W. R. COLLINS.

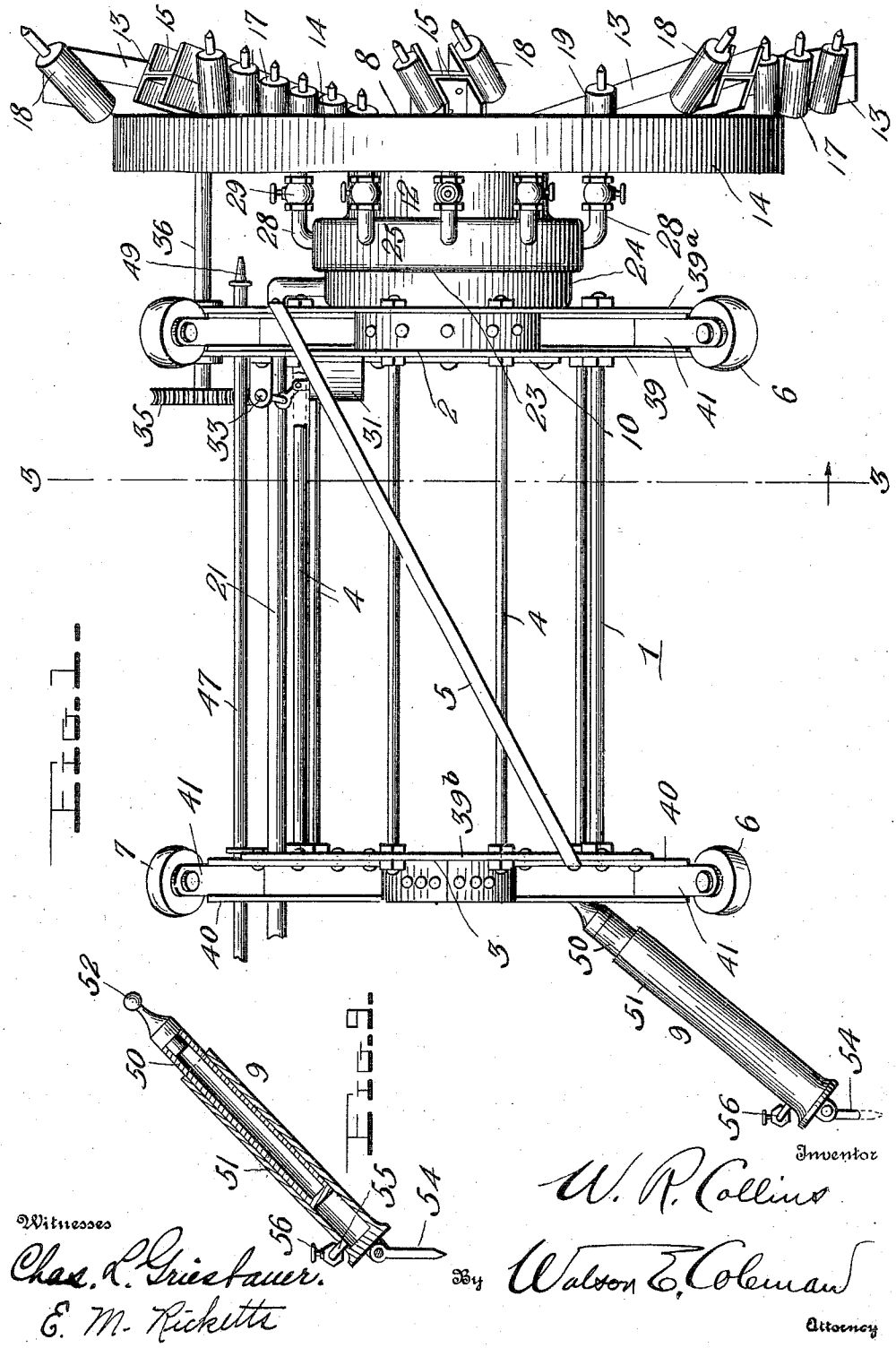
TUNNELING MACHINE.

APPLICATION FILED AUG. 2, 1909.

973,107.

Patented Oct. 18, 1910.

5 SHEETS—SHEET 1.



Witnesses

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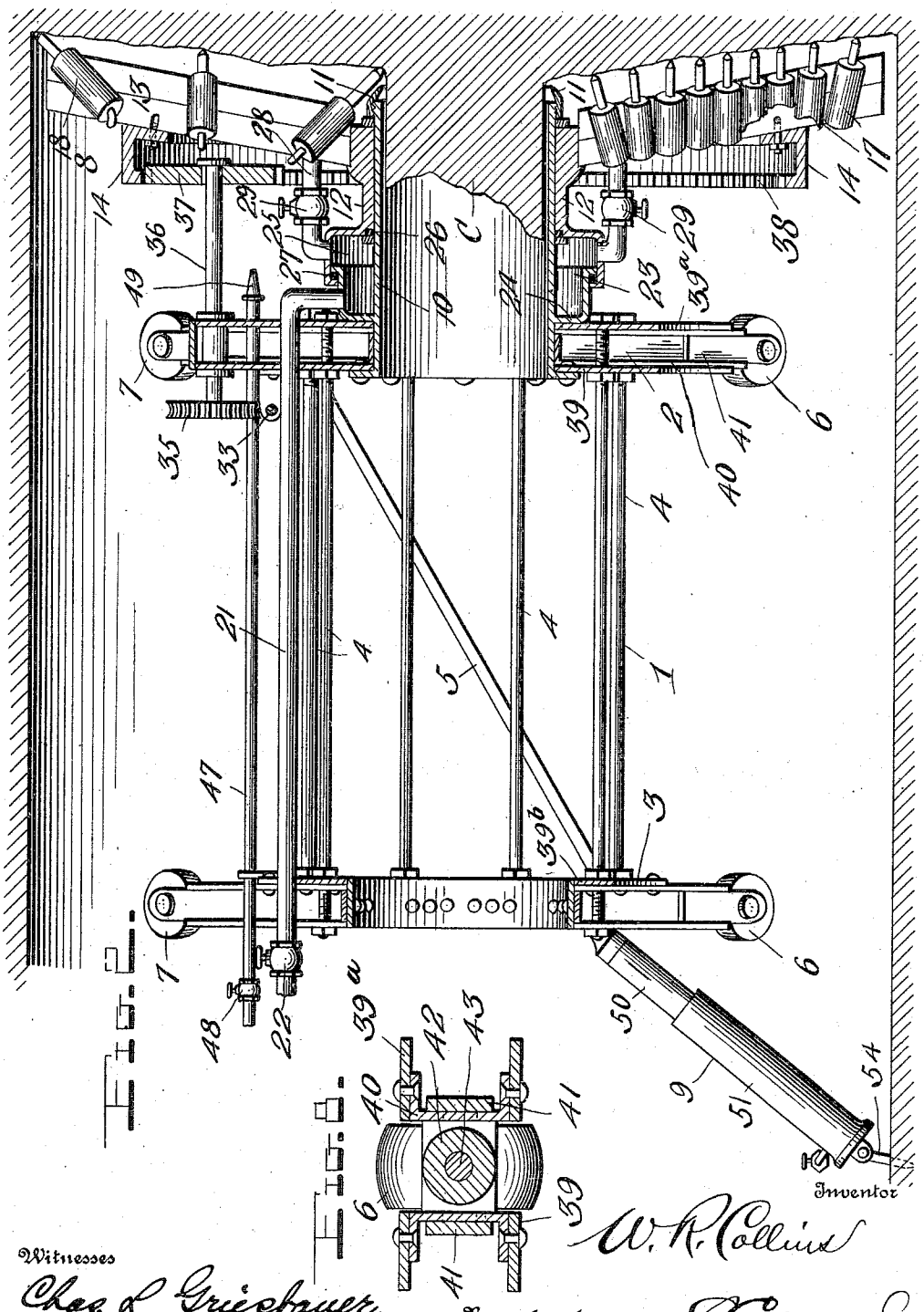

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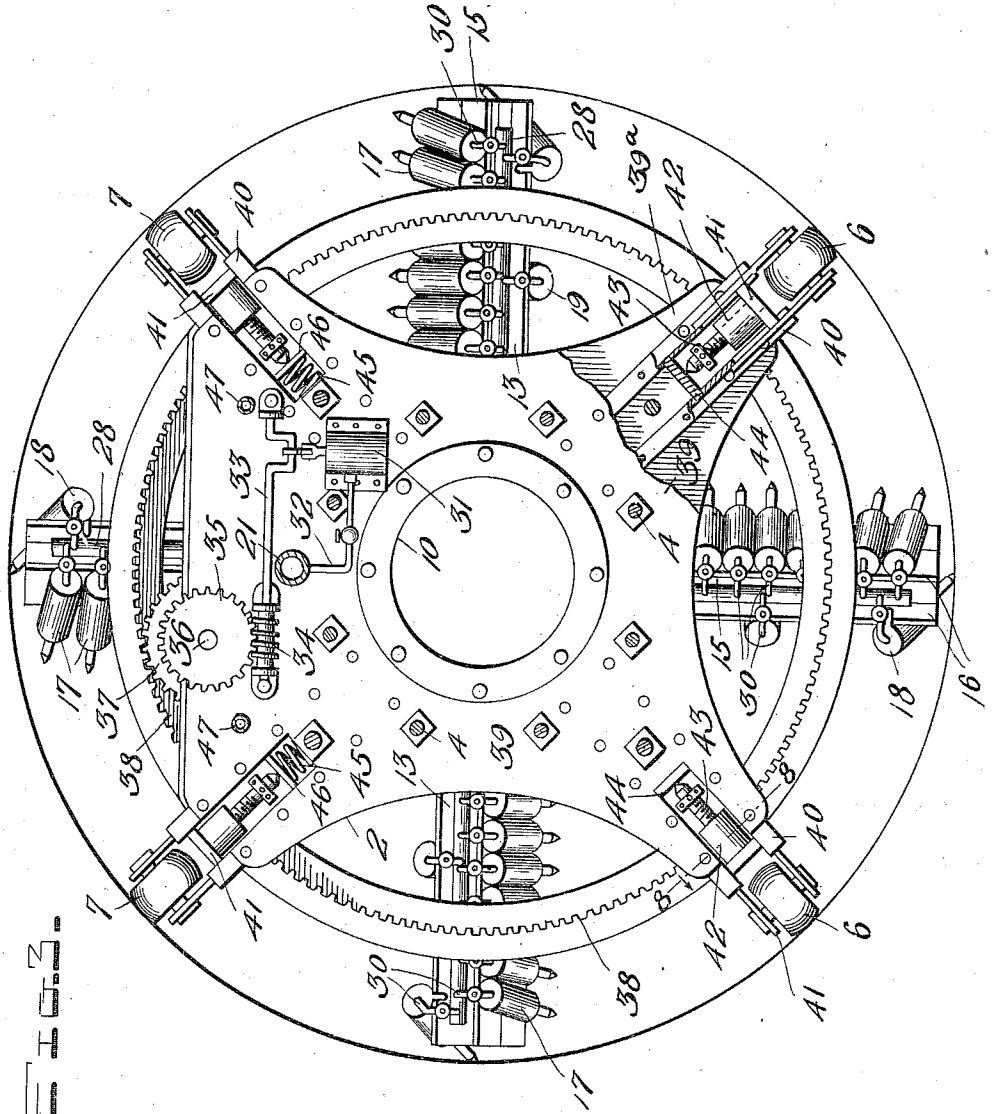

Fig. 2.

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5 SHEETS—SHEET 4.

Fig. 4.

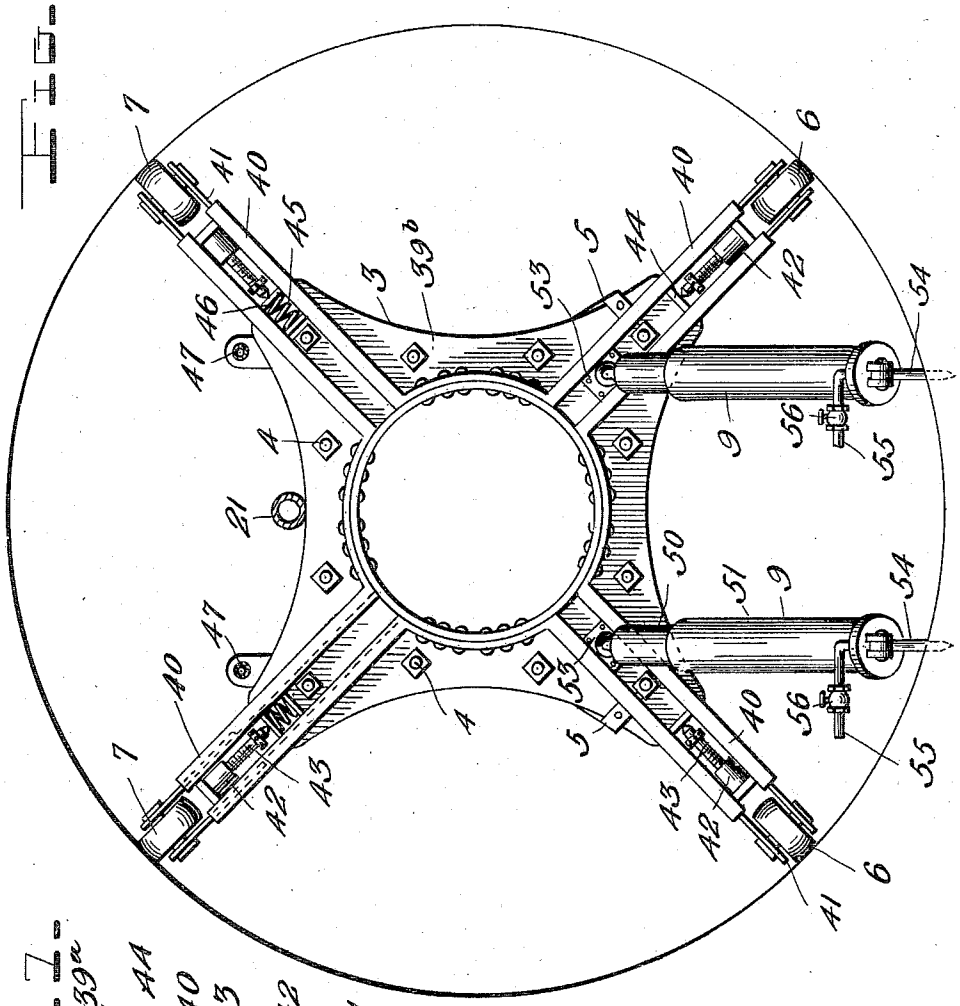
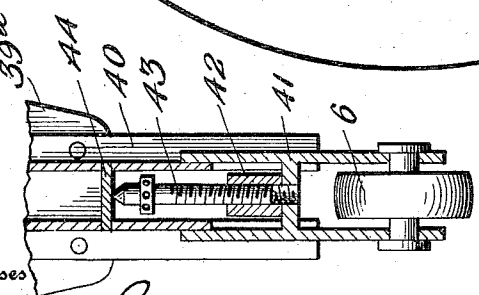


Fig. 7.



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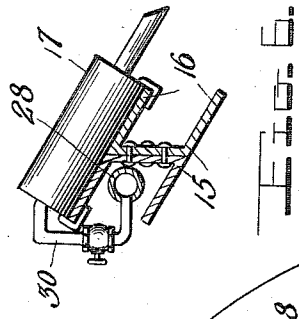

Fig. 6.

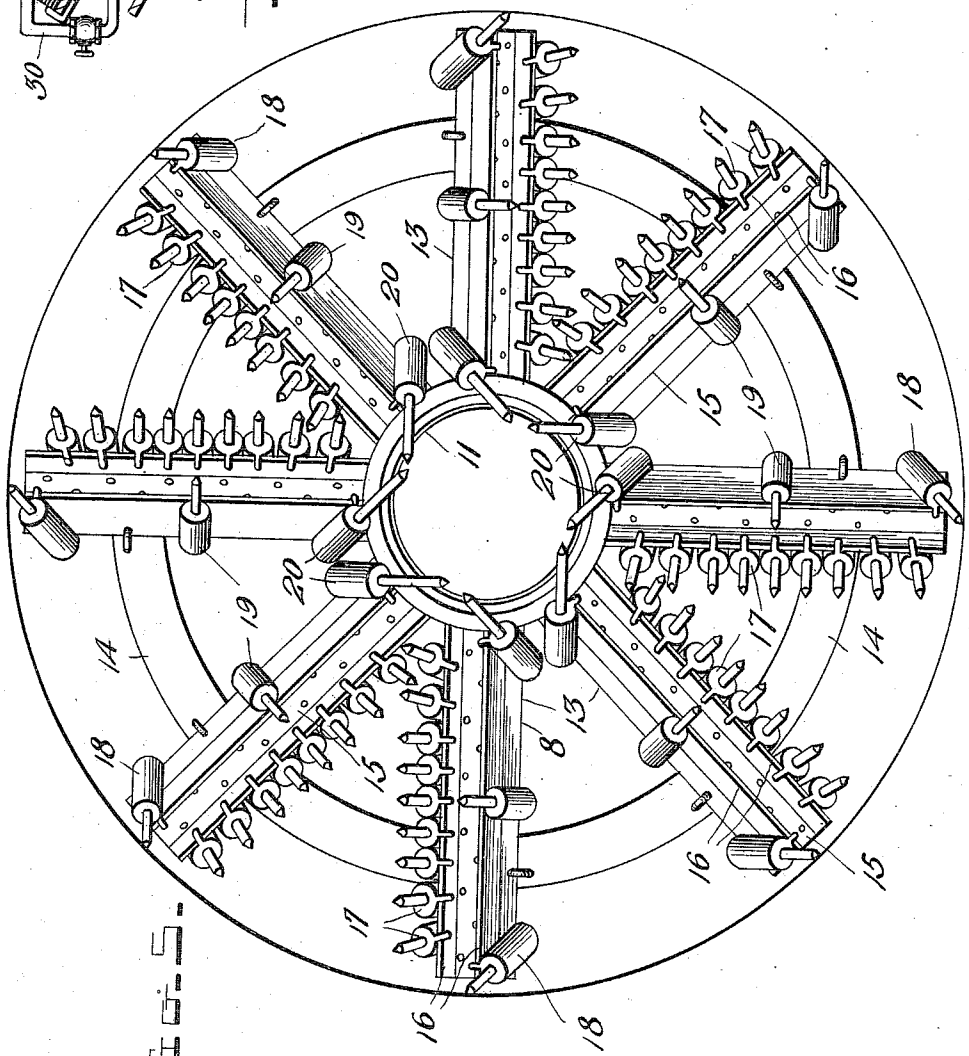

Fig. 5.

Witnesses

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UNITED STATES PATENT OFFICE.

WILLIAM RUSSELL COLLINS, OF GEORGETOWN, COLORADO.

TUNNELING-MACHINE.

973,107. Specification of Letters Patent. Patented Oct. 18, 1910.

Application filed August 2, 1909. Serial No. 510,801.

To all whom it may concern:

Be it known that I, WILLIAM R. COLLINS, a citizen of the United States, residing at Georgetown, in the county of Clear Creek and State of Colorado, have invented certain new and useful Improvements in Tunneling-Machines, of which the following is a specification, reference being had to the accompanying drawings.

This invention relates to improvements in machines for tunneling through rock without the necessity of blasting.

The primary object of the invention is to provide a simple and practical machine of this character which will be light in weight and comparatively inexpensive to construct and effective in operation for performing various kinds of excavating or tunneling operations.

Another object of the invention is to provide a machine of this character having a cutting head which will leave an uncut rock core, thereby saving a certain amount of expensive drill cutting.

A further object of the invention is to provide an improved arrangement of chipping or cutting drills, whereby the recoil of the drills will be counteracted and the cutting head will be balanced.

With the above and other objects in view, the invention consists of the novel features of construction and the combination and arrangement of parts hereinafter fully described and claimed, and illustrated in the accompanying drawings, in which—

Figure 1 is a side elevation of my improved tunneling machine; Fig. 2 is a vertical longitudinal section; Fig. 3 is a vertical cross section looking toward the front end of the machine and taken on the plane indicated by the broken line 3—3 in Fig. 1, the braces 5 being omitted and one of the ends of the plate 39 being broken away and the parts in rear thereof being shown partly in section; Fig. 4 is an elevation of the rear end of the frame or carriage; Fig. 5 is a front elevation of the cutting head; Fig. 6 is a detail section through one of the radiating arms of the cutting head; Fig. 7 is a detail section showing the means for supporting and adjusting one of the supporting wheels; Fig. 8 is a detail section taken on the plane indicated by the line 8—8 in Fig. 3; and Fig. 9 is a sectional view through the pneumatic jack.

Referring more particularly to the drawings 1 denotes the framework or carriage which preferably consists of front and rear members 2, 3 united by longitudinal connecting rods 4 and diagonal braces 5, although it will be understood that the carriage may be otherwise constructed. Each of the members 2, 3 is provided with a lower pair of supporting wheels 6 and an upper pair of guiding and steadying wheels 7, which wheels 6, 7 are adapted to run upon the wall of the circular tunnel as the latter is formed by a rotary cutting head 8 mounted on the front end member 2. The carriage is fed forwardly by pneumatic jacks 9 attached to the rear end member 3 and the head 8 carries radially disposed gangs of peculiarly arranged pneumatic rock chipping drills, whereby an annular path will be cut to form a circular tunnel and to leave an uncut centrally arranged rock core, which latter may be readily broken as the machine advances.

The rotary cutting head 8 is supported by a large tubular shaft 10 arranged and secured centrally in the member 2 and projecting forwardly therefrom so as to receive the rock core, which latter is indicated at C in Fig. 2. The front edge of the tubular shaft 10 may be provided with a sharpened scraper edge 11 preferably formed on a detachable or removable annular rim so that it may be removed and replaced when dulled or worn out. Rotatable on the tubular shaft 10 is the hub 12 of the rotary cutting head 8, which latter also consists of radiating arms 13 and a connecting rim 14. The arms 13 are preferably given a forward inclination with respect to the hub 12 from which they radiate, as shown more clearly in Figs. 2 and 5, and they are united by the rim 14, which latter may be made in sections, if desired, and is bolted to the arms 13 at a suitable distance from their outer ends. Each of the arms 13 is preferably formed from two substantially U-shaped channeled beams 15 united, as shown more clearly in Fig. 6, so that their flanged portions 16 project at an angle of approximately 45° with respect to the longitudinal axis of the tunnel. Pneumatically operated drills of any suitable form and construtcion are secured to the outer faces of the flanges 16 so that the axes of the drills will be disposed at the same angle as the flanges 16 and will consequently

cause the drills to more effectively operate on the rock at the breast or inner end of the tunnel.

On each of the radiating arms 13 of the cutting head is secured a row of drills, indicated by the numeral 17, and for the purpose of balancing the cutting head, each alternate arm 13 has its flanges 16 inclined in an opposite direction to that of the inclination of said flanges of the remaining arms, whereby the adjacent rows of drills 17 will oppose each other. By thus arranging the rows of drills 17, it will be seen that the recoil of one row will counteract that of the other and thereby balance the head 8. It will be understood that any number of the drills 17 may be arranged in each row and that more than one row may be provided on each of the arms 13. In addition to the row of drills 17 on each arm, I preferably provide on the opposite side face of each arm three (or more) similar drills 18, 19, 20. The drills 18 are disposed adjacent to the outer ends of said arms and are inclined outwardly, as shown in Fig. 5, so that they will cut the wall or bore of the tunnel. The drills 20 are arranged in inwardly inclined positions at the inner ends of the arms 13 so that said drills will cut just in advance of the edge of the annular scraper ring 11 of the tubular shaft 10 and consequently cut the core C. The drills 19 are arranged centrally on the arms 13 and have the same angle or inclination as the drills 17.

The several drills are supplied with compressed air from a main supply pipe 21 arranged longitudinally in the carriage and having a controlling valve indicated at 22 in Fig. 2. The forward end of the pipe 21 communicates with an annular compressed air chamber 23 formed by a box or casing having a stationary section 24 secured to the front end member 2 and the tubular shaft 10 and a rotary section 25 secured to the hub 12 of the rotary cutting head 8 and rotatable therewith. Suitable packing may be provided at the points 26, 27 to prevent leakage of compressed air. Feed pipes 28 containing controlling valves 29 radiate from the rotary section 25 of the compressed air box and extend longitudinally through the channeled beams or bars 15 of the arms 13 and from the feed pipes 28 lead valve controlled branch pipes 30 for supplying compressed air to the drills 17, 18, 19, 20, as will be understood on reference to Figs. 2 and 6 of the drawings. Owing to this construction and arrangement, it will be seen that any one or more of the drills on each arm may be thrown out of operation.

The cutting head 8 is rotated by means of an engine 31, preferably a compressed air engine, arranged on the rear face of the front end member 2 and connected by a valve controlled pipe 32 to the main air supply pipe 21. The crank shaft 33 of the engine has fixed to it a worm 34 meshing with a worm gear 35, as shown more clearly in Fig. 3. The worm gear 35 is fixed to the rear end of a longitudinal shaft 36 journaled in bearings in the member 2 and having fixed to its forward end a cog gear 37 which meshes with a gear ring 38 formed or provided on the rim 14 of the cutting head 8.

While the front end member 2 of the carriage may be constructed of structural metal in any suitable manner, I preferably employ in its construction faced plates 39, 39[a] which are riveted or bolted to the side flanges of pairs of radially extending U-shaped channeled bars 40, as shown more clearly in Figs. 2, 3 and 8. Four pairs of the radiating bars 40 are provided and each pair carries one of the wheels 6 or 7. The lower wheels 6 are journaled between the parallel ends of I-shaped members 41, the inner ends of which slide in the channels of the bars 40 and the cross portions of each move in slots in the bars 40 and carry nuts 42 for the reception of jack screws 43. The screws 43 have their inner ends bearing against stationary stop bars 44 so that when they are rotated in one direction the members 41 will be moved outwardly in a radial direction for the purpose of adjusting the wheels 6. The mounting for the upper wheels 7 is the same in all respects to that of the lower wheels 6 with one exception, namely, that coil springs 45 are arranged beneath slide plates 46 against which latter the screws bear, as shown in Fig. 3. The connecting or tie rods 4 have their front ends secured in the plate 39 and their rear ends are secured in a corresponding plate 39[b] of the rear end member 3, which latter is substantially the same in construction as that of the member 2 and it is, therefore, thought that a detail description of the member 3 is unnecessary.

47 denotes water supply pipes containing controlling valves 48 and having at their front ends nozzles 49 for spraying the inner end or breast of the tunnel for the purpose of keeping down dust and cooling the machine. It will be understood that these spraying devices may be of another form, construction and arrangement than that illustrated in Fig. 2. Any suitable means may be provided for carrying away the water and the drill chippings from beneath the machine.

The construction of the pneumatic jack 9 is shown in Fig. 9. This jack has an inner cylinder 50 on which slides an outer telescoping cylinder 51. The cylinder 50 has at its upper end a ball 52 to enter a socket plate 53 on the rear end member 3 and the lower end of the cylinder 51 has pivoted to it an anchoring pin or spur 54 adapted to be inserted in a hole drilled in the floor or

bottom of the tunnel. Compressed air is supplied to the cylinder 51 through a supply pipe 55 containing a controlling valve 56. Two of the jacks 9 are preferably provided, although, it will be understood that a greater or less number may be employed and that they may be otherwise arranged.

In operation, when the machine is set up, as shown in Fig. 2, the pressure in the pneumatic jacks 9 will feed the machine forwardly as fast as the drills cut the tunnel. The engine 31 when in operation drives the worm gearing 34, 35 so that the motion of the shaft 36 will be imparted to the cutting head 8 to slowly rotate the latter. As said head rotates the reciprocating chipping drills 17, 18, 19, 20 will make an annular cut through the rock and leave the core C within the tubular shaft 10. This core will break off of its own weight or it can be readily broken and its formation saves a certain amount of rock cutting.

It will be understood that the machine may be made in any size for cutting a tunnel of any diameter. When extremely large tunnels, for railroad use, are to be cut, a machine such as the one illustrated which will cut a tunnel of about 8 feet in diameter may be followed by a similar machine having a larger cutting head. The invention may be also effectively used for making upraises and inclines in mines, subways, sewers, etc., the machine in such case being provided with a cutting head of four or five feet in diameter.

While I have shown and described in detail the preferred embodiment of my invention, I wish it understood that I do not limit myself to the same, since various changes in the form, proportion and arrangement of parts and in the details of construction may be resorted to within the spirit and scope of the invention.

Having thus described the invention what is claimed is:

1. In a tunneling machine, the combination of a carriage having front and rear members rigidly connected in spaced relation, a tubular shaft fixed concentrically in the front member and projecting forwardly therefrom, a rotary cutting head mounted on the forward portion of said shaft, power actuated reciprocatory drills mounted on said head and adpated to cut an annular path whereby a core is formed to project through said tubular shaft, a scraper ring mounted on the forward extremity of said tubular shaft and having an annular cutting edge projecting inwardly and forwardly in advance of the front extremity of said shaft, means for rotating said head, and means for advancing the carriage.

2. In a tunneling machine, the combination of a carriage having front and rear members rigidly connected in spaced relation, a tubular shaft fixed concentrically in the front member and projecting forwardly therefrom, a rotary cutting head mounted on said shaft and consisting of an annular hub formed at its rear end with an enlarged annular compressed air box, arms radiating from said hub and each composed of a pair of united channel metal beams, a channeled annular rim united to said arms adjacent their outer ends and having its inner flange formed with a gear ring, a longitudinal shaft mounted in bearings on said front member of the carriage and carrying a pinion to mesh with said gear ring, a motor mounted on the carriage for actuating said longitudinal shaft, pneumatically actuated reciprocatory drills secured on the radial arms of the cutting head, a co-acting annular compressed air box fixed to the rear portion of said tubular shaft and having an air-tight connection with the annular box on said hub, valve controlled connections between said drills and said box on the hub, a valve controlled supply pipe connected to said box on the tubular shaft, and means for advancing the carriage.

3. In a tunneling machine, the combination of a carriage composed of front and rear members united by an annular series of longitudinal connecting rods, said rear member consisting of a central ring, radial arms each composed of spaced channel metal beams having their inner ends bent and united to said ring, and a plate uniting and bracing said arms, said front member of the carriage consisting of a forwardly projecting tubular shaft, arms radiating from said shaft and each composed of channeled metal beams having their inner ends united to said shaft, and plates uniting and bracing the last mentioned arms, said longitudinal connecting rods between the two members of the carriage having their ends secured in the plates of the two members whereby they will be held in spaced relation, radially movable slides mounted in the pairs of channeled beams forming the arms of the two carriage members, rollers journaled on the outer ends of said slides, screw jacks for adjusting said slides, springs for projecting the slides in the upper arms of the two carriage members, a rotary cutting head upon the projecting shaft of the front carriage member, power actuated drills on said head, means for rotating said head, and means for advancing the carriage.

4. In a tunneling machine, the combination of a carriage having a member formed with radially projecting arms each composed of opposing channel metal beams arranged in spaced relation and having their channels turned outwardly, the closed inner sides of said channel beams being formed at their outer extremities with longitudinal slots, I-shaped slides having their cross bars

mounted for movement in said slots of the channel beams, their inner ends projecting into and sliding in the channels of said channel beams, stationary nuts on the cross bars of said I-shaped slides, stationary plates uniting the channel beams of each pair, jack screws between said stationary plates and said nuts, and supporting wheels journaled in the spaced outer ends of said I-shaped slide.

5. In a tunneling machine, the combination of a carriage having front and rear members rigidly connected in spaced relation, supporting and guiding wheels carried by said members, a tubular shaft arranged in the front member and projecting forwardly therefrom, a rotary cutting head mounted on said shaft, radially extending rows of reciprocatory, fluid pressure-actuated cutting drills upon said head, the drills of adjacent rows being arranged with their longitudinal axes disposed in converging relation whereby the recoil of the drills will be balanced, said rows of drills being adapted to cut an annular path whereby a core is formed to project through said tubular shaft, a scraper ring mounted on the forward extremity of said tubular shaft and having an annular cutting edge projecting inwardly and forwardly in advance of the front extremity of said shaft, a motor upon the carriage for rotating said head, and means for advancing the carriage.

6. In a tunneling machine, the combination of a carriage, a tubular shaft carried thereby and projecting inwardly therefrom, a rotary cutting head mounted on said shaft, power actuated reciprocatory drills mounted on said head and adapted to cut an annular path whereby a core is formed to project through said tubular shaft, a scraper ring detachably mounted on the forward extremity of said tubular shaft and having an annular cutting edge projecting inwardly and forwardly in advance of the front extremity of said shaft, means for rotating said head, and means for advancing the carriage.

7. In a tunneling machine, the combination of a carriage composed of front and rear members united by an annular series of longitudinal connecting rods, said rear member consisting of a central ring, radial arms each composed of spaced channel metal beams having their inner ends bent and united to said ring, and a plate uniting and bracing said arms, said front member of the carriage consisting of a forwardly projecting tubular shaft, arms radiating from said shaft and each composed of channeled metal beams having their inner ends united to said shaft, and plates uniting and bracing the last mentioned arms, said longitudinal connecting rods between the two members of the carriage having their ends secured in the plates of the two members whereby they will be held in spaced relation, radially movable slides mounted in the pairs of channeled beams forming the arms of the two carriage members, rollers journaled on the outer ends of said slides, means for adjusting said slides, a rotary cutting head on the projecting shaft of the front carriage member, power actuated drills on said head, means for rotating said head, and means for advancing the carriage.

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

WILLIAM RUSSELL COLLINS.

Witnesses:

GEO. DULGLEISH,

D. M. TITUS.