April 16, 1935. E. A. THOMAS ET AL 1,998,294

METHOD OF MINING

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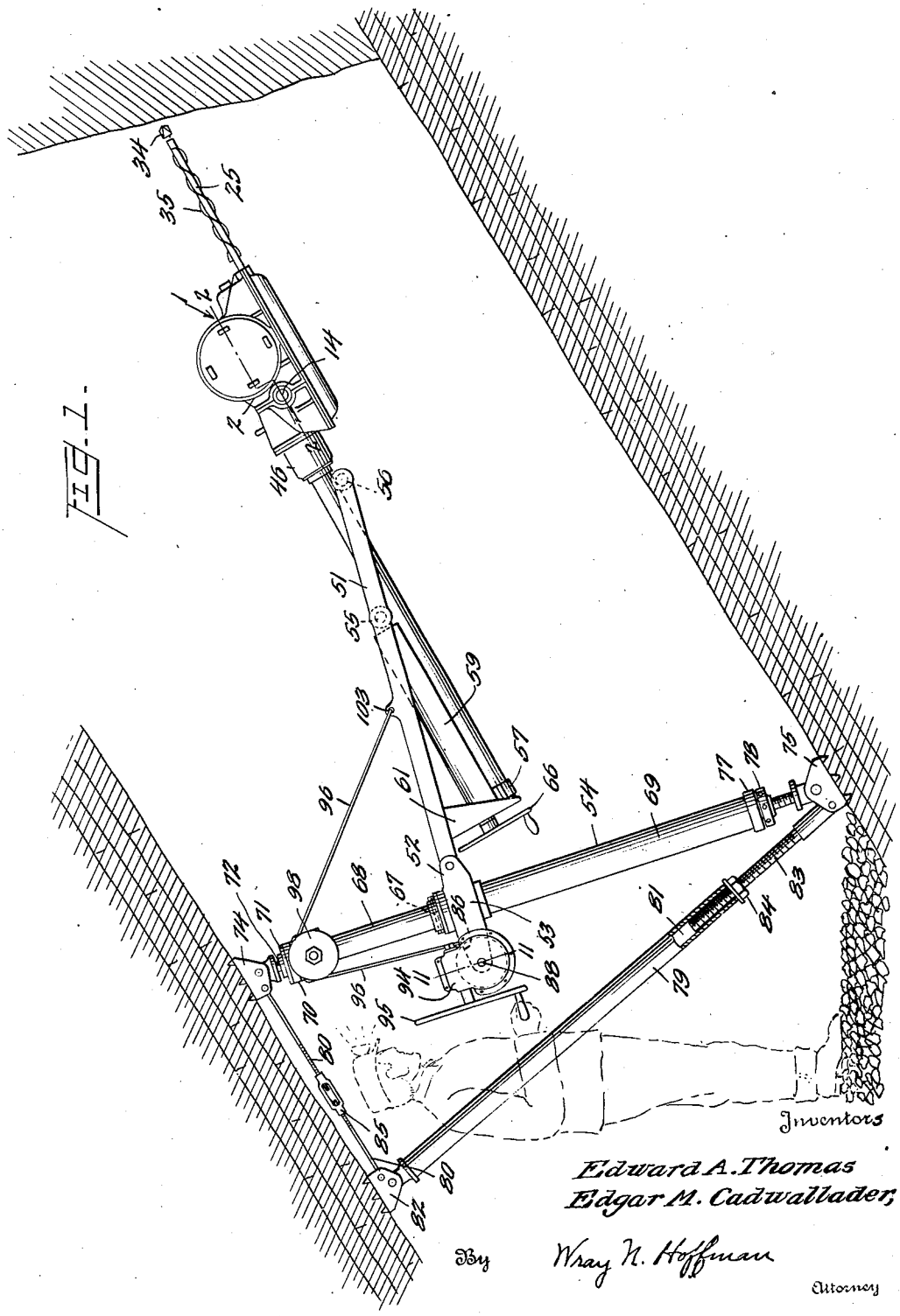


FIG. 1.

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FIG. 2.

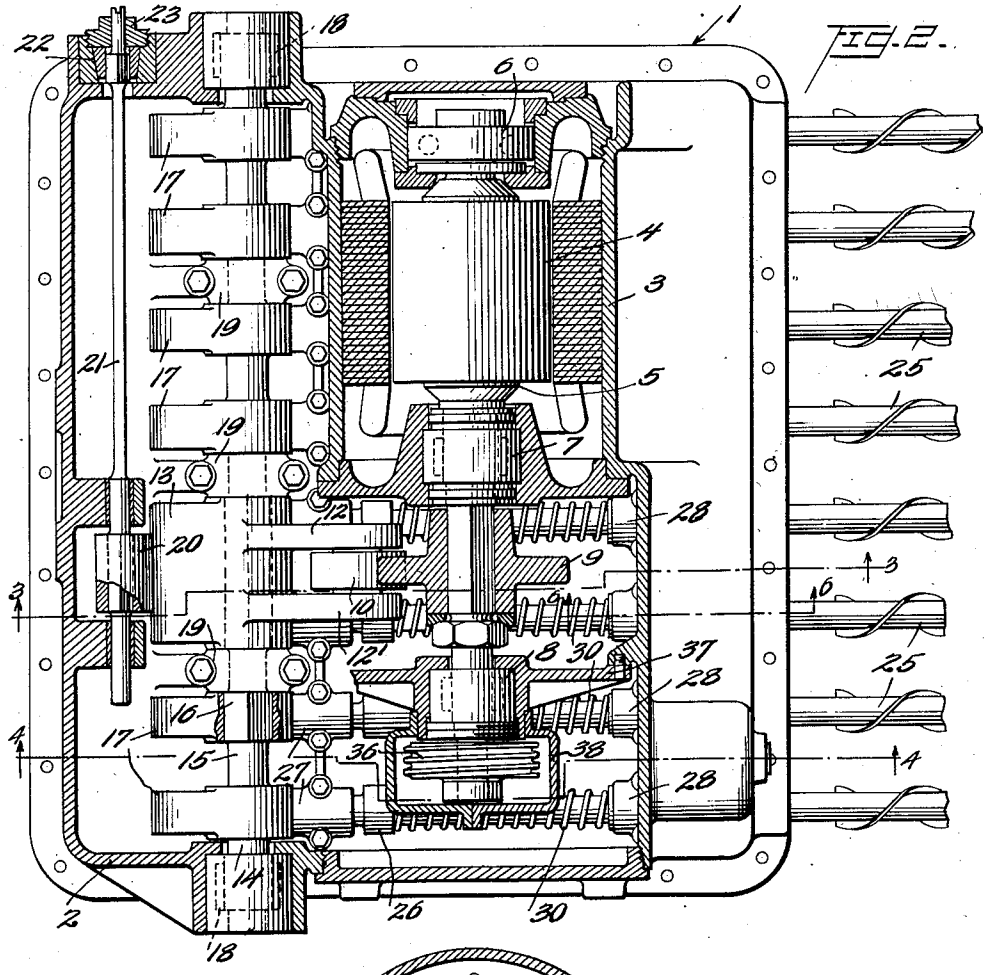
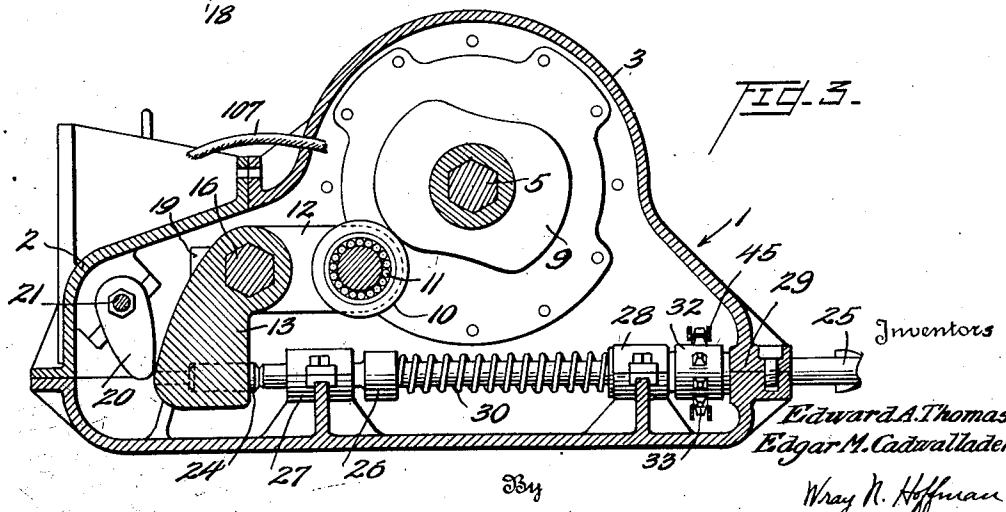


FIG. 3.



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METHOD OF MINING

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FIG. 4.

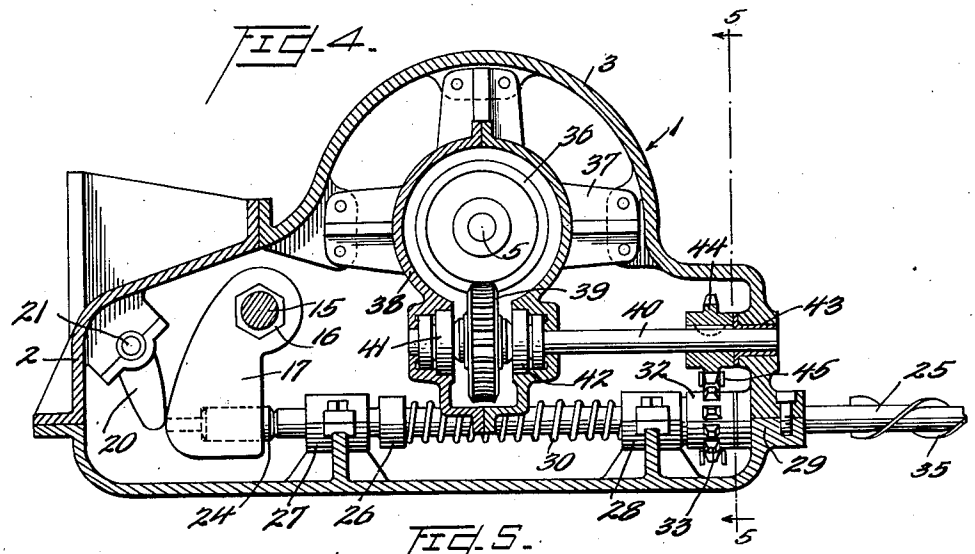


FIG. 5.

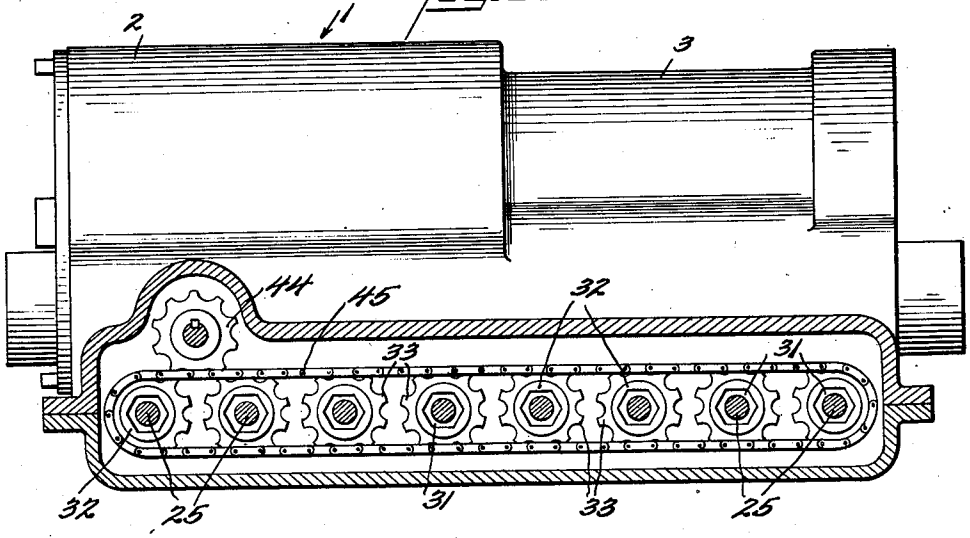
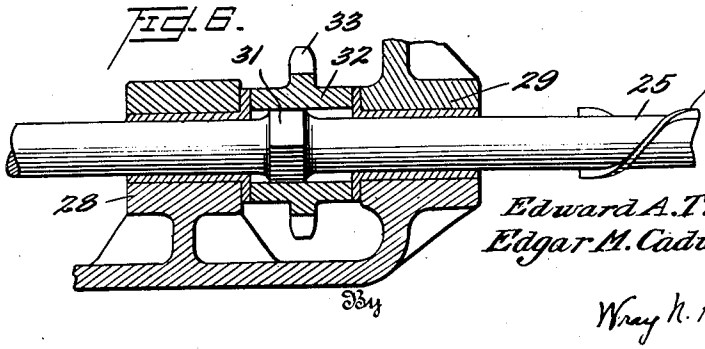


FIG. 6.



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METHOD OF MINING

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FIG. 8.

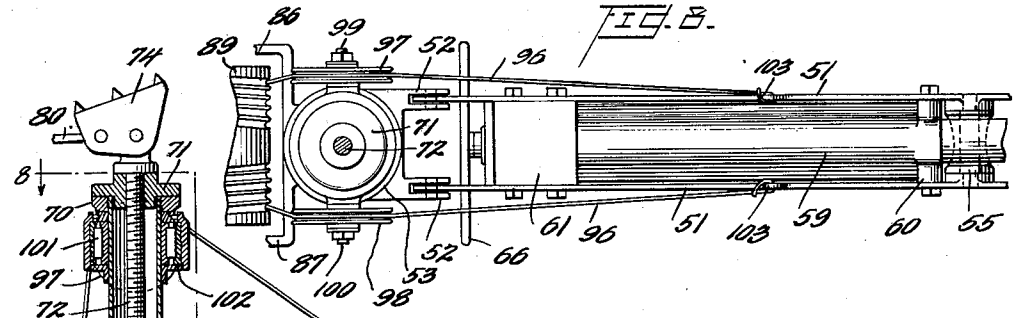


FIG. 7.

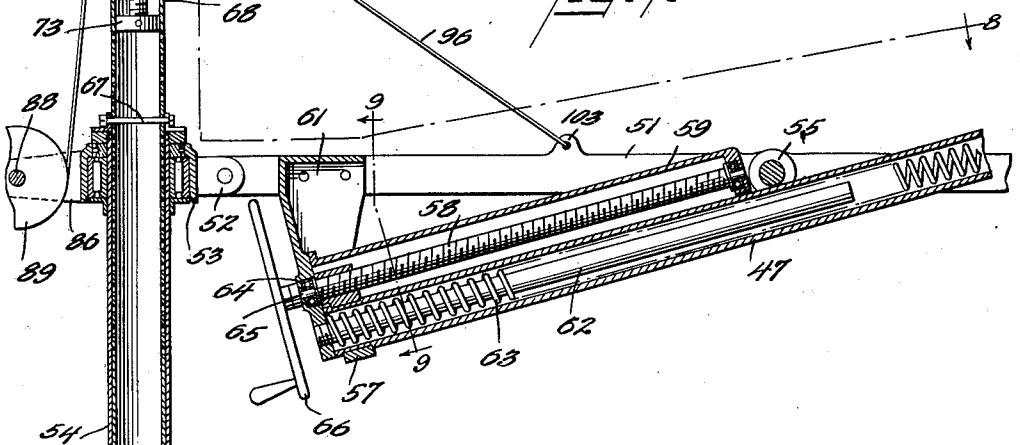
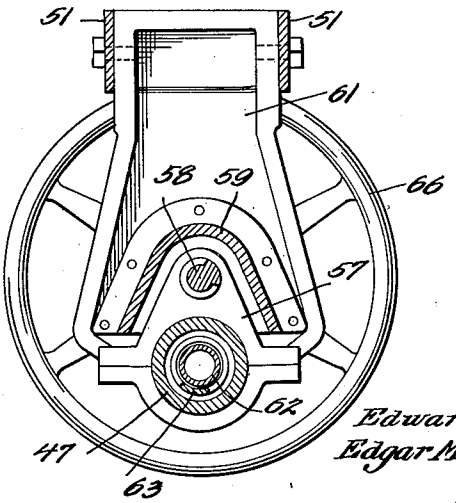
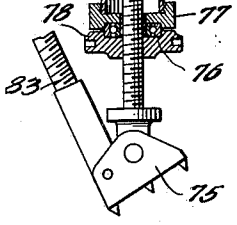


FIG. 9.





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METHOD OF MINING

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FIG. 10.

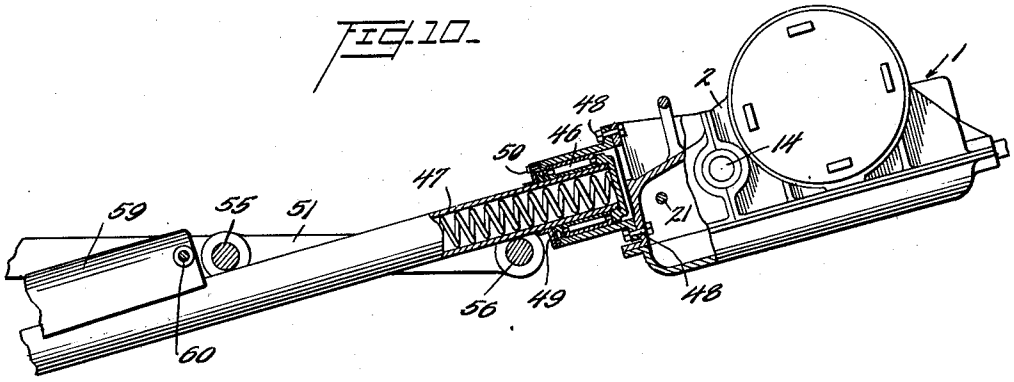


FIG. 11.

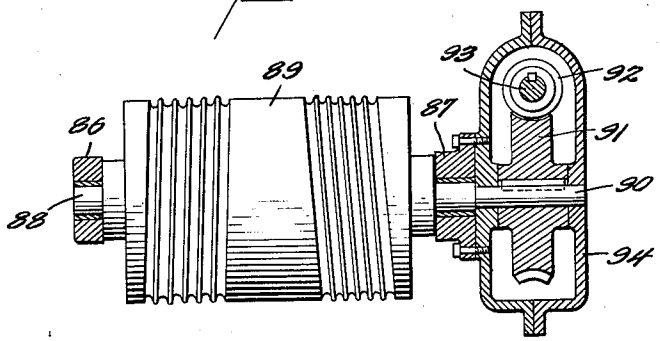
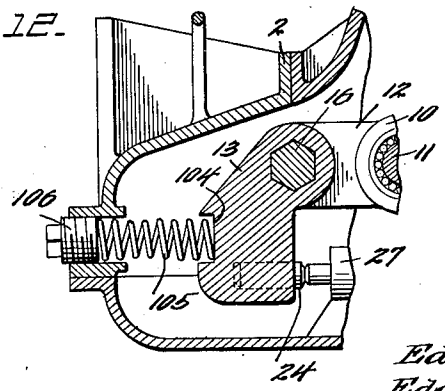


FIG. 12.



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UNITED STATES PATENT OFFICE

1,998,294

METHOD OF MINING

Edward A. Thomas, Telford, Pa., and Edgar M. Cadwallader, Cleveland, Ohio, assignors to Thomas Mineral Cutting Machine Co., Inc., Cleveland, Ohio, a corporation of Delaware

Application October 19, 1933, Serial No. 694,306

16 Claims. (Cl. 262—1)

This invention relates to a method of mining coal. More particularly, the invention relates to the pitch mining of hard coal or similar material.

In most of the localities where hard coal is found, the coal appears in strata or veins which run at an angle with respect to the surface of the ground, such angle or pitch being anywhere from 10° to 70°. In the mining of coal from such strata or veins, it is necessary to first sink a shaft or slope of a depth sufficient to reach the bottom or basin of the various strata of coal, and then form a tunnel or gangway in the basin for the reception of the coal which is mined from the strata. In such tunnel or gangway is mounted suitable machinery for transporting the coal which has collected therein to the shaft or slope, from which point it is conveyed to the surface for preparation for market. From this tunnel or gangway, the strata or veins of coal extend upwardly in different directions and at different degrees of pitch. The mining of coal from pitched strata or veins is what is known as "pitch mining", and will be termed such in the description hereinafter set forth.

In the system of pitch mining the face or breast of the strata or vein facing the tunnel or gangway is punctured by blasting at suitably spaced points therealong, so as to form openings of the desired size which are closed by traps. Such openings are usually of a width of approximately 4 feet square and of a length of about 30 to 40 feet. From each of such openings, a cut is made so as to form a working breast or face of approximately 24 feet in width and extending the full height or thickness of the strata or vein. The edges of each breast or face in turn are bounded by lateral ribs of sufficient thickness to form a support for the roof. These working breasts or faces and lateral ribs are so arranged with respect to each other as to form a battery of tunnels which are in communication with the main tunnel or gangway through said openings. Adjacent to and along the lateral rib of each breast is a man-way for the ingress and egress of the workmen, such man-ways being of a size just sufficient to easily permit the passage of a workman therethrough. In addition, these man-ways act as ventilating ducts, and are also used for the purpose of taking timber, tools and other materials required by the operator at the working face or breast.

Pitch mining as now practiced consists in drilling holes into the face or breast of the coal at suitably spaced points, filling the holes with explosives, and then setting off the charges of explosives. In other words, the coal is broken from the face or breast by blasting. In this method the degree of impact and shattering power of the blast is dependent upon the skill exercised by the miner in selecting the proper relative positions for each hole, in drilling the holes to the proper depth, in employing the correct amount of the explosive charge, and in tamping the charge properly in each of the holes. Thus, it will be apparent that if great care and skill is not exercised by the miner, a blasting effect will result which is of such intensity and repercussion as to cause severe fractures in the lateral ribs and cave-ins in the roof and shatter the coal into a relatively high percentage of small particles of a size known as undersized coal or fines. Further, the coal is blasted primarily from the central portion of the breast, leaving portions of the coal depending from the roof and protruding from the lateral ribs. In order to maintain the breast or face of uniform fracture, it is necessary to remove such portions, and this can only be done by hand-operated wedges, sledges, or picks. As a matter of fact, it is not possible to dislodge the coal by blasting from the entire area of the breast or face without causing some damage to the roof and the lateral ribs. The coal thus mined slides down the pitched floor and collects upon the top of a base of mined coal which extends from the working breast or face to the trap door for controlling the discharge of the mined coal therefrom into the tunnel or main gangway. This bank of mined coal extending from the breast to the trap forms a platform for supporting the workman in his operations incident to mining.

In the blasting method of pitch mining, it is necessary to continually reinforce the roof by means of upright timbers and collars so as to protect the workmen from injury or fatality due to the falling of pieces or sections of the roof. The timber required for this purpose can only be brought up to the workmen in the breast through the man-ways, and this is an extremely difficult and burdensome task, because of the great weight of the timbers. Furthermore, the blasting causes an undue amount of smoke and coal dust which are not only injurious to the health of the workmen, but also unduly tax the system of ventilation. In addition, there is the grave danger of gas explosions and consequent fires which result in many injuries or fatalities to the workmen. Then again, this method of mining produces approximately 35% of what is known as undersized coal or fines of each ton

mined which undersized coal or fines can only be sold at a price below the production cost. Also, the average production of a miner with a helper for each working day of eight hours is only from 6 to 8 tons of coal.

Accordingly, an object of the present invention is to provide a method of pitch mining wherein the coal or similar mineral is mined without blasting.

Another object of the present invention is to provide a method of pitch mining without blasting wherein the coal or similar mineral is broken away and dislodged by the application of vibratory forces to the breast or face of the vein.

A further object of the present invention is to provide a method of pitch mining without blasting wherein the coal or similar mineral is mined in greater quantities of sizable pieces convertible in marketable sizes than is possible by the pitch mining employing blasting.

A still further object of the present invention is to provide a method of pitch mining which enables the coal to be mined without the use of any explosives, and thereby eliminates the fire hazard and consequent injuries or fatalities to the workmen, the avoidance of undue dust and smoke, and materially reduces the amount of timber required for supporting purposes.

Briefly stated, the method according to the present invention comprises forming a fissure extending across the entire face of the breast at an angle substantially parallel to the pitch of the floor at the juncture point of the breast and the floor of the vein, fracturing the cleavage of the coal or mineral from the floor to the roof of said vein along each of the joinder points of the lateral ribs and the breast, forming a series of spaced localized areas of a depth substantially corresponding to said fissure in the breast in a plane spaced from said fissure and at an angle substantially parallel to the pitch of the floor of the vein, and applying to said areas vibratory forces which in themselves and unsupplemented by any auxiliary disruptive forces are of sufficient magnitude to break away and dislodge the coal or mineral in the region of said areas in sizable pieces with a minimum of fines and undersized particles.

The fissure extending across the entire face of the breast may be formed by boring into the face of the breast at the juncture point of the breast and the floor of the vein at an angle substantially parallel to the pitch of the floor to the desired depth. This may be done by causing a series of aligned boring elements to simultaneously bore into a portion of the breast to the desired depth, withdrawing the boring elements, and successively repeating such boring and withdrawing operations upon other portions of the face until the fissure extends across the entire width of the breast. The depth of the fissure is variable, it being dependent upon the length of the boring elements employed. In view of the restricted working space in front of the face of the breast, boring elements of a length just sufficient to bore to a depth of about two feet have been found to be most satisfactory. Although a depth of two feet is preferred, it is to be understood that satisfactory results are obtained if the depth of the fissure is considerably less or more than two feet. The formation of the fissure severs or fractures the cleavage between the bed rock of the floor and the coal or mineral to be mined.

The fracturing of the cleavage of the coal or mineral from the floor to the roof of the vein along the joinder points of the lateral ribs and the breast may be done in a manner like that employed in the formation of the fissure previously described, or in such manner that the coal is just punctured sufficiently at a plurality of spaced points along the joinder point from the floor to the roof of the vein so as to sever or break the cleavage of the coal at such point. Preferably, the depth of the fracture should be substantially the same as that of the fissure.

The application of the vibratory forces to the breast or face of the coal which are of sufficient magnitude in themselves to break away and dislodge the coal or mineral in sizable pieces with a minimum of fines and undersized particles may be effected in a number of ways. One manner of doing this consists in contacting a plurality of aligned and spaced boring elements with the face of the breast in a plane spaced above the fissure and at an angle which is substantially parallel to the pitch of the floor of the vein, causing the boring elements to bore into the coal, and as the boring progresses applying a vibratory force to said elements, the vibratory force being applied continuously, intermittently, or intermittently and successively, preferably successively and at periodic intervals. The selection of the plane above the fissure at which the boring elements are to penetrate the coal depends upon the depth of the fissure and the texture and solidity of the coal or mineral. While it is preferred to have the plane of penetration at a distance of from 1 to 2 feet from the fissure, it is also possible to have the spacing of such plane more or less than the aforesaid distance. The aligned boring elements are preferably of a length sufficient to bore holes of a depth substantially corresponding to that of the fissure and of an overall width corresponding to a multiple of the entire width of the breast, for example, two feet. The boring action of the boring elements with the boring elements equally spaced from each other penetrates the coal and thereby forms spaced localized areas from which the vibratory forces exerted through the boring elements as the boring progresses are distributed to the coal or mineral in the region of each of such areas to an extent sufficient to cause the breaking away and dislodging of the coal. Inasmuch as the overall width of the spaced boring elements is but a multiple of the entire width of the breast, this same treatment which results in the formation of spaced localized areas and the application of vibratory forces to such areas is continued successively along the same plane until the entire width of the breast has been treated. This same operation is successively repeated along suitably spaced planes until the entire face of the breast of coal or mineral has been broken away and dislodged.

An embodiment of an apparatus for use in carrying out the method according to the present invention is illustrated in the accompanying drawings, wherein

Figure 1 is a side elevation showing the apparatus according to the present invention in operative position in a coal or mineral vein of the pitch type.

Figure 2 is a plan view in section, taken on the line 2—2 of Figure 1, showing the device for boring into the coal or mineral and applying vibratory forces thereto.

Figure 3 is a side elevation in section, taken

on the line 3—3 of Figure 2, showing the mechanism for applying vibratory forces to the boring elements.

Figure 4 is a side elevation in section, taken on the line 4—4 of Figure 2, showing the mechanism for effecting the driving of the boring elements.

Figure 5 is a front elevation, partly in section, taken on the line 5—5 of Figure 4 showing the mechanism for driving the plurality of spaced boring elements.

Figure 6 is a partial side elevation in section, taken on the line 6—6 of Figure 2, showing the mechanism for imparting vibratory impulses to the boring elements while they are being driven.

Figure 7 is a side elevation, partly in section, showing the means for effecting relative movement of the device for boring and applying vibratory forces with respect to the breast of coal and the means for supporting and anchoring same within the vein or strata.

Figure 8 is a top elevation taken on the line 8—8 of Figure 7.

Figure 9 is a front elevation, partly in section, taken on the line 9—9 of Figure 7, showing the means for effecting relative movement of the boring and vibratory device with respect to the breast of the coal or mineral.

Figure 10 is a partial side elevation in section, showing the manner of connecting the boring and vibratory device to the means for effecting relative movement of said device with respect to the breast of the coal or mineral.

Figure 11 is a rear elevation, partly in section, taken on the line 11—11 of Figure 1, showing the means for universally adjusting the position of the means for supporting the boring and vibratory device.

Figure 12 is a partial side elevation, in section, showing a modification of the mechanism for applying vibratory forces to the boring elements.

Referring to the drawings, the numeral 1 designates the device for boring into the coal or mineral and applying vibratory forces thereto. Such device comprises a housing 2 which includes as a part thereof a motor casing 3 in which is mounted a combined rotor and stator 4 provided with a shaft or spindle 5. The shaft or spindle 5 is mounted in bearings 6, 7, and 8 and has a portion intermediate the bearings 7 and 8 which is hexagonal in shape. Mounted upon the hexagonal portion of the shaft or spindle 5 is a cam 9 which engages with and rides upon a roller 10 rotatably mounted on a shaft 11 supported by the ears 12 and 12' of a lever 13. The lever 13 in turn is fixedly mounted upon the hexagonal portion 14 of the shaft 15 as shown in Figure 3. The shaft 15 is provided with a plurality of hexagonally shaped portions 16 which are spaced therealong and is rotatably mounted in roller bearings 18 and bushed bearings 19. Upon each of the portions 16 of the shaft 15 is fixedly mounted a lever 17.

The lever 13 contacts with and bears against a torsion lever 20 which is fixedly mounted on a torsion shaft 21. One end of the torsion shaft 21 is provided with a hexagonal shaped portion which extends through an opening in the housing 2 and is securely held against turning in said opening by means of adjusting sleeve 22 and lock nut 23.

Protruding from the face of lever 13 and of each of the levers 17 is a hammer pin 24. Supported by the base of the housing 2 and mounted therein are a plurality of aligned and spaced boring elements or drills 25, which are so positioned with respect to the lever 13 and levers 17 that one end of each of the drills is in operative relation with a hammer pin 24. As shown in Figures 3 and 4, each of the drills 25 is provided with a collar 26 and is rotatably mounted in bearings 27, 28, and 29. Loosely mounted upon each of such drills 25 is a tension spring 30 having one end which bears against the collar 26 and the other end against the bearing 28. Each of the drills 25 is provided with a hexagonal shaped enlargement 31 as shown in Figure 6. Surrounding such hexagonal shaped enlargement 31 of the drill and disposed between the bearings 28 and 29 is a hollow hexagonal shaped hub 32 which is of such construction as to permit the hexagonal enlargement 31 to freely slide therein. The hub 32 is provided with a plurality of teeth protruding from the outer periphery thereof in such manner as to form a sprocket 33. The boring end of the drills 25 may be of any desired shape or configuration, preferably it should comprise a detachable diamond shaped point or bit 34 and a spiral shaped portion 35 as shown in Figure 1.

Mounted on the shaft 5 adjacent to and beyond the bearing 8 is a worm 36. The bearing 8 is supported by bracket 37 to which is secured a casing 38. Within the casing 38 is a worm gear 39 which meshes with the worm 36. The worm gear 39 is carried by a shaft 40 which is mounted at one end in bearings 41 and 42 supported by the casing 38 and the other end in bearing 43 supported in housing 2. Mounted upon shaft 40 is also a sprocket 44 which is in engagement with a driving chain 45 that meshes with the plurality of sprockets 33 carried by the drills 25. The housing 2 is partially filled with a lubricant of the desired viscosity which insures adequate lubrication of all of the mechanism under working conditions.

The device for boring and applying vibratory forces designated by the numeral 1 is attached to a flanged roller bearing 46 carried by an end of a staff 47 by means of bolts 48 which pass through openings in the flange of the bearing 46 and openings of the housing 2 of the device 1, as shown in Figure 10. The opposite end of the bearing 46 is provided with a plurality of openings which are shiftable into complemental relation with openings in a collar 49 carried by the staff 47, and the collar 49 locked to the bearing 46 at any desired position by means of a pin or pins 50. The staff 47 is mounted on and is supported by a pair of arms 51 detachably secured by a pin or bolt to ears 52 of a roller bearing 53 mounted upon and surrounding a hollow tubular section 69 of a standard 54, the portion of said staff carrying the device 1 extending between the arms 51 and resting upon rollers 55 and 56 carried by said arms. The free end of the staff 47 extends through a feeding nut 57 and is clamped thereto. The feeding nut 57 is provided with a threaded opening which engages with a screw 58 mounted in a hollow guide bracket 59 connected at one end to arms 51 as at 60. The other end of the guide bracket 59 is secured to the arms 51 by means of bracket 61. Disposed within the staff 47 is a rod 62 which is surrounded by a tension spring 63. The feeding nut 57 has a threaded opening which engages the screw 58, and also an opening which surrounds the staff 47. One end of the screw 58 is provided with a shank 65

upon which is mounted a thrust bearing 64 and a turn wheel 66.

The standard 54 comprises hollow tubular sections 68 and 69 which telescope into each other. Each of such sections are provided with openings in the sides thereof as shown in Figure 7 for adjusting the relative positions so as to increase or decrease the overall length. The sections are locked in the adjusted position by means of pins or bolts 67. On the free end of section 68 is a collar 70 which bears against a threaded nut 71 in threaded engagement with a shackle bolt 72. On one end of the shackle bolt 72 is a collar 73 which is of a size such as to freely slide within the section 68. To the other end of the shackle bolt 72 is attached a claw shaped shoe 74. The shoe 74 may be adjusted with respect to the section 68 by means of the nut 71. The free end of section 69 is provided with an adjustable claw shaped shoe 75 which is of the same structure as shoe 74 just described, except a thrust bearing 76 is interposed between the collar 77 and the adjusting nut 78, the purpose of such bearing being to take the thrust induced by the rotation of the nut 78 toward the collar 77.

The hollow standard 54 is fixedly anchored and braced against lateral stresses by means of a bracing member 79 and turn buckle tie rod 80. The bracing member 79 comprises a hollow tube 81 having at one end thereof a claw shaped shoe 82 of a structure like that of shoe 74 previously described. The free end of said tube 81 is adjustably connected to the claw shaped shoe 75 by means of a threaded shackle bolt 83 and nut 84. The shoe 82 is connected to or tied to shoe 74 by means of turn buckle tie rod 85.

The roller bearing 53 mounted upon hollow tubular section 69 of the standard 54 is provided with arms 86 and 87 which support a shaft 88, having a grooved drum 89 mounted thereon. The shaft 88 is provided with a shank 90 upon which is mounted a worm gear 91, and such gear in turn is in mesh with worm 92 carried by a shaft 93. A casing 94 encloses such worm gear mechanism and is secured to the arm 87 of the bearing 53. Mounted upon the free end of shaft 93 is a turn wheel 95. Secured to the drum 89 and so disposed as to operate in the grooves are cables 96 which ride over sheaves 97 and 98 mounted on trunnions 99 and 100 extending from opposite sides of roller bearing 101 secured to the top of section 68 of the standard 54 by means of collar 102. The cables 96 extend from the sheaves 97 and 98 to the pair of arms 51 and are detachably secured thereto as at 103.

In carrying out the method of the present invention with the apparatus thus described, the boring and vibratory device 1 is taken up through the man-way to the working face of the breast. The part consisting of the supporting arms 51 and staff 47 is next taken up through the man-way. Then, finally the part consisting of the standard 54, bracing member 79, and turn buckle tie rod 80 is taken up through the man-way. It is to be understood that these parts of the apparatus may be taken up through the man-way to the working face of the breast in any desired order or sequence.

The operator and his helper first set up the standard 54 in such manner that the claw shoes 74 and 75 engage the roof and floor, respectively, whereupon the bracing member 79 is positioned so that the shoe 82 will engage the roof of the vein and thereby adequately brace the standard 54. To fixedly anchor the bracing member 79 and standard 54, the turn buckle tie rod 80 is secured in such manner that the shoes 74 and 82 are tightly connected together, and then the nut 78 is turned until the claws of the bracing member and standard are firmly and securely anchored.

To the thus anchored standard 54 is secured the part consisting of the supporting arms 51 and staff 47 by arranging the ends of said arms in abutting relation with the ears 52 of the bearing 53 carried by section 69 of the standard, and securing the arms thereto by means of a pin or bolt which passes through complemental openings in the ears and arms. The boring and vibratory device 1 is then attached to the end of the staff 47 in such position that the drills are in a truly horizontal position by aligning the openings in the housing 2 with the openings in the flange of the bearing 46, and securing and locking the device in such position to the staff by inserting pins 50 in the aligned openings. The cables 96 are then trained over the sheaves 97 and 98 and in turn attached to the supporting arms 51 as at 103. The operator then turns the wheel 95 in the proper direction to shift the boring and vibratory device 1 to a position such that the drills are at an angle substantially parallel to the pitch of the floor at the juncture point of the breast and the floor.

When the apparatus thus described is in the proper position with respect to the face of the breast of the coal or mineral, the operator connects the cable 107 to a suitable source of electricity which starts the rotation of the motor shaft 5. The rotation of the shaft 5 causes the rotation of the boring drills 25 through the worm 36, worm gear 39, shaft 40, driving sprocket 44, sprocket chain 45, and sprockets 33.

As the shaft 5 rotates the peripheral surface of the cam 9 is caused to ride around the roller 10. The peripheral surface of the cam 9 is such that at certain points of its orbital travel it exerts pressure on the roller 10 to such an extent as to cause the lever 13 to overcome the force exerted thereon through the torsion lever 20 and then abruptly releases such pressure. The application of the pressure of such extent upon the lever 13 through the roller 10 so as to overcome the tensional stress or force exerted thereon by the torsion lever 20 induces the hammer pins 24 to be moved away from the complemental ends of the drills 25, and the abrupt release of such application of pressure causes the hammer pins of not only lever 13 but also levers 17 to strike against the complemental ends of the drills to exert a vibratory force upon the drills while they are being rotated. The striking of the hammer pins upon the complemental ends of the drills causes the hexagonal shaped enlargements 31 on each of the drills to move longitudinally within the hexagonal shaped hubs 32, which movement is translated into a vibratory force which in turn is distributed to the coal or mineral in the regions of contact of the drills when the drills are operating in the coal or mineral.

While the boring and vibratory device 1 is in operation, the operator turns the wheel 66 in the proper direction to a degree sufficient to cause the feeding nut 57 and screw 58 to advance the staff 47 until the drills contact with the face of the breast of coal or mineral. The drills which are rotating upon contact with the face of the breast begin to bore a plurality of spaced holes in the coal or mineral. The operator gradually continues the turning of the wheel 66

until the drills have bored holes of the desired depth, for example a depth corresponding to the length of the drills or less. Preferably, the drills are urged toward the face of the breast until holes of a depth corresponding to the length of the drills are bored. When the holes have been bored to the desired depth, the operator turns the wheel 66 in the opposite direction until the drills are clear of the face of the breast, whereupon the drills are shifted to a position such that the ends will contact with the portions of the coal intermediate the plurality of spaced holes previously bored. The operator then turns the wheel 66 in the proper direction to advance the drills into the coal and continues the gradual turning until the coal intermediate the plurality of spaced bored holes has been bored away to the same depth, and thereby forms a continuous cut or fissure in the coal in the portion defined by the drills in the face of the breast at the juncture point of the floor and breast. This operation is continued until a fissure has been formed clear across the breast at this point. Since the drills bore at an angle, the borings are picked up by the spiral portion 35 and are conveyed back toward the working space of the vein and discharged upon the pitched floor. The formation of such fissure severs the coal from the bed rock of the floor.

When the fissure at the base of the breast has been formed, the operator shifts the mounting of the boring and vibratory device 1 to a position such that the drills are in a vertical plane. This is done by removing the pins 50, tilting the device to the desired position, aligning the openings in the housing 2 with the openings in the flange of the bearing 46, and then inserting the pins 50 in the aligned openings. The wheel 95 is then turned in the proper direction to shift the boring and vibratory device 1 to a position such that the drills are positioned in a vertical plane just above the fissure and at one of the lateral ribs of the breast. It is to be noted that the drills in such position are also at an angle substantially parallel to the pitch of the floor of the vein or strata. The operator next turns the wheel 66 in the proper direction to a degree sufficient to cause the feeding nut 57 and screw 58 to advance the staff 47 until the drills contact with the face of the breast of coal or mineral, and continues such turning of the wheel until a plurality of spaced holes have been bored into the coal or mineral to the desired depth, preferably to the same depth as that of the fissure, whereupon the wheel 66 is turned in the opposite direction until the drills are clear of the coal. The boring and vibratory device 1 is then elevated by means of the wheel 95 to a position such that the drills are just above the portion containing the thus drilled plurality of spaced holes, but in the same vertical plane. Then the operator again turns the wheel 66 in the proper direction to a degree sufficient to cause the advancement of the drills into contact with the face of the breast of coal or mineral at such point, and continues such advancement until another series of spaced holes are bored, whereupon he turns the wheel 66 in the opposite direction until the drills are again clear of the coal. These operations are repeated successively until the coal along the lateral rib has been punctured from the floor to the roof of the vein or strata. When this has been done, the coal along the opposite lateral rib is punctured from the floor to the roof in the same manner. The boring of spaced holes in the coal of the breast along each of the lateral ribs from the floor to the roof of the vein or strata fractures the cleavage of the coal at such points. If desired, a continuous unbroken fissure in the coal or mineral along each of the lateral ribs may be formed in the same manner as the fissure extending across the entire width of the breast at the juncture point of the face of the breast and the floor, previously described, but it has been found that puncturing the coal at spaced points along the lateral ribs is sufficient to fracture the cleavage of the coal or mineral at such points.

It is to be noted that while vibratory forces are imparted to the coal during the formation of the fissure at the base of the breast and the puncturing or fracturing of the cleavage of the coal along the lateral ribs from the floor to the roof of the vein or strata, such forces exert their desired functions and results only in the subsequent steps which are subsequently described herein below.

Upon completion of the step of fracturing the cleavage of the coal along the lateral ribs from the floor to the roof of the vein or strata, the operator shifts the mounting of the boring and vibratory device 1 to a position such that the drills are in a horizontal plane. This is done by removing the pins 50, tilting the device to the desired position, aligning the openings in the housing 2 with the openings in the flange of the bearing 46, and then inserting the pins 50 in the aligned openings. The wheel 95 is then turned in the proper direction to shift the boring and vibratory device 1 to a position such that the drills are positioned in a horizontal plane spaced, preferably about 2 feet, from the fissure in the base of the breast and at an angle substantially parallel with the pitch of the floor of the vein or strata. The staff 47 is then moved about its pivot until one of the drills is adjacent the fracture in one of the lateral ribs. The operator then turns the wheel 66 in the proper direction to a degree sufficient to cause the feeding nut 57 and screw 58 to advance the staff 47 until the drills contact with the face of the breast of coal or mineral. As the drills contact with the face of the breast, they begin to bore into the coal and form spaced localized areas. The operator continues to gradually turn the wheel 66 and continues such turning until the localized areas are of the desired depth, preferably of the same depth as the fissure. As the boring progresses vibratory forces are periodically and successively applied, in the manner previously described, to the coal in the region of such areas, which forces in themselves and unsupplemented by any auxiliary disruptive forces are of sufficient magnitude to break away and dislodge the coal or mineral in the region of such areas in sizable pieces with a minimum of fines and undersized particles. In other words, these vibratory forces break away and dislodge the coal in the space bounded by the fissure and the portion of the plane in which the spaced localized areas are being formed. The coal thus mined slides down the pitched floor and collects upon the top of a base of mined coal which extends from the working breast to the trap door for controlling the discharge of coal therefrom. At this point the operator turns the wheel 66 in the opposite direction until the drills are free of the face of the breast, whereupon the drills are shifted to a position such that the ends will contact with a portion of the face of the breast of coal or mineral adjacent the por-

tion just broken away and dislodged. It is to be understood that the drills are merely moved to a position in the same plane and still are positioned at an angle substantially parallel to the pitch of the floor of the vein or strata. The operator then turns the wheel **66** in the proper direction to advance the drills into the coal and continues such turning gradually until the coal in the space defined by the drills and the fissure is broken away and dislodged to the same depth as the adjacent space previously mined. This operation is continued until the coal has been broken away and dislodged clear across this plane. The operator then shifts the boring and vibratory device to a plane above and spaced from the first plane and then causes such device to operate in turn upon multiple portions of the breast along such plane until the coal bounded by such plane and the first plane has been mined. This is continued until all of the coal or mineral in the face of the breast has been broken away and dislodged.

In place of torsion lever **20**, torsion shaft **21**, adjusting sleeve **22**, and lock nut **23**, the torsion spring device as shown in Figure 12 may be used. In this structure the outside face of the lever **13** is cut away as at **104** so as to provide a seat for one end of the torsion spring **105**. The other end of said spring extends through an opening in the housing **2** and is placed under the desired tension by means of an adjusting nut **106** threaded within said opening of the housing.

By the method of pitch mining according to the present invention, it is possible for an operator and a helper to mine 4 to 5 times more coal or mineral per working day of eight hours than is capable of being mined by the blasting method of pitch mining. Besides, by the present invention method, the percentage of undersized coal or fines of each ton mined is only from 10% to 15%.

Having fully described the invention, what we claim as new and desire to secure by Letters Patent is:

1. The method of pitch mining of coal or similar minerals without blasting which comprises forming a fissure extending across the entire face of the breast at an angle substantially parallel to the pitch of the floor at the juncture point of the breast and the floor of the vein, fracturing the cleavage of the coal or mineral from the floor to the roof of said vein along each of the joinder points of the lateral ribs and the breast, forming a series of spaced localized areas of a depth substantially corresponding to said fissure in the breast in a plane spaced from said fissure and at an angle substantially parallel to the pitch of the floor of the vein, and applying to said areas vibratory forces which in themselves and unsupplemented by any auxiliary disruptive forces are of sufficient magnitude to break away and dislodge the coal or mineral in the region of said areas in sizable pieces with a minimum of fines and undersized particles.

2. The method of pitch mining of coal or similar minerals without blasting which comprises forming a fissure extending across the entire face of the breast at an angle substantially parallel to the pitch of the floor at the juncture point of the breast and the floor of the vein, fracturing the cleavage of the coal or mineral from the floor to the roof of said vein along each of the joinder points of the lateral ribs and the breast, forming a series of spaced localized areas of a depth substantially corresponding to said fissure in the breast in a plane spaced from said fissure and at an angle substantially parallel to the pitch of the floor of the vein, and applying to said areas intermittent vibratory forces which in themselves and unsupplemented by any auxiliary disruptive forces are of sufficient magnitude to break away and dislodge the coal or mineral in the region of said areas in sizable pieces with a minimum of fines and undersized particles.

3. The method of pitch mining of coal or similar minerals without blasting which comprises forming a fissure extending across the entire face of the breast at an angle substantially parallel to the pitch of the floor at the juncture point of the breast and the floor of the vein, fracturing the cleavage of the coal or mineral from the floor to the roof of said vein along each of the joinder points of the lateral ribs and the breast, forming a series of spaced localized areas of a depth substantially corresponding to said fissure in the breast in a plane spaced from said fissure and at an angle substantially parallel to the pitch of the floor of the vein, and applying to said areas intermittently and successively vibratory forces which in themselves and unsupplemented by any auxiliary disruptive forces are of sufficient magnitude to break away and dislodge the coal or mineral in the region of said areas in sizable pieces with a minimum of fines and undersized particles.

4. The method of pitch mining of coal or similar minerals without blasting which comprises forming a fissure extending across the entire face of the breast at an angle substantially parallel to the pitch of the floor at the juncture point of the breast and the floor of the vein, fracturing the cleavage of the coal or mineral from the floor to the roof of said vein along each of the joinder points of the lateral ribs and the breast, forming a series of spaced localized areas of a depth substantially corresponding to said fissure across the entire breast in a plane spaced from said fissure and at an angle substantially parallel to the pitch of the floor of the vein, and applying to said areas vibratory forces which in themselves and unsupplemented by any auxiliary disruptive forces are of sufficient magnitude to break away and dislodge the coal or mineral in the region of said areas in sizable pieces with a minimum of fines and undersized particles.

5. The method of pitch mining of coal or similar minerals without blasting which comprises forming a fissure extending across the entire face of the breast at an angle substantially parallel to the pitch of the floor at the juncture point of the breast and the floor of the vein, fracturing the cleavage of the coal or mineral from the floor to the roof of said vein along each of the joinder points of the lateral ribs and the breast, forming a series of spaced localized areas of a depth substantially corresponding to said fissure across the entire breast in a plane spaced from said fissure and at an angle substantially parallel to the pitch of the floor of the vein, and applying to said areas intermittent vibratory forces which in themselves and unsupplemented by any auxiliary disruptive forces are of sufficient magnitude to break away and dislodge the coal or mineral in the region of said areas in sizable pieces with a minimum of fines and undersized particles.

6. The method of pitch mining of coal or similar minerals without blasting which comprises forming a fissure extending across the entire face of the breast at an angle substantially parallel

to the pitch of the floor at the juncture point of the breast and the floor of the vein, fracturing the cleavage of the coal or mineral from the floor to the roof of said vein along each of the joinder points of the lateral ribs and the breast, forming a series of spaced localized areas of a depth substantially corresponding to said fissure across the entire breast in a plane spaced from said fissure and at an angle substantially parallel to the pitch of the floor of the vein, and applying to said areas intermittently and successively vibratory forces which in themselves and unsupplemented by any auxiliary disruptive forces are of sufficient magnitude to break away and dislodge the coal or mineral in the region of said areas in sizable pieces with a minimum of fines and undersized particles.

7. The method of pitch mining of coal or similar minerals without blasting which comprises forming a fissure extending across the entire face of the breast at an angle substantially parallel to the pitch of the floor at the juncture point of the breast and the floor of the vein, fracturing the cleavage of the coal or mineral from the floor to the roof of said vein along each of the joinder points of the lateral ribs and the breast, forming a series of spaced localized areas of a depth substantially corresponding to said fissure in the breast in a plane spaced from said fissure and at an angle substantially parallel to the pitch of the floor of the vein, applying to said areas vibratory forces which in themselves and unsupplemented by any auxiliary disruptive forces are of sufficient magnitude to break away and dislodge the coal or mineral in the region of said areas in sizable pieces with a minimum of fines and undersized particles, and continuing the formation of a series of spaced localized areas in other planes spaced from said fissure and the application of vibratory forces to said areas until the entire face of the breast of coal or mineral has been broken away and dislodged.

8. The method of pitch mining of coal or similar minerals without blasting which comprises forming a fissure extending across the entire face of the breast at an angle substantially parallel to the pitch of the floor at the juncture point of the breast and the floor of the vein, fracturing the cleavage of the coal or mineral from the floor to the roof of said vein along each of the joinder points of the lateral ribs and the breast, forming a series of spaced localized areas of a depth substantially corresponding to said fissure in the breast in a plane spaced from said fissure and at an angle substantially parallel to the pitch of the floor of the vein, applying to said areas intermittent vibratory forces which in themselves and unsupplemented by any auxiliary disruptive forces are of sufficient magnitude to break away and dislodge the coal or mineral in the region of said areas in sizable pieces with a minimum of fines and undersized particles, and continuing the formation of a series of spaced localized areas in other planes spaced from said fissure and the application of vibratory forces to said areas until the entire face of the breast of coal or mineral has been broken away and dislodged.

9. The method of pitch mining of coal or similar minerals without blasting which comprises forming a fissure extending across the entire face of the breast at an angle substantially parallel to the pitch of the floor at the juncture point of the breast and the floor of the vein, fracturing the cleavage of the coal or mineral from the floor to the roof of said vein along each of the joinder points of the lateral ribs and the breast, forming a series of spaced localized areas of a depth substantially corresponding to said fissure in the breast in a plane spaced from said fissure and at an angle substantially parallel to the pitch of the floor of the vein, applying to said areas intermittently and successively vibratory forces which in themselves and unsupplemented by any auxiliary disruptive forces are of sufficient magnitude to break away and dislodge the coal or mineral in the region of said areas in sizable pieces with a minimum of fines and undersized particles, and continuing the formation of a series of spaced localized areas in other planes spaced from said fissure and the application of vibratory forces to said areas until the entire face of the breast of coal or mineral has been broken away and dislodged.

10. The method of pitch mining of coal or similar minerals without blasting which comprises forming a fissure extending across the entire face of the breast at an angle substantially parallel to the pitch of the floor at the juncture point of the breast and the floor of the vein, fracturing the cleavage of the coal or mineral from the floor to the roof of said vein along each of the joinder points of the lateral ribs and the breast, forming a series of spaced localized areas of a depth substantially corresponding to said fissure across the entire breast in a plane spaced from said fissure and at an angle substantially parallel to the pitch of the floor of the vein, applying to said areas intermittently and successively vibratory forces which in themselves and unsupplemented by any auxiliary disruptive forces are of sufficient magnitude to break away and dislodge the coal or mineral in the region of said areas in sizable pieces with a minimum of fines and undersized particles, and continuing the formation of a series of spaced localized areas in other planes spaced from said fissure and the application of vibratory forces to said areas until the entire face of the breast of coal or mineral has been broken away and dislodged.

11. The method of pitch mining of coal or similar minerals without blasting which comprises boring a fissure extending across the entire face of the breast at an angle substantially parallel to the pitch of the floor at the juncture point of the breast and the floor of the vein, boring into the coal or mineral from the floor to the roof of said vein along each of the joinder points of the lateral ribs and the breast to fracture the cleavage of the coal or mineral, boring a series of spaced localized areas of a depth substantially corresponding to said fissure in the breast in a plane spaced from said fissure and at an angle substantially parallel to the pitch of the floor of the vein, and applying to said areas during the boring thereof vibratory forces which in themselves and unsupplemented by any auxiliary disruptive forces are of sufficient magnitude to break away and dislodge the coal or mineral in the region of said areas in sizable pieces with a minimum of fines and undersized particles.

12. The method of pitch mining of coal or similar minerals without blasting which comprises boring a fissure extending across the entire face of the breast at an angle substantially parallel to the pitch of the floor at the juncture point of the breast and the floor of the vein, boring into the coal or mineral from the floor to the roof of said vein along each of the joinder points of the lateral ribs and the breast to fracture the cleavage of the coal or mineral, boring

a series of spaced localized areas of a depth substantially corresponding to said fissure in the breast in a plane spaced from said fissure and at an angle substantially parallel to the pitch of the floor of the vein, and applying to said areas during the boring thereof intermittent vibratory forces which in themselves and unsupplemented by any auxiliary disruptive forces are of sufficient magnitude to break away and dislodge the coal or mineral in the region of said areas in sizable pieces with a minimum of fines and undersized particles.

13. The method of pitch mining of coal or similar minerals without blasting which comprises boring a fissure extending across the entire face of the breast at an angle substantially parallel to the pitch of the floor at the juncture point of the breast and the floor of the vein, boring into the coal or mineral from the floor to the roof of said vein along each of the joinder points of the lateral ribs and the breast to fracture the cleavage of the coal or mineral, boring a series of spaced localized areas of a depth substantially corresponding to said fissure in the breast in a plane spaced from said fissure and at an angle substantially parallel to the pitch of the floor of the vein, and applying to said areas during the boring thereof intermittently and successively vibratory forces which in themselves and unsupplemented by any auxiliary disruptive forces are of sufficient magnitude to break away and dislodge the coal or mineral in the region of said areas in sizable pieces with a minimum of fines and undersized particles.

14. The method of pitch mining of coal or similar minerals without blasting which comprises boring a fissure extending across the entire face of the breast at an angle substantially parallel to the pitch of the floor at the juncture point of the breast and the floor of the vein, boring into the coal or mineral from the floor to the roof of said vein along each of the joinder points of the lateral ribs and the breast to fracture the cleavage of the coal or mineral, boring a series of spaced localized areas of a depth substantially corresponding to said fissure across the entire breast in a plane spaced from said fissure and at an angle substantially parallel to the pitch of the floor of the vein, applying to said areas during the boring thereof vibratory forces which in themselves and unsupplemented by any auxiliary disruptive forces are of sufficient magnitude to break away and dislodge the coal or mineral in the region of said areas in sizable pieces with a minimum of fines and undersized particles, and continuing the boring of a series of spaced localized areas in other planes spaced from said fissure and the application of vibratory forces to said areas until the entire face of the breast of coal or mineral has been broken away and dislodged.

15. The method of pitch mining of coal or similar minerals without blasting which comprises boring a fissure extending across the entire face of the breast at an angle substantially parallel to the pitch of the floor at the juncture point of the breast and the floor of the vein, boring into the coal or mineral from the floor to the roof of said vein along each of the joinder points of the lateral ribs and the breast to fracture the cleavage of the coal or mineral, boring a series of spaced localized areas of a depth substantially corresponding to said fissure across the entire breast in a plane spaced from said fissure and at an angle substantially parallel to the pitch of the floor of the vein, applying to said areas during the boring thereof intermittent vibratory forces which in themselves and unsupplemented by any auxiliary disruptive forces are of sufficient magnitude to break away and dislodge the coal or mineral in the region of said areas in sizable pieces with a minimum of fines and undersized particles, and continuing the boring of a series of spaced localized areas in other planes spaced from said fissure and the application of vibratory forces to said areas until the entire face of the breast of coal or mineral has been broken away and dislodged.

16. The method of pitch mining of coal or similar minerals without blasting which comprises boring a fissure extending across the entire face of the breast at an angle substantially parallel to the pitch of the floor at the juncture point of the breast and the floor of the vein, boring into the coal or mineral from the floor to the roof of said vein along each of the joinder points of the lateral ribs and the breast to fracture the cleavage of the coal or mineral, boring a series of spaced localized areas of a depth substantially corresponding to said fissure across the entire breast in a plane spaced from said fissure and at an angle substantially parallel to the pitch of the floor of the vein, applying to said areas during the boring thereof intermittently and successively vibratory forces which in themselves and unsupplemented by any auxiliary disruptive forces are of sufficient magnitude to break away and dislodge the coal or mineral in the region of said areas in sizable pieces with a minimum of fines and undersized particles, and continuing the boring of a series of spaced localized areas in other planes spaced from said fissure and the application of vibratory forces to said areas until the entire face of the breast of coal or mineral has been broken away and dislodged.

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