

Sept. 21, 1937.

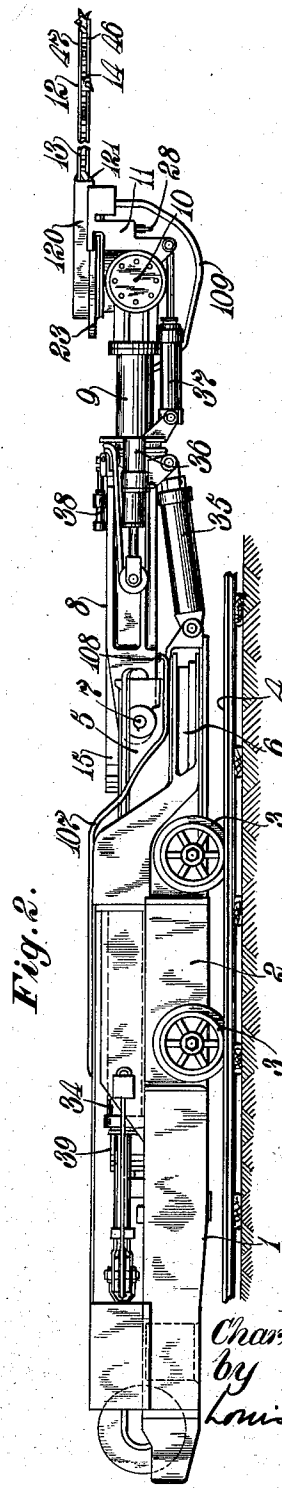
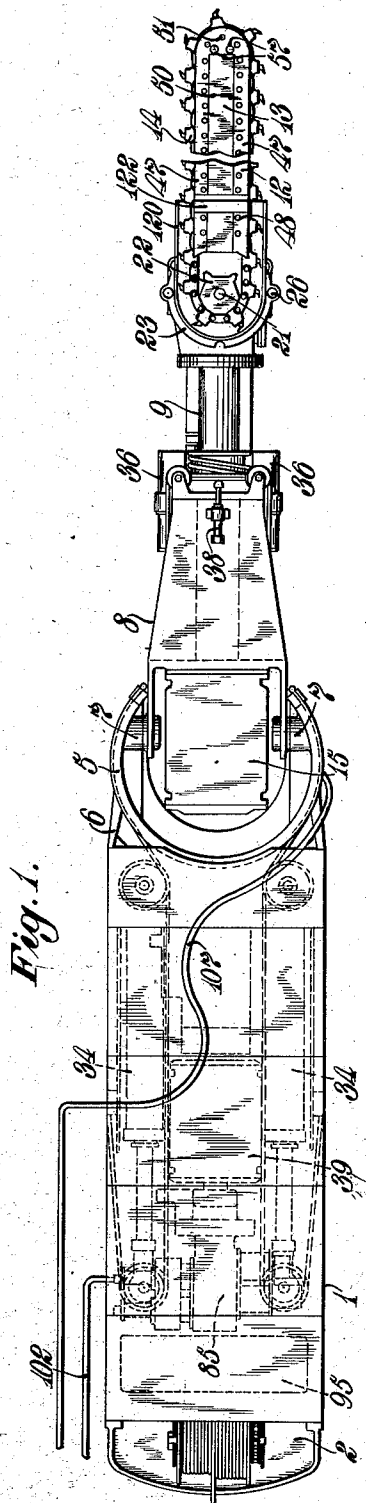
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2,093,476

METHOD OF AND APPARATUS FOR MINING

Original Filed Nov. 15, 1935

7 Sheets-Sheet 1



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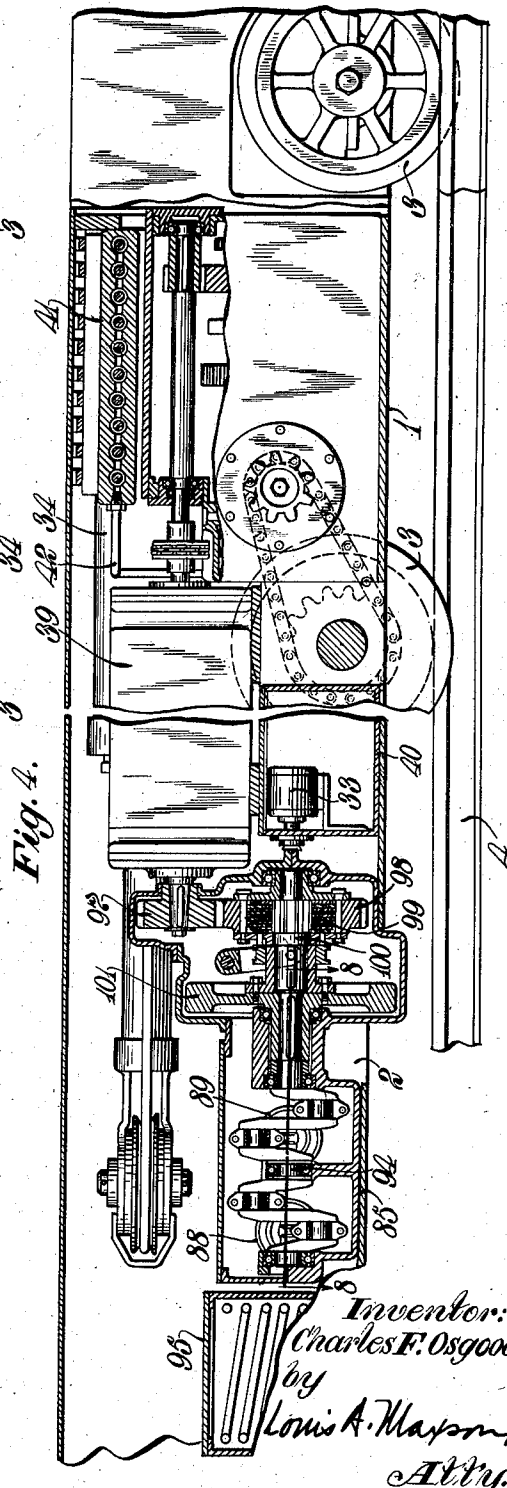
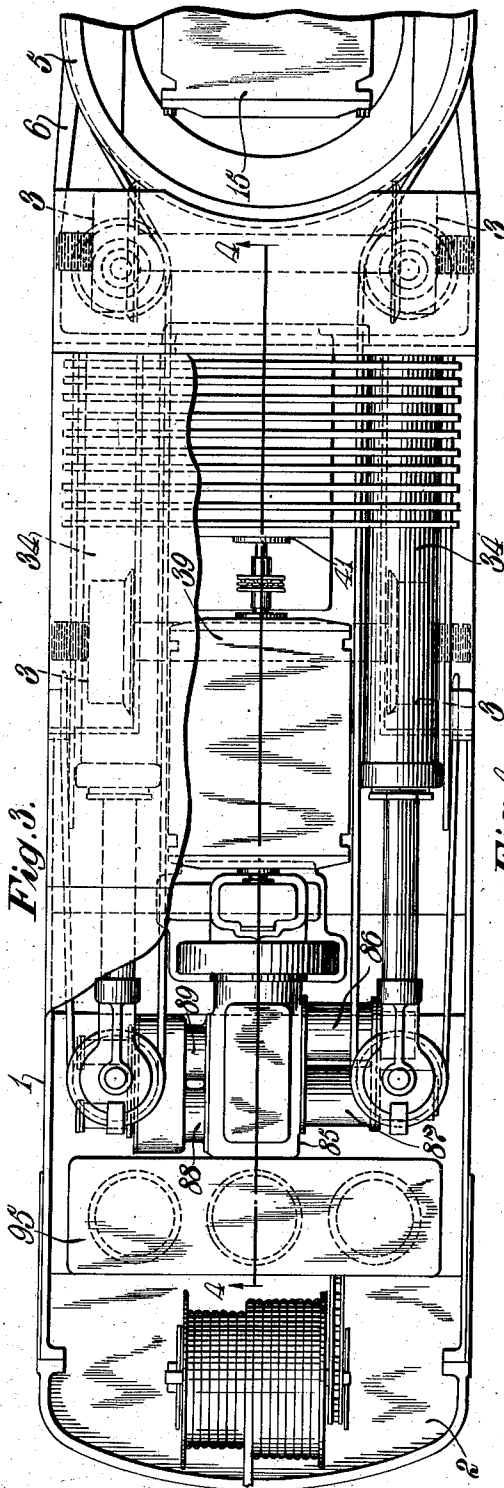
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METHOD OF AND APPARATUS FOR MINING

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7 Sheets-Sheet 2



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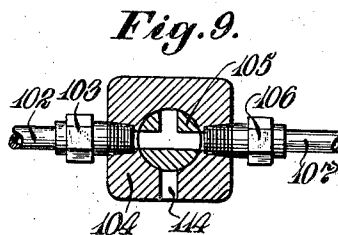
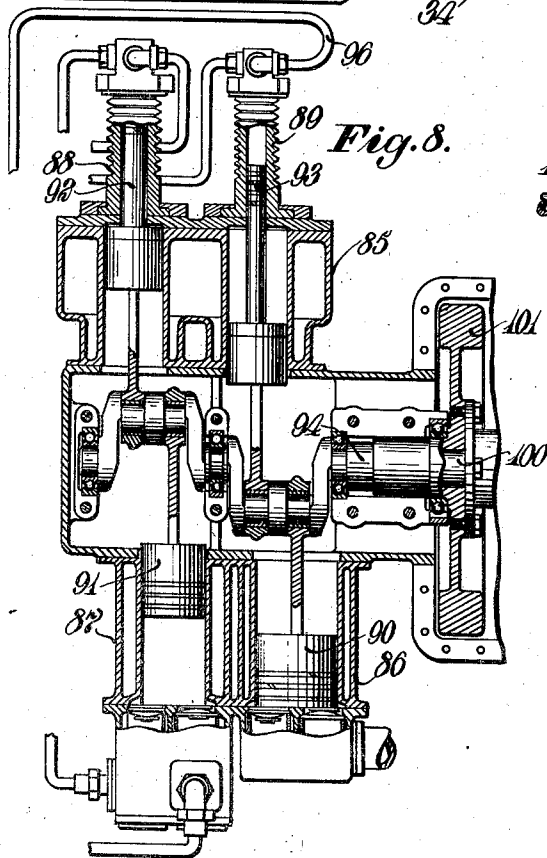
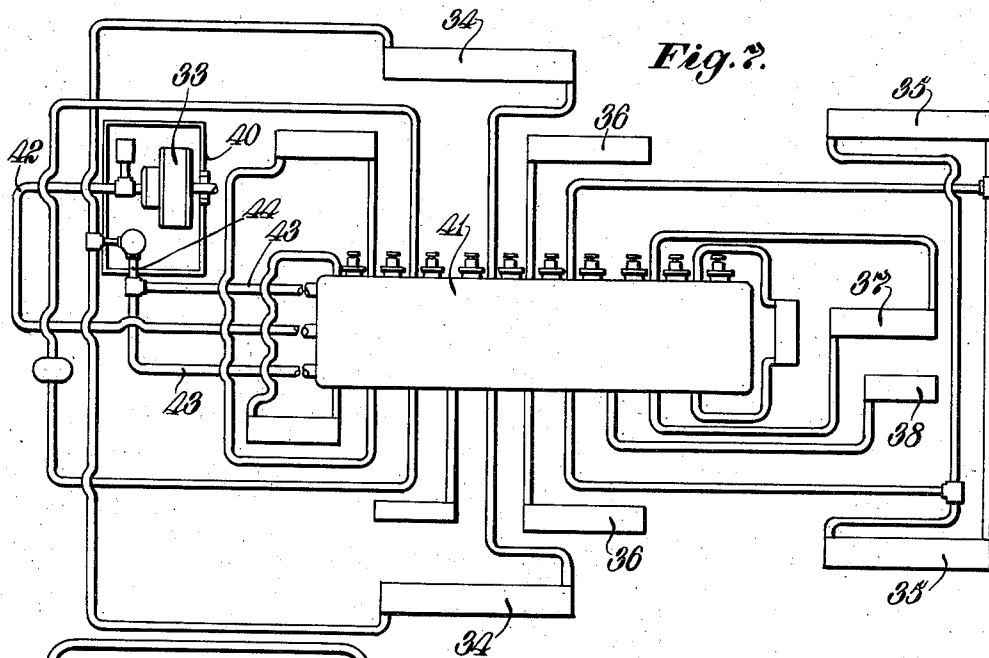
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METHOD OF AND APPARATUS FOR MINING

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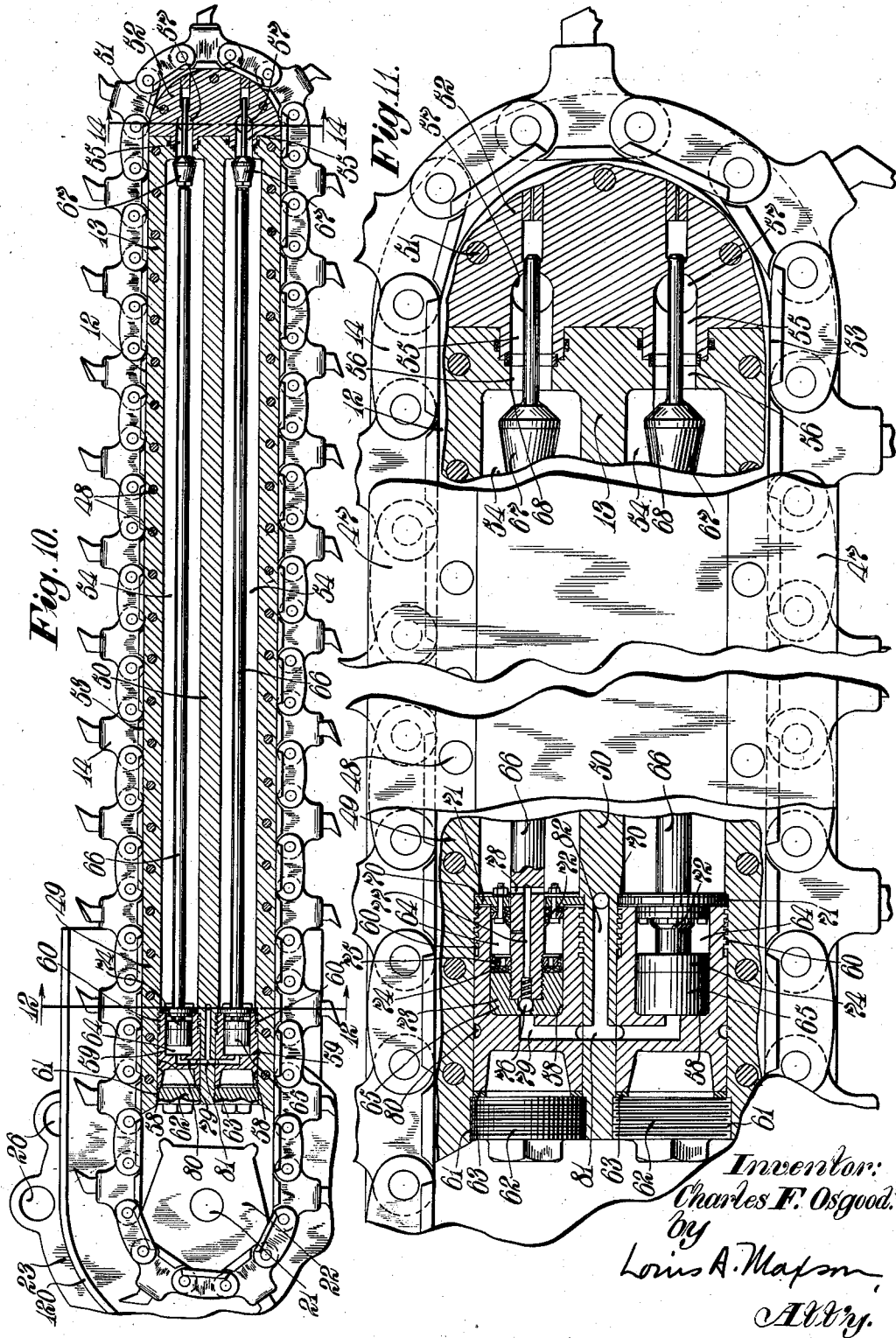
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Fig. 12.

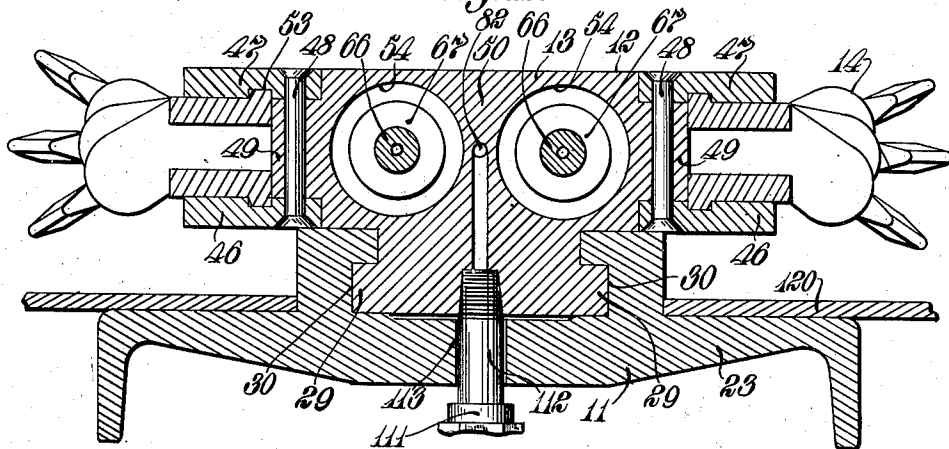


Fig. 13.

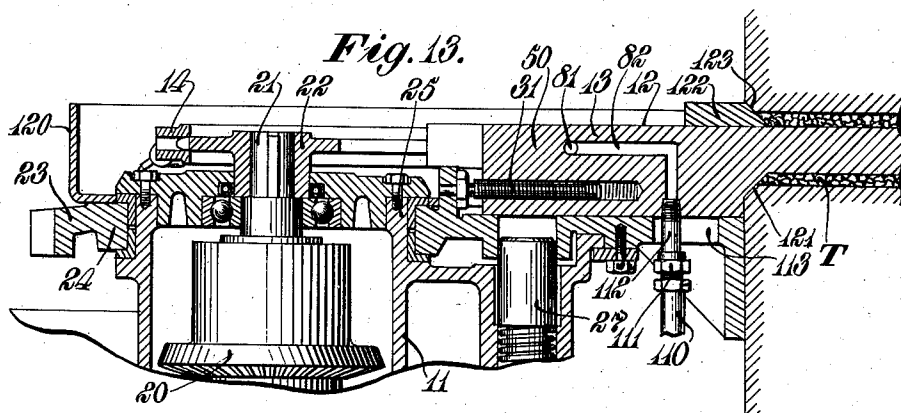


Fig. 14.

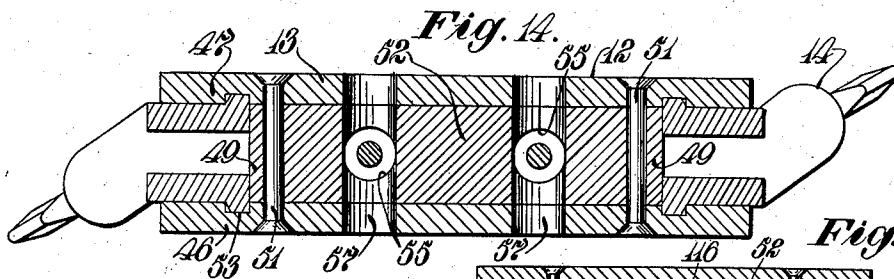


Fig. 16.

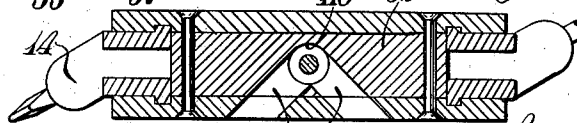
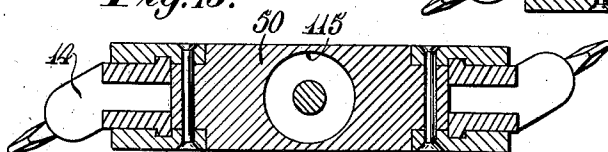


Fig. 15.



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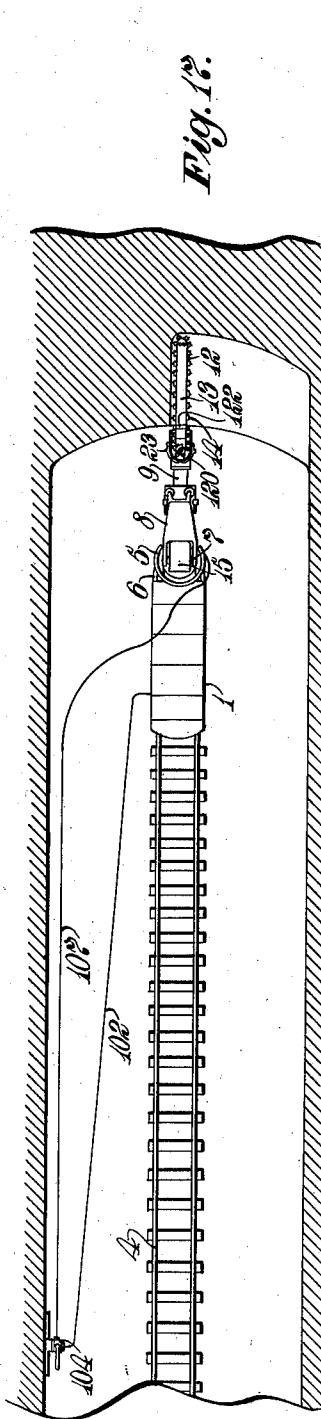


Fig. 1.

Fig. 20. J

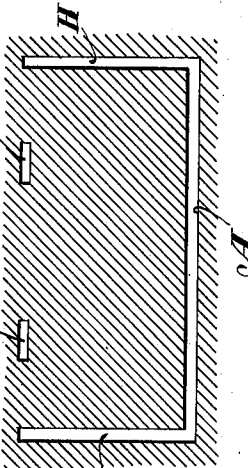


Fig. 19. F

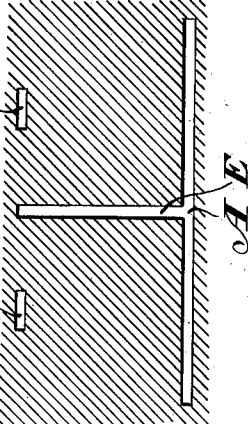


Fig. 18. B

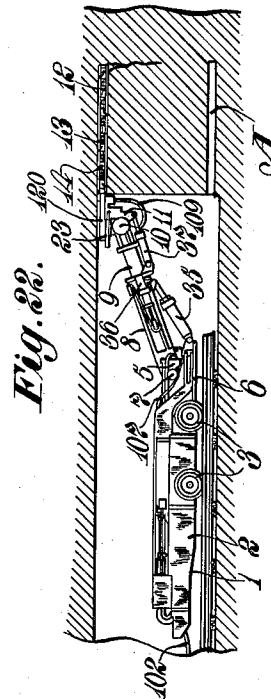
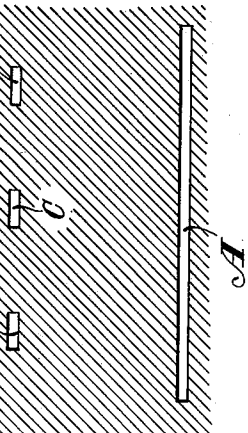
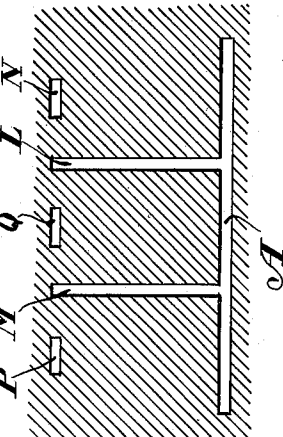


Fig. 22.



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UNITED STATES PATENT OFFICE

2,093,476

METHOD OF AND APPARATUS FOR MINING

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Application November 15, 1935, Serial No. 50,028
Renewed November 30, 1936

20 Claims. (Cl. 262—28)

This invention relates to improved methods of and apparatus for mining, and more particularly to an improved coal mining apparatus for cutting the coal in a coal seam and for "blasting" the coal previously cut, together with the improved methods of use of such an apparatus.

It has previously been proposed to break down material from the solid by forming an opening in the material to be broken—using for that purpose a drilling implement—; confining within the opening so formed—specifically, within the drilling implement—a charge of a gas at blasting pressure; and suddenly releasing from its confinement, while the opening-forming implement remains in the opening, the charge into said opening. This subject matter is disclosed in the application of Warren Noble, Serial No. 33,876, filed July 30, 1935, owned by my assignee; and this present invention is subordinate to that of said application on all common subject matter, both from its method and apparatus aspects, being confined to the use of, and to apparatus including, a kerf cutter for cutting a plane kerf. It has also previously been proposed to break down material by cutting an opening in the material by means of a suitable kerf-cutting implement—desirably after the preliminary formation of and in suitable space relation to a kerf cut to provide clearance towards which the material may be broken—and releasing into the opening, while the kerf cutter remains therein, and through the kerf cutter, a fluid material breaking medium. This subject matter is disclosed in the Joseph P. Joy application, Serial No. 49,782, filed Nov. 14, 1935, also assigned to my assignee; and this present invention is also subordinate to the disclosure of that application as to all common subject matter, both from its method and apparatus aspects; and essentially involves the feature of the confinement, prior to its release, of a charge at blasting pressure within the opening and, specifically, within the kerf cutter, prior to its release into the opening.

An object of this invention is to provide improved methods of and apparatus for the mining of coal whereby the coal is cut and broken down from a coal seam in an improved manner. Another object is to provide an improved coal mining apparatus for cutting kerfs in a coal seam and thereafter releasing a coal breaking charge into the coal previously cut by the cutting means, to break down the coal from the coal seam. A further object is to provide an improved coal mining apparatus having kerf cutting means for cutting kerfs in the coal seam and having asso-

ciated with the kerf cutting means improved means for conducting a "blasting" charge into the coal previously cut by the cutting means, to dislodge the coal from the coal face. A still further object is to provide an improved coal "blasting" means embodied in the kerf cutter of the kerf cutting means whereby, when the kerf cutter is inserted in the coal, a powerful "blasting" charge at coal breaking pressure may be released from the kerf cutter into the coal to break down the latter. Yet another object is to provide an improved kerf cutter having embodied therein means for confining a "blasting" charge at a relatively high coal breaking pressure and for effecting release of the "blasting" charge into the coal to break down the coal by the action of the "blasting" pressure thereon and embodying discharge means for the "blasting" charge for releasing the latter in planes perpendicular to the plane of the kerf cut by the kerf cutter, thereby to attain a powerful breaking action directly on the coal to be broken down. A further object is to provide, in a coal breaking kerf cutter of the above character, improved means embodied in the kerf cutter for confining a charge of pressure fluid at a relatively high "blasting" pressure and for suddenly releasing the charge from the confining means. Still another object is to provide an improved adjustable supporting structure for the coal cutting and "blasting" means whereby a "blasting" charge may be released into the coal at any desired location in the coal face and in either rib, an element of the cutting means of the apparatus constituting an element of the "blasting" means. A further object is to provide an improved coal "blasting" means embodied in the kerf cutting means, wherein a highly compressed gas, such as highly compressed air, is employed as a "blasting" medium. Other objects and advantages of the invention will, however, hereinafter more fully appear.

In the accompanying drawings there are shown for purposes of illustration one form and a modification thereof which the invention may assume in practice.

In these drawings,—

Fig. 1 is a plan view of a coal mining apparatus having embodied therein one illustrative form of the improved coal "blasting" means.

Fig. 2 is a side elevational view of the mining apparatus shown in Fig. 1.

Fig. 3 is an enlarged plan view of the rearward portion of the apparatus shown in Fig. 1, with

the casing broken away to show details of the interior construction.

Fig. 4 is an enlarged view in longitudinal section taken substantially on line 4—4 of Fig. 3.

5 Fig. 5 is an enlarged plan view of the forward portion of the apparatus shown in Fig. 1.

Fig. 6 is a view in longitudinal section taken substantially on line 6—6 of Fig. 5.

10 Fig. 7 is a diagrammatic view showing the hydraulic fluid system and the associated control means.

Fig. 8 is an enlarged horizontal sectional view taken substantially on line 8—8 of Fig. 4, illustrating the fluid compressor.

15 Fig. 9 is a detail sectional view showing the control valve for the "blasting" means.

Fig. 10 is an enlarged plan view, partially in horizontal section, of the kerf cutter, showing the "blasting" pressure confining and release means embodied therein.

Fig. 11 is an enlarged sectional view taken in the plane of Fig. 10, showing details of construction of the "blasting" pressure confining and release means.

25 Fig. 12 is an enlarged cross sectional view taken substantially on line 12—12 of Fig. 10, showing the "blasting" pressure confining chambers.

Fig. 13 is an enlarged fragmentary sectional view taken in the plane of Fig. 6, illustrating the improved tamping means associated with the kerf cutter.

Fig. 14 is an enlarged cross sectional view taken substantially on line 14—14 of Fig. 10, showing the "blasting" pressure release passages.

35 Figs. 15 and 16 are cross sectional views taken in the planes of Figs. 12 and 14, respectively, illustrating a modified form of "blasting" means.

Fig. 17 is a diagrammatic plan view showing the apparatus in a mine with the kerf cutter in a position to release a "blasting" charge into a coal seam, and illustrating the improved remote control means for the "blasting" charge release means.

45 Figs. 18 to 21, inclusive, are diagrammatic cross sectional views showing various methods of cutting and "blasting" the coal in the coal seam.

Fig. 22 is a diagrammatic side view showing the mining apparatus in the mine with the kerf cutter in a "blasting" position in the coal seam.

50 In this illustrative construction, both forms of the improved coal breaking or "blasting" kerf cutter are shown embodied in a coal mining apparatus of the so-called universal cutter type, herein of the same general character as that disclosed in a copending application to one Joseph F. Joy, Ser. No. 20,826, filed May 10, 1935, although it will be evident that the improved coal blasting means may be embodied in the cutting means of mining apparatus of various other types.

60 The coal mining apparatus disclosed herein comprises a portable base 1 in the form of a truck frame 2 mounted on wheels 3 adapted to run along a mine trackway 4 laid on the mine floor. As described in the above mentioned Joy application,

65 the truck frame 2 has mounted thereon at its forward end a horizontal turntable 5 journaled for rotation about a vertical axis with respect to the truck frame on a forwardly projecting horizontal frame portion 6 extending in advance of the front truck wheels, the turntable axis being located on the truck in advance of the front truck wheels. Pivotaly mounted at 7 on the horizontal turntable 5 for vertical swinging movement with respect thereto is an elongated arm structure or boom 8 having mounted there-

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on at its forward extremity for rotation about an axis extending longitudinally of the arm structure a revolving head 9 in turn having pivotally mounted thereon to swing relative thereto about an axis 10 at right angles to the head axis a cutter support 11 carrying a kerf cutter 12 of an improved design. The kerf cutter is in the form of an elongated plane cutter bar 13 having mounted for circulation orbitally about its margin an endless cutter bit carrying cutter chain 14. Supported at the rearward portion of the swingable arm structure 8 is a motor 15 having its power shaft 16, as shown in Fig. 6, extending longitudinally of the arm structure and connected through a coupling 17 to a longitudinal shaft 18 suitably journaled within the arm structure, with its axis in coincidence with the revolving head axis. Keyed to the forward end of the shaft 18 is a bevel gear 19 which drives, through bevel gearing in a manner clearly described in the above mentioned copending application, a bevel gear 20 connected to a shaft 21. The shaft 21 is suitably journaled in the tiltable cutter support 11 and has keyed thereto a chain sprocket 22 which engages and drives the endless cutter chain 14.

25 The cutter bar 13 is mounted on a hanger 23 having an annular bearing portion 24 journaled on bearing sleeves supported by a cylindrical bearing support 25 formed integral with the tiltable cutter support 11 so that the cutter bar may be swung relative to the support 11 about the axis of the shaft 21. The hanger frame 23 is provided with a plurality of apertures 26 within which a slidable locking pin 27 is adapted to project to lock the bar hanger to the cutter support, the locking pin being guided on the cutter support and having suitable manual release means 28. As shown most clearly in Fig. 12, the cutter bar has formed thereon longitudinal guides 29 mounted in longitudinal guideways 30 formed on the hanger 23, and arranged between the hanger and the cutter bar is an adjusting screw 31 for adjusting the cutter bar longitudinally with respect to the hanger to vary the tightness of the cutter chain 14.

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In accordance with this invention, supported within the truck frame is a motor driven pump 33 for supplying hydraulic pressure to hydraulic cylinders 34, 34 for rotating the turntable 5, hydraulic cylinders 35 for vertically swinging the arm structure 8, hydraulic cylinders 36 for revolving the head 9, a hydraulic cylinder 37 for swinging the cutter support 11, a hydraulic lock cylinder 38 for the revolving head 9 and the hydraulic operating cylinders for the truck drive control clutches and truck wheel brake. Also mounted within the truck frame is motor driven means for driving the truck wheels to propel the apparatus along the mine trackway both during transport and the cutting operation. As the various hydraulic adjusting devices, the lock and clutch cylinders, the brake operating cylinder and the truck wheel driving mechanism are clearly described in the copending application above referred to and do not per se enter into this invention, further detailed description of the specific structure thereof is herein considered unnecessary other than to state that the kerf cutter may be adjusted to cut horizontal and vertical kerfs at any desired location in the coal face and in either rim.

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Now referring to the hydraulic system and associated control means shown in Fig. 7, it will be noted that the pump 33 is driven by a motor 39 (see Figs. 3 and 4) which also drives the trans-

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mission mechanism for propelling the apparatus in a manner clearly described in the above mentioned Joy application, Ser. No. 20,826. This pump 33 is arranged in a tank 40 adapted to contain a liquid, preferably oil, and the pump, submerged in the liquid, is adapted to supply hydraulic pressure to the various hydraulically operated devices of the apparatus. Arranged within the truck frame is a horizontal valve box 41 of a design similar to that described in the above mentioned copending application, and this valve box has formed therein a series of horizontal valve bores each containing a balanced-type slide valve for controlling the flow of hydraulic pressure to the various hydraulic cylinders. The pump 33 is herein of the variable displacement, triple rotor type of a conventional design and is provided with the usual variable displacement control valves for regulating the pressure in the fluid system. The discharge side of the pump 33 is connected through a conduit 42 to the supply passage of the valve box 41, while the discharge passages of the valve box are connected through branched conduits 43, 43 to a conduit 44 leading to the tank 40. Conduits connect the hydraulic cylinders 34, 35, 36, 37, and 38 and the truck drive control clutch and truck wheel brake cylinders, with the valve box 41, and as previously mentioned, this valve box contains slide valves for controlling the flow of hydraulic pressure through these conduits to the cylinders. As these various conduits and the particular slide valve structure are likewise clearly described in the above mentioned Joy application, further description thereof is herein considered unnecessary other than to state that the turntable 5 may be rotated, the arm structure 8 swung vertically, the revolving head 9 rotated and the cutter support 11 tilted, to vary the position of the kerf cutter and for swinging the kerf cutter during the cutting operation.

Now referring to the improved "blasting" means embodied in the kerf cutter for confining therein a charge of pressure fluid at a blasting pressure, and the particular cutter bar structure associated therewith, it will be noted that the cutter bar 13 (see Figs. 12 and 14) comprises parallel top and bottom plates 46 and 47 secured as by rivets 48 to lateral bar-like projections 49 formed integral with a centrally located, longitudinally extending cylinder block 50 herein extending lengthwise of the cutter bar throughout a substantial portion of its length. Interposed between and secured to the top and bottom plates by rivets 51 at the tip end of the cutter bar is an end block 52 of generally semi-circular shape, and the plates 46 and 47 cooperate with the blocks 50 and 52 to form a guideway 53 about the margin of the cutter bar, within which the endless cutter chain 14 is guided. In this construction, the hanger guides 29 on the cutter bar are preferably formed integral with the cylinder block 50. As clearly shown in Figs. 10, 11, and 12, the cylinder block 50 is formed with parallel bores 54, 54 extending longitudinally of the cutter bar, and these bores, as hereinafter described, constitute chambers for receiving and confining charges of pressure fluid at a blasting pressure. In this instance, the end block 52 of the cutter bar forms a discharge cap having axial orifices 55 communicating with aligned openings 56 in the cylinder block and connected by oppositely extending discharge passages 57, 57 with the exterior of the cutter bar, these discharge passages preferably extending in directions to release the blasting

charges from the charge receiving chambers in planes perpendicular to the plane of the cutter bar. Alined with the chamber-forming bores 54, 54 at the rear end thereof are enlarged bores 58 having arranged therein control cylinders 59 threadedly secured at 60 within the cylinder block. Threaded at 61 within the outer ends of the bores 58 and engaging the control cylinders 59 are plugs 62 for sealing the bores against leakage, there being interposed between the plugs and the control cylinders suitable sealing gaskets 63. Formed in each of these control cylinders is a control chamber 64 containing a reciprocable control piston 65. The piston rods 66 of the control pistons 65 extend inwardly within the pressure chambers 54, 54 and have fixed to their inner extremities pressure release valves 67, 67 adapted to seat at 68 at the inner ends of the pressure chambers to prevent communication of the discharge orifices 55 with the pressure chambers 54, the valve seats being formed on the inner end walls of the bores providing the openings 56. Positioned between shoulders 70 at the rear end of the chamber bores 54 and the adjacent end surfaces of the control cylinders 59 are heavy steel plates or discs 71 to which are secured hat leathers 72, surrounding and adapted to seal on the exterior surfaces of the valve rods 66 which pass therethrough. The control pistons 65 each consist of a steel plunger 73 carrying a cup leather 74 held in position by a keeper 75 threaded on the valve rod. Suitable check valves 76 are provided in the plungers 73 as a means for permitting the flow of high pressure air from the control chambers 64 at the outer sides of the control pistons through axial passages 77 in the valve rods and communicating radial passages 78, into the pressure receiving chambers 54, and preventing flow in the reverse direction. Passages 79 in the control cylinders connect grooves 80 surrounding the control cylinders with the control chambers, and these grooves communicate with a transverse passage 81 formed in the cylinder block. A longitudinal pressure fluid supply passage 82 in the cylinder block communicates with the transverse passage 81. The introduction of high pressure air through the passages 82, 81, grooves 80 and passages 79 to the control chambers at the outer sides of the control pistons results in axial movement of the valve and piston assemblies to bring the valves 67 into tight sealing engagement with their seats 68 at the ends of the chamber bores. At the same time the high pressure air flows from the control chambers past the check valves 76 and through the passages 77 and 79 into the pressure chambers 54. As the pressure builds up in the chambers 54, high pressure air will pass from the chambers 54 along the valve rods 66 into the spaces at the inner sides of the control pistons and between said control pistons and the metal plates 71, the hat leathers 72 functioning as check valves opening toward such spaces. In other words, air under pressure from the chambers 54 passes between the hat leathers 72 and the valve rods and into the spaces between the inner sides of the control passages and the discs 71. It will be observed, however, that rapid reverse flow along the outside of the valve rods cannot occur when the pressure in the chambers 54 falls because of the check valve action of the hat leathers 72 which then takes place. When charges of high pressure air of desired value have been introduced into the pressure chambers 54, discharge thereof is effected by cutting off the supply of high pressure air to the passage 82 and con-

necting the latter to atmosphere. Any suitable means, such as a three-way valve as shown in Fig. 9, or a more complex mechanism, may be used for this purpose. This then results immediately in the lowering of the pressure in the control chambers 64 at the outer sides of the control pistons, and bearing in mind that the pressure of the air trapped in the spaces at the inner sides of the control pistons between the latter and the discs 71 is substantially the same as that of the charges of pressure that were introduced into the pressure chambers 54, it will be apparent that the reduction of pressure in chambers 64 at the outer sides of the control pistons immediately results in axial movement of the valve and piston assemblies toward the left from the position shown in Fig. 10 and in opening of the valves 67. Note, of course, that the effective area of the valves 67 within the chambers 54 is less than the effective area of the right hand sides of the pistons 65. The initial opening of the pressure release valves 67 naturally results in an immediate and extremely rapid drop in pressure within the chambers 54, but in view of the check valve action of the hat leathers 72, the pressure trapped between the discs 71 and the inner sides of the control pistons will be sufficiently maintained to preclude the pressure in the control chambers outside the control pistons from reclosing the valves 67. Thus the compressed air in the spaces at the inner sides of the control pistons serves to move the valve and piston assemblies positively toward open position and to maintain them in that position until the charges of blasting pressure have been released from the chambers 54. It will thus be seen that any desired blasting pressure may be built up within the chambers 54, it being possible for the operator to determine, by means of a usual gage in the compressed air supply line or the compressor discharge pipe, the pressure of the blasting charges in accordance with the requirements of the coal to be broken.

The fluid compressing means associated with the blasting pressure receiving and confining means in the kerf cutter, comprises an air compressor 85 of an extremely compact design, supported within the rearward portion of the truck frame at the rear of the driving motor 39 for the fluid pump and truck wheel driving mechanism, in a position substantially to counterbalance the kerf cutting mechanism. This air compressor is of the horizontal four-stage high pressure type comprising a low pressure cylinder 86, a second-stage cylinder 87, a third-stage cylinder 88 and a high pressure cylinder 89, these cylinders containing reciprocable pistons 90, 91, 92, and 93, respectively, connected by connecting rods to a crank shaft 94. The compressor cylinders are provided with usual intake and discharge valves, and are connected through piping to intercooling means generally designated 95, through which the compressed air flows between the different stages of compression, and the high pressure cylinder 89 is provided with a discharge pipe 96 through which the highly compressed air is finally discharged from the compressor. The compressor discharge pressure is extremely high; it sometimes reaching a pressure exceeding ten thousand pounds per square inch. As this compressor is of a well known commercial design, further description of the detailed structure thereof is herein considered unnecessary. The compressor is driven by the motor 39 through a spur gear 97 keyed to the rear end of the motor

power shaft and meshing with a spur gear 98 connectible by a multi-disc clutch 99 of a usual design to a shaft 100. The shaft 100 is alined with the compressor crank shaft 94 and is connected to the latter through a fly wheel coupling 101. In this illustrative construction, the discharge pipe 96 of the compressor is connected through a flexible tubing 102 to a coupling 103 threaded within the valve box 104 of the three-way valve above referred to, and is communicable under the control of a manually operable valve element 105 through a coupling 106 to a flexible tubing 107, the latter leading to a connection 108 (see Fig. 6) on the arm structure 8. Leading from the connection 108 and extending along the arm structure is a flexible tubing 109, this tubing passing out of the arm structure through an opening 110 and connected at its outer extremity to a coupling 111. The coupling 111 is connected through a pipe 112 to the supply passage 82 in the cylinder block of the cutter bar. As shown in Fig. 6, the pipe 112 extends through a longitudinal slot 113 in the bar hanger 23 so that the cutter bar may be adjusted along its guideways with respect to the hanger in the manner above described. When the valve element 105 is in the position shown in Fig. 9, highly compressed air may flow from the compressor through the air discharge pipe 96, tubing 102, the passage in the valve 105, the tubing 107, and tubing 109 to the passage 82 in the cutter bar and thence, in the manner previously described, to the chambers 54 of the blasting charge receiving and confining means. When the valve element 105, shown in Fig. 9, is turned into its opposite position, the tubing 107 is connected to exhaust through a vent passage 114, and as a result the control chambers 64 of the blasting means are vented, thereby to effect, in the manner above described, sudden opening of the blasting pressure release valves 67 to release the blasting charges from the chambers 54, through the orifices 55 and discharge passages 57. The valve box 104 shown in Fig. 9 may be mounted on the rear end of the truck frame, or if desired may be located at a point remote from the coal face, the flexible supply tubing 102, 107 being of sufficient length to enable location of the control valve 105 at a remote point. There is sufficient flexibility in the tubing 109 extending along the arm structure to enable rotation of the head 9 and tilting of the support 11 so that irrespective of the position of the kerf cutter, compressed air may be supplied to the blasting means embodied in the kerf cutter.

In the modified form of construction shown in Figs. 15 and 16, the cylinder block 50 of the cutter bar is formed with but a single centrally located bore 115 similar to the parallel bores above described and having similarly arranged therein a valve mechanism for confining the blasting charge in the chamber and for effecting release of the blasting charge. Formed in the end block 52 at the tip end of the bar is an axial discharge orifice 116 communicable with the chamber 115 and connected through downwardly inclined discharge passages 117 with the exterior of the cutter bar at the bottom surface of the cutter bar. It is accordingly evident that when the blasting pressure has been built up in the chamber 115 and the valve mechanism is operated to effect release of the charge, the blasting pressure flows from the chamber 115 through the axial discharge orifice 116 and the discharge passages 117 to act on the coal at one side of the

cutter bar. Otherwise this form of the invention is the same as that above described.

In both forms of the invention self-tamping means is provided, herein in the form of a U-shaped cuttings-retaining member 120 secured to the cutter bar hanger 23 and extending about the rearward portion of the cutter chain of the cutter bar. As shown most clearly in Fig. 13, the cutter bar is provided with an inclined wedging surface 121, while secured to the opposite surface of the cutter bar is a wedge block 122 having an inclined wedging surface 123. This cuttings-retaining member 120 and the inclined wedging surfaces 121, 123 cause the rear end of the opening formed by the kerf cutter, as the latter is fed in an endwise direction into the coal seam, to clog with cuttings when the inclined surfaces and the retaining member are brought up against the coal face, thereby to tamp the outer end of the opening formed by the kerf cutter so that when the blasting charges are released from the kerf cutter, the tamping T, clogging the outer end of the opening, impedes the flow of the blasting pressure outwardly through the opening so that a substantial blasting effect is transmitted directly to the coal to be broken.

The general mode of operation of the improved coal cutting and blasting apparatus is as follows: The apparatus may be propelled along the mine trackway at either a relatively high transport speed or a relatively low speed suitable for cutting, in the manner clearly described in the above mentioned copending application, and when the working place is reached with the apparatus in the position shown diagrammatically in Figs. 17 and 22, the turntable 5, arm structure 3, revolving head 9 and cutter support 11 may be adjusted to move the kerf cutter 12 into any desired location with respect to the working face and either rib. When the kerf cutter is suitably positioned, it may be sumped in, swung arcuately in its plane and withdrawn from the coal, in the manner well understood by those skilled in the art, to form a plane kerf in the coal seam. In Figs. 18 and 22 a horizontal plane kerf at the level of the mine floor is indicated at A. When the cut in the coal is completed, the arm structure and cutter support may be swung to position the kerf cutter near the roof level, and thereafter the kerf cutter may be sumped in an endwise direction into the coal in the position indicated at B in Fig. 18. When the kerf cutter is in the position indicated at B highly compressed air is supplied from the air compressor to the blasting charge confining means in the kerf cutter, and thereafter blasting charges of highly compressed air are suddenly released from the kerf cutter to break down the coal above the kerf A. As previously mentioned, the control valve element 105 for effecting release of the blasting charges from the kerf cutter may be located at the rear end of the truck frame, and suitable shielding means may be set up to protect the operator during the blasting operation. It is desirable, however, to locate the control valve element 105 at a point remote from the coal face during the blasting operation, as illustrated in Fig. 17. To complete the breaking down of the coal above the horizontal kerf A, the kerf cutter may thereafter be inserted in an endwise direction into the coal successively into the positions indicated at C and D in Fig. 18 and "blasting" charges released into the coal, when the kerf cutter is so positioned, to break down completely the undercut coal from the coal face. In

Fig. 19, a vertical kerf E is cut in the coal face midway between the ribs in planes perpendicular to the horizontal kerf A. The kerf cutter is then sumped in an endwise direction into the coal to the position indicated at F in Fig. 19 and "blasting" charges released into the coal to break down the coal between the right hand rib and the vertical kerf E. Thereafter, the kerf cutter is positioned at G in Fig. 19 and "blasting" charges are released in the coal between the left hand rib and the vertical kerf E to complete the breaking down of the face. In Fig. 20 parallel vertical kerfs H and I are cut at the ribs perpendicular to the horizontal kerf A and the kerf cutter is inserted successively in positions J and K and "blasting" charges released into the coal to break down the coal between the vertical kerfs. In Fig. 21, parallel vertical kerfs L and M are cut in the coal face in spaced relation between the ribs in planes perpendicular to the horizontal kerf A and the kerf cutter is thereafter moved successively to the positions N, O and P and "blasting" charges released into the coal to break down the coal between the ribs and between the vertical kerfs.

As a result of this invention, it will be noted that an improved coal mining apparatus of the combined cutting and "blasting" type is provided whereby the coal in the coal seam may be quickly and expeditiously cut and broken down, thereby reducing the time consumed in the preparation of the coal for the loading machine. It will also be noted that by embodying the improved "blasting" means in the kerf cutter of a coal cutting apparatus of the type disclosed, it is possible to release a "blasting" charge into the coal at any desired location in the coal face and in either rib. It will further be evident that by combining the "blasting" means with the kerf cutting means of a coal cutting machine in the manner disclosed, it is possible to cut the coal and thereafter insert the kerf cutter into the coal to form a "blast" opening, and, without removing the kerf cutter from the opening, to release "blasting" charges in the opening to break down the coal, thereby greatly reducing the time consumed in the mining cycle. It will also be evident that by the provision of air compressing means which operates to supply compressed air to the air receiving means in the kerf cutter during the cutting operation, the cutting and "blasting" functions may be effected in a relatively rapid succession. Further, by combining the cutting and "blasting" means in a self-contained unitary apparatus, not only is the time consumed in the cutting and "blasting" of the coal substantially reduced, but the expense necessitated by separate pieces of heavy equipment performing distinct functions, is also greatly reduced. It will also be noted that by incorporating the improved "blasting" type kerf cutter in a coal mining apparatus of the type disclosed, the hydraulically operated adjusting and supporting means for the kerf cutter act as a recoil means for absorbing any shocks which might occur when the blasting charges are released from the kerf cutter into the coal seam, thereby reducing the possibility of injury to the adjusting and supporting structure. Other uses and advantages of the improved coal mining and "blasting" apparatus will be clearly apparent to those skilled in the art.

While there are in this application specifically described one form and a modification thereof which the invention may assume in practice, it will be understood that this form and modifica-

tion are shown for purposes of illustration and that the invention may be modified and embodied in various other forms without departing from its spirit or the scope of the appended claims.

5 What I claim as new and desire to secure by Letters Patent is:

1. In an apparatus of the character described, a kerf cutter for cutting a plane kerf in a coal seam, means embodied in said kerf cutter for confining a blasting charge at coal breaking pressure, discharge means for said confining means, and means for controlling said discharge means for effecting sudden release of the blasting charge from said confining means into the coal seam to break down the coal previously cut by said kerf cutter.

2. In an apparatus of the character described, a kerf cutter for cutting a plane kerf in a coal seam, means embodied in said kerf cutter providing a chamber for confining a blasting charge at coal breaking pressure, and means for effecting sudden release of the blasting charge from said chamber into the coal seam previously cut by said kerf cutter to break down the coal.

25 3. In combination, a kerf cutter for cutting a plane kerf in a mine wall, means embodied in said kerf cutter for confining a charge of pressure fluid at a blasting pressure, and means for effecting sudden release of the charge from said confining means to effect blasting.

30 4. In combination, a kerf cutter for cutting a plane kerf in a mine wall, means embodied in said kerf cutter for confining a charge of pressure fluid at a blasting pressure, and means operable from a remote point for effecting rapid release of the charge from said confining means to effect blasting.

35 5. In combination, a kerf cutter for cutting a plane kerf in a mine wall, means embodied in said kerf cutter providing a chamber for confining a charge of pressure fluid at a blasting pressure, discharge means for said chamber, and a valve in said chamber for rapidly releasing the charge from said chamber through said discharge means to effect blasting.

40 6. In combination, a kerf cutter for cutting a plane kerf in a mine wall, means embodied in said kerf cutter providing a pair of parallel chambers for receiving separate charges of pressure fluid at a blasting pressure, discharge means for said chambers, and valve means in said chambers respectively for rapidly releasing the blasting charges from said chambers through said discharge means to effect blasting.

45 7. In combination, a kerf cutter for cutting a plane kerf in a mine wall, means embodied in said kerf cutter providing a pair of parallel chambers for receiving separate charges of pressure fluid at blasting pressure, discharge means for said chambers, and valve means in said chambers for confining the charges in said chambers and operable at will for effecting sudden simultaneous release of said charges from said chambers through said discharge means to effect blasting.

50 8. In combination, an elongated plane cutter bar having an endless cutter chain guided for circulation about its margin, means embodied in said cutter bar for confining a blasting charge at a coal breaking pressure, discharge means for said confining means, and means for effecting sudden release of the blasting charge from said confining means through said discharge means to effect blasting.

55 9. In combination, an elongated plane cutter bar having an endless cutter chain guided for

circulation about its margin, means embodied in said cutter bar providing a chamber for receiving a blasting charge at a coal breaking pressure, a valve in said chamber for confining the charge therein and for suddenly releasing the charge to effect blasting, and control means for said valve.

10. In combination, an elongated plane kerf cutter, means embodied in said kerf cutter for confining a blasting charge at coal breaking pressure, and means for suddenly releasing the charge from said confining means in a direction perpendicular to the plane of the kerf cutter.

11. In combination, an elongated plane kerf cutter, means embodied in said kerf cutter for receiving a charge of pressure fluid at a blasting pressure, and means for effecting sudden release of the blasting charge from said receiving means in a direction perpendicular to the plane of the kerf cutter.

12. In combination, a kerf cutter for cutting a plane kerf in a mine wall, means embodied in said kerf cutter for receiving a charge of pressure fluid at blasting pressure, and a differential valve mechanism in said receiving means for confining the charge in said receiving means and for suddenly releasing the charge from said receiving means to effect blasting.

13. In combination, a kerf cutter for cutting a plane kerf in a mine wall, means embodied in said kerf cutter for receiving a charge of pressure fluid at blasting pressure, and a differential valve mechanism in said receiving means for confining the charge in said receiving means and for suddenly releasing the charge from said receiving means to effect blasting, and means for controlling said valve mechanism from a point remote from said kerf cutter.

14. In a coal cutting and blasting apparatus, a portable base, a kerf cutter mounted on said base and adapted to cut a plane kerf in a mine wall, a fluid compressor mounted on said base, means embodied in said kerf cutter providing a chamber for receiving a charge of pressure fluid at a blasting pressure, means for conducting compressed fluid from said compressor to said charge receiving chamber irrespective of the adjusted position of said kerf cutter, and means under operator control for effecting rapid release of the blasting charge from said chamber when a predetermined blasting pressure is attained therein.

15. In a coal cutting and breaking apparatus, a portable base, a kerf cutter mounted on said base and adapted to cut a plane kerf in a mine wall, a fluid compressor mounted on said base, means embodied in said kerf cutter providing a chamber for receiving a charge of compressed fluid at a blasting pressure, means for conducting compressed fluid from said compressor to said charge receiving chamber, valve means for confining the charge in said chamber and for releasing the charge to effect blasting, and means operable from a point remote from said kerf cutter for effecting opening of said valve means rapidly to release the charge from said chamber.

16. The method of dislodging material from a mine wall which comprises cutting the material with a suitable elongated kerf-cutting implement to provide an opening substantially rectangular in cross section on a plane perpendicular to its depth and to the length of said kerf-cutting implement and having two of its mutually opposite bounding surfaces substantially plane and parallel to each other and spaced from each other by a distance less than half their width, said 75

opening having one of said two surfaces facing generally in the direction in which it is desired to exert a material dislodging force, whereby a blasting pressure released into said opening will exert its rupturing force in greater degree in the desired direction rather than in a direction at right angles to such direction, confining a blasting charge within the opening so formed in the material, and while the cutting implement remains in said opening releasing the blasting charge from its confinement into said opening.

17. The method of dislodging material from a mine wall which comprises cutting the material with a suitable elongated kerf-cutting implement to provide in the material an opening having a pair of mutually opposite bounding surfaces extending longitudinally of said opening, and further having another pair of mutually opposite bounding surfaces also extending longitudinally thereof, said last mentioned surfaces each extending between and connecting said first mentioned surfaces, and being plane and each of at least twice the width of said first mentioned mutually opposite surfaces, said opening having one of said pair of plane parallel surfaces facing generally in the direction in which the material dislodging force is to be exerted, whereby a blasting pressure released into said opening will exert its major force in the desired direction, confining a blasting charge within the opening so formed in the material, and, while the cutting implement remains in the material, releasing, through the cutting implement, the blasting charge from its confinement within the opening in the material formed by the cutting implement, into said opening.

18. A method of cutting and blasting coal comprising the steps of inserting a kerf-cutting implement into the coal to form a plane kerf therein, sumping the kerf-cutting implement in an

endwise direction into the coal to form an opening at a point spaced from said plane kerf, confining a blasting charge at coal breaking pressure within the opening formed by said cutting implement, and finally, while the kerf-cutting implement remains in said opening, releasing the blasting charge at coal breaking pressure from its confinement within said opening into the latter, to break down the coal previously cut by the cutting implement.

19. A method of cutting and blasting coal comprising the steps of inserting a kerf-cutting implement into the coal to form a plane kerf, sumping the kerf-cutting implement in an endwise direction into the coal to form an opening at a point spaced from said plane kerf, confining within said kerf-cutting implement a blasting charge at coal breaking pressure, and finally, while the kerf-cutting implement remains in said opening, releasing into said opening, in a direction perpendicular to the plane of said kerf, said blasting charge at coal breaking pressure, to break down the coal previously cut by the cutting implement.

20. A method of cutting and blasting coal comprising the steps of inserting a kerf-cutting implement into the coal to form a plane kerf therein, sumping the kerf-cutting implement in an endwise direction into the coal to form an opening at a point spaced from said plane kerf, confining a blasting charge at coal breaking pressure within the opening formed by said cutting implement, and finally, while the kerf-cutting implement remains in said opening, releasing from within the cutting implement the blasting charge at coal breaking pressure from its confinement in said opening, into the latter, to break down the coal previously cut by the cutting implement.

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