in the same direction, means coöperating with said motors to make one cutter begin its cut in advance of the adjacent cutter, and means to return all cutters simultaneously after all the cutters have completed their cut.

22. In a mining machine the combination with a plurality of shearing down cutters, of motors for operating said cutters, and means to coöperate with the motors and control said cutters so that an inside cutter begins its cut in advance of the cutters on each side of it.

23. In a mining machine the combination with a plurality of shearing down cutters, of motors for driving said cutters, said motors comprising pistons and cylinders and ports therefor, said cylinders, ports and pistons so arranged that the piston of one cylinder controls a port of another and adjacent cylinder, and the piston and attached cutter of one cylinder begins its stroke and cut before the cutters of the other cylinders.

24. In a mining machine, the combination with a plurality of shearing down cutters, of motors therefor, each motor having a cylinder, port, and a piston, the piston of one of said motors controlling the port of another and adjacent motor, a single controller for all of said motors, and means to cause one of the motors to start its stroke in advance of another.

25. In a mining machine the combination with a plurality of shearing down cutters, of motors therefor adapted to reciprocate said cutters, a main controller for governing both the main and reverse strokes of each of said motors, and supplemental reversing controllers one for each pair of motors.

26. In a mining machine the combination

with a plurality of shearing down cutters, of motors therefor adapted to reciprocate said cutters, a main controller for governing both the main and reverse strokes of each of said motors, and supplemental reversing controllers one for each pair of motors adapted to govern the main controller in reversing said motors.

27. In a mining machine the combination with a plurality of shearing down cutters, means for reciprocating said cutters forward and backward, and means coöperating with said reciprocating means whereby all of said cutters go to the end of their forward stroke before any of them are reversed or returned on their backward stroke.

28. In a mining machine the combination with a plurality of shearing down cutters, of means for reciprocating said cutters forward and backward, said means being constructed and arranged whereby one cutter begins its forward stroke or cut in advance of another, and means coöperating with said reciprocating means whereby all of said cutters go to the end of their forward stroke before any of them are reversed or returned on their backward stroke.

29. In a mining machine the combination with a plurality of shearing down cutters, of motors for reciprocating the cutters forward and backward, and reverse controlling means coöperating with said reciprocating motors whereby all of the cutters go to the end of their forward strokes before any of them are reversed or returned on their backward stroke.

30. In a mining machine the combination with a plurality of shearing down cutters, of motors for reciprocating said cutters, a main controller for all of said motors, and a supplemental controller connected to the forward end of each motor governing said main controller and constructed to insure that all cutters go to the end of their forward strokes before any of them are reversed.

31. In a mining machine the combination with a plurality of shearing down cutters, of motors for reciprocating said cutters, a main controller for all of said motors, and a supplemental controlling device for each motor connected to the forward end of each motor, said devices being constructed to insure that all cutters go to the end of their forward strokes before any of them are reversed.

32. In a mining machine the combination with a plurality of shearing down cutters, of fluid pressure motors for reciprocating said cutters, a main controller for all of said motors having a cylinder and a piston, a supplemental controller cylinder for each motor, pistons in said cylinders, and connections between said supplemental controller cylinders and to said main controller cylinder and also to the forward end of each motor constructed to connect said main cylinder with a source of fluid supply when the pistons in the supplemental cylinders are in a predetermined position.

33. In a mining machine the combination with a frame or support and an upright guideway thereon, of a shearing down cutter on said guideway, a multiple unit motor for driving said cutter, means for feeding said cutter step by step, means coöperating with one unit of said motor for operating said feeding mechanism, and means coöperating with the other unit of said motor for controlling the reversing of both units of said motor.

34. In a mining machine the combination with a frame or suport and a guideway thereon, of a shearing down cutter on said guideway, a main driving motor, means for feeding said cutter on said guideway, a clutch for connecting said feeding means to said motor, and a brake for said feeding means.

35. In a mining machine the combination with a frame or support and a guideway thereon, of a shearing down cutter on said guideway, a main driving motor, means for feeding said cutter on said guideway, a clutch for connecting said feeding means to said motor, a brake for said feeding means, and means for releasing said brake and closing said clutch.

36. In a mining machine the combination with a frame or support having a guideway, of a shearing down cutter thereon, means for operating said cutter, automatic means for feeding said cutter at the end of each operation of the cutter, and manually controlled means for throwing said automatic means out of operation and for operating said cutter at will without feeding the same.

37. In a mining machine the combination with a frame or support, of a guideway thereon, a shearing down cutter on said guideway, means for operating said cutter, means for feeding said cutter step by step along said guideway, means for locking said cutter on said guideway, means for releasing said feeding and locking means, after a certain number of cuts are made, and means to move the cutter back to original position.

38. In a mining machine the combination with a frame or support, of a guideway thereon, a shearing down cutter on said guideway, means for operating said cutter, means for feeding said cutter step by step along said guideway, and for releasing said feeding means, after a certain number of cuts are made, and means to move the cutter back to original position.

39. In a mining machine the combination with a frame or support, of cutting mechanism, thereon, means for controlling said mechanism to cause it to undercut the coal, means for controlling said mechanism to cause it to shear down the coal, and means

for feeding said mechanism step by step during the shearing down operation.

40. In a mining machine the combination with a frame or support, of cutting mechanism thereon, means for feeding said mechanism step by step, means for throwing said feeding mechanism out of operation and for operating said cutting mechanism as an undercutting mechanism, and means for throwing said feeding mechanism into operation to operate said cutting mechanism as a shearing down mechanism.

In testimony whereof I affix my signature in presence of two witnesses.

CHARLES O. BEMIES.

Witnesses:

OLIVER HOSTETLER,

THOMAS G. CHRISTOPHER.

In testimony whereof I affix my signature in presence of two witnesses.

JAMES F. BEMIES.

Witnesses:

E. L. CARTLETT,

E. W. SMITH.