Sept. 11, 1923. 1,467,513

G. W. STARR ET AL

MINING MACHINE

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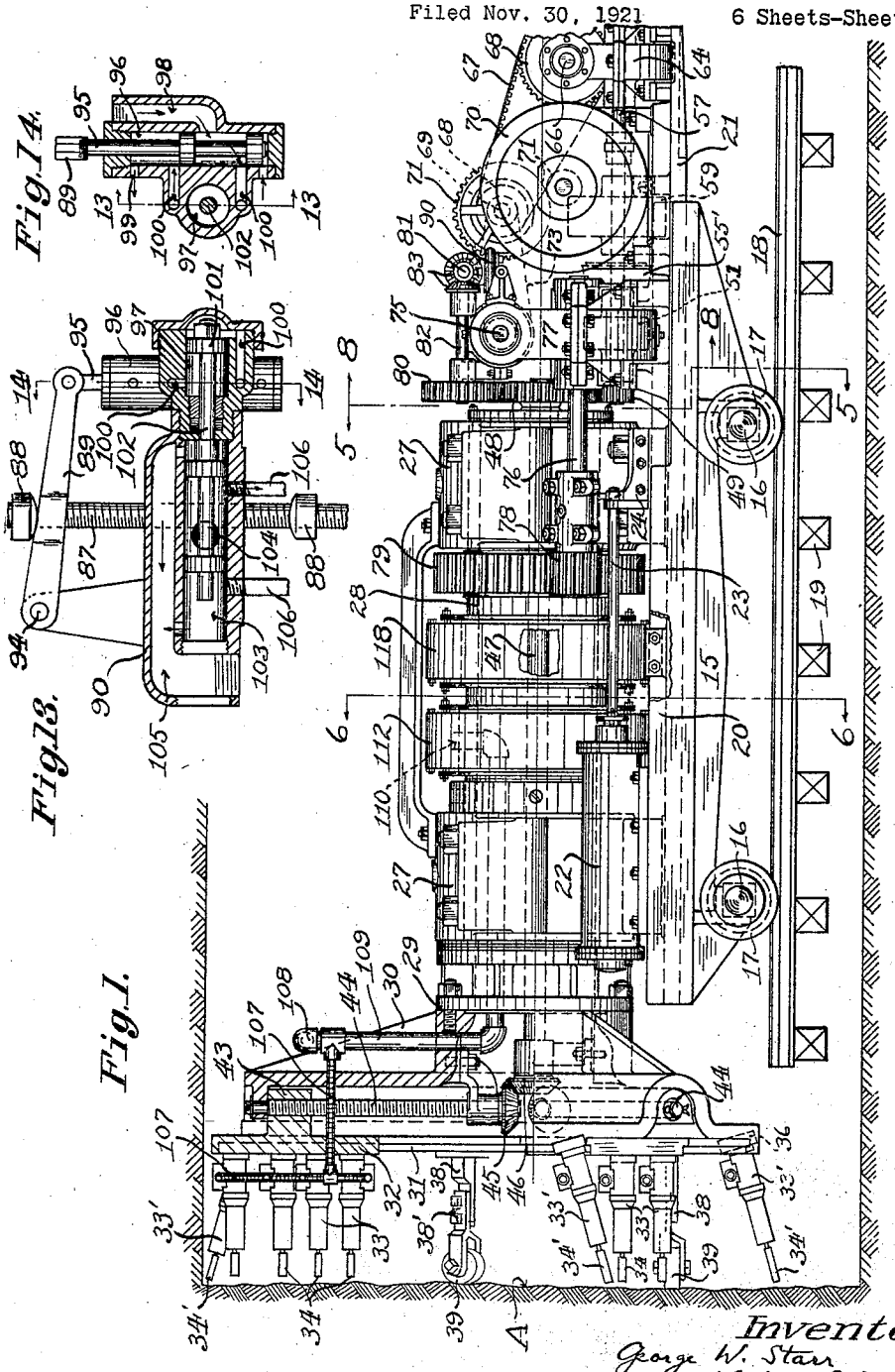


Fig. 1.

Fig. 13.

Fig. 14.

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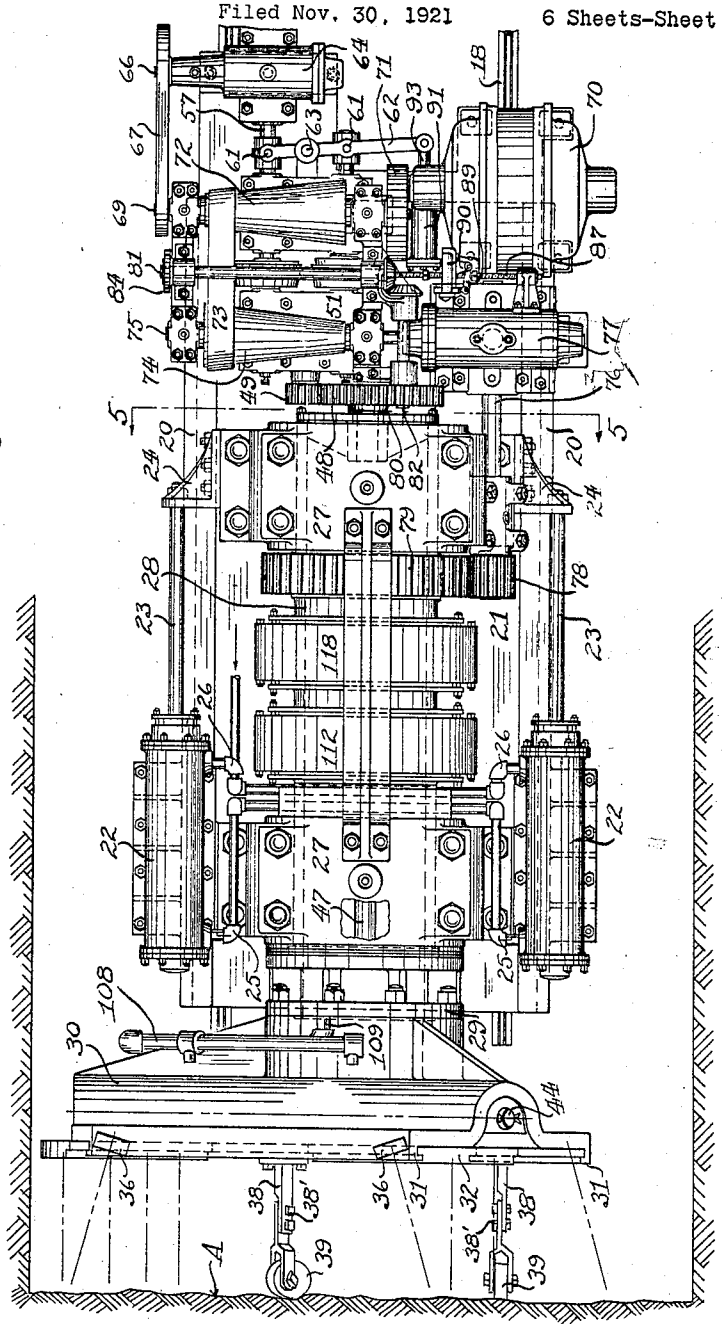
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Fig. 2.



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Fig. 11

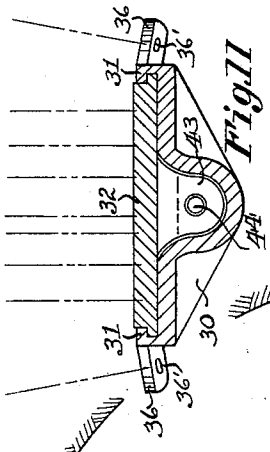


Fig. 12.

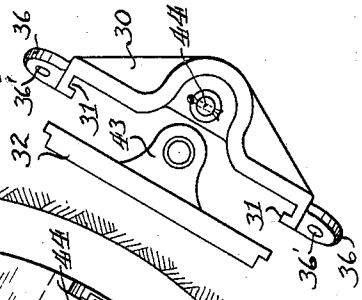
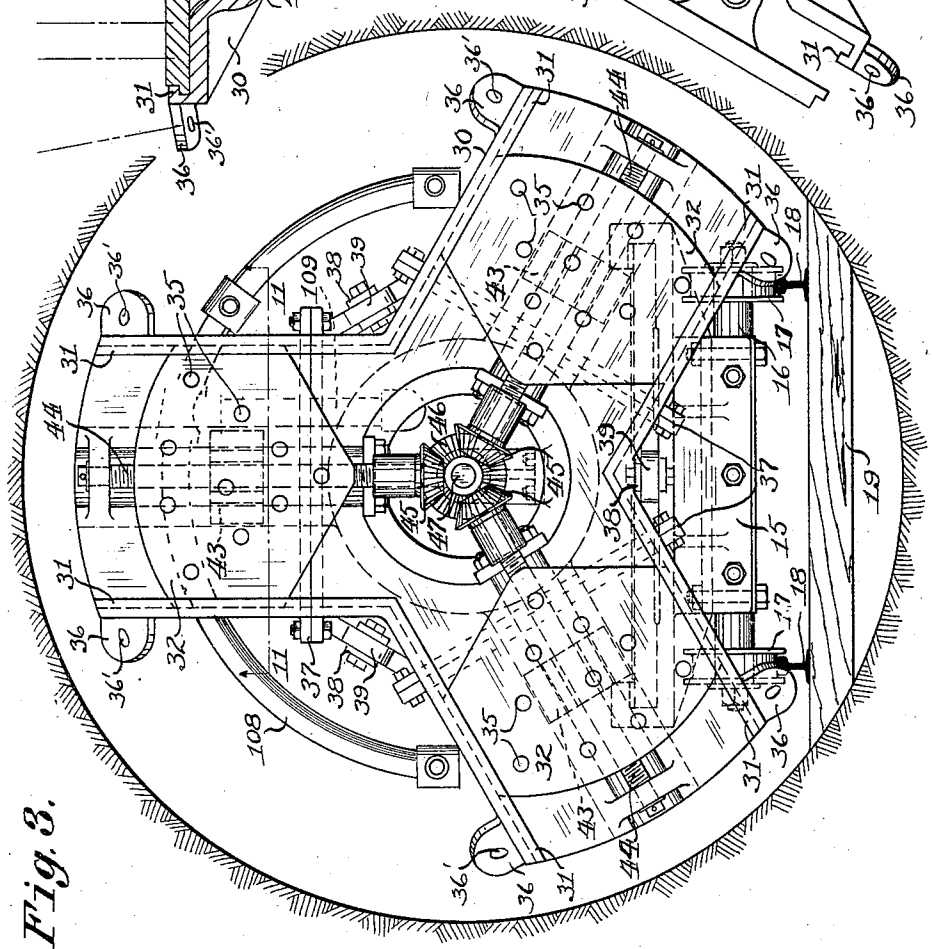


Fig. 3.



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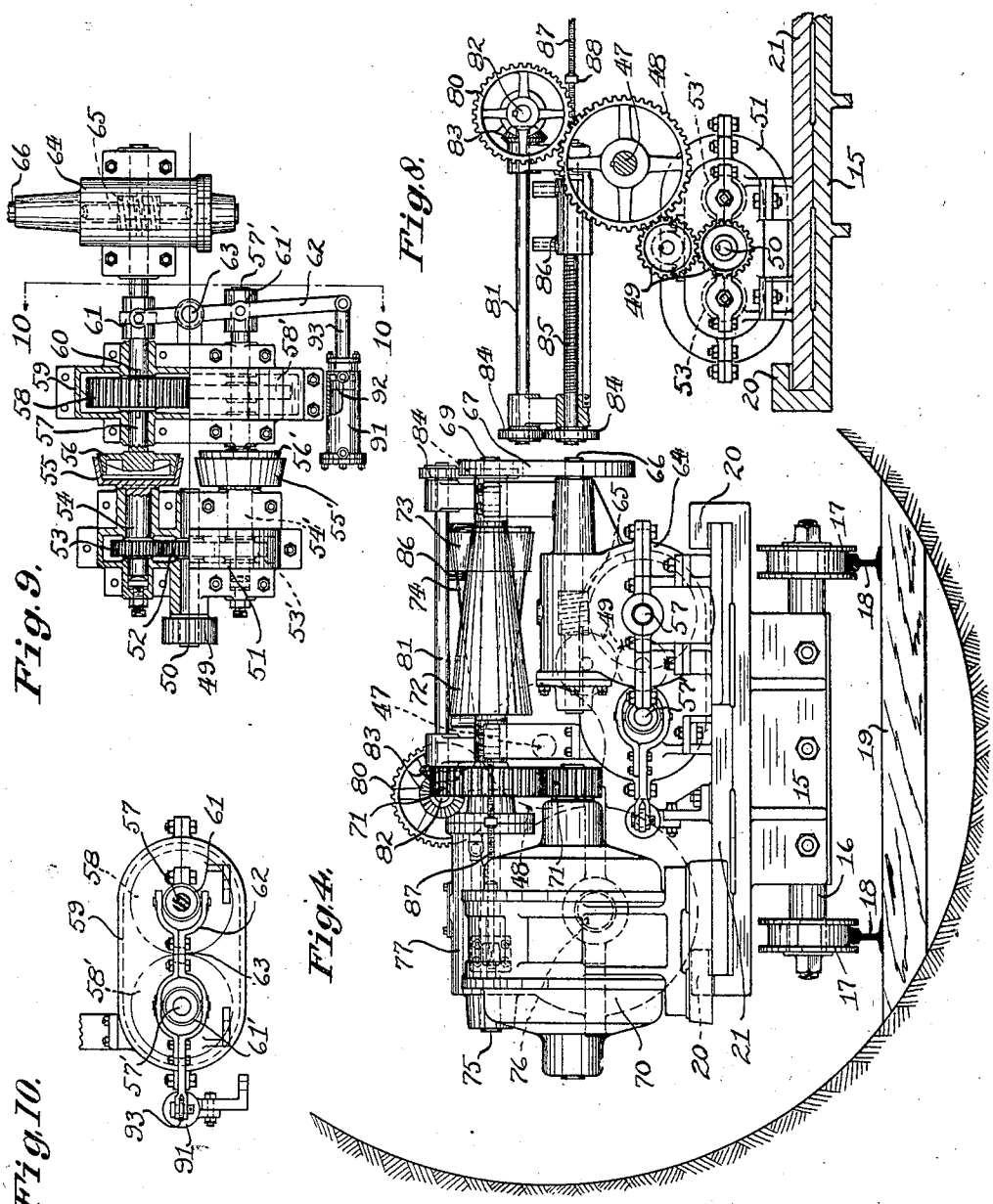


Fig. 8.

Fig. 9.

Fig. 10.

Fig. 4.

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Sept. 11, 1923.

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Fig. 6.

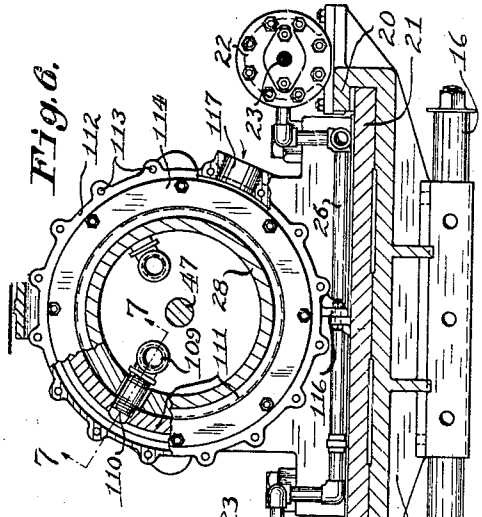


Fig. 4.

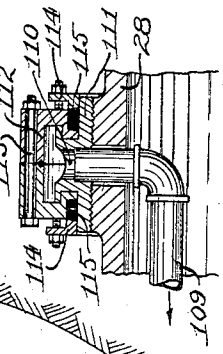
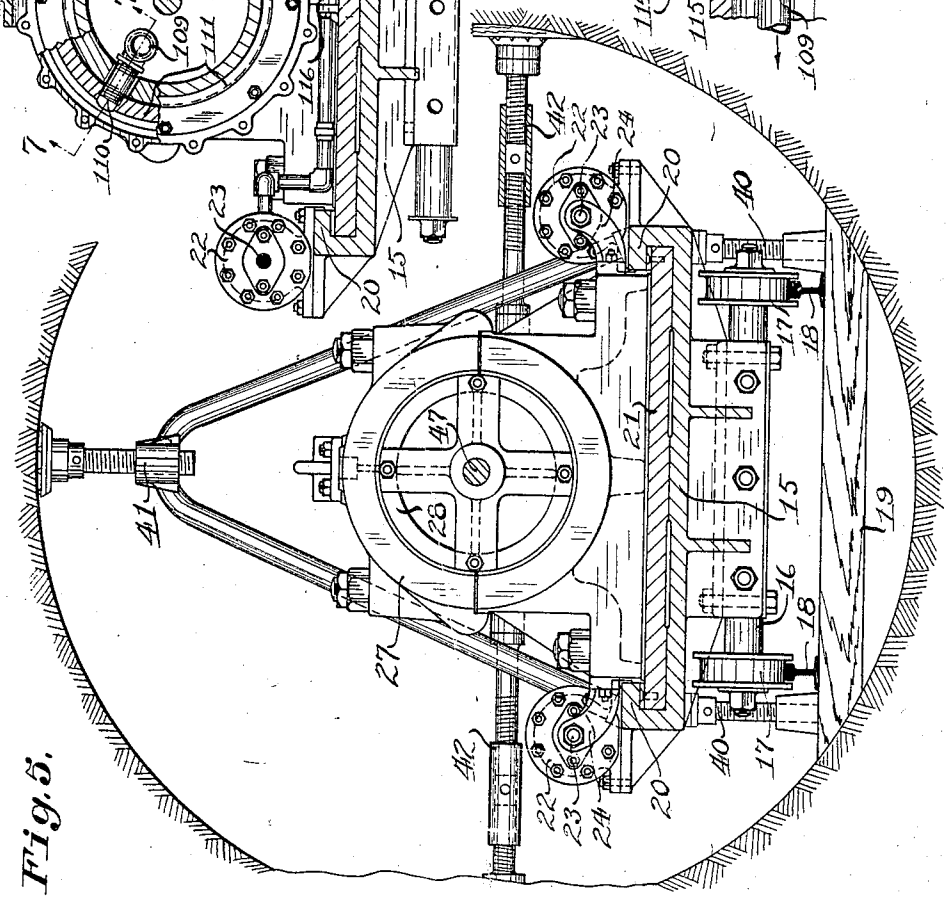


Fig. 5.



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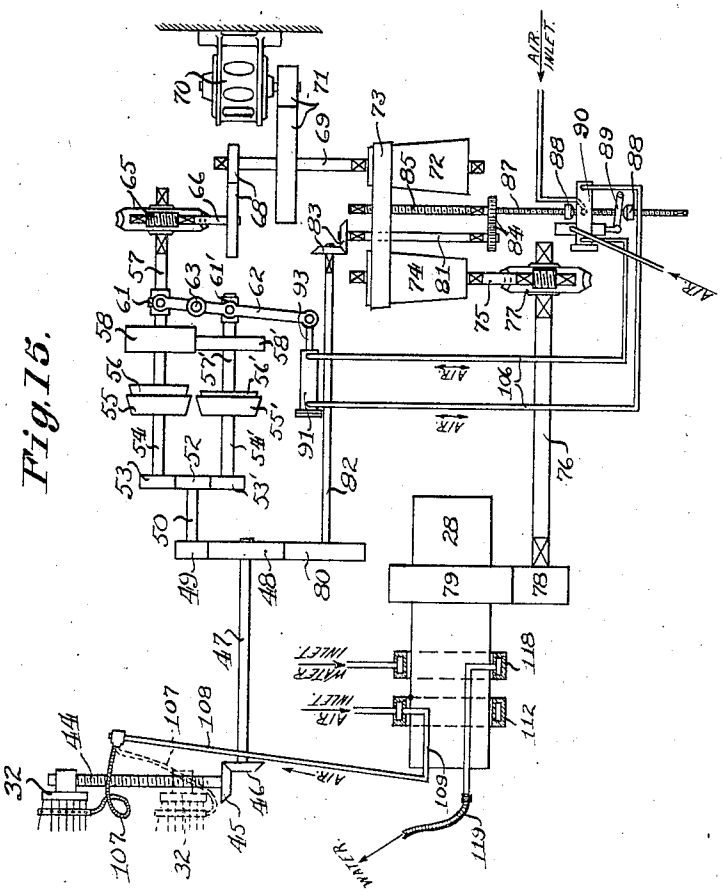
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Fig. 15.



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Patented Sept. 11, 1923. 1,467,513

UNITED STATES PATENT OFFICE.

GEORGE W. STARR AND WILLIAM D. PAYNTER, OF GRASS VALLEY, CALIFORNIA.

MINING MACHINE.

Application filed November 30, 1921. Serial No. 518,789.

To all whom it may concern:

Be it known that we, GEORGE W. STARR and WILLIAM D. PAYNTER, citizens of the United States, residing at Grass Valley, in the county of Nevada and State of California, have invented certain new and useful Improvements in Mining Machines, of which the following is a specification.

Our invention relates to mining machines, and more particularly to machines for driving drifts or tunnels through subterranean rock formations.

The object of our invention is to provide a machine capable of driving a drift or tunnel through solid rock, by the process of chipping away the surface of the head of the drift. This not only obviates the necessity for blasting, with the consequent undesirable shattering of the surrounding rock, but also removes the rock in fragments of such size that it can be easily sluiced out. Moreover, where the drift runs through a vein of ore, the small size of the fragments enables the ore to be run through the stamps at a minimum cost and better adapts it for treatment.

A further object of our invention is to provide, in a machine of the described type, means for automatically regulating its operation in such a manner that the face of the drift or tunnel will be worked out evenly over its entire surface, and will therefore remain flat and not become either convex or concave.

The preferred embodiment of our invention, as herein described and illustrated, is a machine particularly adapted for use in the mining of gold, where underground drifts or tunnels are driven through the ore vein, but the machine may also be used, with equal success, for driving any drift or tunnel through rock formations. Moreover, although our machine is herein described and illustrated in its preferred form, it is to be understood that changes, within the scope of the claims hereto appended, may be made in the form and construction of the machine, without affecting the essential features of the invention or departing in any degree from the spirit thereof.

Broadly speaking, our machine comprises a working head, adapted to carry a battery of percussion chipping machines, and mounted upon a truck or carriage in such a manner that it can be fed into the working face at the end of the drift. The head rotates continuously, and at the same time the percussion machines carried thereby are continuously moved toward and away from the center of the head, so that every portion of the surface of the working face is traversed by the cutting bits of said machines. Moreover, in order to insure the chipping of the working face to an even depth over its entire surface, i. e. so that it will remain flat, and not become either convex or concave, the rotative speed of the head is accelerated as the percussion machines, in their radial travel, approach the central regions of said face, and is retarded as said machines approach the peripheral regions thereof. This variation in the rotative speed of the head causes the chipping bits to traverse the central region of the working face more rapidly, but gives them more time to operate upon the peripheral regions, where the area to be worked is comparatively greater.

Our invention will now be more fully described with reference to the accompanying drawings, wherein—

Fig. 1 is a side elevation, partly in section, of our complete mining machine.

Fig. 2 is a plan view of the same, the percussion chipping machines being omitted.

Fig. 3 is a front elevation, the percussion chipping machines being removed.

Fig. 4 is a rear elevation, with the cutting head omitted.

Fig. 5 is a transverse section taken in the direction of the arrows on the line 5—5 of Figs. 1 and 2, showing the steadying jacks, the cutting head being omitted.

Fig. 6 is a transverse section taken in the direction of the arrows on the line 6—6 of Fig. 1.

Fig. 7 is a sectional detail taken in the direction of the arrows on the line 7—7 of Fig. 6.

Fig. 8 is a sectional detail taken in the direction of the arrows on the line 8—8 of Fig. 1, showing a portion of the feed mechanism.

Fig. 9 is a plan view, partly in section, of the cross-feed reversing mechanism.

Fig. 10 is a section taken in the direction of the arrows on the line 10—10 of Fig. 9.

Fig. 11 is a transverse section of one of the arms of the cutting head, and is taken in the direction of the arrows on the line 11—11 of Fig. 3.

Fig. 12 is an end elevation of the same showing the slide removed from its guide.

Fig. 13 is a longitudinal section, enlarged, of the reverse control valve, taken in the direction of the arrows, on the line 13—13 of Fig. 14.

Fig. 14 is a transverse section of the same, taken in the direction of the arrows on the line 14—14 of Fig. 13.

Fig. 15 is a diagram of the power transmitting connections, both fluid and mechanical, of the entire machine.

In the drawings, the reference numeral 15 designates a truck or carriage upon which the entire machine is mounted. Said truck is carried upon axles 16, Figs. 1, 3, 4 and 5, upon which are journaled flanged wheels 17 adapted to run upon rails 18 laid upon cross-ties 19 in the usual manner. The truck 15 is provided with longitudinal guides 20, Figs. 1, 2, 4, 5 and 6, in which is mounted, for sliding movement, the frame 21 of the machine. This frame carries the cutting-head and the percussion chipping machines, in a manner to be presently described, and is moved forward upon the truck 15, to feed said chipping machines into the working face of the drift, by a pair of fluid pressure cylinders 22, Figs. 1, 2, 5 and 6, mounted upon said truck. Slidable pistons, not shown in the drawings, within said cylinders, are connected with piston rods 23, Figs. 1 and 2, which are connected with the frame 21 by brackets 24. The cylinders 22 are double-acting, and fluid under pressure, either air or water, is admitted to the front and rear ends of said cylinders, for moving the frame 21 backward or forward, by the respective pipes 25 and 26—Fig. 2.

The frame 21 carries two journal pedestals 27, Figs. 1 and 2, in which is rotatably mounted a longitudinally disposed hollow shaft 28 of comparatively large diameter. This shaft has a flange 29 at its forward end, to which is secured the cutting-head 30. Said cutting-head has three equally spaced radial branches, as shown in Fig. 3, each having guides 31 in which is mounted a radially movable slide 32. These slides carry most of the percussion chipping machines, which may be of any suitable type, but are here represented, in Fig. 1 of the drawings, as air drills 33 of the usual well known form, carrying and operating chipping bits 34 for chipping the rock from the working face A of the drift. Said percussion machines may be secured to the slides 32 in any convenient manner, not shown in the drawings, said slides being shown as provided with holes 35, Fig. 3, for this purpose.

The head 30, carried by the shaft 28, revolves, slowly and continuously, during the operation of the machine, and at the same time the slides 32 are reciprocated in and out, by mechanism to be described later, in order to carry the chipping bits 34 over every portion of the working face A.

In addition to the percussion machines 33 thus carried by the slides 32, there are others, mounted rigidly upon angularly disposed ears 36 extending laterally from the end portions of the head guides 31. The six percussion machines 33′ so mounted are inclined outwardly with respect to the percussion machines 33, so that their chipping bits 34′ work up to and cut the corner or periphery of the drift, as shown in Fig. 1. Said ears 36 are shown in Fig. 3 as provided with holes 36′ for securing the chipping machines 33′ thereto in any desired manner.

The head 30 is provided with flanged and bolted joints 37, Fig. 3, in its arms, so that the outer end portions of said arms may be removed to enable the machine to be passed through restricted places in the drifts or shafts through which it is moved.

As before stated, the chipping machines are fed into the working face A by the action of the fluid-pressure cylinders 22. In order to limit such feeding, and to prevent said machines from being fed too rapidly, the head 30 carries forwardly projecting arms 38, Figs. 1, 2 and 3, upon whose ends are mounted rollers 39 adapted to bear against the working face A. The length of said arms 38 is adjustable, as shown at 38′ in Figs. 1 and 2, to compensate for the wear and consequent shortening of the chipping bits.

In order to permit the feeding forward of the frame 21 of the machine, which carries the chipping machines, the truck 15 must be held stationary. This is accomplished by screw jacks 40 and 41, Fig. 5, the jacks 40 being placed under said truck, and the jack 41 above. When said jacks are tightened, the truck 15 is firmly held against rearward movement, and the frame 21 can be fed forwardly by the fluid pressure cylinders 22. When the limit of such movement is reached, the jacks 40 and 41 are loosened, and a pair of horizontal jacks 42 are tightened against the sides of one of the journal pedestals 27, thus holding the frame 21 stationary. Fluid pressure is then admitted to the forward ends of the cylinders 22, thereby moving the truck 15 ahead to a new position.

Returning now to the cutting head 30, the slides 32 are provided with threaded lugs 43, Figs. 1 and 3, projecting from their rear faces, and these lugs are engaged by rotatable screws 44, so that the slides 32 are moved inwardly or outwardly, by the rotation of said screws. The screws 44 carry bevel gears 45 at their inner ends, all of which mesh with a common bevel gear 46 fixed upon the end of a longitudinal shaft

47, extending centrally through, and suitably journaled within, the hollow supporting shaft 28. At its rear end, said shaft 47 is provided with a gear 48, Figs. 1, 2 and 8, and is driven through a train of gears 49, by the shaft 50 of a reversing mechanism, which is illustrated particularly in Fig. 9.

The shaft 50 extends into a housing 51, and carries therein a gear 52, which meshes with two oppositely disposed gears 53 and 53′, mounted upon shafts 54 and 54′, whose rear ends carry conical clutch members 55 and 55′ respectively. Cooperating clutch cones 56 and 56′ are carried upon rotatable and axially slidable shafts 57 and 57′ in such a manner that the clutches comprising the members 55 and 56 and 55′ and 56′ may be respectively engaged or disengaged by endwise movement of the shafts 57 and 57′. Said shafts 57 and 57′ carry inter-meshing gears 58 and 58′, within a housing 59. The gear 58′ is fixed upon its shaft 57′, but the gear 58, which is wider than said gear 58′, is slidably secured to its shaft 57 by a key or feather 60.

The shafts 57 and 57′ are provided with thrust collars 61 and 61′ respectively, which are adapted to be engaged by a bifurcated lever 62, Figs. 9 and 10, fulcrumed at 63 mid-way between said shafts. Thus by moving the free end of said lever 62 forward, the clutch 55′ and 56′ is engaged and the clutch 55 and 56 is disengaged, and by moving said lever rearwardly the opposite effect is produced. The shaft 57 is extended rearwardly into a housing 64, Figs. 4 and 9, and is driven, at a reduced speed, by means of worm gearing 65, from a transverse shaft 66. The latter is driven by a chain 67 and sprockets 68, Figs. 1, 2 and 4, from a transverse shaft 69, which, in turn, is driven by an electric motor 70 through spur gearing 71. The train of power transmitting mechanism above described can be clearly seen in the diagram of Fig. 15.

The transverse shaft 69 carries a conical pulley 72. Figs. 2, 4 and 15, which is connected by a belt 73 with a similar but oppositely disposed pulley 74 mounted on a parallel shaft 75, which is connected with a longitudinal shaft 76 by worm gearing enclosed within a housing 77. The shaft 76 carries a pinion 78, Figs. 1, 2 and 15, at its forward end, which meshes with a gear 79 upon the hollow cutting head supporting shaft 28. The cutting head 30 is thus continuously rotated by the motor 70, but its speed is varied, within certain limits, by shifting the belt 73 upon its conical pulleys 72 and 74. This variation in the rotative speed of the head 30 is controlled automatically by the slide cross feed mechanism, and is so related to the movements of the slides 32, as to cause the head 30 to revolve with increasing speed as said slides approach their inner or more central positions, and with decreasing speed as they approach the outer limits of their radial travel. This results in the chipping machines 33 being carried over approximately equal areas of the working face in equal times, irrespective of their radial positions, for, when they are nearer the center of the face, where the area is less, the rotative speed of the head is greater than it is when said chipping machines are nearer the peripheral regions of said face, where the area is greater. This automatic control of the rotative speed of the head 30 is effected by the following mechanism, which is shown in Figs. 1, 2, 4 and 8, and diagrammatically in Fig. 15.

The gear 48, mounted on the rear end of the central cross-feed shaft 47, meshes with a gear 80, which drives a transverse shaft 81, through a short longitudinal shaft 82, and bevel gears 83. The shaft 81 is connected by a pair of gears 84, Fig. 8, with a rotatable screw 85, which carries a belt shifter 86 for sliding the belt 73 along its conical pulleys. The speed ratio of the various gears is such that said belt moves in unison with the slides 32.

The same devices control the cross feed reversing mechanism described above. The screw shaft 85 is hollow, and is interiorly threaded to receive an exteriorly threaded rod 87, Figs. 2, 4, 8 and 15, which projects from its end and is caused to move linearly by the rotation of said screw shaft. This rod 87 carries two spaced collars 88, Figs. 8, 13 and 15, which are adapted to engage the operating lever 89, Figs. 2, 13 and 15, of a fluid control valve 90, which, in turn, controls the admission of fluid under pressure to a working cylinder 91, Figs. 2, 9 and 15. This cylinder has a piston 92, Fig. 9, connected with the reversing lever 62, by a rod 93.

The construction of the control valve 90 is shown in Figs. 13 and 14. The operating lever 89, Fig. 13, is fulcrumed at 94, and its other end is connected with a valve rod 95. This rod, which has a sliding movement, operates a piston valve within a cylinder 96, Fig. 14, to control the admission of fluid, preferably air, under pressure, to a working cylinder 97. 98 and 99 are, respectively, the inlet and exhaust ports of said valve, and 100 are the ports connecting the valve cylinder 96 with the two ends of the working cylinder 97. Said working cylinder 97 has a piston 101, Fig. 13, whose rod 102 operates a second piston valve within a cylinder 103 to control the admission of fluid under pressure (also preferably air) to the reversing cylinder 91. 104 is the air inlet, 105 the exhaust, and 106, shown in Figs. 13 and 15, are the pipes connecting said valve with the reversing cylinder 91.

The rod 87, operated by the screw 85, moves in unison with the drill carrying slides 32, and, as said slides reach either end of their radial movement, one of the collars 88 upon said rod 87 engages the valve operating lever 89, as shown in Fig. 13, thereby shifting the valve rod 95. This reverses the air pressure in the working cylinder 97, and shifts the valve 102, which, in turn, reverses the air pressure in the cylinder 91, whose piston 92, Fig. 9, and rod 93 shift the reverse lever 62, thereby reversing the direction of rotation of the shaft 50, and consequently reversing the movement of the slides 32. Thus said slides are continuously and automatically moved in and out, radially, in the head 30, while said head itself is continuously revolved at a constantly varying speed, such speed being greater when the slides 32 are near the center, and less when they are nearer the outside, of the working face A. This variation in the rotative speed of the head 30 causes the chipping machines to traverse approximately equal areas of the working face in equal times, thereby chipping out said face to an even depth over its entire area. In the machine as shown in the accompanying drawings the head 30 revolves about three and one-half times faster when the slides 32 are at the inner limits of their radial travel than when said slides are at their outer limits.

Fluid (preferably air) under pressure is supplied to the percussion machines 33 and 33′ through flexible connections 107, Fig. 1, leading from a manifold 108, Figs. 1, 2 and 3, carried by the head 30. Said manifold is supplied by a pipe 109, Fig. 1, running longitudinally inside the hollow shaft 28, and terminating, as shown in Figs. 1, 6 and 7, in an orifice 110 formed in a flanged ring 111, Figs. 6 and 7, secured exteriorly upon said shaft 28. This flanged ring, which rotates with said shaft 28, is encircled by a stationary channeled ring 112, formed in two halves, as shown in Fig. 7, held together by bolts 113, and provided with adjustable packing rings 114, the joint between said stationary ring 112 and the rotatable ring 111 being made tight by means of suitable packing 115. The stationary ring 112 is secured to the frame 21 by coacting lugs 116, bolted together as shown in Fig. 6. The channel of the stationary ring 112 forms an annular chamber, to which air is supplied through an exterior connection 117, and from which it is supplied to the manifold 108 by the interior pipe 109.

A similarly constructed fluid connection 118, Figs. 1, 2 and 15, is provided upon the shaft 28, by means of which water may be supplied to the head 30 for sluicing out the chipped rock. The various pipes for conducting the sluicing water from said connection 118 are not shown except diagrammatically at 119 in Fig. 15, it being understood that any suitable arrangement of conduits may be made for directing the water against the working face.

We claim:—

1. A mining machine comprising a rotatable working head; a plurality of independent sets of cutting tools mounted upon the face of the head for movement in independent radial paths; means for operating said tools; and means for carrying each of said sets of tools towards and away from the axis of said head during its rotation.

2. A mining machine comprising a rotatable working head; cutting tools carried thereby; means for continuously moving said tools back and forth across the face of said head, toward and away from the axis thereof; and means for rotating said head at a constantly varying speed.

3. A mining machine comprising a rotatable working head; cutting tools carried thereby; means for continuously moving said tools back and forth across the face of said head, toward and away from the axis thereof; and means for rotating said head at a constantly varying speed, such speed increasing as said tools approach the axis of said head, and decreasing as they move away therefrom.

4. A mining machine comprising a rotatable working head; cutting tools carried by said head; means for moving said tools back and forth across the face of said head, toward and away from the axis thereof; and automatic means for increasing the rotative speed of said head as said tools approach the axis and decreasing it as they move away therefrom.

5. A mining machine comprising a rotatable working head; cutting tools carried by said head; means for moving said tools back and forth across the face of said head, toward and away from the axis thereof; and means actuated by said tool-moving means for varying the rotative speed of said head.

6. A mining machine comprising a rotatable working head; cutting tools carried by said head; means for moving said tools back and forth across the face of said head, toward and away from the axis thereof; and means actuated by said tool-moving means for increasing the rotative speed of said head as said tools approach the axis and decreasing it as they move away therefrom.

7. A mining machine comprising a rotatable working head; cutting tools carried thereby; means for simultaneously rotating said head and moving said tools back and forth across the face thereof; and means controlled by the linear movement of said tools for automatically varying the rotative speed of said head.

8. A mining machine comprising a rotatable working head; cutting tools movably mount-

ed upon the face of the head; other cutting tools fixed to the head at the border thereof; and means for carrying the movable tools across the face of the head during its rotation.

9. A mining machine comprising a working head; a rotatable shaft carrying said head; cutting tools movably mounted upon the head; power-transmitting connections carried through the head shaft for moving the tools across the face of the head; and means for simultaneously driving said head shaft at constantly varying rotative speed as described and operating said power-transmitting connections.

In testimony whereof we have signed our names to this specification.

GEORGE W. STARR.
WILLIAM D. PAYNTER.