W. F. TROTTER.

MINING MACHINE.

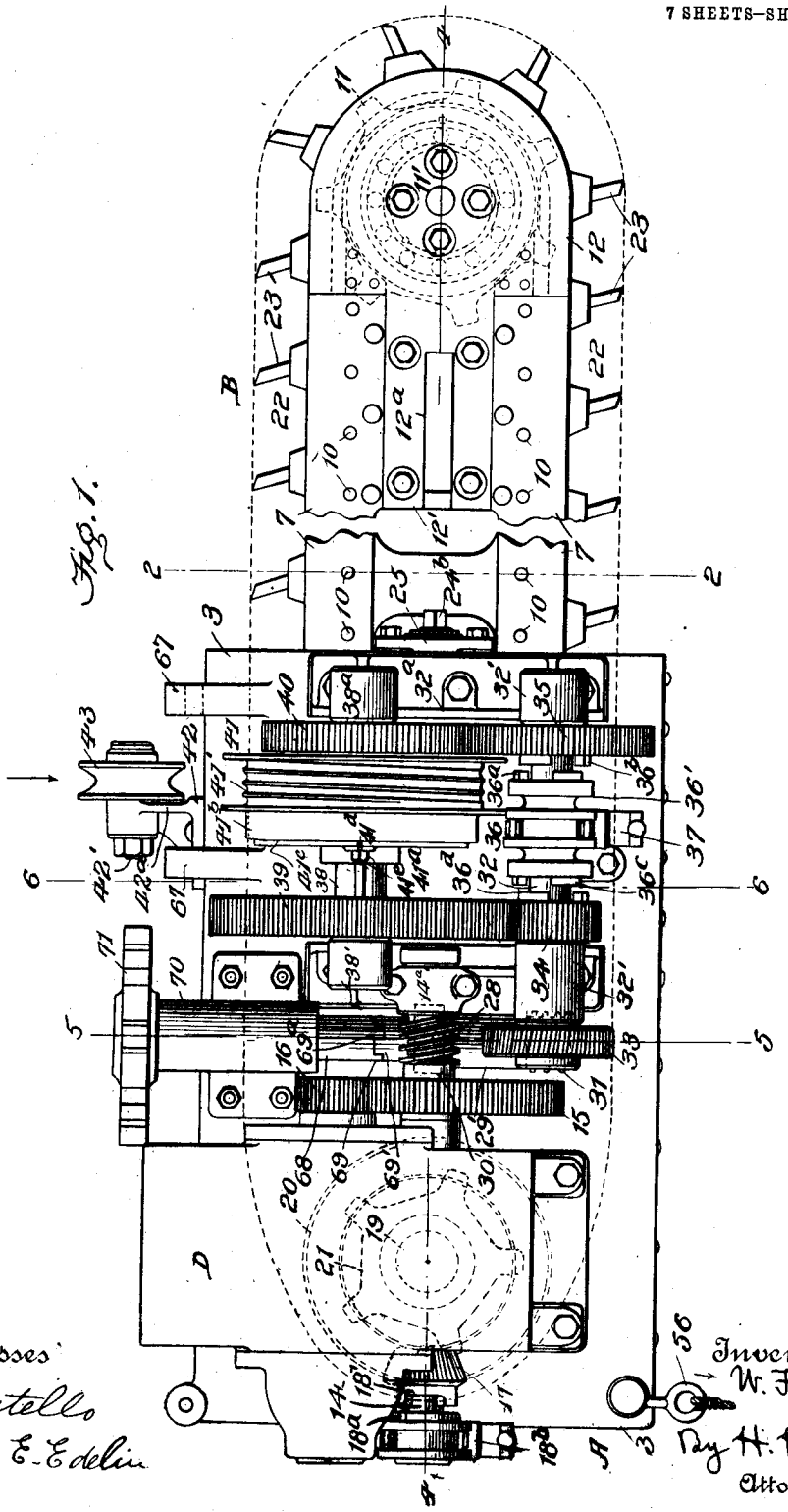
APPLICATION FILED SEPT. 11, 1907. RENEWED FEB. 3, 1912.

1,127,699.

Patented Feb. 9, 1915.

7 SHEETS—SHEET 1.

Fig. 1.



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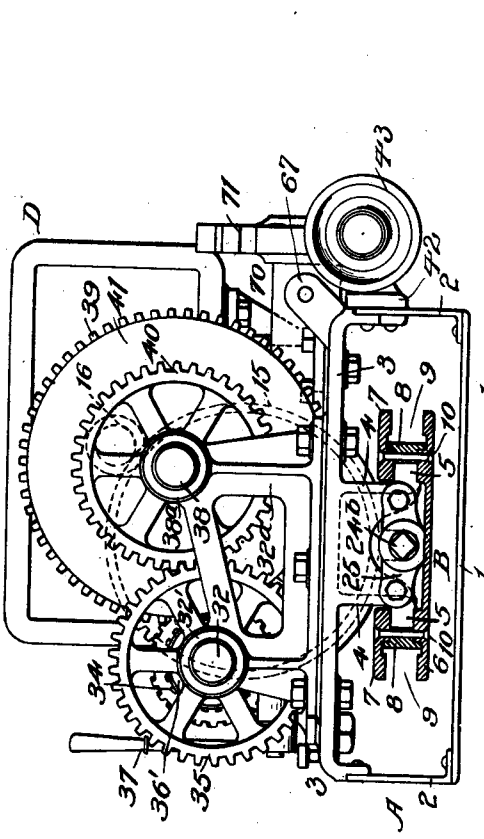

Fig. 2.

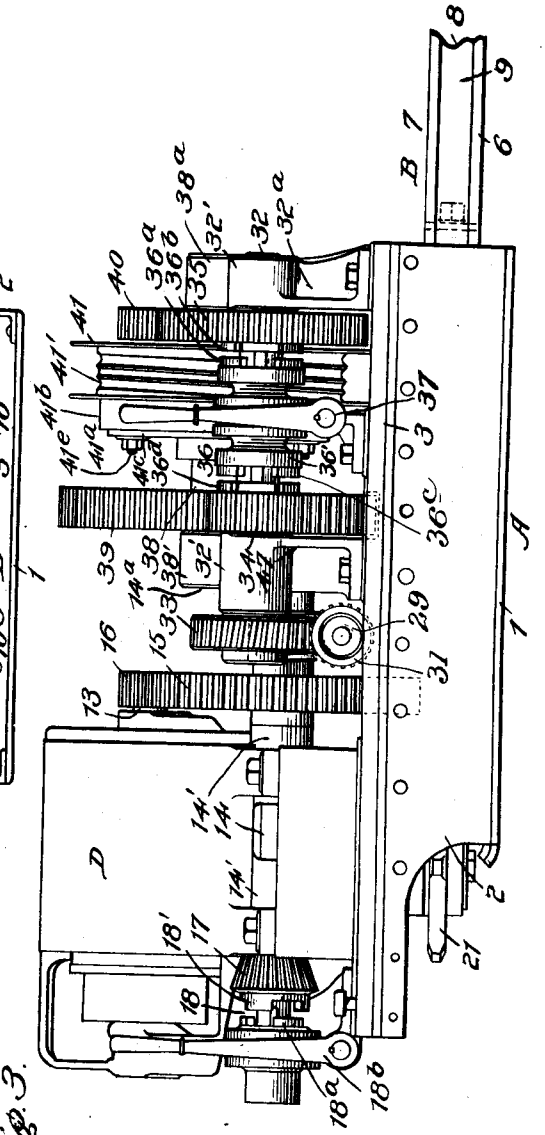

Fig. 3.

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7 SHEETS—SHEET 3.

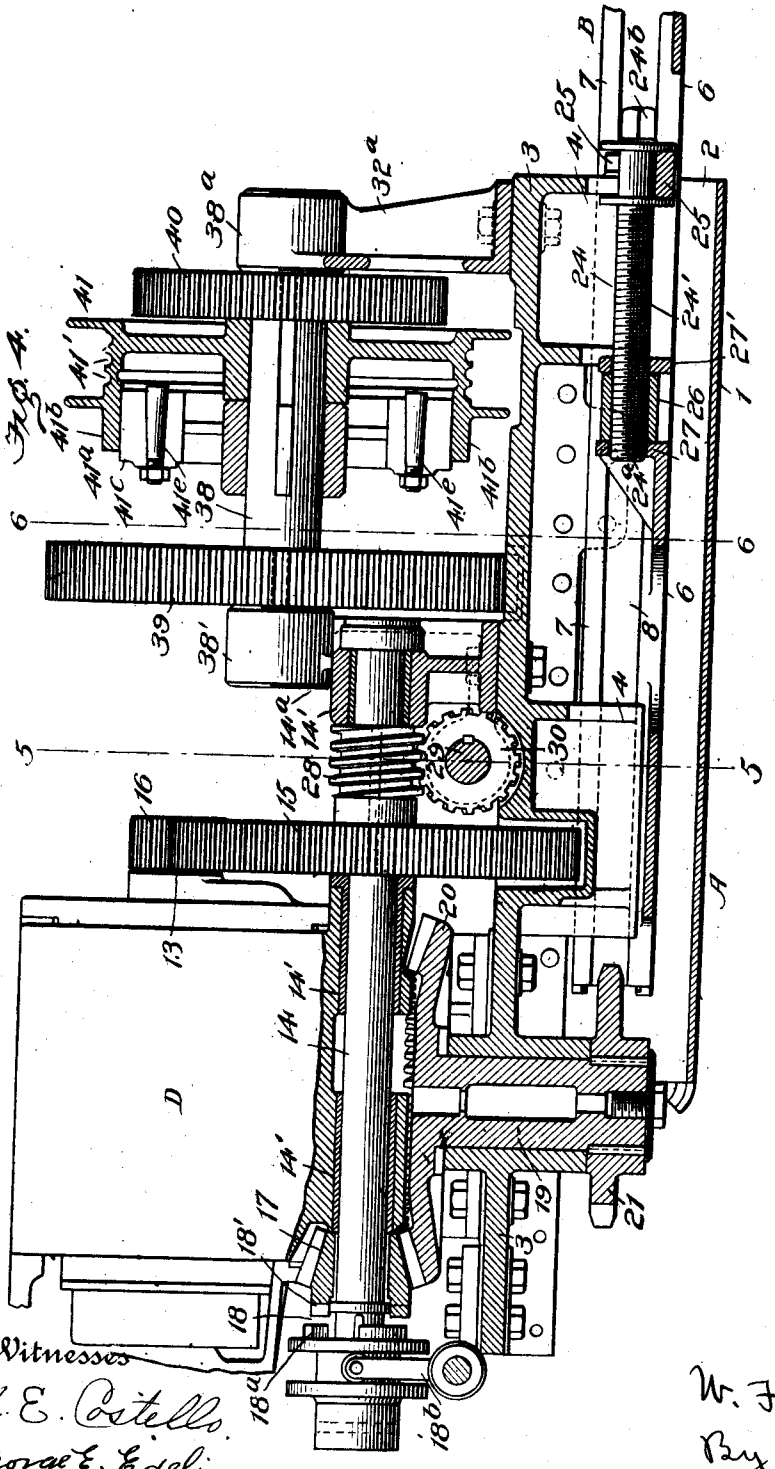

Fig. 4.

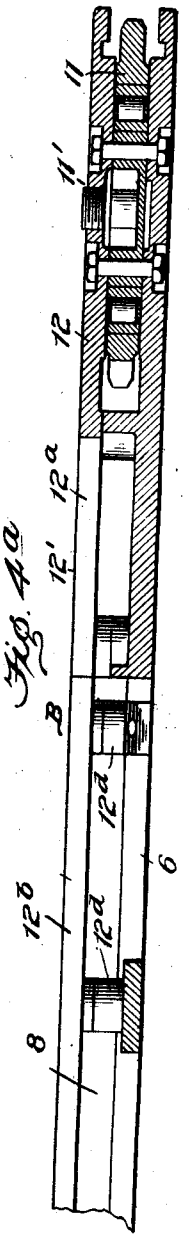

Fig. 4a

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7 SHEETS—SHEET 4.

Fig. 5

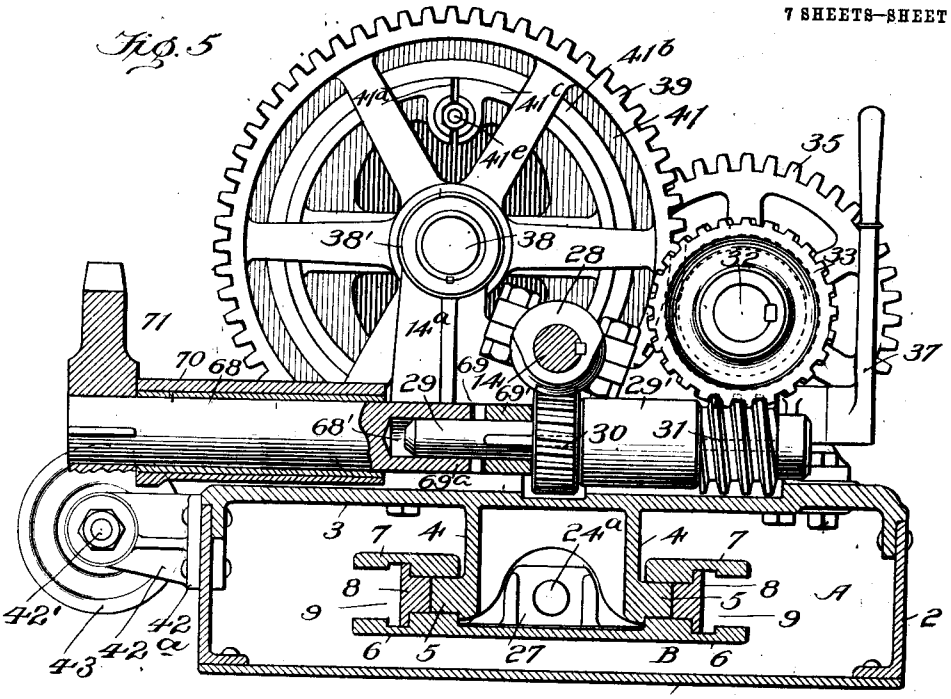
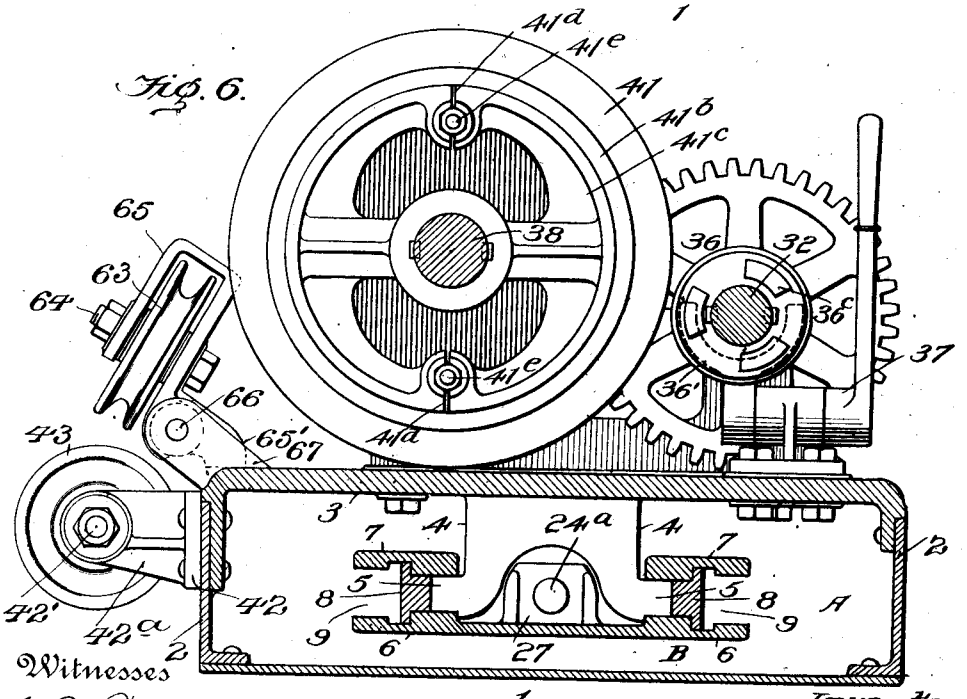


Fig. 6.



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7 SHEETS—SHEET 5.

Fig. 9.

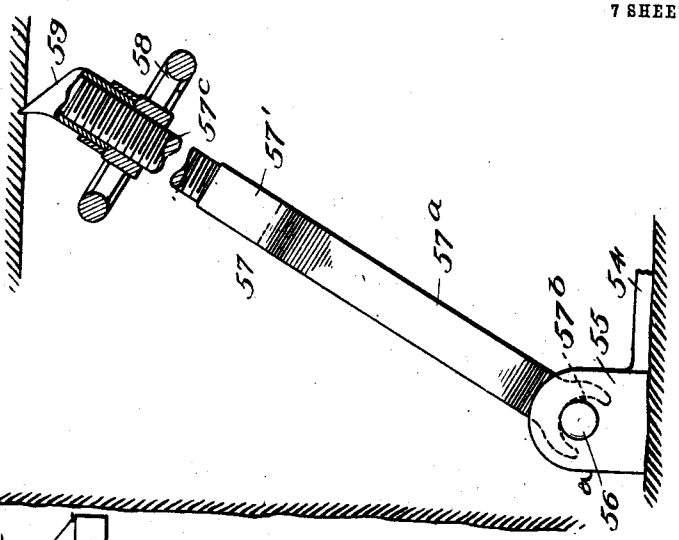


Fig. 7.

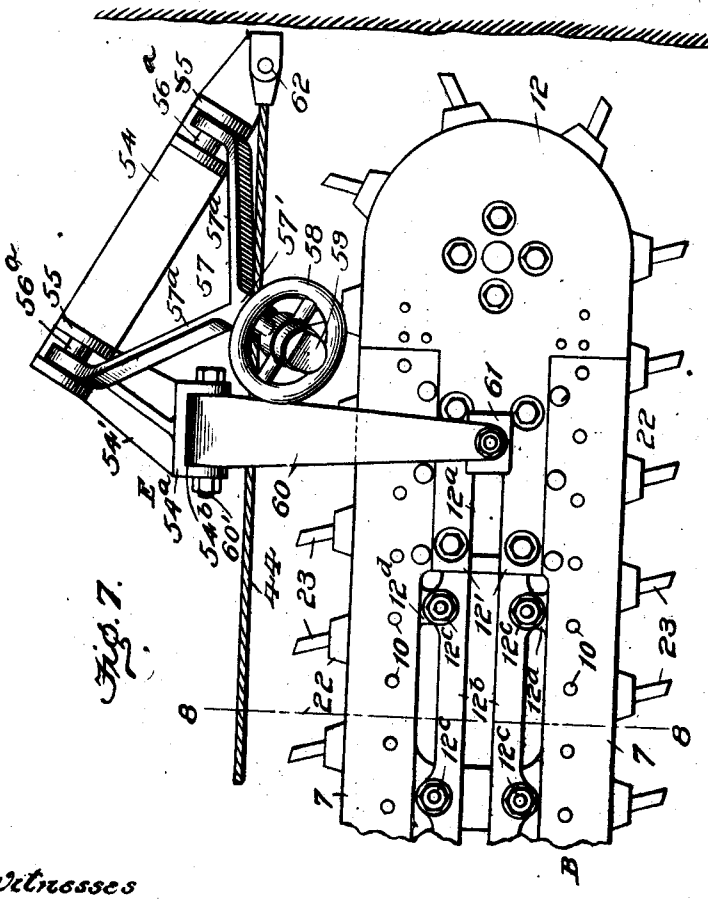
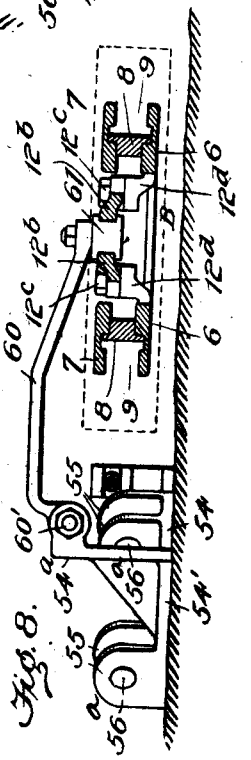


Fig. 8.



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7 SHEETS—SHEET 6.

Fig. 10.

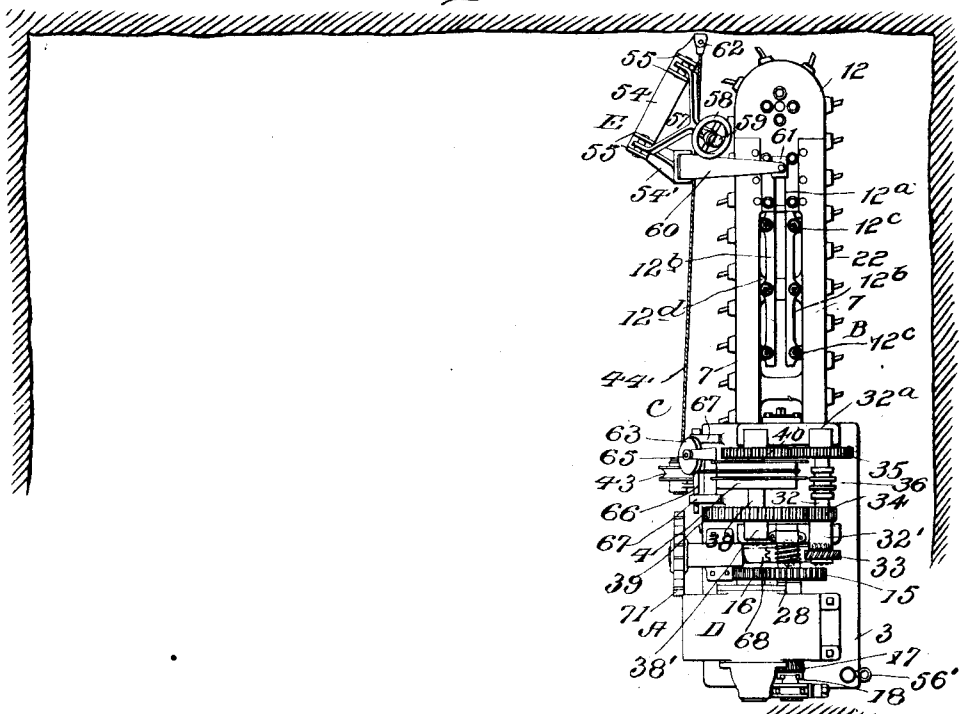
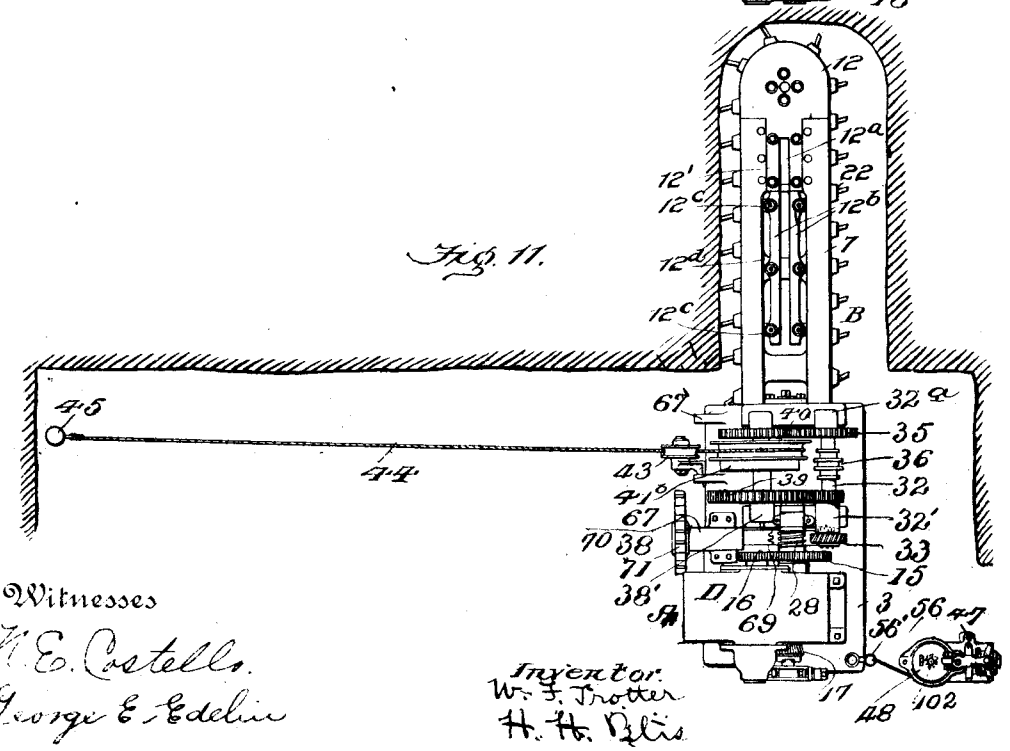


Fig. 11.



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7 SHEETS—SHEET 7.

Fig. 12.

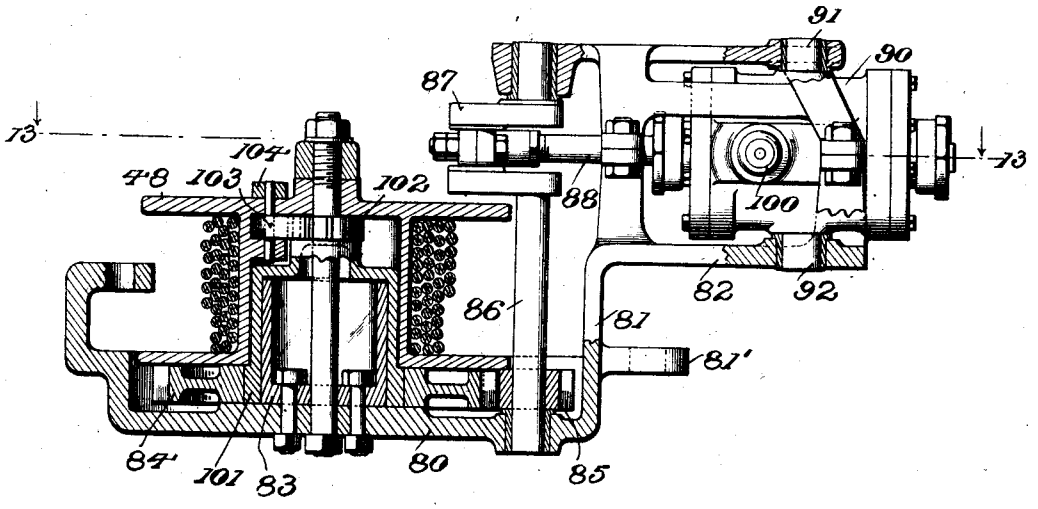
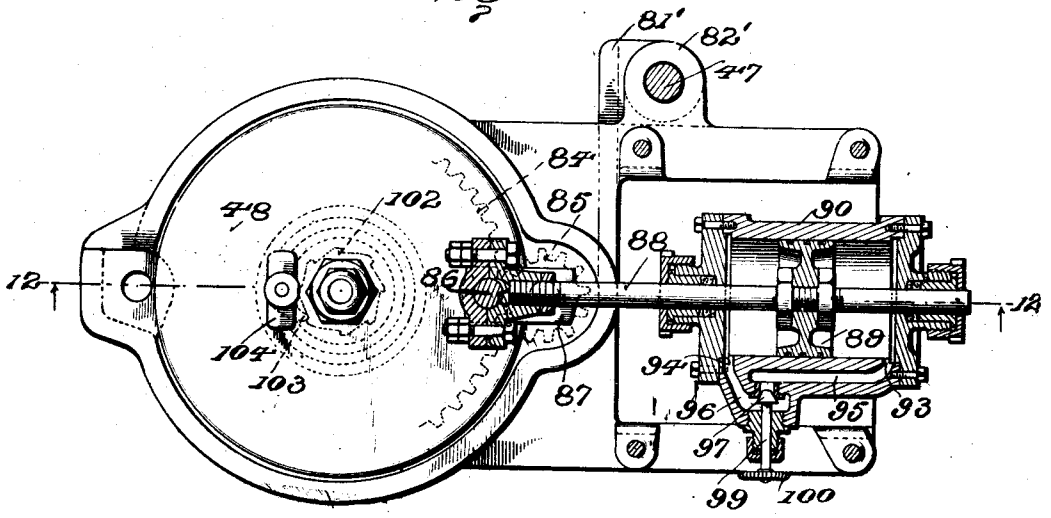


Fig. 13.



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MINING-MACHINE.

1,127,699. Specification of Letters Patent. Patented Feb. 9, 1915.

Application filed September 11, 1907, Serial No. 392,372. Renewed February 3, 1912. Serial No. 675,344.

To all whom it may concern:

Be it known that I, WALTER F. TROTTER, a citizen of the United States, residing at Charleston, in the county of Kanawha and State of West Virginia, have invented certain new and useful Improvements in Mining-Machines, of which the following is a specification, reference being had therein to the accompanying drawing.

This invention relates to improvements in mining machines, particularly to side cutting mining machines. It has been proposed heretofore to provide machines of this class with flexible draft devices adapted to propel the machine along the face of the coal and to guide it or hold it to its work. In some cases cables were to be used as the flexible draft and holding members, while there were others in which the functions of propelling and guiding the machine were to be performed by chains in connection with sprocket mechanisms or the like on the machines adapted to engage positively and rigidly with the chains. In one form of these latter machines, for example, a single continuous chain is provided having one end fixed to an anchor or the like in advance of the machine and its other end fixed to an anchoring device on the rear side of the machine, while intermediate its ends the chain passes over sprocket drive mechanisms on the machine.

My invention contemplates the use, preferably, of cables for propelling and guiding the machine and is intended to provide a machine in which are overcome certain disadvantages and difficulties that have heretofore been experienced in the use of side cutting machines, especially in room and pillar mining.

The nature and all of the various objects of the invention will be understood in detail from the following description in connection with the drawings.

Of the drawings—Figure 1 is a plan view of a mining machine embodying my improvements; Fig. 2 is a section on the line 2—2, Fig. 1; Fig. 3 is a side elevation of the same; Figs. 4 and 4ª are enlarged sections on the line 4—4, Fig. 1, showing the actuating mechanism and cutter frame, respectively; Fig. 5 is an enlarged section on the line 5—5, Fig. 1; Fig. 6 is an enlarged section on the line 6—6, Fig. 1; Fig. 7 is a plan view of the inner portion of the cutter carrier and the guiding mechanism for feeding it transversely to the coal face; Fig. 8 is a section on the line 8—8, Fig. 7, the adjustable jack being removed; Fig. 9 is a view partly in elevation and partly in section of the jack stand and jack; Fig. 10 is a plan view showing the mining machine arranged to feed transversely to the coal face at the beginning of a cut; Fig. 11 is a plan view showing the mining machine and its operating parts arranged to feed laterally along the coal face; Fig. 12 is an enlarged side elevation partly in section of the hydraulic retarding device, and Fig. 13 is an enlarged sectional plan view of said retarding device, the section being taken on line 13—13, Fig. 12.

For the purposes of illustration, I have shown in the drawing a mining machine of which A indicates the main frame as an entirety, B the cutting apparatus extending from the inner end thereof and supported thereby, C the feeding and guiding mechanism for advancing the cutting apparatus and machine either longitudinally or laterally, D the motor mechanism, and E the auxiliary parts employed when it is desired to have the cutting apparatus advanced into the coal transversely to the face thereof.

The main frame may be of any suitable construction, as far as some features of my invention are concerned, but, for reasons which will later appear, I prefer a construction of the character shown. This construction comprises a plate-like shoe 1 adapted to rest upon the ground and slide freely thereon in any direction, longitudinally arranged angle bars or plates 2, 2, secured to said shoe at either side thereof and a suitable platform 3 resting upon and secured to said longitudinal side bars.

4, 4, are webs or plates depending from the platform 3 and carrying at their lower ends the outwardly turned longitudinally extending cutting apparatus guides, 5, 5.

The main frame thus constructed constitutes a box which is closed on all sides except the inner and outer ends. It will be observed on reference to Figs. 3 and 4 that the platform 3 extends at its outer end beyond the bottom plate or shoe 1 and that the side plates 2 are correspondingly cut away. In other words, the outer end of the upper platform part of the main frame overhangs considerably.

The cutting apparatus comprises a longi-

tudinally arranged horizontally disposed base plate, two longitudinally arranged horizontally disposed guide plates 7, above said base plate and spaced therefrom by the longitudinally arranged bars 8 so as to form a chain guide or recess 9, the parts just referred to being secured together in any suitable manner, as by rivets 10.

11 is an inner sprocket wheel mounted upon a vertical axle 11', and between the inner end of the base plate 6 and a top plate 12 suitably secured to the base plate and having an outwardly extending centrally arranged part 12', fitted snugly between the top bars 7, 7 of the chain frame.

The motor D is suitably secured upon the platform 3 with its armature shaft 13 arranged longitudinally of the machine.

14 is a longitudinally arranged shaft, preferably having its axis in the vertical longitudinal-plane of the axis of the chain frame. It is suitably mounted near either end in bearings 14', 14', one of which is carried by a bearing standard 14^a suitably secured to the platform 3. The inner standard 14^a extends transversely of the machine in either direction from the shaft 14 for the purpose to be hereinafter described.

15 is a spur gear rigidly secured to the shaft 14 and meshing with a pinion 16 secured to the inner end of the armature shaft 13.

17 is a bevel pinion loosely mounted on the shaft 14 near the outer end thereof.

18 indicates a positive clutch interposed between the said shaft 14 and the bevel pinion 17, the longitudinally stationary element 18' of said clutch being secured to the said bevel pinion and the longitudinally movable element 18^a being splined to the shaft.

18^b indicates suitable mechanism for moving the element 18^a of the clutch in either direction.

19 is a vertically disposed shaft suitably mounted in bearings carried by the main frame of the machine and having its axis in the vertical plane containing the axis of the shaft 14. 20 is a bevel gear secured to the upper end of the said vertical shaft and in mesh with the bevel pinion 17.

21 is a sprocket drive wheel rigidly secured to the lower end of the vertical shaft 19.

22 indicates as an entirety an endless cutter chain or carrier extending around the sprocket drive wheel 21 and the inner sprocket 11 carried by the cutter frame, it being arranged at either side within the guides 9 of the said cutter frame and carrying cutters 23 of any suitable construction. The cutter frame is supported from the main frame by the longitudinally arranged slides or guides 5 depending from the main frame and arranged to fit snugly between the base plate and the upper plate of the chain frame. The main frame and the chain frame are normally held from longitudinal movement relative to each other by mechanism indicated as an entirety by 24, which also serves as an adjusting means for moving the frames relative to each other to vary the tension upon the cutter chain. The adjusting mechanism 24 comprises a longitudinally arranged screw threaded shaft 24' mounted near its inner end in a bearing in a depending plate 25, which is secured to the inner end of the main frame platform 3. Near its outer end it is fitted into a threaded nut 26 which is arranged between uprights or projections 27, 27' carried by the base plate 6. The inner end of this shaft is squared as indicated at 24^b to receive a suitable wrench for turning the shaft in either direction so as to further extend the chain frame or to retract it relative to the main frame, as desired.

28 is a worm gear rigidly secured to the longitudinally arranged shaft 14 near the inner end thereof and between the bearing standard 14^a and the gear wheel 15 secured to the said shaft. 29 is a shaft arranged beneath the said shaft 14 and transversely of the main frame. It is suitably mounted in a bearing 29' secured to the platform of the said frame. 30 is a worm wheel secured to the inside end of the said transverse shaft 29 and in mesh with the worm 28 on the shaft 14.

31 is a worm rigidly secured to the outside end of the shaft 29.

32 is a longitudinally arranged shaft mounted near either end in bearings 32', 32', carried by bearing standards 14^a and 32^a, the latter being arranged parallel to the former end of substantially the same width and secured to the platform of the main frame. The axis of this shaft 32 is in a vertical longitudinal plane of the axis of the shaft 14 from armature shaft 13.

33 is a worm wheel rigidly secured to the outer end of the shaft 32 and in mesh with the worm 31 on the transverse shaft 29.

34 is a spur gear loosely mounted upon the shaft 32 adjacent to the bearing standard 14^a, and 35 is a gear wheel of greater diameter than the gear wheel 34 and loosely mounted upon the said shaft 32 adjacent to the bearing standard 32^a.

36 indicates as an entirety clutch mechanism for alternately connecting the gears 34 and 35 to the shaft 32. Of this clutch mechanism 36' indicates a longitudinally movable element splined to the shaft 32 and carrying at one end clutch jaws 36^a adapted to engage clutch jaws 36^b secured to the gear wheel 35 and at its other end clutch jaws 36^c adapted to engage with the clutch jaws 36^d carried by the gear wheel 34.

37 indicates as an entirety suitable mechanism for shifting the movable element 36' of the clutch in either direction at will.

38 is a longitudinally arranged drum shaft suitably mounted near either end in bearings 38′, 38ª, in the bearing standards 14ª and 38ª, respectively. The axis of the shaft is on the opposite side of the vertical plane containing the axis of the shaft 14 from the axis of the shaft 32.

39 is a gear wheel rigidly secured to the shaft 38 near one end thereof and in mesh with the gear wheel 34 on the shaft 32, and 40 is a gear wheel of smaller diameter than the gear wheel 39 and rigidly secured near the opposite end of the shaft 38 and in mesh with the gear wheel 35 on the shaft 32.

41 is a cable winding drum loosely mounted on the shaft 38 and preferably adjacent to the gear wheel 40 at the inner end thereof. The periphery of the cable drum may be spirally grooved as indicated at 41′ to assist in the spooling upon it of a draft cable 44 which has one end suitably fastened to said drum. The drum is preferably connected to the shaft 38 by means of a friction clutch 41ª, one element of which is a ring or casing 41ᵇ carried by the drum and extending outwardly therefrom, and the other element of which is a pulley or ring 41ᵉ having its rim radially slotted at 41ᵈ, 41ᵈ, as indicated. 41ᵉ are adjustable wedges or expanders arranged between the sections of the rim at said slots and adapted to force the periphery of the rim into engagement with the inner walls of the ring 41ᵇ in the well known manner. By varying the adjustment of the expanders the clutch can be made to slip when the resistance to the rotation of the winding drum reaches any given amount.

43 is a pulley or sheave arranged to receive and guide the cable 44 as it is wound upon or is paid out from the drum 41.

42 is a bearing bracket secured to the side plate 2 adjacent the drum 41.

42′ is a longitudinally arranged shaft suitably supported by the laterally extending arm 42ª of the said bracket.

43 is an idle pulley on the shaft 42′. When the machine is in operation and is being advanced along the coal, this pulley guides the cable while it is being wound upon the drum.

When the machine is in operation, it is advanced along the face of the coal by tension in the draft cable 44 due to the rotation of the drum 41. Under the action of this forward draft, the outer end of the machine tends to swing forward relative to the cutter frame because of the resistance which the coal offers to the advance of the cutters. To overcome this tendency and maintain the machine in proper working position relative to the face of the coal, I use a cable or flexible holding or guiding device supplemental to, and wholly independent of, the main draft cable 44. Such cable is indicated at 56. It is adapted to have one of its ends detachably secured to a holder at the outer end of the machine. This attaching can be effected by means of a hook 56′ on the cable and a stud, pin, hook or perforated lug on the frame. It extends back from the rear side of the machine toward, and is at its other end secured to, devices for anchoring it and for paying it out under any desired tension.

47 indicates a stationary holder which can be a screw jack such as is commonly used for holding machines in mine work. Between this and the cable the take-up mechanism is interposed.

48 is a reel to which the cable is secured. It is mounted in a frame or carrier having parts indicated by 80, 81 and 82. The vertical part 81 and the upper horizontal part 82 of said frame carry lugs 81′ and 82′ respectively perforated to receive the anchoring jack 47. A bearing member 83 is secured to the member 80 of the frame and on said member a sleeve 101 is mounted to turn. The sleeve carries at its upper end the ratchet wheel 102 with which engages the pawl 103 carried by the reel. A handle 104 provides for ready manual control of the pawl. To the lower end of the sleeve 101 there is secured a gear wheel 84 which meshes with a pinion 85 on a shaft 86 mounted in the parts 80 and 82 of the frame. This shaft has a crank at 87 with which is connected the rod 88 of a piston 89. This piston is fitted in a cylinder 90 having trunnions 91, 92, mounted in suitable bearings on the part 82 of the frame. At the ends of the cylinder chamber there are ports 93, 94 and these are connected by a by-pass having the ducts 95 and 96. 97 is a valve adapted to close this by-pass, there being at 98 a seat for receiving it. The valve is carried by a screw stem 99 having an adjusting wheel or handle at 100.

The cylinder 90 is filled with suitable retarding liquid, such as oil, or the like, which will act to impede the movement of the piston 89, the retardation thereof being proportional to the extent to which the by-pass is opened or closed.

In longwall mining an undercut is usually easily started at a free face, but in room and pillar work an entering or "sumping" cut must be made in order to get the cutting apparatus under the coal, this entering cut being made adjacent one or the other of the ribs constituting the side walls of the room. With my improved machine the sumping cut is made by feeding the machine longitudinally forward so as to project the cutting apparatus into the coal in a manner like that in which "breast" mining machines are operated. For this purpose I have devised the combined jack stand and cutter mechanism guide E illustrated in

Figs. 7, 8, 9 and 10. 54 is a base plate of the said jack stand adapted to rest upon the floor of the mine closely adjacent to the coal face and at an angle thereto, as shown. Near either end of this base plate is a pair of upwardly extending arms or lugs 55 supporting between them a shaft or pivot 56^a with its axis arranged longitudinally of the base plate.

57 indicates the jack proper comprising a shank or bar 57′ forked at its lower end as indicated at 57^a, the ends of each arm of said fork being recessed as indicated at 57^b to fit over one of the shafts 56 on the base plate. The upper end of the jack shank is screw threaded at 57^c to receive a screw-threaded hand adjusting wheel 58.

59 is a pointed head for the jack swiveled on the upper end of the jack 57′ and bearing against the upper face of the hub of the wheel 58 by means of which it is adjusted longitudinally of the shank.

54′ is an arm or plate extending laterally from the base plate 54 and carrying the upright bracket 54^a which at its upper end is bifurcated as indicated at 54^b to receive one end of a swinging arm 60, which is pivotally connected to the upright 54^a by means of a bolt 60′. At its forward free end the arm 60 has pivotally connected to and depending from it a slide 61 which is longitudinally grooved at either side to receive the adjacent longitudinal guide bar 12^b on the chain frame. These guide bars 12^b are rigidly secured in position by means of bolts 12^c screw threaded into inwardly projecting lugs 12^d carried by the base plate 6 of the chain frame. The slide 61 may be introduced into position within the said top plate at the rear ends of the guides 12^b. The slidable connection between the slide 61 and the cutter frame permits the longitudinal movement of the cutter frame relative to the slide while tending to prevent the lateral movement in either direction of the cutter frame relative to the base plate 54. It will thus be seen that when the jack stand is securely fastened in position by means of the jack 57, the cutter frame may be caused to travel inward in a substantially straight line. When the slide 61 reaches the ends of its guides 12^a it may be swung upwardly out of the path of travel of the cutter frame.

To operate the machine for room and pillar work it is unloaded at the corner of the room where it is desired to begin the cut and with the inner end of the cutter frame closely adjacent the face of the coal. The combined jack and cutter frame guide E is then clamped securely in position on the left hand side of the cutter frame near the inner end thereof, as indicated in Fig. 10, the slide 61 having been introduced into its guide in the top plate of the said frame. The cable 44 is next carried inward from the drum 41 along the side of the machine to the inner end of the jack frame and pivotally connected thereto, as indicated at 62, a suitable idler guide 63 serving to direct the course of the cable from the drum toward the said jack stand. This idler guide 63 is mounted on a journal 64 carried by a U-shaped bracket 65 which is pivotally mounted on a longitudinal shaft 66 carried by lugs 67, 67 projecting laterally from the main frame. The U-shaped bracket 65 has a laterally extending lug or projection 65′ which is adapted to engage with the platform of the main frame to limit the inward travel of the bracket 65 about the axis of the shaft 66, as indicated in Fig. 6. The bracket 65 may be readily detached by removing the shaft 66, whenever it is not desired to use the idler guide 63.

The motor having been started, the cutting apparatus and the slow-feed gearing of the winding drum are then connected to the motor by clutches 18 and 36, respectively. As the drum winds up on the cable 44 it pulls the main frame of the machine toward the coal face, the cutting apparatus simultaneously undercutting the coal. The cutter frame guiding mechanism tends to insure that the cutting apparatus will be moved inward in a substantially straight line. When the slide 61 reaches the ends of the guides 12^a it is withdrawn therefrom and the shoe machine will feed inward if necessary without further guiding. The sumping cut having been completed, the machine is stopped, the guide jack E and the idler guide 63 removed, the feed cable 44 extended to the far rib and secured to an anchor or jack 45. And, the reel 48 having been secured at the near rib by a jack 47, the cable 56 is then secured to the rear outer corner of the bed frame. See Fig. 11. The motor is now started, and clutches 18 and 36 closed, driving the cutters and the winding drum 41, the latter through the slow speed gearing. The rotation of the winding drum creates tension in the cable 44 tending to advance the machine along the face. Under the action of the draft of the cable 44 and the resistance which the coal offers to the cutters, the outer end of the machine tends to swing forward. but this is resisted by the rear tail cable 56 which is paid out by the reel 48 under the control of the hydraulic brake devices. It will be seen that as the machine moves forward toward the front jack 45, the cable 56 unwinds from the reel 48. The resulting motion of the reel, through the gear wheels 84 and 85, rotates the shaft 86 and imparts a reciprocatory movement to the piston 89 in cylinder 90. As above indicated, this movement of the piston is retarded by the fluid in the cylinder. and this retarding action is determined by adjustment of the valve 97.

This valve is set in relation to its seat at the place where the desired tension on the cable will be secured. Thus, if the cutters encounter an increased resistance due to meeting harder or denser coal, the outer end of the machine will tend to swing forward, but this the machine runner can readily prevent by simply adjusting the valve 97 nearer its seat so as to increase the breaking action on the reel 48. This ability to readily control the retardation of the outer end of the machine is an important thing because coal of quite uniform character is rarely encountered.

The hydraulic brake is not only useful in maintaining the machine at such an angle to the face as is best suited for efficient cutting, but can also be used to readily change the angle of the machine when it is desirable to do so. Obviously, if the control valve 97 is adjusted away from its seat, the outer end of the machine can be allowed to swing forward relative to the inner end to any desired extent. And, on the other hand, by adjusting the valve toward its seat, retardation of the outer end of the machine can be increased so as to swing it rearward, and, within the angular working limits of the machine, any particular angular position to which the machine is moved can be maintained by means of the hydraulic brake control.

Obviously, if the valve 97 is entirely closed, the reel 48 will thereby be positively locked against rotation. If the machine is fed forward by tension in the feed cable 44 when the reel 48 is thus locked, the rear outer corner of the machine becomes practically a stationary pivotal point around which the machine swings forward. Between this maximum braking action on the reel or drum 48 and the minimum braking effect secured with the valve 97 full open, there are an infinite number of retarding effects available by simply adjusting the throttle valve, so that the machine can easily be controlled to meet a great variety of working conditions.

In the foregoing, reference has been made to variations in the coal or material being cut existing for a substantial distance along the face, rather than to minor variations in the material which the cutters would pass through relatively quickly. My machine, however, works advantageously in encountering these minor variations. Thus, when a thin streak or a small nodule of harder material is encountered, the hydraulic brake, responding automatically to the increased tension in the tail cable 56, permits the said cable to be paid out more rapidly and the outer end of the machine to swing forward correspondingly while the cutters are passing through the temporarily increased resistance. Then, as soon as the harder material is passed the outer end of the machine tends to angle rearward again to its initial or normal position relative to the cutters. Thus, the machine, as it moves along the face, will be seen from time to time to oscillate backward and forward under the momentarily varying character of the material encountered by the cutters. This ability of the machine to automatically accommodate itself to temporary changes in the resistance encountered by the machine saves it from the severe strains and stresses which would otherwise result and which do, in fact, result in other constructions which have heretofore been proposed. Thus, in the case of a machine which is fed forward and guided by a continuous unyielding chain, which extends from an anchor at the forward rib and across the machine to an anchor at the rear rib, it is impossible for the machine to automatically swing while passing temporarily increased resistances. In the case of applicant's improved machine the devices which retard the outer end of the machine are wholly separate from and independent of the devices which feed the machine forward along the face, and the outer end of the machine can be retarded or permitted to advance quite independently of the movements of the inner end of the machine. Of course, applicant's friction clutch, by which the winding drum 41 is connected to the driving gears, can be set to give way before the stresses to which the machine is subjected are great enough to break the machine, but this ultimate safety provision is supplemented in a valuable manner by the oscillatory movement of the machine which is permitted by the automatic action of applicant's retarding devices. The advantage from this automatic swinging consists not only in the easing of stresses by permitting the outer, frame part of the machine to move forward more rapidly than the cutter frame, but also in causing the cutters to be presented at a more advantageous angle, as, for example, when a nodule of sulfur or other hard material is encountered. In such cases a change in the line of attack of the cutters often facilitates the loosening of the nodule.

In applicant's machine the peculiar retarding devices and their operation independent of the feed devices and of the movement of the machine, as a whole, are important and valuable in other respects. For example, it is possible with applicant's machine to set the rear jack or anchor 47 at various distances from the face of the coal without interfering with the uniform advance of the machine along the face: whereas, in the case of machines having a unitary feed and retarding mechanism, it is necessary to maintain the flexible feed element—cable or chain—parallel with the

flexible retarding element, else the angular relation of the machine to the face will be changed in a purely arbitrary and undesirable way as the machine advances.

It will be understood, of course, that the oscillatory movement of the machine and the swinging thereof under the manual control of the retarding brake, are possible by reason of the fact that the main frame of the machine rests upon and is freely slidable upon the floor of the mine. This freedom of the machine for horizontal sliding movement is facilitated by the use of the common flat skids which are practically always employed in connection with these machines where the mine floor is soft or uneven. These skids, which are in the form of thin metal plates a few inches wide, are laid upon the floor of the mine in the direction of the machine's advance and by affording a hard, smooth surface for the main frame, greatly facilitate the movement of the machine.

The free movement of the machine over the floor of the mine makes possible not only angular or swinging movements, such as have been referred to, but also bodily movements of the machine outward from and inward toward the coal face—movements which would, of course, be quite impossible if the machine were operated upon a track. Thus, if the cutters, while making a cross undercut, encounter a very hard obstacle of substantial dimensions, for example, a roll or a large sulfur ball, which is found to lie in the inner part of the cut, the machine can be stopped and jacks placed against the inner sides of the feed and check or tail cables. Then, when the machine is started again, the tension in the cables will draw the machine outward away from the face as it advances, until the inner end of the cutter bar clears the obstruction and, the cut having continued past the obstruction and the supplemental jacks having been removed, or preferably suitably placed against the outer sides of the cables, the machine is fed inward again toward the face and the undercut continued at full depth. Such a procedure as this, in which the angular relations of the feed and retarding cables to each other and to the machine proper are radically changed, is greatly facilitated by the independent character of the retarding devices of applicant's machine. For, as has been pointed out, the fact that applicant's retarding cable 56 and feed cable 44 may not be parallel, does not interfere with the guidance of the machine as it advances as would be the case if the retarding and feeding cables were integrally connected.

It sometimes happens that obstructions of such a nature are encountered by the cutters that it is impossible to guide the machine outward around the obstructions in the manner above described. In some such cases it is found possible to avoid the obstruction by cutting under or over it. Thus, if a roll is encountered near the outer part of the kerf, it may be found possible to back the machine off along the face to a suitable distance from the obstruction and then by blocking up the skids, which, as previously noted, are commonly used under such machines, the cutters can be guided in an upwardly inclined path over the obstruction and then gradually downward again to the normal level. Such a handling of the machine as this is greatly facilitated in the case of applicant's machine by the fact that the winding drum and guide sheave with which the feed cable engages are mounted to turn upon horizontal axes so that said cable does not interfere with the free tipping of the machine about its longitudinal axis, while the same is true of the retarding cable by reason of the manner in which it is connected to the machine frame.

In connection with the swing or oscillatory movements of the machine, it is to be noted that the machine while in operation is subjected to three principal forces, to-wit, the tension in the feed cable 44, the reaction of the coal on the cutters, and the tension in the retarding cable 56. As the first of these forces is applied to the machine at a point between the other two forces and in opposition to them, the machine tends to swing about the point of application of said first force. In other words, there is a tendency for the guide pulley 43 to act as a fulcrum in the swinging or oscillating movements referred to.

With reference to the means which I provide for retarding the outer end of the machine during the cross undercutting, it will be observed that the desired retarding tension in the tail cable 56 is secured by a braking action upon the winding drum 84 by which said cable is paid out as the machine advances, and that this braking action is due to the frictional resistance to the movement of the liquid through the by-pass connecting the two ends of the hydraulic cylinder. The hydraulic devices, together with the devices which connect them to the winding drum, constitute in reality a friction brake. A friction brake of this character in which the frictional resistance is applied to a liquid, is, in several respects, superior to friction brakes in which only solid materials are used. In the case of the liquid or hydraulic brake the intensity of the braking action can easily be controlled with great nicety and easily maintained with great uniformity. In the case of metallic shoe brakes or band brakes, on the other hand, the effects of wear and of heating make it difficult to

maintain a uniform braking action, or to effect a nice adjustment of the braking action, without frequent attention.

In the application of the braking action to the winding drum 84 it will be seen that by reason of the ratio of the gears 85 and 84 and the large diameter of the latter gear relative to the drum, the braking resistance is applied with a relatively large mechanical advantage or leverage in comparison with the leverage of the check cable on said drum.

Reference has already been made to the box-like construction of the main frame of the machine. This I regard as a feature of much practical importance. During the cutting operation the fine coal or slack which is formed is dragged out of the kerf by the cutters and must be handled or disposed of in such a way as not to clog or interfere with the cutters or other working parts of the machine. In my improved construction this fine coal is drawn into and outward through the box-like bed frame to the outer end of the machine by the cutters. There as the cutter chain rounds the driving sprocket wheel, the fine material falls either quite clear of the machine as it advances, or, if it is not delivered entirely clear of the machine, it is possible for the machine runner or his helper to readily shovel it away because the cutting away of the side plates of the frame at the outer end thereof leaves a free space adjacent the driving sprocket wheel and beneath the upper platform part of the frame which permits ready and effective use of the shovel for the purpose stated. Furthermore, it will be observed that with the exception of the cutters and the sprocket wheel which drives them, all of the working parts—gears, winding drums, clutches, motor, etc.—are mounted above the upper platform part of the frame so as to be fully protected from contamination with the fine coal or slack which cannot rise and enter any of these working parts during its passage from the face outward to the point where it is delivered by the cutters free of the machine. In this connection it will be observed that practically all of the gears, shafts and clutches constituting the driving mechanism are grouped compactly together on one part of the frame platform while the motor occupies another part. This arrangement of the motor and the driving gearing greatly facilitates the complete protection of the gearing from dust because it makes it possible to inclose the gearing by means of a simple protecting casing.

In the foregoing description of the operation of the machine its use in room and pillar mining was considered. It will be obvious without further detailed description that the operation in making an under-cut along the face would be essentially the same in longwall mining. Ordinarily, in longwall mining it is not necessary to make an entering or sumping cut because the cut can be started at a free face.

Referring to Figs. 1, 2 and 3, I have shown means by which power may be transmitted to gearing on a suitable mining machine truck upon which the mining machine may be mounted, said gearing being for the purpose of propelling the truck. This mechanism comprises a transversely arranged shaft 68 in axial alinement with the transverse shaft 29, the inside end of which latter shaft is fitted into a recess 68′ in the inside end of the shaft 68.

69 is a positive clutch, one element of which 69′ is secured to the shaft 29 and the other element 69ª is carried by the inside end of the shaft 68. The shaft 68 is suitably supported on a bearing 70 secured to the main frame.

71 is a sprocket wheel rigidly secured to the outside end of the shaft 68 and adapted to be connected with the propelling mechanism on the mining machine truck. When not required in use the shaft 68 may be removed from the machine by drawing it longitudinally out from the bearing 70.

The devices for effecting the sumping out, as shown and described, are such as are set forth and claimed in the application filed by me September 20, 1906, Serial No. 335,453; and I do not herein present claims for the said devices, the claims herein relating to the construction and arrangement of the parts by which the machine is propelled and guided or adjusted in its positions relative to the coal and relative to its line of travel along the coal face.

What I claim is:

1. In a mining machine, the combination of a main frame, cutting apparatus carried thereby, means for propelling the frame and cutting apparatus bodily along the coal, and guiding or alining mechanism interposed between the frame and a holder on the rear side thereof and comprising an extensible tension device and a fluid cylinder and piston for resisting the extension thereof, substantially as set forth.

2. In a mining machine, the combination of a main frame, cutting apparatus carried thereby, a winding reel on the frame, means for advancing the frame and cutting apparatus bodily along the face of the coal, and a guiding or alining mechanism having an element extending from the outer part of the frame to a stationary holder, a fluid receptacle, a piston or means therein for pressing against the fluid, and means for retarding the flow of the fluid, the said element of the guiding mechanism being operatively connected to said piston, substantially as set forth.

3. In a mining machine, the combination

of a main frame, cutting apparatus thereon, means for advancing the frame and cutting apparatus along the coal, and a guiding or alining device having an extensible tension device, a fluid cylinder and piston, and power transmitting devices between the tension device and the piston for moving the latter independently of the movement of the main frame, substantially as set forth.

4. In a mining machine, the combination of a main frame, cutting apparatus carried thereby, means for moving the frame and the cutting apparatus along the coal, and guiding or alining mechanism having a cable, a stationary holder, a fluid cylinder and a piston connected to the cable, and all interposed between the frame and the stationary holder to exert a retarding force on the outer part of the frame, substantially as set forth.

5. In a mining machine, the combination of a main frame, cutting apparatus carried thereby, means for moving the frame and the cutting apparatus along the coal, a cable for guiding or alining the frame and cutting apparatus, a reel for the cable, a retarding piston and cylinder, and means interposed between the reel and the cylinder and piston for transmitting movement to the latter from the reel, substantially as set forth.

6. In a mining machine, the combination of a main frame, cutting apparatus, means for moving them bodily together, a retarding cylinder and piston, rotary devices connected to the frame for imparting movement to the piston, and means actuated by the movement of the frame for driving the rotary devices, substantially as set forth.

7. In a mining machine, the combination with a main frame and cutting apparatus movable bodily, of a cable, a stationary holder, and the following parts interposed between the frame and the holder, to-wit: a retarding cylinder and piston, and a reel for the cable connected to the piston and the cylinder, and adapted to be rotated by the tension of the cable, substantially as set forth.

8. In a mining machine, the combination with a main frame and cutting apparatus movable bodily along the coal, of a guiding or alining cable, a reel for the cable, a train of gearing actuated by the reel, a retarding piston connected with said gearing, a fluid cylinder containing the piston, and means for varying the movements of the fluid, substantially as set forth.

9. In a mining machine, the combination with a main frame and cutting apparatus bodily movable along the coal, of a guiding and alining mechanism having a cable, a retarding piston and cylinder, means for controlling the passage of the fluid in the cylinder, and power transmitting devices for the piston connected to the cable and adapted to be actuated by the tension exerted by the cable, substantially as set forth.

10. In a mining machine, the combination with a main frame, cutting apparatus carried thereby, means for moving the frame and cutting apparatus along the coal, and means for guiding or alining the frame and cutting apparatus comprising a stationary holder and, interposed between said holder and the frame of the machine, a cable, a winding reel therefor, and a fluid retarding cylinder and piston operatively connected to said reel, said cylinder having a by-pass for the fluid and means for controlling the flow of fluid therethrough, substantially as set forth.

11. In a mining machine, the combination of a main frame, cutting apparatus extending from the inner end thereof, means for propelling the frame and cutting apparatus bodily along the coal, and guiding or alining mechanism comprising a stationary holder on the rear side of the machine, an extensible tension device connected to the outer part of the machine frame, and a rotary device connected to the holder and independent of the machine frame for paying out said tension device as the machine advances along the coal, substantially as set forth.

12. In a mining machine, the combination of a main frame, cutting apparatus extending from the inner end thereof, means for propelling the frame and cutting apparatus bodily along the coal, and guiding or alining mechanism comprising a stationary holder on the rear side of the machine, an extensible tension device connected to the outer part of the machine frame, a rotary device connected to the holder and independent of the machine frame for paying out said tension device as the machine advances along the coal, and means for controlling the rate of rotation of said rotary device, substantially as set forth.

13. In a mining machine, the combination of a main frame, cutting apparatus extending from the inner end thereof, means for propelling the frame and cutting apparatus bodily along the coal, and guiding or alining mechanism comprising a stationary holder on the rear side of the machine, an extensible tension device connected to the outer part of the machine frame, a rotary device connected to the holder and independent of the machine frame for paying out said tension device as the machine advances along the coal, a brake device for resisting the rotation of said rotary device, and manual means for varying the resistance of the brake, substantially as set forth.

14. In a mining machine, the combination of a main frame adapted to rest upon the floor of the mine and to oscillate and slide freely

in all directions over said floor when the machine is in operation, cutting apparatus extending from the inner end of said frame, means comprising a flexible draft device acting on the inner end of the frame to propel the machine along the face of the coal, and means independent of the said propelling means operating automatically to retard the outer end of the frame, said retarding means being controllable at will to permit the outer end of the frame to advance at a speed equal to, or faster than, the speed at which the inner end of the frame advances, or to cause said outer end to advance at a speed slower than that at which the inner end of the frame advances, substantially as set forth.

15. In a mining machine, the combination of a main frame, cutting apparatus extending from the inner end thereof, means for propelling the frame and cutting apparatus bodily along the coal, a guiding or alining mechanism comprising a stationary holder on the rear side of the machine, an extensible tension device independent of the aforesaid propelling means and connected to the outer part of the machine frame, a rotary device separate from the main frame of the machine for carrying and automatically paying out said tension device as the machine advances along the coal, and means for controlling the rate of rotation of said rotary device.

16. In a mining machine, the combination of a main frame, cutting apparatus extending from the inner end thereof, means for propelling the frame and cutting apparatus bodily along the coal, a guiding or alining mechanism comprising a stationary holder on the rear side of the machine, an extensible tension device independent of the propelling means and connected to the outer part of the machine frame, and a rotary device separate from the main frame of the machine for carrying and automatically paying out the said tension device as the machine advances along the coal.

17. In a mining machine, the combination of the main frame, cutting apparatus extending from the inner end thereof, means for propelling the frame and the cutting apparatus bodily along the coal, a guiding or alining mechanism comprising a stationary holder on the rear side of the machine, an extensible tension device independent of the propelling means and connected to the outer part of the machine frame, a rotary device for carrying and paying out said tension device as the machine advances along the coal, a brake device for resisting the rotation of said rotary device, and manual means for varying the resistance of the brake.

18. In a mining machine, the combination of a main frame, power driven cutting apparatus projecting from the inner end thereof, power devices for feeding the machine along the face of the coal, and means for retarding the outer end of the machine comprising a cable adapted to be connected to an anchor at the rear side of the machine, and means independent of the aforesaid power feeding devices and separate from the main frame of the machine for paying out the cable, said means being conected to the cable and adapted to automatically resist the lengthening of the rearward extending part thereof.

19. In a mining machine, the combination of a main frame, power driven cutting apparatus projecting from the inner end thereof, power devices for feeding the machine along the face of the coal, and means for retarding the outer end of the machine comprising a cable adapted to be connected to a relatively stationary anchor at the rear side of the machine, and means supported at points remote from the main frame of the machine and independent of the power feeding devices for paying out the cable, as the machine advances along the coal face.

20. A mining machine having in combination a frame, cutting devices extending from the inner end of the frame, feeding devices arranged to exert a forward propelling force on the frame, and retarding means arranged to exert an opposing force on the machine on a line offset from that of the forward force, said retarding means comprising a flexible device, a rotatable winding device for paying out the flexible device as the machine advances along the coal face, the said winding device being separate from the frame of the machine, and means under manual control for retarding the rotation of the said rotatable winding device.

21. A mining machine having in combination a main frame, cutting devices extending from the inner end of the said frame, feeding devices arranged to exert a forward propelling force on the inner part of the main frame, and retarding means arranged to exert an opposing force on the machine frame, said retarding means comprising a flexible tension device independent of the aforesaid propelling means and arranged to extend from the outer part of the said main frame to a stationary holder on the rear side of the machine, a rotary device for carrying and paying out of the said tension device as the machine advances along the face of the coal and a brake device for controlling the rotation of the said rotary device.

22. In a mining machine of the class described, the combination of a main frame, power driven cutting apparatus extending from the inner end thereof, means for mov-

ing the frame and cutting apparatus along the face of the coal, and means for guiding or alining the machine comprising stationary holding means on the rear side of the machine and, interposed between said holding means and the outer part of the machine frame, a flexible retarding member, a rotary device connected rigidly to the retarding member and paying it out as the machine advances, and a brake device for controlling the rotation of said rotary device.

23. In a mining machine of the class described, the combination of a main frame, power driven cutting apparatus extending from the inner end thereof, means for moving the frame and cutting apparatus along the face of the coal, and means for guiding or alining the machine comprising a stationary holder and, interposed between said holder and the frame of the machine, a cable, a winding reel therefor, and a brake device for controlling the rotation of the reel, the cable being arranged to exert a retarding force on the outer part of the machine frame.

24. In a mining machine of the class described, the combination of a main frame, power driven cutting apparatus extending from the inner end thereof, means for moving the frame and cutting apparatus along the face of the coal, and means for guiding or alining the machine comprising a stationary holder and, interposed between said holder and the frame of the machine, a cable, a winding reel therefor, a brake device for the reel, and means for adjusting the brake device to vary its retarding effect, the cable being arranged to exert a retarding force on the outer part of the machine frame.

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

WALTER F. TROTTER.

Witnesses:
F. L. SESSIONS,
C. E. WAXBOM.