No. 874,603. PATENTED DEC. 24, 1907.

A. D. LEE & F. J. E. NELSON, Jr.

ROCK DRILLING MACHINE.

APPLICATION FILED NOV. 14, 1906.

3 SHEETS—SHEET 1.

Fig. 2.

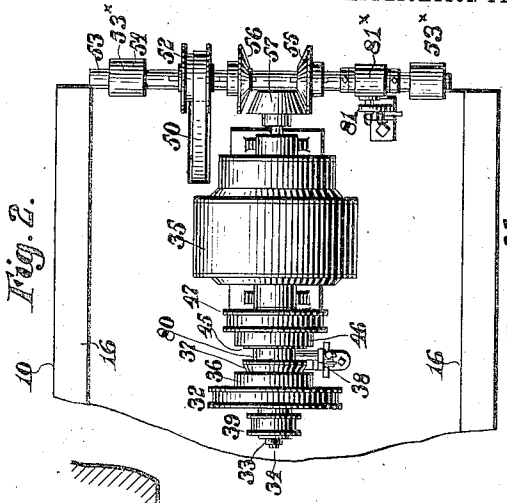
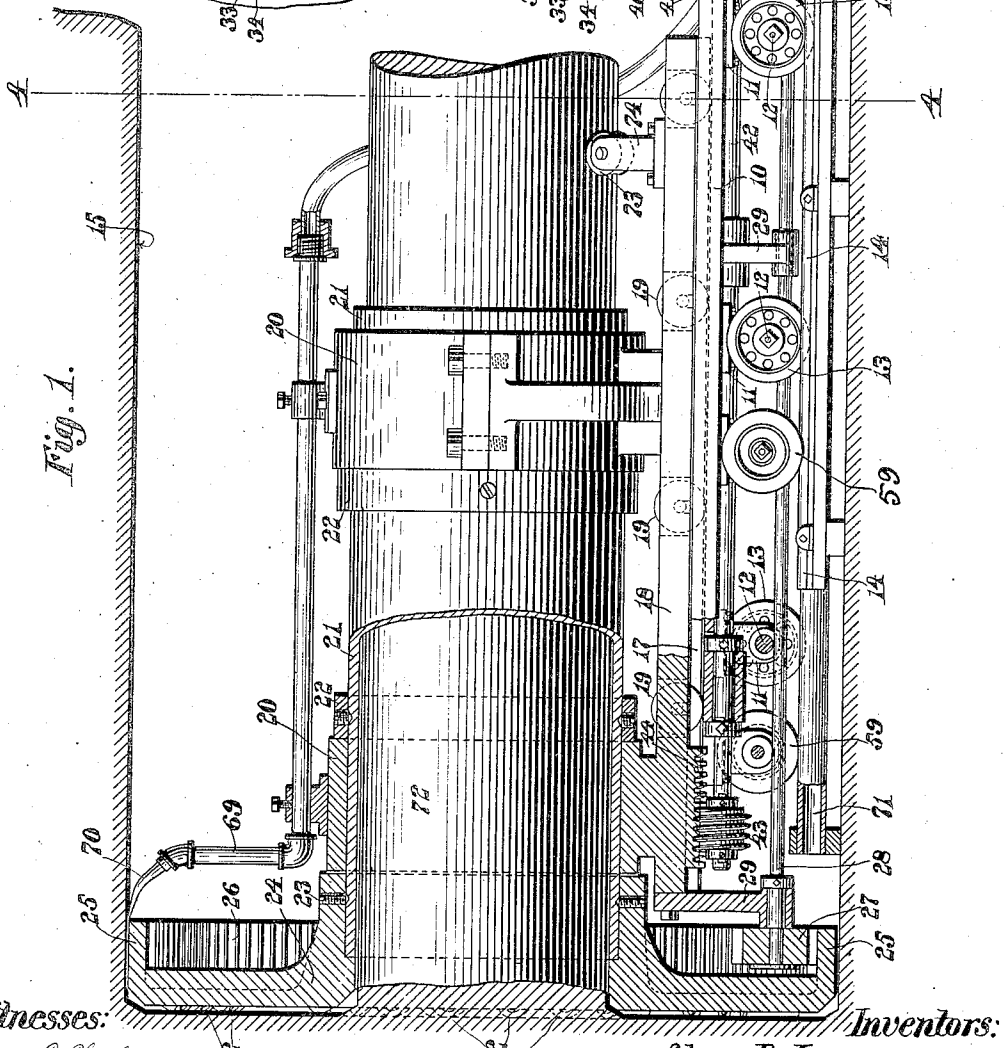


Fig. 1.



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3 SHEETS—SHEET 2.

Fig. 4.

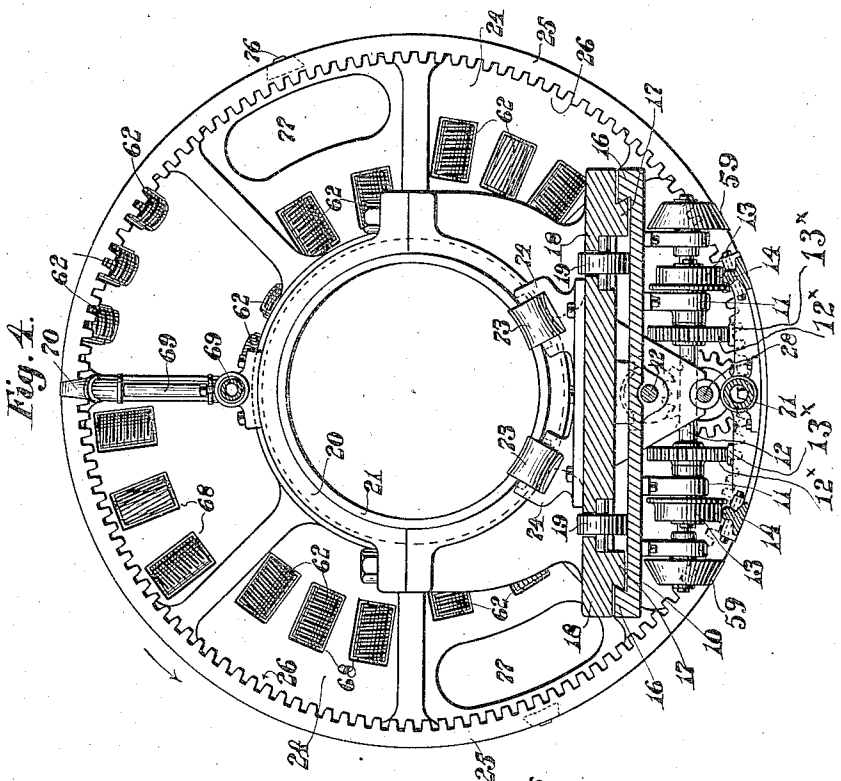
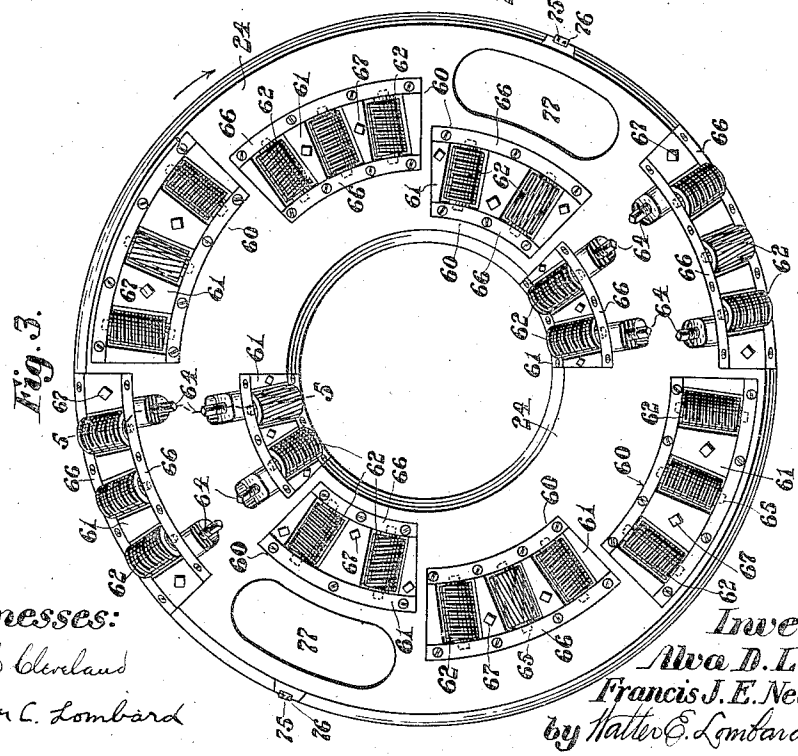


Fig. 3.



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3 SHEETS—SHEET 3

Fig. 5.

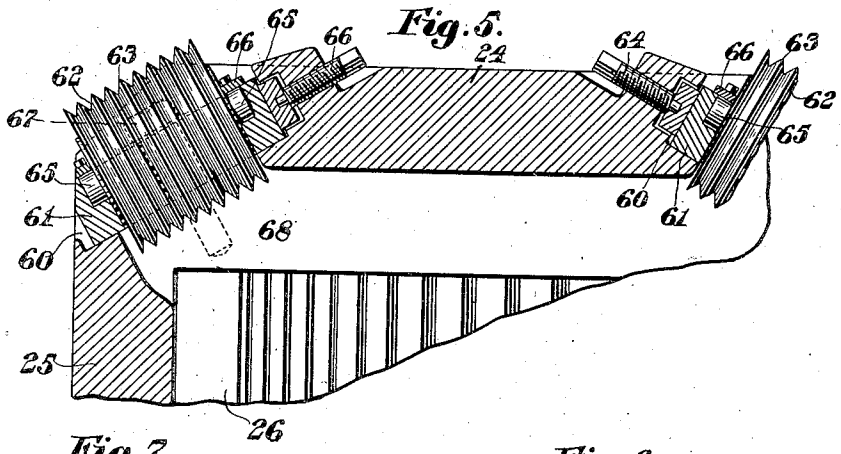


Fig. 7.

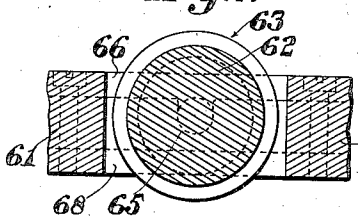


Fig. 6.

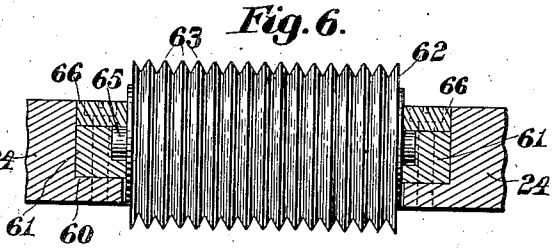


Fig. 11.

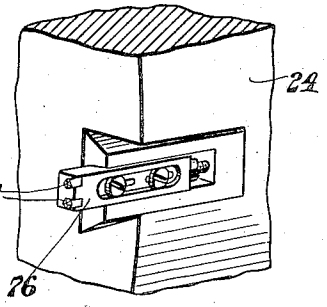


Fig. 8.

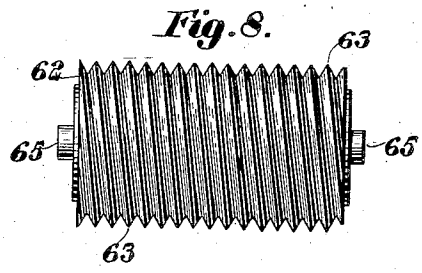


Fig. 10.

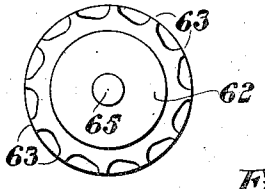


Fig. 9.

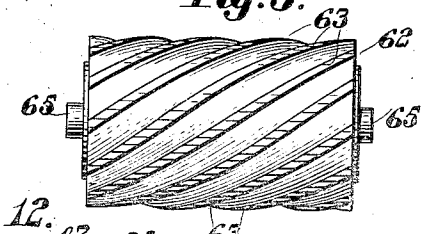
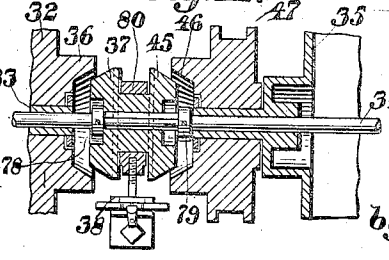


Fig. 12.



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UNITED STATES PATENT OFFICE.

ALVA D. LEE, OF BROOKLINE, AND FRANCIS J. E. NELSON, JR., OF EAST BOSTON, MASSACHUSETTS.

ROCK-DRILLING MACHINE.

No. 874,603. Specification of Letters Patent. Patented Dec. 24, 1907.

Application filed November 14, 1906. Serial No. 343,322.

To all whom it may concern:

Be it known that we, ALVA D. LEE and FRANCIS J. E. NELSON, Jr., citizens of the United States of America, and residents, respectively, of Brookline, in the county of Norfolk, and East Boston, in the county of Suffolk, both in the State of Massachusetts, have invented certain new and useful Improvements in Rock-Drilling Machines, of which the following is a specification.

This invention relates to rock cutting machines and particularly to such machines adapted for cutting cylindrical tunnels through the rock.

It has for its principal object the cutting of an annular groove through the rock leaving a central core uncut which is supported by means of a movable carriage which follows in the path of the cutters.

The invention consists in certain novel features of construction and arrangement of parts which will be readily understood by reference to the description of the drawings and to the claims hereinafter given.

Of the drawings: Figure 1 represents a side elevation of a machine embodying the features of this invention, the front portion being shown in section. Fig. 2 represents a plan of a portion of the lower carriage and its motor with the automatic feed and cutter plate rotating devices. Fig. a represents a front elevation of the revoluble cutter plate. Fig. 4 represents a transverse vertical section of the same on line 4—4 on Fig. 1. Fig. 5 represents a section on line 5—5 on Fig. 3, drawn to an enlarged scale. Fig. 6 represents a section showing in elevation one of the revoluble intermediate cutters. Fig. 7 represents a transverse section of the same. Fig. 8 represents an elevation of a revoluble cutter having a spiral cutting edge. Figs. 9 and 10 represent, respectively, an elevation and an end view of one of the revoluble reamer cutters. Fig. 11 represents a perspective view of the adjustable diamond cutters, and Fig. 12 represents an enlarged detail of the clutch mechanism.

Similar characters designate like parts throughout the several figures of the drawings.

In the drawings, 10 represents a movable carriage to the under face of which are secured a plurality of bearings 11, in each pair of which is mounted a revoluble shaft 12, on either end of which is secured a flanged truck wheel 13 adapted to coöperate with a rail 14 on which said carriage 10 is adapted to be moved longitudinally of the cylindrical bore 15 cut through the rocks by means of the gears 12* coacting with racks 13* extending longitudinally of the bore 15 parallel with the rails 14. The upper face of the carriage 10 is provided with guides 16 co-acting with projections 17 extending longitudinally of a top carriage 18 which is adapted for movement longitudinally of the lower carriage 10. Rollers 19 are interposed between the top carriage 18 and the lower carriage 10, said rollers supporting the upper carriage 18 and reducing the friction between the two carriages to a minimum.

The projecting members 17 and the guides 16 are each provided with co-acting inclined sides which prevents the upper carriage from being separated from the lower carriage in an obvious manner. The upper carriage 18 is provided with bearings 20 in which is revolubly mounted the cylindrical member or tube 21. Annular members 22 are secured to said member 21 between the bearings 20—20 to prevent any lateral movement of the same.

Secured to the front end of the tube or cylindrical member 21 by set screws 23 or other similar means is an annular ribbed plate 24. This plate 24 is provided with a rearwardly extending flange 25 having cut therein or secured thereto an internal annular gear 26 with which meshes a pinion 27 mounted upon a shaft 28 mounted in bearings 29 secured to the top carriage 18. This shaft 28 has secured thereto a long flanged pulley 30 connected by means of a belt 31 to a revoluble pulley 32 freely revoluble upon a sleeve 33 mounted upon a central shaft 34 controlled by any suitable motor 35.

The pulley 32 is provided with a female clutch member 36 adapted to coact with the male clutch member 37 operated by means of the shipper handle 38 to throw the pulley 32 into action to cause a movement to be transmitted through the belt 31 in the direction indicated by the arrows on Fig. 1 to cause a rotation of the annular plate 24.

On the same sleeve 33 to which the pulley 32 is secured is also secured a smaller pulley

39 connected by a cross belt 40 to a pulley 41 mounted upon the shaft 42 to the front end of which is secured a worm 43 meshing with a rack 44 secured to the under face of the top carriage 18. As the plate 24 is revolved through the medium of the revoluble pinion 27 and annular gear 26 the worm 43 is acting upon the rack 44 to move the plate forward as fast as the cutting of the rock will permit such movement.

The clutch member 37 is keyed to the shaft 34 of the motor 35 and is provided with another male clutch member 45 coacting with a female clutch member 46 on a pulley 47. This pulley 47 is connected by a belt 48 with a pulley 49 on the shaft 42 and by means of this connection the worm 43 may be reversed when the worm 43 has reached the end of the rack 44 so that it may be moved to its normal position ready to move the top carriage 18 further forward. This is accomplished by moving the lower carriage 10 forward during the reversal of the movement of the worm 43 so that it counteracts the tendency of the worm to move the top carriage 18 to the rear. The movement of the lower carriage forward is secured by means of the belt 50 interposed between a pulley 51 mounted upon the rear shaft 12 and a pulley 52 secured to a shaft 53 mounted in bearings 53* in the rear bracket 54 in which it is adapted to be reciprocated. The rotation of the rear shaft 12 in this manner causes the gears 12* to so act upon the stationary rack 13* as to effect the required forward movement.

The shaft 53 has secured thereon the friction gears 55 and 56 which alternately engage with the friction gear 57 mounted upon the rear end of the motor shaft 34. It is obvious that by the shifting of the friction gears 55 and 56 so that either one or the other alternately engage with the drive gear 57 the lower carriage 10 may be driven in either direction.

When the reversing feed mechanism is in operation the drive gear 57 is coöperating with the gear 55 to move the lower carriage forward but when the drive gear 57 is in engagement with the friction gear 56 to reverse the movement of the carriage to move it out of the bore the male clutch members 37 and 45 will be intermediate the female clutch members and disengaging therefrom. These clutch members 37 and 45 will also be in an intermediate position when the drive gear 57 is in engagement with the friction gear 55 for the purpose of moving the carriage into the bore at all times when it is not desired to change the relative positions of the worm 43 and rack 44. As the cutting continues and the carriage moves forward the truck wheels 13 will soon run off of the front ends of the rails 14 and in order to properly position the front end of the device when this has been done the carriage 10 is provided with beveled wheels 59 which engage the inner periphery of the bore cut by the cutters.

The front plate 24 of the tube is provided with a plurality of depressions 60 in each of which is mounted a frame 61 each of these frames being provided with a plurality of revoluble cutters 62 each having knife edges 63 adapted to cut the rock in advance of the front face of the plate 24. The axes of these cutters 62 revolve in bearings in the frame 61 embedded in the depressions 60, the frames 61 being sunk in said depressions sufficiently far to cause the axes of the cutters to be to the rear of the front face of said front plate. These frames are so located relative to each other that the cutters of each series overlap one another so that as the plate 24 revolves against the face of the rock in advance thereof all the surface of said rock comes in contact with said cutters. The frames 61 on the outer and inner edge of the annular plate 24 are inserted at an angle to the face of the plate as clearly shown in Figs. 3 and 5 and these frames are made adjustable by means of the threaded members 64 which are adapted to keep the outer edge of the cutters 62 always at the same distance from the center of the bore and thereby maintain it constantly at the same diameter. The cutters 62 are provided with trunnions 65 which rest in pockets in the frames 61 and are prevented from being removed therefrom by means of the caps 66. The frames 61 are secured to the plate 24 by means of bolts 67. Each frame 61 is provided with a plurality of cutters 62 which are freely revoluble therein, the cutters in each frame being each of a different form so that as the plate 24 revolves, the cutters in each frame will have a different action upon the surface of the rock being cut.

The form of cutters used consists, first, of a cutter the cutting edges of which extend circumferentially of the cutter member; second, of a cutter the cutting edges of which extend spirally of the cutter member in one direction; third, a similar cutter the cutting edges of which extend spirally in the opposite direction, and fourth, of a cutter member the cutting edges of which extend diagonally along the periphery of the cutter member from end to end. These latter cutters are designated as reamer cutters for the reason that they act upon the material in the same manner that an ordinary reamer does.

In each inner series of cutters one of each of these forms of cutters is used so that as the plate 24 revolves the surface of the rock opposite the cutters will alternately come under the action of these different forms of cutters to insure the rock being properly cut into and then broken away by means of the action of the cutting edges following which act upon the projecting portions of the rock

transversely of the previous cuts made. By this construction the rock is very quickly removed permitting the machine to steadily advance for the purpose of continuing the cutting. The plate 24 is cut away as at 68 in the rear of each of the cutters 62 so that the dust and chips may pass through into the bottom of the bore already cut. A pipe 69 with a spray nozzle 70 is adapted to send a spray of water over the face of the rock being cut by the cutter 62. This water and the chips and dirt collected in the bottom of the bore already cut passes through a pipe 71 in the bottom of the bore and is pumped out through the rear end of the bore.

The device is so constructed as to cut an annular groove in the rock leaving the inner core 72 which passes through the cylindrical member 21, the rear end of said core being supported by means of the trucks 73 mounted in brackets 74 secured to the upper face of the upper carriage 18. This core is broken off as desired and removed from the bore in any desired manner. To keep the bores always at the right diameter the diamond cutters 75 are provided which are mounted in a member 76 adjustably secured to the outer periphery of the plate 24. As the plate 24 revolves these diamond cutters clean out the corners and insure that the bore is always of the proper diameter to admit of the further advance of the machine.

The plate 24 is provided with a manhole 77 through which the frames 61 may be removed when the cutters are out of order. In order to remove these frames 61 the carriage is moved slightly to the rear and a man enters the bore in front of the plate 24 and removes any damaged section and calls for a section to replace it which when inserted leaves the machine in condition for immediate operation.

The male clutch members 37 and 45 are made integral and are splined to the shaft 34 to revolve therewith but at the same time have a movement longitudinally thereof. The shaft 34 has two rings or collars 78—79 adjustably secured to it one on either side of said clutch members 37—45. A movement of the clutch members 37—45 longitudinally of said shaft 34 until they contact with one of these collars 78 or 79 will cause the meshing or unmeshing of the cone gear 57 with its co-acting cone gear 55 or 56 as the case may be. This longitudinal movement of the clutch members 37—45 is effected by means of the shipping lever 38 which is secured to a collar 80 mounted in an annular depression in said clutch members so that these members 37—45 are free to revolve freely therein.

The shipping lever 38 is shown in Fig. 2 in an intermediate position with the cone gear 57 in contact with the friction gear 55. While in this position the lower carriage 10 is caused to be moved forward without having any action on the various other parts. By shipping the friction gear 56 (see Fig. 2) into contact with the cone gear 57 by means of the lever 81, which is similar to and acts in the same manner as the lever 38, a reverse movement of the lower carriage 10 is obtained. The lever 81 is connected to a suitable collar 81* in which the shaft 53 is adapted to revolve and by which it is adapted to be reciprocated in its bearings 53* to cause the engagement of either the friction gear 55 or 56 with the friction gear 57.

A forward drive of the lower carriage 10 with reversal of the worm feed is obtained by throwing the clutch 45 into contact with the clutch 46 which drives the belt 48 by means of the pulley 47 thereby producing a forward movement of the lower carriage in the manner heretofore described. The plate 24 is at the same time moved in the reverse directions by means of the belts 40 and 31 as has already been clearly set forth.

In order to throw the cone gear 57 out of contact with the friction gear 55 or 56 the clutch member 37 may be moved against the collar 78 to cause a longitudinal movement of the shaft 34 in its bearings, this movement moving the cone gear 57 into a position where neither of the friction gears 55 and 56 is able to engage therewith. In order to again throw the cone gear 57 into position to engage with either of the friction gears 55 and 56 the clutch member 45 is moved by means of its shipper 38 against the collar 79 causing a longitudinal movement of the shaft 34 to the right thereby moving the cone gear 57 into a position where it may readily engage with either of the friction gears 55 or 56 which may be moved into engagement therewith. This movement of the clutch member 45 will engage the female clutch member 46 as well but the withdrawal of the member 45 from contact with the member 46 will cause no movement on the cone gear 57 until the collar 78 is again acted upon.

In the operation of the invention rails 14 are placed in position in the direction in which it is desired to operate and the machine is placed upon these rails and power is applied to the motor 35 to cause the machine to advance against the rock desired to be operated upon. As soon as the front plate 24 contacts with the rock to be cut the wheels of the lower carriage are chocked to prevent back movement and the clutches are operated to rotate the plate and give it an advance feed. As soon as the plate rotates the revoluble cutters of the various forms begin to cut and chip at the rock and cause it to be quickly cut away, the chips and dust accumulating therefrom being washed down by means of the water from the spray nozzle 70. These pass through the various openings in

the rear of the cutters and accumulate in the bottom of the bore from which they are pumped through the pipe 71. The core in the center of the bore which is not acted upon passes through the cylindrical tube 21 and is supported thereby and as its rear end extends through the cylindrical tube it is broken off as desired and removed from the bore. As has been already described when the feed worm 45 reaches the limit of its movement in one direction, by a reversal of the movement thereof and at the same time an advance movement of the lower carriage, the worm is fed into its normal position ready to cause a further advance of the upper carriage. This construction in rock drilling machines makes a very effective apparatus for cutting tunnels for the use of miners and is very effective in its operation, being capable of cutting through the hardest rocks with very little difficulty while the bore cut is always of the same diameter and if desired the machine may be followed with a tubular casing to hold in position any material cut through other than the self-sustaining solid rock.

From the foregoing it is believed the operation of the invention and its advantages will be understood without any further description.

Having thus described our invention, we claim:

1. In a rock drilling machine, the combination of an annular face plate provided with a plurality of depressions in its face; means for rotating said plate; and a plurality of cutters secured in said depressions with their axes radial to the axis of said plate and at different distances from said center thereby effecting in the revolution of said plate a cutting from the central opening to the outer periphery of said plate.

2. In a rock drilling machine, the combination of an annular plate; a plurality of frames distributed at various distances from the center over the face thereof; and a plurality of cutters in each frame each mounted upon an independent axis.

3. In a rock drilling machine, the combination of an annular plate; a plurality of frames secured to the face thereof at different distances from the center; a plurality of cutters in each frame; and means for adjusting said frames relative to the axis of said plate.

4. In a rock drilling machine, the combination of an annular plate; a plurality of frames secured to the face thereof; a plurality of series of cutters on the face thereof; and a plurality of forms of cutters in each series.

5. In a rock drilling machine, the combination of an annular plate; a plurality of frames secured to the face thereof; a plurality of overlapping series of cutters on the face thereof; and a plurality of forms of cutters in each series.

6. In a rock drilling machine, the combination of an annular face plate; a plurality of cutters revoluble on axes to the rear of said front face; and a plurality of diamond cutters secured to the outer periphery thereof.

7. In a rock drilling machine, the combination of an annular plate provided with a front face having a plurality of depressions therein; a plurality of cutters revoluble in said depressions; and a plurality of diamond cutters removably secured to the outer periphery thereof.

8. In a rock drilling machine, the combination of an annular face plate having a continuous outer periphery corresponding to the diameter of the bore to be cut; a plurality of cutters thereon extending from said central opening to the outer periphery, the axes of said cutters being embedded in the face of said plate; and means for revolving said plate to cut an annular groove in the rock.

9. In a rock drilling machine, the combination of an annular plate; a plurality of cutters thereon; means for revolving said plate to cut an annular groove in the rock; and means separated from said plate and in the rear thereof for supporting the core thus formed.

10. In a rock drilling machine, the combination of an annular plate having a continuous outer periphery; a plurality of cutters on the front face thereof; a cylindrical support for said plate revoluble therewith and having a bore of the same diameter as the central opening in said plate adapted to support the core cut from the rock; a gear on said plate; a revoluble pinion to drive said gear; and means for revolving said pinion.

11. In a rock drilling machine, the combination of a movable carriage; a plurality of bearings thereon; a tubular revoluble member mounted therein the bore of which is of the same diameter throughout its length; an annular face plate secured thereto the central opening of which corresponds in diameter to that of said bore and is adapted to support the core cut from the rock; a plurality of cutters on the outer face of said plate; and means for revolving said plate.

12. In a rock drilling machine, the combination of a movable carriage; a plurality of wheels on said carriage adapted to run on rails; a plurality of other wheels adapted to run on the face of the bore; a plurality of bearings on said carriage; a tubular revoluble member mounted therein the bore of which is of the same diameter to that of said bore; an annular face plate secured thereto the central opening of which corresponds in diameter to that of said bore; a plurality of

cutters on the outer face of said plate; and means for revolving said plate.

13. In a rock drilling machine, the combination of a movable carriage; a top carriage thereon movable longitudinally of the lower carriage; a tubular member revoluble in bearings on said top carriage and having a central bore of equal diameter throughout its length; a face plate secured to said tubular member having a central opening therein corresponding in diameter to that of said tubular member; a plurality of cutters on the outer face of said plate; and means for moving said top carriage longitudinally.

14. In a rock drilling machine, the combination of a movable carriage; a top carriage thereon movable longitudinally of the lower carriage; a tubular member revoluble in bearings on said top carriage and having a central bore of equal diameter throughout its length; a face plate secured to said tubular member having a central opening therein corresponding in diameter to that of said tubular member; a plurality of cutters on the outer face of said plate; and means for moving said top carriage longitudinally in either direction.

15. In a rock drilling machine, the combination of a movable carriage; a top carriage thereon movable longitudinally of the lower carriage; a rack on said top carriage; a revoluble worm on said lower carriage meshing therewith; a tubular member revoluble in bearings on said top carriage and having a central bore of equal diameter throughout its length; a face plate secured to said tubular member having a central opening therein corresponding in diameter to that of said tubular member; a plurality of cutters on the outer face of said plate; and means for moving said top carriage longitudinally in either direction.

16. In a rock drilling machine, the combination of a movable carriage; a top carriage thereon movable longitudinally of the lower carriage; rolls interposed between said carriages; a rack on said top carriage; a revoluble worm on said lower carriage meshing therewith; a tubular member revoluble in bearings on said top carriage; an annular plate secured to said tubular member; a plurality of cutters on the outer face of said plate; and means for moving said top carriage longitudinally in either direction.

17. In a rock drilling machine, the combination of a movable carriage; a top carriage thereon movable longitudinally of the lower carriage; rolls interposed between said carriages; guides secured to one of said carriages co-acting with ways in the other; a rack on said top carriage; a revoluble worm on said lower carriage meshing therewith; a tubular member revoluble in bearings on said top carriage; an annular plate secured to said tubular member; a plurality of cutters on the outer face of said plate; and means for moving said top carriage longitudinally in either direction.

18. In a rock drilling machine, the combination of a movable carriage; a top carriage thereon movable longitudinally of the lower carriage; rolls interposed between said carriages; guides secured to one of said carriages co-acting with ways in the other; a motor mounted upon the lower carriage; means for moving the lower carriage longitudinally thereby; a rack on said top carriage; a revoluble worm on said lower carriage meshing therewith; a tubular member revoluble in bearings on said top carriage; an annular plate secured to said tubular member; a plurality of cutters on the outer face of said plate; and means for moving said top carriage longitudinally in either direction.

19. In a rock drilling machine, the combination of a movable carriage; a top carriage thereon movable longitudinally of the lower carriage; rolls interposed between said carriages; guides secured to one of said carriages co-acting with ways in the other; a motor mounted upon the lower carriage; means for moving the lower carriage longitudinally thereby; a rack on said top carriage; a revoluble worm on said lower carriage meshing therewith; a tubular member revoluble in bearings on said top carriage; an annular plate secured to said tubular member; a plurality of cutters on the outer face of said plate; and means for moving said top carriage longitudinally in either direction.

20. In a rock drilling machine, the combination of a movable carriage; a top carriage thereon movable longitudinally of the lower carriage; rolls interposed between said carriages; guides secured to one of said carriages co-acting with ways in the other; a motor mounted upon the lower carriage; means for moving longitudinally either of said carriages thereby; a rack on said top carriage; a revoluble worm on said lower carriage meshing therewith; a tubular member revoluble in bearings on said top carriage; an annular plate secured to said tubular member; a plurality of cutters on the outer face of said plate; and means for moving said top carriage longitudinally in either direction.

21. In a rock drilling machine, the combination of a revoluble plate; a plurality of frames distributed over the front face of said plate at different distances from its center; and a plurality of cutters having cutting edges in each frame, the cutting edges of each cutter in each of said frames extending in a different direction.

22. In a rock drilling machine, the combination of an annular plate; a plurality of frames secured to the face thereof at different distances from the center; and a plurality of revoluble cutters in each frame each revoluble upon a separate axis.

23. In a rock drilling machine, the combination of an annular plate; a plurality of frames secured to the face thereof at different distances from the center; a plurality of revoluble cutters in each frame; and means for adjusting said frames relative to the axis of said plate.

Signed by us at Boston, Mass., this 22d day of October, 1906.

ALVA D. LEE.
FRANK. J. E. NELSON, JR.

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