E. C. MORGAN.
METHOD OF MINING COAL.
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To all whom it may concern:

Be it known that I, EDMUND C. MORGAN, a citizen of the United States, residing in Columbus, county of Franklin, and State of Ohio, have invented certain new and useful Improvements in Methods of Mining Coal, of which the following is a specification.

My invention relates to a method of mining coal or other material and one of its objects is to provide a method of mining coal by which the coal may be rapidly and efficiently broken away in large lumps.

A further object of the invention is to provide a method of mining coal whereby a dirty vein or vein of other objectionable substance running through the vein of material to be mined may be readily cut out of the vein of the desirable substance and conveyed away without becoming mixed with the latter.

Other objects of the invention will appear hereinafter, and the novel features will be particularly pointed out in the appended claims.

It should be understood, however, that my improved method of mining coal may be performed by the use of different or varied machines or devices, or with apparatus varied from that herein shown.

In carrying out my improved method I prefer to use that type of mining machine which is supported on tracks or ways and driven into the drift or tunnel by suitable power usually mounted upon the machine itself, and serving at the same time as means for operating the cutters or mining tools. The coal or other material to be mined is cut into slabs in the face of the drift or wall at the end of the tunnel in such a manner that they may be readily broken down and transferred to the rear or to whatever place desired. Thekerfs or channels in the wall of the tunnel necessary for producing these slabs may be produced in the manner described and then the slabs wedged apart, causing the main body of coal or of other material being mined to be broken from the main body, or at the same time that the cutting operation is being performed the slabs may be wedged apart to break down the coal as the cutter advances farther into the wall of the tunnel.

Referring to the accompanying drawings Figure 1 is a plan view of a mining machine with which my invention may be carried out; Fig. 2 is a view mostly in vertical section thereof and partly in side elevation; Fig. 3 is a plan section thereof; Fig. 4 is a detail transverse section of one of the sections of the way, showing also a portion of the truck or carriage and the fraction gear taken longitudinally of the forward axle; Fig. 5 is a similar section taken longitudinally of the rear axle, showing the means for adjusting the frame; Fig. 6 is a vertical section of a modification of one of the spiders for carrying some of the cutters and showing also means for tripping the cutter arms, the extensions 63 and 66 being pivoted to the under sides of the arms 62, 63 instead of the upper sides; Fig. 7 is an enlarged transverse section of one of the cutter arms and a portion of the cutter dovetailed therein, said section being taken on the line 7--7 of Fig. 2; Fig. 8 is a detail perspective view of one section of the way; Figs. 9 to 12 inclusive are sectional views of the channel in different stages formed in the wall of the ore or coal preparatory to the breaking down operation; Figs. 13 to 16 inclusive are elevations of the tools which may be used effectively for producing these different stages of the main cut; Fig. 17 is a sectional view of the channel, showing the manner in which the slab is broken out after the final vertical cut; Fig. 18 is an elevation of the wedge which may be used for breaking down the coal; Fig. 18 is a similar view of a half wedge or a wedge having a single taper, which may be used for breaking down the coal; Fig. 19 is a vertical sectional view showing a modification comprising full angle adjustment of the cutter spiders; Fig. 20 is a plan view thereof partly broken away; Fig. 21 is a further modification thereof; Fig. 22 is a modified form showing an automatic means for actuating the tripping mechanism for the cutter arms; Fig. 23 is a vertical sectional view of Fig. 22 on the line 23--23, looking in the direction of the arrows; Fig. 24 is a plan view of one of the spider arms and the cutter arm supported thereon, showing a modification of the means for throwing the cutter into and out of position; Fig. 25 is a vertical longitudinal sectional view of a portion of the forward part of the machine, showing a certain modification in the means of supporting and actuating the cutters, and also showing an attachment comprising means for conducting...
the material removed from the dirty vein to the rear and keeping it separate from the material being mined; and Fig. 2 is a plane section of Fig. 3 taken in a plane just above the upper one of the dirty vein cutters and showing the individual permanent cutters as well as the relatively movable cutters. Fig. 27 is a modified form of apparatus for cutting out a vein of undesirable substance and illustrates a modified method of separating such substance from the desirable material.

Referring to Fig. 1 it will be seen that 1 designates the supporting wheels of the car, rig or truck, having axles 2 and 3 running on a track or way comprising rails 4 and 5. These rails 4 and 5 are formed at the sides or ends of short blocks or sections 6, which are placed one in advance of another, as shown in Fig. 2, and if desired may have interlocking tongues 7 and grooves so that when properly located with respect to each other they will constitute a continuous track or way. These sections are comparatively narrow and short with respect to the length of travel of the machine, so that as the machine proceeds into the tunnel or drift the sections which the wheels 1, 2 have left in the rear may be taken up and placed in advance of the wheels in front, thus requiring but a comparatively few number of these members. It should be understood, however, that in order to save time and secure the greatest efficiency by the use of my method the forward feed of the machine is preferably continuous. Therefore there should always be a sufficient number of sections 6 placed forward from the rear to preclude the necessity of stopping the forward feed of the machine. The upper surfaces of the sections 6 are provided with rack-bars 8 extending longitudinally thereof parallel with the rails 7 and in alignment with each other so as to constitute a continuous rack for the engagement of a traction gear 9 secured to the forward axle 2 and serve for the propulsion of the machine. The bottoms of the sections of the way are provided with spurs 10 for preventing them from slipping rearward, and if desired this rearward motion may also be further guarded against by the employment of one or more jacks, as shown in Fig. 3. These jacks comprise two members 11, 12, having screw-threaded turn-buckle connections 13, thereby constituting a means for forcing the member 12 against a lug 14 or socket on the side of one of the sections 6, and the member 12 against the wall of the tunnel.

The forward axle-boxes 15 are secured by or formed on side members 16 of the main frame, as shown in Fig. 4; while the rear axle-boxes 17 are mounted in vertical slots 18 in said side members 16 of the main frame, as shown in Fig. 6; and these side members are supported on the boxes by means of vertical screws 19, which have their upper ends screw-threaded in the frames 15 and their lower ends stopped in the boxes 17. By rotating these screws the entire main frame supported by said side members 16 thereof may be adjusted in a rotary direction around the forward axle 2 without interfering with the proper engagement of the traction gear 9 with the rack 8. These screws 19 may be rotated for adjusting the frame by any suitable means, as, for example, worm wheels 20 secured to the edge of the screws 19 and each having an engaging worm 21 mounted upon the adjacent boxes 17 in any suitable way, as shown in Fig. 2. If desired, these worms may be connected together by sprockets 22 and chain 23, so that by rotation of either crank 24 on the worms 21 the two screws 19 may be simultaneously rotated for producing the forward adjustment, the purpose of which is to tilt the cutting mechanism at the proper angle for changing the direction to suit the run of the vein, as will be hereinafter described.

The traction gear 9 derives its propelling power from any suitable source, as, for example, an electric motor 25 mounted directly upon the machine and having bevel gear 26 in connection with a perpendicularly shaft 27 or near the lower end of which is secured the worm 28 engaging two worm wheels 29, 30, arranged on opposite sides thereof, and running loosely on two horizontal shafts 31, 32, respectively (see Fig. 3). The shaft 32 has a bevel pinion 33 engaging a bevel gear 34 on the sleeve 35 forming a part of or secured to the traction gear 9. This shaft 32 also has a pinion 36 engaging a clutch member 38 which is splined on the worm 37, so that when desired the shaft 32 may be rotated in the proper direction for driving the machine into the tunnel.

When it is desired to withdraw the machine or reverse its direction of motion, the shaft 31 which is connected by a bevel gear 36 to a bevel pinion 37 secured to the axle 2, is connected with a worm 28. This is accomplished by a similar means, namely, a clutch member 38 which is splined on the shaft 31 and adapted to engage a clutch member 39 secured to or formed on the worm wheel 29, clutch member 38 being provided with a shifting lever 40 for facilitating its described operation. It will be seen therefore that the rotation of the shaft 31 by the worm 28 will impart a reverse rotation to the axle 2. It will be observed that to the rear of the clutches 35 and 39 are additional clutches 200 and 201. Insuch as the power for operating the traction gear 9 is imparted through the vertical shaft 32 and the worm gears 29 and 30, the shafts 120.
31 and 32 are free to rotate when the clutches 29 and 35 are thrown to releasing position. If the apparatus is on an incline there may be a tendency for the same to move when it is intended that it should not so. Furthermore, when the cutters are in operation the apparatus should be kept from being moved backwardly. By throwing the members 33 and 38 to the rear the clutches 200 and 201 are closed which will prevent movement of the truck. One member of each of the clutches 200 and 201 is mounted in fixed position in the cross-piece 42, and the movable member of each of these clutches is splined to the shafts 31 and 32. These various parts of the machine which are carried by the truck and are adjustable together with the side member 16 of the main frame, may be supported on the main frame in any suitable way. For example, the motor casing may be connected directly to the side members 16 in Fig. 1, while the shafts 31, 32 are journaled in cross-bars 41, 42, (Fig. 3); and for the purpose of carrying the cutting mechanism and its power transmitting devices, which will now be described, the frame is provided with longitudinal extensions 43, 44, along the top and bottom thereof respectively and secured to the side members 16. Journalled in the ends of these frame extensions 43, 44 is an upright shaft 45, upon which are secured a plurality of hubs 46, 47, 48, constituting parts of the spider frames which support the cutters and breakers, as will be presently explained. (See Fig. 2.) Preferably the intermediate hubs 47, 48 are formed with rigid or integral arms 49, four of which in this example of the machine for carrying out my improved method, are employed in each of said hubs, and alternating with the arms 49 are shorter integral or rigid arms 50, 51, 52, 53, as shown in Fig. 3, while the hubs 46 and 48 at the upper and lower ends respectively of the upright shaft 45, shown in Fig. 2, are provided with flexible or hinged arms connected thereto by means of pivots 54, as shown in Figs. 1 and 2, so as to be capable of rotating and oscillating in perpendicular planes or planes extending longitudinally of the shaft 45, whenever its position may be such that the hinged arms turn away from the face of the tunnel or entry they may be moved away from the top and bottom of such entry to prevent engaging therewith when the machine is tipped or adjusted on the truck axle 2, as before explained. The top series of these hinged arms lower out of the way of the top of the tunnel by gravity and are held in their horizontal or operative position by a cam 54, mounted upon the extension 43, while the lower series of these hinged arms are thus carried by a hub 48 falling into operative position by gravity and are lifted away from the bottom of the tunnel by any suitable cam 54, supported in any suitable way as by brackets 54 on the upper sides of the frame extension 44, as shown in Fig. 3. The arms of the lower series or those connected with the hub 48 are limited in their descending movement by stops 54 of any suitable construction. There are two series of these hinged arms; a long series comprising arms 55, preferably four in number, and a short series alternating with arms 55 and comprising arms 56, 57, 58, 59. In the outer ends of the longer arms 49, 55 of all these spiders are mounted bits or cutters 60, of any appropriate form but preferably the bifurcated form shown in Fig. 15, which is adapted to produce the first cut or kerf 61, shown in Fig. 9. As the arms 49, 55 swing around on the shaft 45, the vein of coal or ore 62 which is left between the bifurcations of the cutter 60 are broken down and crumble away as the cutter arms 49, 55 advance into the kerf. In practice this bifurcated form of the cutting end of the cutter is best produced by the employment of two separate cutters, one in the upper and one in the lower side of the spider arm, and which separate cutters may be dovetailed in opposite sides of the spider arm as shown in Fig. 7, for the sake of strength and simplicity of construction, but the particular form of cutter is immaterial, so long as it is capable of producing a kerf or channel in the face of the wall of the tunnel or drift. Preferably the shaft 45 is rotated a sufficient number of times to carry the arms 49 and 55 with the cutters 60 into the wall to produce the kerfs at the top and bottom of the tunnel and at as many intermediate points between the top and bottom as there are spiders 47 employed, and when a plurality of parallel slits or kerfs have been formed a sufficient distance into the wall of the tunnel, the other cutters for producing the succeeding stages of the cut shown in Figs. 10 to 12 and the breaker for wedging into the kerfs may then be brought into successive operation, as will now be explained.

The arms 50 to 53 of the rigid spiders and the arms 56 to 59 of the flexible or hinged spiders (which are the short arms in every instance), are provided with flexible extensions 64, 65, 66 respectively, which are hinged to their respective arms by the vertical pivots 67, whereby these extensions may be turned inwardly in horizontal planes toward the center of rotation of the spiders in order to carry the cutters or tools mounted in such extensions out of the way of the faces of the tunnel while the cutters 60 are producing the first cut. These flexible extensions are rigidly secured to their pivot 67, and to the lower end of each of these pivots is rigidly secured two pro
sections 68, 69, by means of which the flexible arms may be rotated with respect to the arms to which they are pivoted. This is done at the will of the operator by pushing or pulling one of the handles 70, 71, 72, 73, according to whether it is desired to throw the flexible arms into or out of cutting position. The handle 70 shown in Fig. 2 connected to a rocking lever 74 pivoted on the extension 75 of the frame 43 and having two trips or pins 76, 77, which are alternately pushed upwardly through said extension 76, as the lever 74 is oscillated into the path of the extensions 68, 69, whereby one or the other of the pins 76, 77 will engage with one or the other of the extensions 68, 69, and rotate the flexible arms to which said extensions are secured into positions either at an angle to the main arm of the spider, as shown in Fig. 3 of the drawing, or into positions substantially straight or aligned with such arm as shown in Fig. 1 of the drawing. When pin 77 is raised the short extension 65 will be engaged and thereby straighten out the flexible arm and cause the cutter thereon to enter the kerf and produce a portion of the lateral breaking groove 78, (see Fig. 12) formed in the opposed faces of the kerf. This first one of these flexible arms to be thrown out from each of the spiders is the one carrying the form of cutter 79, shown in Fig. 14, for producing a portion of the breaking groove shown at 90 in Fig. 10. This cutter 79 like the cutter 60, may be formed in two pieces, and inserted, like the cutter 60, in opposite faces of its flexible carrying arm, such flexible arm being the one marked 63, which immediately follows the short flexible arm 59 of the top and bottom spiders and the short rigid arm 53 of the intermediate spiders; that is to say, it is the first one of the short arms to enter the kerf all the long arms have gone around. As shown in Fig. 14, cutters 79 are formed with angular or lateral extensions 79', which produce the portion 80 of the breaking groove. One revolution of the cutters 79 in each kerf would ordinarily be sufficient to produce its allotted portion of the breaking groove 78, and consequently after the arm 63 has passed out of the kerf it may be thrown back into its angular position with respect to the spider arms by the operator imparting a reverse movement to the handle 70 and in fact to all of the handles 70 to 73, one for each of the cutters thereon to produce the breaking groove in all of the kerfs. This movement of the tripping handle throws the pin or trip 76 up into the path of the extension 69 and returns the flexible arm into the position shown in Fig. 3, the extension 69 passing between the pins 76, 77 at that time. Each of the other handles 71 to 73 inclusive is provided with a tripping mecha-

anism similar to trip pins 76, 77 of a hand rocking lever 74, one for each of the spiders. The rocking lever for the handle 71 is shown at 81 in Fig. 3 pivoted to the extension 45 and its tripping lugs 32, 33. The rocking lever for the handle 72 is shown at 82 and its pins at 85, 86, and this lever together with the one for the remaining handle 73 is pivoted to the extension 44, the latter lever being shown at 87 and its tripping pins at 88, 89. The pins 85 and 86 for the lever 84 are turned upwardly so as to trip the flexible arms belonging to the lowermost spider of which 48 is the hub. It will be observed that there is sufficient space for an operator to reach the upwardly-projecting handles of the rods 72 and 73. The same is true with respect to the rods 70 and 71 shown in Fig. 1. Furthermore, insomuch as these rods can be operated with the application of a slight amount of power, short operating rods may be used by the operator to push the rods 70, 71, 72 and 73 into proper position at any time desired.

The flexible arm 63 on all of the spiders having traversed their respective kerfs and being again thrown back into the angular position with respect to their spider arms, as shown in Fig. 3, the next flexible arm 64 on each of the spiders is thrown out into operative position in a manner similar to that described with reference to the arm 63, by the same tripping mechanism which operated upon the arm 63, and the additional portion 90 of the breaking groove or channel 78 is then produced by the lateral or angular extensions 91 of the cutters 69 carried by the flexible arms 64, the main difference between the extensions 79' being one of length, so as to cut the breaking groove a little deeper than the cut produced by the extensions 79'. The arms 64 having passed around or fully traversed the kerf, they in turn are thrown back again into the position shown in Fig. 8, while the tripping mechanism before described and the next flexible arm 65 in the series are then projected in a similar manner to the operation of those already described by a proper manipulation of the tripping handles and the angular extensions 93 of the cutter or bit 84 will finish the formation of the breaking groove 78 by drawing the bottom or inner walls of the grooves in an apex or nearly so, as shown in Fig. 12, so that the slab of coal or other material will break more readily along a definite line when the breaking down wedge enters the kerf. It will be seen that by this method of operation large blocks of coal may be broken away. The pins 85 and 86 are at
ranged so as to stay where put on account of the friction of the parts connected there-

of Fig. 2 so that neither one will project into the path of the arms 68 and 69.

The wedge which may be used is shown at 92 in Figs. 1, 3, 17 and 18. It is carried by one of the flexible arms in each of the series such as the arm 66, as shown in Figs. 1 and 3. The flexible arm 66 is thrown outwardly into operative position so that the wedge 92 may enter the kerf in the same manner that the other flexible arms are actuated. The wedge, as better shown in Figs. 17 and 18, is tapered in two directions; that is to say, in a direction lengthwise of the side spider arm which carries the flexible arm 66 when the flexible arm is in its extended or operative position and also transversely of the direction with the narrower end of the wedge pointed in the direction of rotation so that the wedge will more readily enter the kerf, and by gradually forcing the walls of the kerf apart, cause the slab of coal or other material to break down and fall out. If the wedge 92 is tapered both at the top and at the bottom it will effect the breaking of the top slab as well as the bottom one, as shown in Fig. 17, but whether it be provided with this double taper or not will depend upon the character of the material being mined, in some instances a single taper would as shown in Fig. 18 being sufficient where a wedge is employed in every alternate spider. It should be observed that at the same time that the coal is being dislodged by the wedges entering the kerf, the cutting operation by the cutters 60 continues.

Therefore, during the operation of dislodging the coal two component forces are acting, one in the plane of the cut or kerf acting to cut the coal and the other component force working at an angle to the plane of the kerf or cut which is the wedging action, whereby the coal is cut and dislodged simultaneously. Of course the wedges 92 may be held extended during the cutting of the kerfs so that while the continuous cutting is going on the coal is being intermittently broken down or dislodged. During such operation the flexible arms 63, 64, 65 could be retained in their initial or bent positions. In order to dislodge larger lumps of coal, however, it is preferable to make the vertical cuts by extending the flexible arms 63, 64, 65 one after another, which may be done in a single rotation of the shaft 45 and also while the machine is being fed forward and while the cutters 60 continue to cut the kerfs deeper. Then when the wedges 92 are brought into operative position during the last part of the rotation of the shaft 45, large lumps of coal will be dislodged along the arc-shaped lines or vertical cuts produced by the cutters 70, 91 and 93. Even when the cutters on the flexible arms 63, 64, 65, are brought into operation after a kerf has been cut to the desired depth, it is preferable to continue the cutting by means of the cutters 60 while the entire machine is being fed forward, in order to save time. If it were attempted to stop the forward feed of the machine it would be found difficult or impossible to release the clutch 33 because of the considerable backward thrust of the shaft 32, holding the clutch member 33 in frictional engagement with the sleeve 35 with considerable force. It would be practicable, however, to stop the electric motor so that this backward thrust will be relieved, and in some instances it would be necessary to reverse the motor before the clutch 33 could be thrown to inoperative position. Although the forward feed of the machine may thus be stopped so that the cutters 60 would not produce deeper kerfs or horizontal cuts in the wall of the coal, the wedge 92 may be thrown into operation at the time that the cutters 91 and 93 are still in operative position, the cutters 91 being about to leave the kerf and the cutter 93 having about 90° of the remaining travel in the kerf.

In order that the intermediate spiders 85 may be adjusted vertically on the shaft 45 for changing the levels at which the cutters enter the wall, the shaft in the vicinity of the hubs of these spiders may be provided with a spline 90°, over which the hubs slide while being propelled thereby to rotate with the shaft, and the hubs are provided with set-screws 96, 97, or any other suitable means for holding them in their adjusted positions on the shaft. The vertical shaft 45 is supported in its downward movement by the lower hub 47 taking its bearing on the frame extension 44, or directly upon one or more shims 98 interposed between said hub and the frame extension 44.

The shaft 45 is rotated by the motor 25 through any suitable train of gears 100, 101, 102, the first of which is keyed to the shaft 45 and the last of which is mounted loosely on the shaft 27, while the intermediate gear 101 is an idler mounted upon a stud shaft 103 secured in cross-bars 104 extending across the machine and connected to the side frame 16. The gear or pinion 102 constitutes one member of a clutch and is provided on its lower face with clutch teeth 105 adapted to engage with a companion member 106 of said clutch which is connected by a spline 107 with the shaft 27, and is supported by a shifting yoke 108 capable of throwing it into engagement with the clutch teeth 105 when it is desired to rotate the cutter shaft 45. This shifting yoke may be actuated at the will of the operator by means of a suitable handle 109.
In the modification shown in Fig. 19, means are provided for adjusting the spiders with greater facility than would be possible with the set-screws 96 or 97 already described and shown in Fig. 2. In the modification shown in Fig. 19, the upper side of the spider is provided with two flanges 110, 111, under which engage two shoes 112, (Fig. 20), secured to the lower ends of two links 113 on diametrically opposite sides of the hub 47 of the spider, the upper ends of said links being pivoted respectively to the branches of a yoke 114, which is fastened in a support 115 on its frame extension 48 and has an arm 116 constituting in effect with said yoke a bell-crank lever, the arm 116 being connected to one end of a screw-threaded rod 117 passing through an abutment 118 on extension 48 and carrying an adjusting nut 119 on the other side of the abutment.

In Fig. 21 a substitute for the pivoted arms of the spiders at the upper and lower ends of the shaft 45, is shown. This consists in making the shaft 45 hollow or providing it at one end with a socket 49, and inserting therein a short section of shaft 45′, upon which the hub 120 of the spider is rigidly secured, the shaft 45′ being splined in the socket 49′ and held in its vertical adjustment by a set-screw 121. In this form the spider arms shown at 122 are illustrated as being adjustable longitudinally with reference to their hub 120, and held in place by set-screws 122. This modification avoids the use of the cans 54′ and 54″ and the hinged spider arms, because with this arrangement the lower spider may be elevated to carry it away from the bottom of the tunnel and the upper spider lowered to carry it away from the top of the tunnel when the machine is to be backed out. It should also be observed that when this modification is used the cutters at the outer end of the cutting operation are taking place to dislodge the coal.

In Figs. 22 and 23 is shown an automatic means for shifting the trips which throw the flexible cutter and breaker into and out of position. This comprises a box cam 124 pivoted on a stud 125, connected to the rocking lever 81 which actuates the trip levers 82, 83, by means of rods 126, 127 connected together by a set-screw 128, and having a pin 130 meshing with a pinion 132 on the upper end of shaft 57, and if one of these automatic devices be provided for each of the spiders there will of course be as many as there are spiders, and the shaft 125 will be provided with as many pinions 132 as there are cans 124. The single example shown in Figs. 22 and 23 is sufficient, however, for the purposes of illustration and an understanding of this automatic device.

In the modification shown in Fig. 24, a substitute is illustrated for the flexible arms 63 to 66, which carry the series of cutters 75 for producing the breaking groove 78, and which also carries the breaking wedge 94. This modification consists in sliding the supplemental arm longitudinally of the spider arm which supports it, instead of deflecting such supplemental arm on a vertical axis as is done with the supplemental arms 63 to 66. The supplemental arm in this modified form is indicated at 133, and has a shank 135 sliding in the end of the spider arm, the one return resided in this figure being the arm 50.

The shank of the supplemental arm is provided with a pin or lug 134 engaging in slot 136 of the shifting lever 130 pivoted on the arm 50, and so arranged as to be struck by one or the other of the trip levers 82, 83, which are projected alternately down into the path of the lever 136, as before described with reference to the projections 68, 69, the pin 83 serving to throw the supplemental arm 96 outwardly and the pin 82 acting to withdraw it.

In Fig. 17 is shown a modification of the breaking wedge, comprising a bifurcated support 137, which engages over the fin 62 at the inner edge of the kerf and sustains the wedge at its outer end during the breaking or wedging operation. The bifurcation is sufficient to prevent binding while the machine is being fed forward and the cutters 80 continue to operate. When the form of breaking wedge shown in Fig. 18 is used, the forward feed of the machine and the cutting may be as much as desired, while the wedging operation is taking place, it being understood that the wedge 96, shown in Fig. 18, enters the kerf laterally and moves in the arc of a circle with the narrower face of the wedge foremost. This may be understood from the various views 116 and particularly Fig. 19, which shows the wedge 85 in elevation on the spider arm, which is shown in section.

In Figs. 25 and 26 are shown the construction which may be used for carrying 129 out the method of removing a dirty vein or objectionable stratum from the desirable ore or coal. This construction comprises a modification of the cutters and their carrying spiders as well as an attachment for 125 removing the dirty vein without permitting the cutter to make contact with desirable ore or coal.

In Fig. 25 the shaft 45 is shown as being provided at its upper end and at its lower end with the same form of spiders and cut-
ters as described with reference to Figs. 1 to 3, and one of the intermediate spiders 47 in this view is also the same as the upper intermediate spider in the aforesaid figures. 5 But in lieu of the lower intermediate spider are substituted two spiders of special form, comprising hubs 138 and arms 139. These spiders and their cutting mechanism are the same in construction and hence the description of one will answer for both, suffice it to say that they are reversed on the shaft 45 with respect to each other. 10 The end of each of the arms 139 is pivoted a disk 140, which serves as a substitute for the flexible tool carrying arms or supplemental arms 63 to 66, or the supplemental arm 152 shown in Fig. 24. Four of these disks 140 are employed in this instance to rotate on their pivots 141 in planes substantially parallel with the planes of rotation of the spiders 138, 139, the plane of rotation of each of the spiders being also parallel with that of the other. In the peripheries of these disks 140 are secured respectively the cutters 70, 72 and 94 and the breaker or wedge 91. Secured rigidly to the shaft 45 so as to rotate therewith is a large disk 142, the periphery of which is provided with circular openings 143, in which the cutter disks 140 are situated and rotate, and this disk 142 is in substantially the same plane as the disks 140 and carries in its unbroken periphery as at many points between the openings 143 as desirable a number of fixed cutters 60, which as the disk 142 rotates produce a kerf the same in form as the kerf 61 shown in Fig. 9. The peripheries of the disks 140, shown in Figs. 25 and 26, being within the circle of the periphery of the main disk 142, the smaller disks 140 will not affect the cutting of the wall except when the cutters mounted in the periphery thereof are turned outwardly through the apertures 143. This rotation of the disks 140 for accomplishing that result is produced successively as the disk 142 rotates in the same or substantially the same manner as the supplemental arms 63 to 66 or 132 are thrown into active position. The arm 139 of each of the disks 140 has rigidly secured to it in any suitable way a ratchet 144, and pivoted to the disk is a spring-actuated handle 145 arranged to engage this ratchet for preventing the disk from making a retrograde rotation as its cutting tool engages the wall of the tunnel. The cutting tool of the disk within the wall having traversed the kerf and performed its allotted function, however, the disk 140 is rotated about one quarter turn in a direction away from its ratchet, when one of the series of lugs 146 of the disk 140 engages one of the trip pins or lugs 82, 83, which may be thrown downwardly into the path of the lugs 146 at the proper time by the operator, as before described. When the pin 83 is thrown downwardly it engages one of the lugs 146 at the inner side of the series or next the shaft 45, and that causes the disk 140 to turn forwardly or in the same direction in which it was rotating, thus carrying its cutter into the press 143 and out of the way of the shaft. When the pin 82 is thrown downwardly, however, the lugs 146 are engaged on the outer side of the series and this restores the disk 140 to their former or operative position. The trip lugs or pins 82, 83 are thus manipulated at the will of the operator as required for successively throwing the tools carried by the various disks 140 into and out of their operative positions, or, if desired, such manipulation may be done automatically by the construction shown in Figs. 22 and 23. An advantage of this form of spider and cutting mechanism is that the main disk 142 and the smaller disks 140 constitute together a platform or rotating table on which to receive the material cut out and thrown down and which rotation serves to conduct the material to the rear. In Fig. 25 these table-like cutters are illustrated as cutting out what is called the dirty vein 147, which occurs in coal mines and which may consist of ordure of dirt or soil, slate or other material, the presence of which in the coal or substance being mined would be objectionable. The material cut out from the wall by these table-like cutters and thrown down thrown by the wedge or breaker or by any other means, is carried around with the lower table or disk on which it rests until it strikes a deflector or shield 148 which extends partially around the edge of the lower main disk 142 and terminates in a chute or trough 149, and which may be supported in any suitable manner, as for instance by the arm 149 on the arm 114. With the instance this shield 148 is of sufficient height to practically cross the space between the disks 142, 149 so that all of the material carried on the lower disk will strike against the shield and be finally directed into the chute 149, whence it falls into the tunnel at one side of the machine. If the lower disk 114 rotates 115 clockwise as viewed in Fig. 26, assuming the left hand side to be the forward end of the machine, the shield or deflector 118 would be located in what would be the right hand side of the machine, while the chute 149 would be located on the opposite or left hand side, so that when the coal or valuable material is passed out on the right hand side by the other cutters or by the sweep of the bottom spider arms or the dirty 125 material will be thrown out on the opposite side and kept separate from the material of value. The spiders 138, 139 are adjustable vertically on the shaft 45, so that the cutters 139
carried thereby may be arranged at different elevations to suit the position in the vein to be cut out, and when so adjusted they will be fixed in place by set-screws 150 or any other suitable devices. If desired, a collar 53 may be fixed on the shaft 45 by a set-screw 152 beneath the upper spider 158 for effecting a better support of the same.

It is evident that when the breaking wedge 94 is in operative position the cutting by the fixed cutters 86 in main disks 152 and the cutting by the cutters 78 and 92 continues while the machine is being fed forward, and it is also evident that when the dirty vein is being broken out the cutting operation of the uppermost spider, of the lowersmost spider and of the intermediate spider 94 continues to increase the depth of the horizontal kerfs or slits in the wall of the mine. If desired, the wedging member 96 may be moved to operative position initially and maintained in such position while the cutters 60 are cutting horizontal slits in the wall of the mine and the cutters 78, 92 and 94 kept out of operation. When this method of operation is carried out, the dirty vein is immediately broken away piecemeal until entirely removed. It may be preferred, however, in some instances to facilitate its removal to break away the dirty vein in larger lumps, in which event the wedging operation is not performed until the horizontal kerfs or slits have been cut to a certain depth, when the cutters 78, 92 and 94 are brought successively into operation and then the wedge 94 brought into operative position to break and dislodge the undesirable vein in the manner herebefore explained with reference to the first described form of the machine which may be used in carrying out my improved method of mining coal. Whether the wedge 94 is brought into action immediately after the cutting of the wall begins or only after it has been cut to a certain depth, it is evident that the wedging operation takes place only intermittently. This is because the wedge rotates and is brought into the kerf only intermittently, and also because after the wedges engages the material which it breaks off the cutters must cut a deeper kerf before the wedge again comes into engagement with the material to break it away. As before explained, the backward thrust on the clutch member 38 will prevent its release and therefore the forward feed of the entire machine will continue, and therefore the kerfs will be cut deeper even when the wedging operation takes place. However, by stopping the motor and reversing it for a small space of time, the pressure on the clutch 38 may be relieved so that it can be released. After the clutch is released the shaft 45 may again be rotated in the proper direction and the vertical cuts made by the cutters 78, 92 and 94, and the wedging operation performed to break away the undesirable vein in large lumps and easily transferred to the desired place without producing much dust or fine particles.

Although the machine described for carrying out my improved method produces a plurality of horizontal slits simultaneously in the wall or solid coal at right angles to the face thereof, these slits or kerfs need not be at right angles nor horizontal, because the frame of the machine may be tilted on the axles 2 of the truck. This may be an advantage in some instances where it is desired to mine coal from the roof of a tunnel. In such case inclined cuts may be made and the coal permitted to break off by its own weight.

Fig. 27 illustrates a modified dirty vein cutter in that cutters 60' of greater depth than the cutters 60 are used at the outer ends of the spider arms of the upper spider 47. The cutters 60' in operation will then cut away the dirty vein continuously and the dust and small particles thus produced will mingle with the large lumps of coal broken away by the other spider arm horizontal kerf cutters, vertical or cross cutters and wedges. Upon removal of the large lumps of coal with particles from the dirty vein 96 mixed therewith the latter may be easily and quickly removed by screening. This method may be preferred in some instances where simpler apparatus is desirable. Furthermore, time may often be saved by substituting cutters 60' of increased depth for removable cutters 60 and adjusting the spider vertically to the proper position. It will also be noted that the corresponding arms of the various spiders on the vertical shaft 45 need not be in vertical alignment. They may in some instances be so arranged that when the wings are brought into action the slabs may be broken at or near the vertical cross cuts by wedging action, first on one side of the 110 slab of coal and then on the other. In such arrangement the arms carrying the wedges are staggered. As before explained, the wedges may be brought into action as soon as the cutting of the plurality of parallel 115 kerfs or slits begins and therefore at the same time that the parallel cuts are being made in the seam of the coal forces are brought to bear on the partially severed blocks of coal at an angle to the direction of the cuts, first on one side of said partially severed block and then on the opposite side and in the opposite direction. By this method of operation, the coal is dislodged by intermittent forces applied first to one 126 side of the slab or block of coal and then on the other. In other words, when the wedges are brought into action at the same time that the plurality of parallel cuts are being made in the seam of the coal, the direct cut
tions for making each cut and working in each cut is sub-divided intermittently into three component forces, one component force working in the plane of the cut and the other two component forces working at an angle to the plane of the cuts and in opposite directions, whereby the coal is dislodged by intermittent forces thus applied. This method of mining coal obtains blocks of coal of medium size, and when larger lumps or blocks are desired, I prefer to partially sever the coal to a greater extent than by the parallel cutting alone, by producing the vertical cross cuts before the wedges are brought into play. But it should be observed that even with the latter method the wedges may be brought into action alternately so that the larger slabs or blocks of coal, partially severed not only by the parallel cuts, but also by the vertical cross cuts, are piled first in one direction and then in the other, in order to break the coal away at the cross cuts. Furthermore, it should be observed that the vertical positions of the wedges with respect to each other may be predetermined initially by the construction of the apparatus used, and if desired, any one of them may be changed 180 degrees by removal of the spider and replacing the same in proper position. What I claim is:

1. The method of mining coal consisting in cutting a plurality of slits in the wall or solid of the coal, and discontinuing the coal lying between said slits by applying a wedging force in each of said slits while said cutting action continues.

2. The method of mining coal consisting in cutting a plurality of slits simultaneously in the wall or solid of the coal, and dislodging the coal between said slits by applying wedging action therein while said cutting action continues.

3. The method of mining coal consisting in cutting a plurality of slits simultaneously in the wall or solid of the coal, and dislodging the coal lying between said slits by applying wedging action while said cutting action continues.

4. The method of mining coal consisting in cutting continuously a plurality of slits simultaneously in the wall or solid of the coal, and during such cutting applying a wedging force intermittently in the slits at an angle to the plane of the cut.

5. The method of cutting coal consisting in cutting a plurality of parallel cuts in the wall or solid of the coal, thereafter making a series of cross cuts at the rear of the cuts first produced, and breaking loose the coal between said parallel cuts simultaneously with the cross cutting action.

6. The method of mining coal consisting in cutting a plurality of kerfs in the wall or solid of the coal, and breaking loose the coal by wedging action in said kerfs while the cutting continues.

7. The method of mining coal consisting in cutting a plurality of kerfs in the wall of the coal, making cross cuts at or near the inner ends of said kerfs, and breaking loose the coal at or near said cross cuts by wedging action in said kerfs.

8. The method of mining coal consisting in cutting a plurality of slits or kerfs in the wall or solid of the coal and simultaneously breaking loose the coal by wedging action in said kerfs.

9. The method of mining coal consisting in cutting a plurality of parallel slits in the wall or solid of the coal, and simultaneously breaking loose the coal by wedging action in said kerfs.

10. The method of mining coal consisting in cutting a plurality of parallel slits or kerfs in the wall or solid of the coal, making cross cuts at or near the inner ends of said slits, and loosening the cut coal by wedging action in said parallel slits.

11. The method of mining coal consisting in cutting a plurality of horizontal parallel slits or kerfs in the wall of said solid, discontinuing said cutting, afterward producing cross cuts at or near the inner ends of said kerfs, and breaking loose the cut solid at or near said cross cuts by wedging action in said kerfs.

12. The method of mining solids consisting in making a plurality of parallel kerfs in the wall of the solid, and intermittently discontinuing said kerf cutting and making cross cuts at or near the inner ends of said kerfs and wedging the cut coal in the kerfs to break loose the same at said cross cuts.

13. The method of mining solids consisting in making a plurality of parallel kerfs in the wall of the solid, and intermittently discontinuing said kerf cutting and making cross cuts at or near the inner ends of said kerfs and wedging the cut coal in the kerfs to dislodge the said kerfs and simultaneously with said kerf cut-
ting action removing a vein of undesirable material without mixing the same with the dislodged coal.

16. The method of mining coal consisting
in cutting and dislodging coal and moving the same toward one side of a tunnel, and also simultaneously cutting out and conveying away to the other side of the tunnel a vein of undesirable material.

17. The method of mining coal consisting in cutting and dislodging the coal and also simultaneously cutting a vein of undesirable material and intermittently breaking it away.

18. The method of mining coal consisting in cutting a plurality of parallel kerfs or slits in the body of the coal, producing cross cuts at or near the inner ends of said kerfs, wedging the cut slabs from the body of the coal, and during the foregoing operations conveying away a broken slab of undesirable material separately from the desirable coal.

19. The method of mining coal consisting in making a slit or kerf in the body of the coal at or near the roof of the tunnel, also a kerf at or near the floor of the tunnel, and breaking away the coal between said kerfs by wedging action therein.

20. The method of mining coal consisting in making horizontal kerfs in the body of the coal one at the roof of the tunnel and the other at the floor of the tunnel, also producing one or more horizontal slits in the body of the coal intermediate the roof and floor of the tunnel, making cross cuts at or near the inner ends of the intermediate kerfs, and by applying wedging forces in the intermediate kerfs breaking away all the coal between the roof cut and the floor cut.

21. The method of mining coal, consisting in making a plurality of parallel cuts at the same time in the seam of coal, then bringing forces to bear on the partially severed block of coal at an angle to the direction of the cuts, first on one side of said partially severed block and then applying a force in the opposite direction on the opposite side of said block, whereby the coal is dislodged by intermittent forces thus applied.

22. The method of mining coal, consisting in making a plurality of parallel cuts at the same time in the seam of coal, then bringing forces to bear on the partially severed block of coal at right angles to the direction of the cuts, first on one side of said partially severed block and then applying a force in the opposite direction on the opposite side of said block, whereby the coal is dislodged by intermittent forces thus applied.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, on this 26th day of January A.D. 1911.

EDMUND C. MORGAN.

Witnesses:

M. B. ALEXANDER,

DUDLEY T. FERSTER.