J. RETALLACK.

TUNNELING MACHINE.

APPLICATION FILED OCT. 2, 1907.

906,741.

Patented Dec. 15, 1908.

5 SHEETS—SHEET 1.

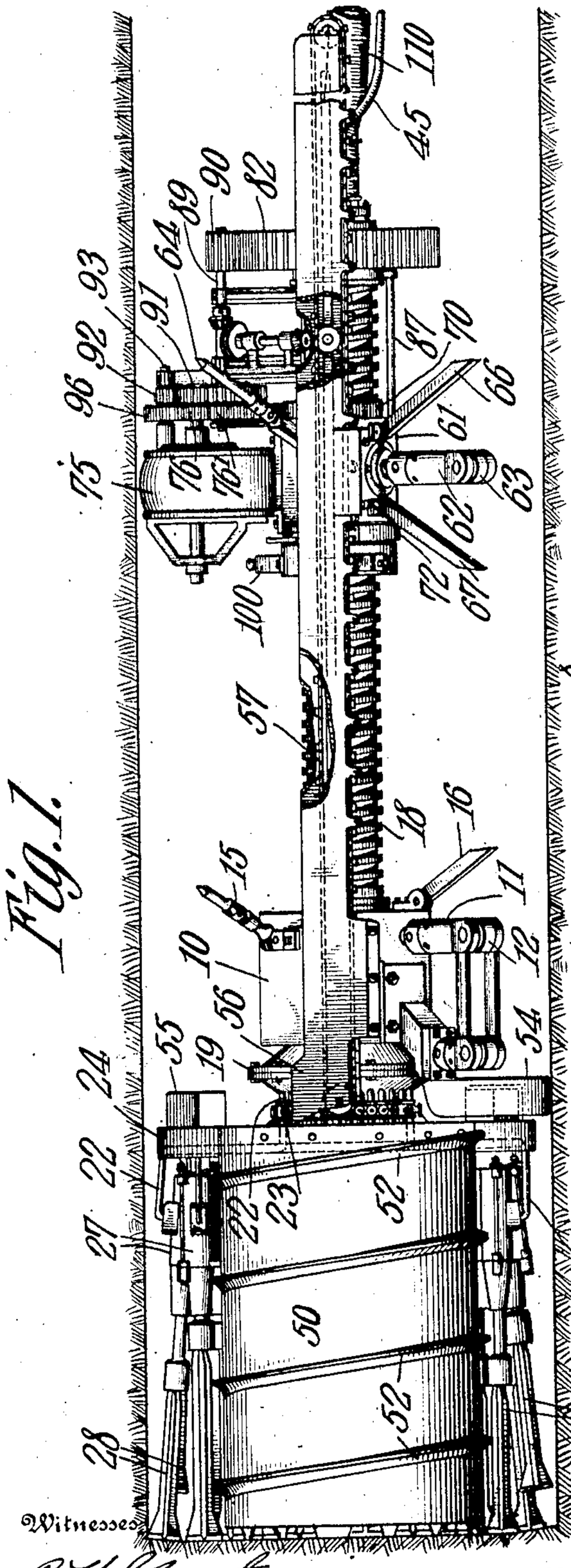

Fig. 1.

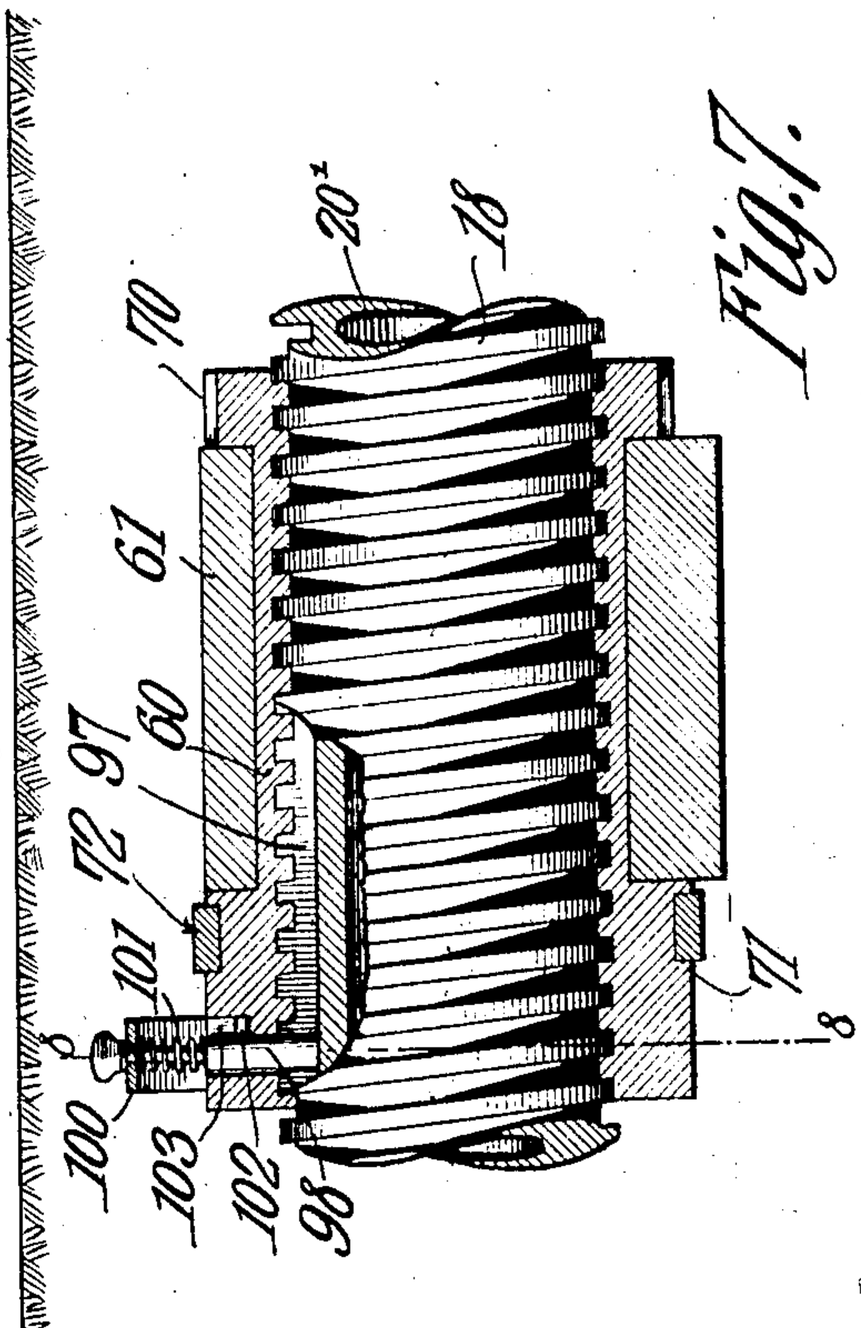

Fig. 7.

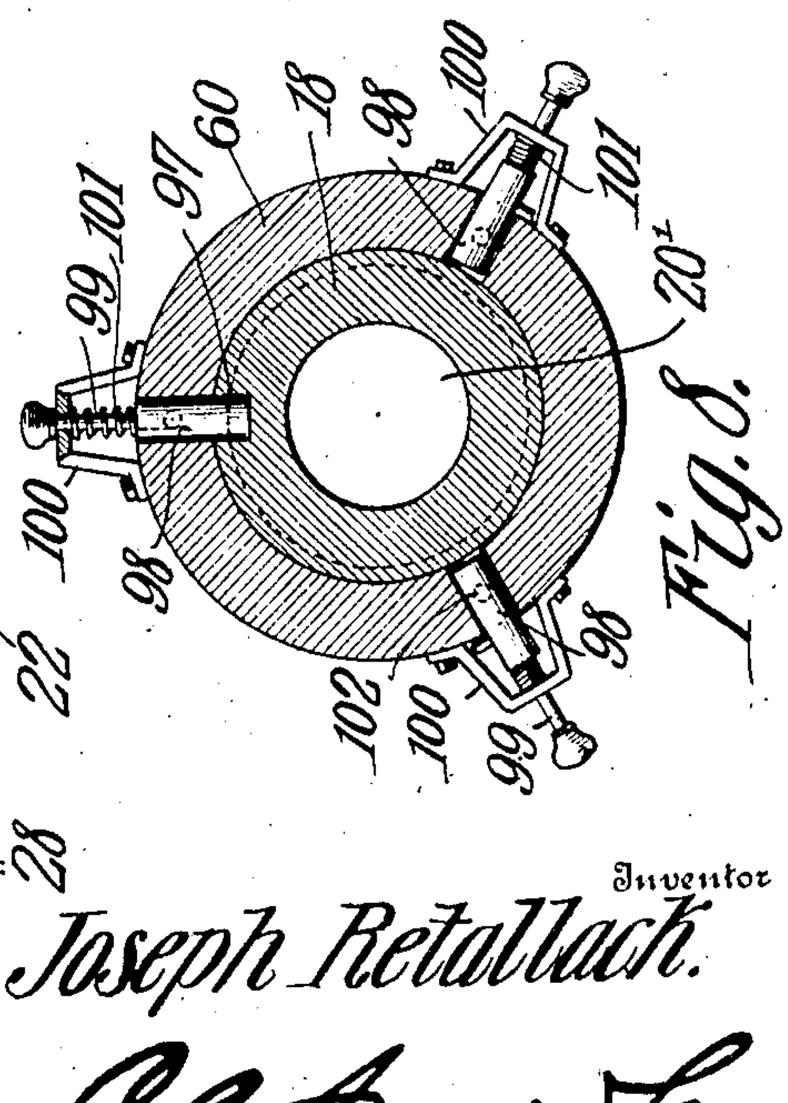

Fig. 8.

Witnesses

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5 SHEETS—SHEET 2.

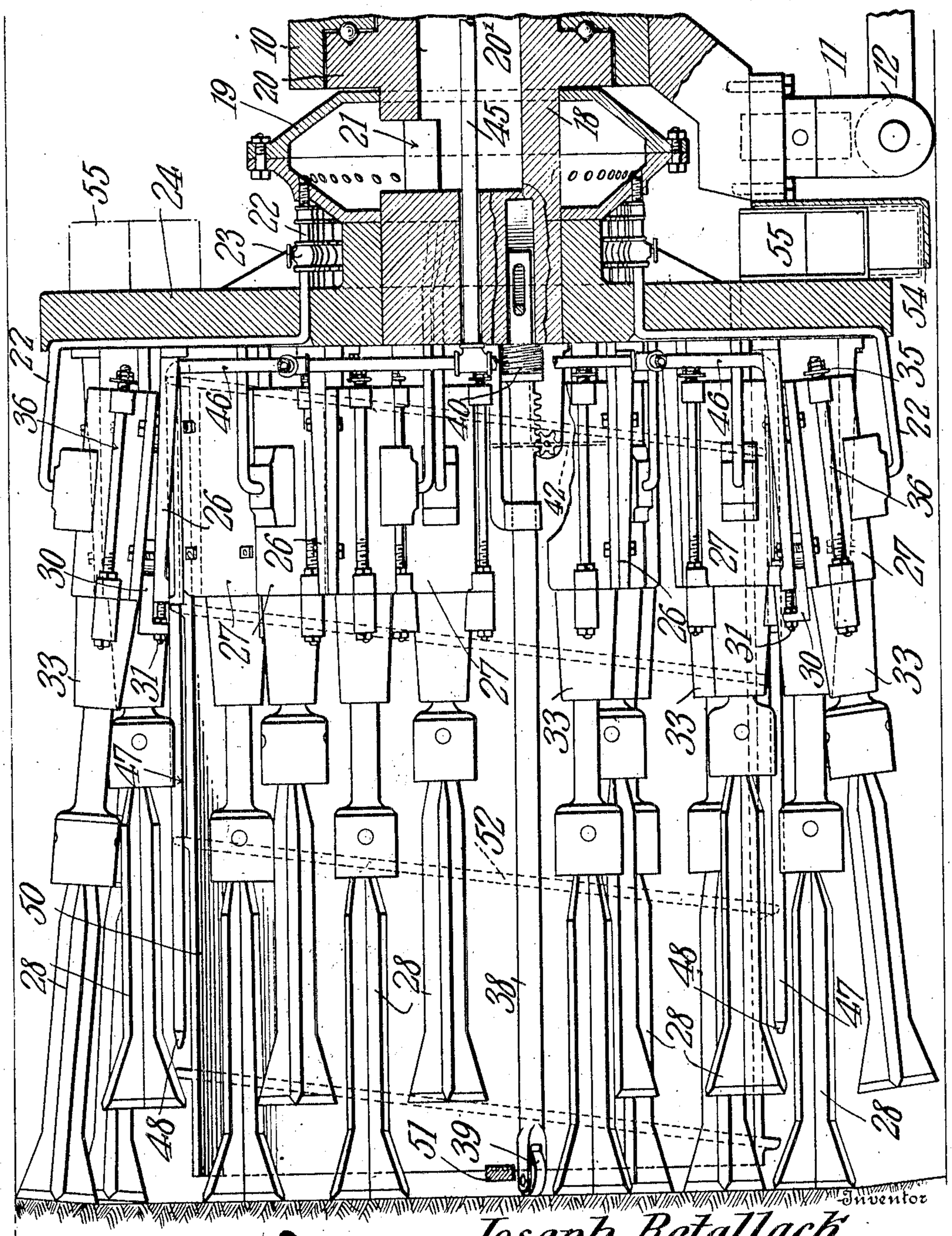

Fig. 2.

Witnesses

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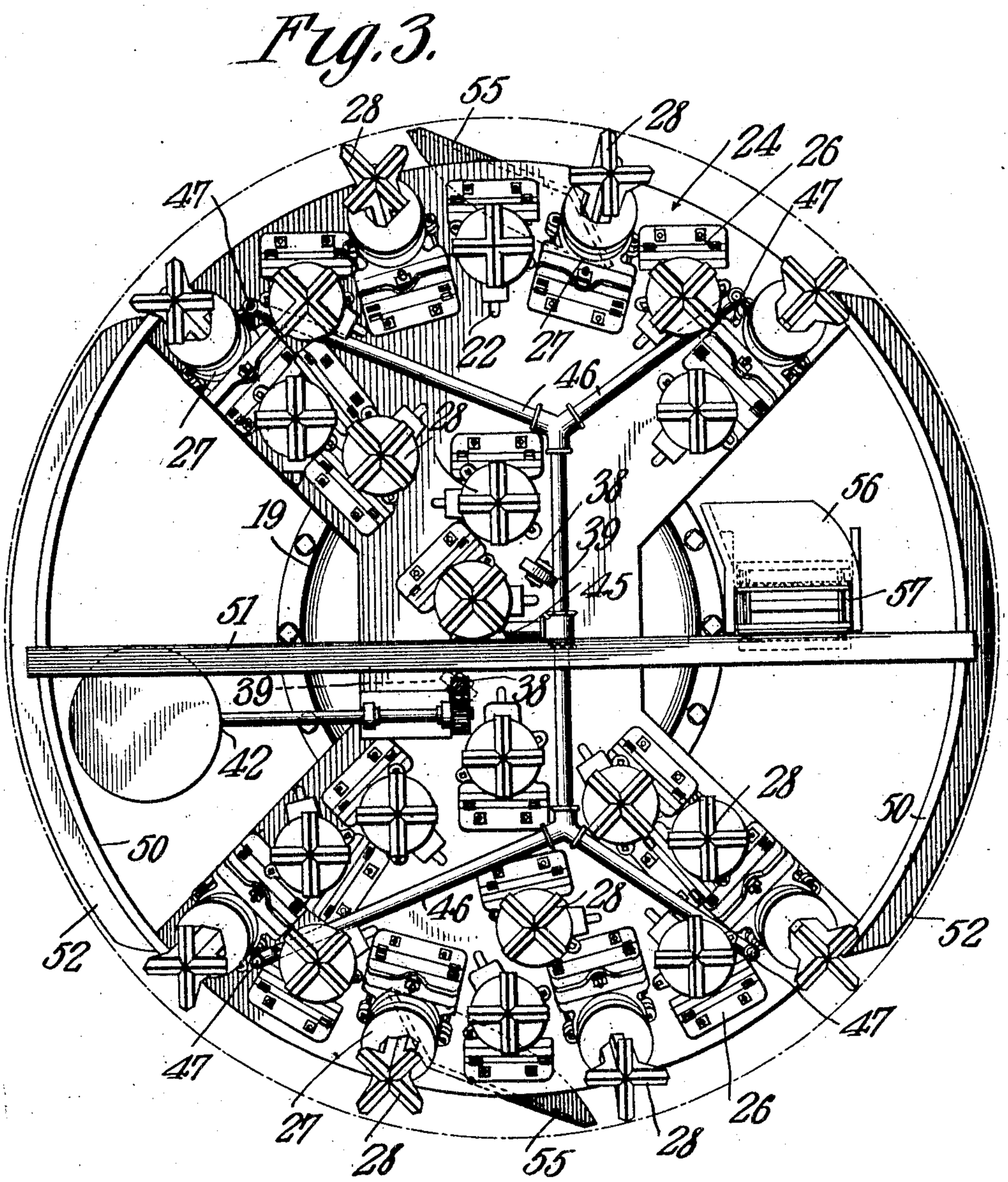
5 SHEETS—SHEET 3.

Fig. 3.



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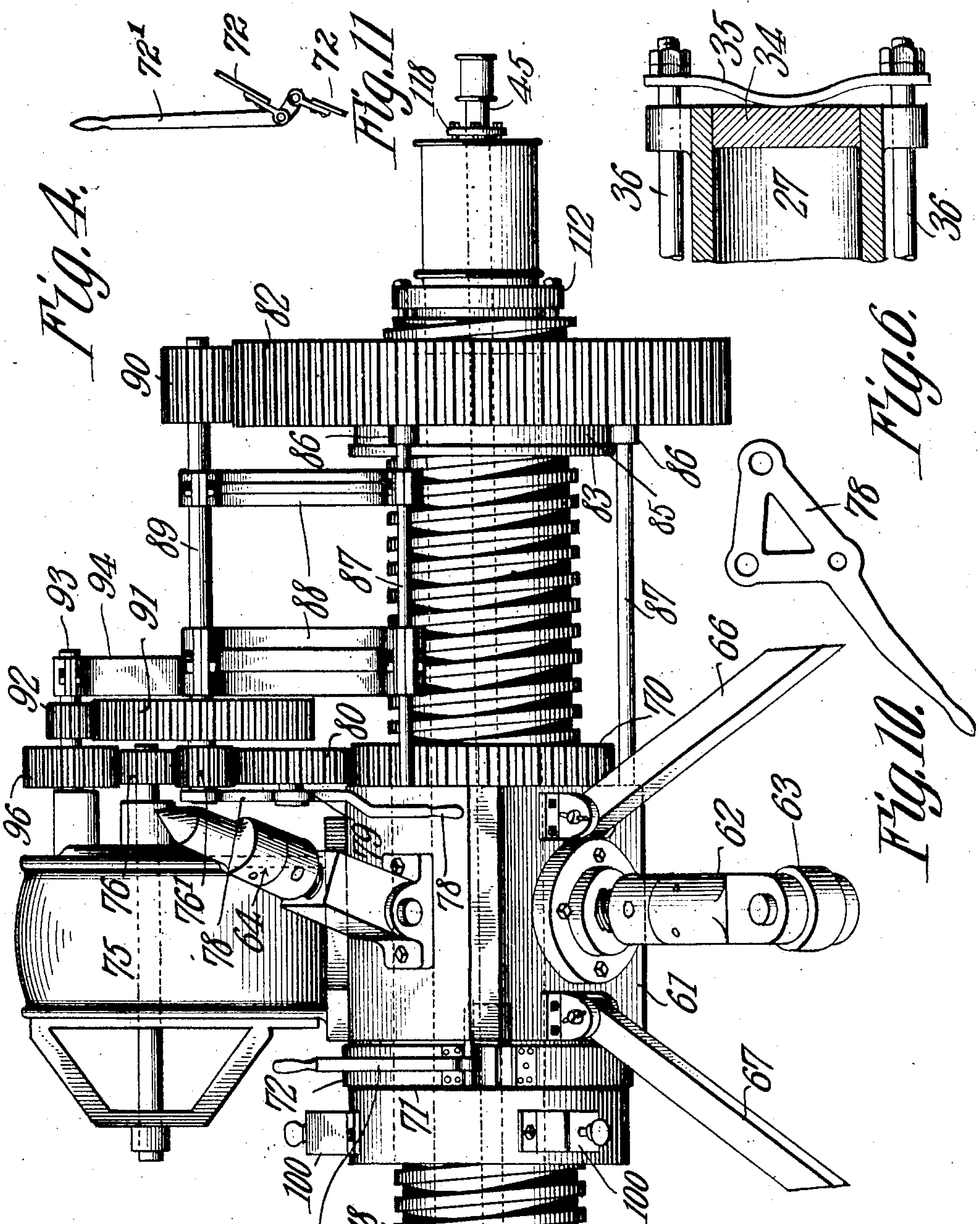
5 SHEETS—SHEET 4.



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Patented Dec. 15, 1908.
5 SHEETS—SHEET 5.

Fig. 5.

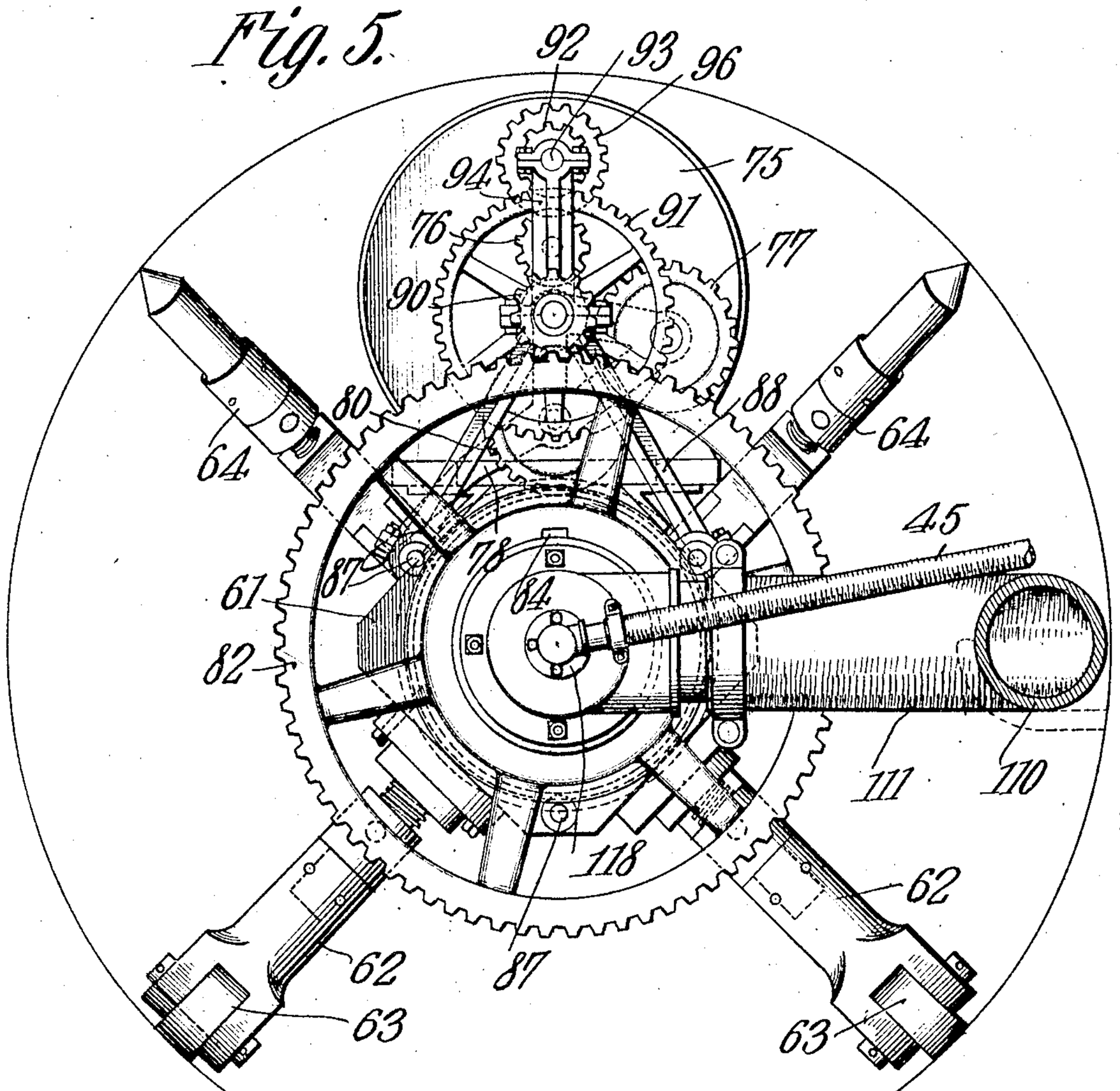
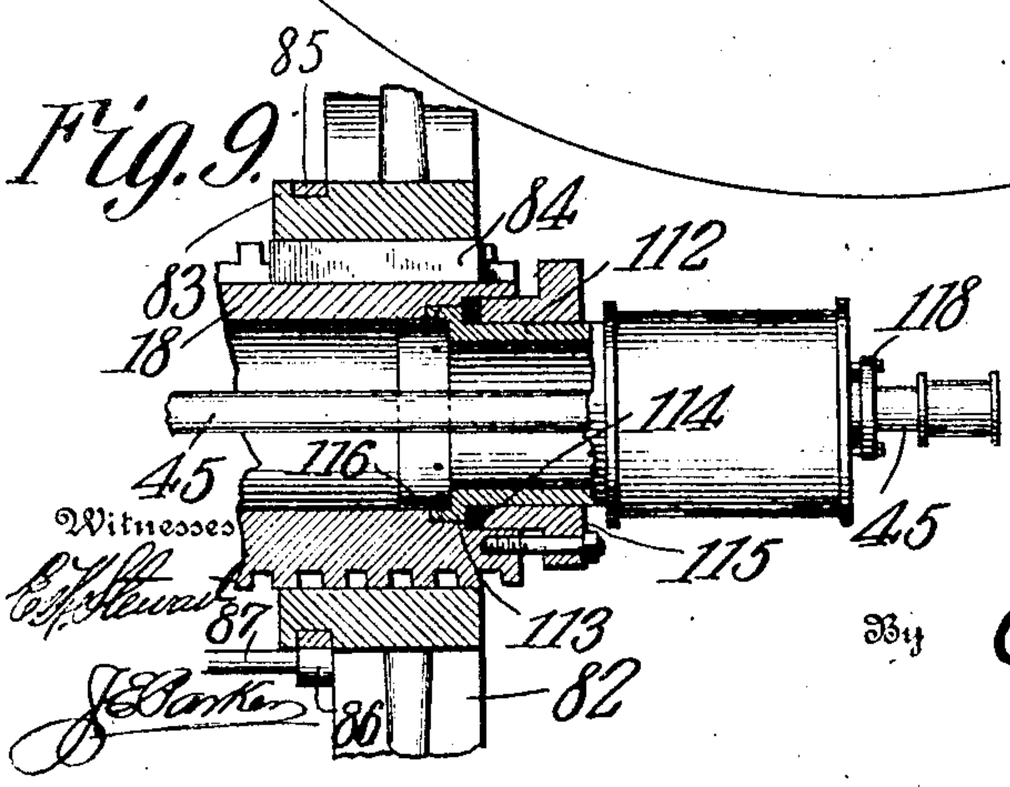


Fig. 9.



Witnesses
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J. E. Barker

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UNITED STATES PATENT OFFICE.

JOSEPH RETALLACK, OF DENVER, COLORADO, ASSIGNOR OF ONE-HALF TO JOHN H. REDFIELD, OF DENVER, COLORADO.

TUNNELING-MACHINE.

No. 906,741. Specification of Letters Patent. Patented Dec. 15, 1908.

Application filed October 2, 1907. Serial No. 395,594.

To all whom it may concern:

Be it known that I, JOSEPH RETALLACK, a citizen of the United States, residing at Denver, in the county of Denver and State of Colorado, have invented a new and useful Tunneling-Machine, of which the following is a specification.

This invention relates to drilling machines of that general class employed in the boring of tunnels and drifts.

The principal object of the invention is to provide a machine of great strength and simple construction, which may be operated at a speed proportioned to the resisting qualities of the rock or other material being penetrated, and which may be readily adjusted while in operation should the character of the boring change.

A further object of the invention is to provide a machine in which a large number of independently operable drills are mounted on a revoluble head which may be rotated and fed forward at any desired speed.

A still further object of the invention is to provide a means for insuring the most effective operation of the cutting drills, provision being made for always maintaining the same distance between the point of impact of the tools and the main drill carrying head, so that all the drills may operate under full stroke.

A still further object of the invention is to provide a means for automatically signaling the position of the head so that the operator may know when to stop and start the feed.

A still further object of the invention is to so construct the drills as to avoid breakage of the cylinder head in case of excess movement in either direction.

A still further object of the invention is to provide a novel means for supplying all of the drills with compressed air or other operating fluid and further to provide for independent control of the several drills.

A still further object of the invention is to provide an improved construction of drill head which will permit of the ready passage of a workman to a point in advance of the head should it become necessary to examine, adjust, or repair any of the mechanism.

A still further object of the invention is to provide an improved means for removing the cuttings and fragments of rock from position in front of the head and for conveying the same to the end of the tunnel or other distant point.

A still further object of the invention is to provide an improved feeding means of such nature as to permit the free revolving of the head without forward movement; to permit forward feed at different speeds, and to permit rearward movement when it is desired to withdraw the head from the work.

With these and other objects in view, the invention comprises the various novel features of construction and combination and arrangement of parts, which will be hereinafter more fully described, and pointed out particularly in the appended claims.

In the accompanying drawings:—Figure 1 is a side elevation of a drilling or tunneling machine constructed in accordance with the invention. Fig. 2 is a longitudinal sectional view through the forward end of the device. Fig. 3 is a face view of the drill head and drills. Fig. 4 is a side elevation of the rear carriage showing the nut and the gearing connections through which movement is imparted to the threaded shaft and nut. Fig. 5 is a transverse sectional view showing the rear carriage and operating mechanism in elevation. Fig. 6 is a detail sectional view, on an enlarged scale, of a portion of one of the drill cylinders. Fig. 7 is a longitudinal sectional view through the threaded shaft and nut, illustrating the means for locking the nut to the shaft. Fig. 8 is a transverse sectional view through the nut and shaft, on the line 8—8 of Fig. 7. Fig. 9 is a longitudinal section, with parts in elevation, of a portion of the rear end of the machine. Figs. 10 and 11 are detail views.

Corresponding parts in the several figures are indicated throughout by similar characters of reference.

The machine is especially designed for driving tunnels or drifts through rock, and it comprises, in general, a revoluble tool head which may be idly rotated or fed forward or backward at pleasure. The head carries a large number of independently actuated rock drills which attack the face of the rock as the head is rotated. The head is carried by a threaded shaft that is hollow from end to end and serves as a duct for the passage of the air or other fluid to actuate the drills. Provision is also made for introducing water at the drilling point and for automatically

gathering up and conveying away the fragments of rock as the tunneling operation proceeds.

The drill head and the forward portion of the mechanism are supported by a massive carriage 10 that is provided with vertically adjustable legs 11 at the bottom of which are arranged rollers 12 so that the carriage may freely move lengthwise of the tunnel. The several legs may be suitably constructed so as to be adjusted independently of each other for the purpose of properly positioning the carriage.

To the upper portion of the carriage are pivoted struts 15 each formed of adjustably connected sections, and the outer ends of the struts are pointed so that they may firmly engage in the roof of the tunnel. These struts may be inclined rearwardly or forwardly, but when the device is at work are preferably inclined rearwardly in order to resist the end thrust of the head and drills. To the rear of the lower portion of the carriage is pivoted an arm 16 having a pointed lower end arranged to engage the floor of the tunnel and assist in resisting the backward thrust of the drilling mechanism. This carriage is bored for the reception of the forward end of a large shaft 18 that is held from independent longitudinal movement in one direction by an air chest 19 and in the opposite direction by a flange or collar 20 that is secured to the shaft and bears at its rear face against the carriage, while the forward face of the flange bears against the air chest. This shaft, as will hereinafter appear, is hollow for practically its entire length, forming a duct 20′ through which air passes to the chest 19 by way of a port 21, and the air is distributed from this chest to the several drills by pipes 22 having controlling valves 22.

Secured rigidly to the forward end of the shaft is a drill supporting head 24 which, as shown in Fig. 3, is practically in the form of a pair of connected quadrants, the spaces between these quadrants forming passages, so that workmen may enter and examine, adjust or repair the drilling mechanism.

Secured to the forward face of the head 24 are a large number of brackets 26 that are scattered at intervals from the center to the periphery of the head, the largest number being adjacent the periphery to compensate for the increased area or surface to be attacked at that point. To each of these brackets is secured a compressed air drill 27 of ordinary construction, the drills being preferably of that type in which the tool carrying chuck receives intermittent rotative movement. Each of these drills has a cutting tool 28 of ordinary construction. The drills are so staggered that during the rotative movement of the head every portion of the area of the end wall of the tunnel will be attacked.

Inasmuch as the area of the tunnel must be greater than that of the head in order to permit the advance of the carriage, the outermost brackets are arranged at a slight angle to the horizontal, so that the outermost drills will be held at a corresponding angle, as shown, for instance, in Fig. 2. The angular position of each drill may be adjusted by a block 30 that is arranged to enter between the bolting flanges of the bracket and the drill cylinder, and which may be adjusted and held by a screw 31. This adjustment is of considerable importance in that it permits control of the diameter of the tunnel and enables the workmen to readily adjust the angle of any drill in case the drill cutter should become unduly worn.

In order to prevent breakage in case of excessive movement of any of the drill pistons, both the front head 33 and the rear head 34 of each drill cylinder is movable. The rear head is held in normal position by a leaf spring 35, the central bowed portion of which rests against the central portion of the rear head, while the opposite ends of the spring are provided with openings for the passage of bolts 36 that pass through openings formed in lugs on the cylinder and the front head thereof. The front end of this bolt is provided with a head that bears against the lug, while the rear end has a nut or nuts that bear against the spring. In case of excessive rearward movement of the piston, the head 34 will yield outward against the bowed portion of the spring, while if the forward movement is in excess, the front head will yield and in yielding will carry with it the rod 36 against the stress exerted by the end portions of the spring.

The head 24 carries one or more rods 38 at the extreme forward ends of which are rollers 39, the axis of each roller being preferably in a line radiating from the axis of rotation of the head. This roller is kept against the face of the rock, and forms a limiting means for preventing excessive forward feed of the head, so that the drills will not be crowded and will be maintained in such position as to exert the most effective stroke at all times. For the convenience of the operator, one of these rods is yieldably mounted on a spring 40, so arranged that when the roller at the end of the rod is thrust against the end wall of the tunnel, the spring must yield to allow slight rearward movement of said rod. The rear end of the rod is operatively connected to a target or semaphore arm 42 carried by the head and which serves to display at the rear of the head, and within view of the operator, a signal to stop forward feed. So long as the semaphore remains in display position, the feed is stopped, but the rotative movement of the head continues. When the signal moves to display position, it is time for the restarting of the forward feed.

In order to facilitate the operation of the drills, a water pipe 45 is led through the air duct 20 of the shaft and extends through a smaller opening formed in the extreme forward end of the shaft. This pipe has a number of outwardly extending branches 46 which are connected to horizontal pipes 47 that terminate in discharge nozzles 48. These nozzles direct streams of water against the face of the rock in order to wash away the dust and smaller fragments, and to facilitate the cutting operation.

Connecting the quadrant-like members of the head 24 are two arcuate plates 50 that are curved to conform to the contour of the periphery of the head. These plates are bolted to the head proper and at their forward ends are connected by one or more strengthening bars 51. On the outer faces of these plates are helical ribs 52 that extend out close to the walls of the tunnel and which engage the detached fragments of rock and feed the same rearward to a point beyond the periphery of the head, so that there will be a clear working space in advance of the head. As the rock is gradually moved to the rear, it will be forced to enter a hopper-like collecting casing 54 that is permanently secured to the forward end of the carriage.

Secured to the rear face of the head 24 are a number of lifting buckets 55 which travel in the casing 54 and during each passage therethrough will engage and carry up a quantity of the cuttings, and these loads will be consecutively dumped into a hopper 56 from whence they will be directed onto an endless conveyer 57 that is suitably supported adjacent the side wall of the tunnel, the conveyer being of such size and traveling at such speed as to remove all of the cuttings and fragments of rock as the drilling operation proceeds.

The periphery of all of that portion of the shaft 18 to the rear of the carriage 10 is provided with a right-handed screw thread and passes through a nut 60 that is supported by a second carriage 61. This carriage 61 has adjustable legs 62 at the lower ends of which are rollers 63 arranged to travel on the floor of the tunnel. At the top of the carriage 61 are pivoted struts 64 which may be inclined either forward or rearward for the purpose of preventing rearward or forward movement of the carriage. Under normal working conditions, the struts are inclined rearward in order to resist the rearward end thrust of the shaft, and are only adjusted to the forward inclined position when it is desired to draw the main carriage and drill head away from the work. The lower portion of the carriage 61 is held from rearward movement by an arm 66 pivoted to the carriage and having a pointed lower end to engage the floor of the tunnel. The carriage has also a pivoted arm 67 which may be allowed to move into engagement with the floor of the tunnel for the purpose of preventing forward movement of the carriage when the drill head and shaft are being withdrawn from working position.

The nut 60 may rotate freely within the central bore of the carriage 61, but is held from independent longitudinal play by a gear wheel 70 at one end and a friction band collar 71 at the opposite end, the gear and collar being rigidly secured to the nut and bearing against the end walls of the carriage when the nut is being rotated.

The nut may be held stationary by means of a friction band 72 that fits within the grooved collar 71, said band having a suitable operating lever 72′ arranged at one of its ends and when the nut is thus held the threaded shaft may be rotated in the manner hereinafter described for the purpose of feeding forward the main drill head and at the same time rotating it.

On the carriage 61 is arranged a motor 75, an electric motor being preferably employed, and to the armature shaft of this motor is secured a continuously driven pinion 76. The pinion 76′ is in constant mesh with a small gear 77 that is journaled in a handle frame 78 pivotally mounted on the carrying shaft of the pinion. The frame 78 also carries a stud 79 on which is mounted a small gear 80 that is in constant mesh with the gear 77. The frame 78 may be rocked with the pinion shaft as a center to any one of three positions. In the first of these positions, the gears 77 and 80 are both out of mesh with the nut gear 70. In the second position, the gear 77 and nut gear 70 are in mesh, thus rotating the nut gear in one direction, while in the third position, the gear 80 meshes with the nut gear 70 and transmits movement thereto in the opposite direction.

Mounted on the rear end of the threaded shaft is a gear wheel 82 having an elongated hub 83 that is provided with a bore of slightly greater diameter than the major diameter of the threaded shaft, so that the gear 82 is free to slide lengthwise of the shaft, or vice versa. The gear and shaft are connected together by a feather 84 that permits the independent longitudinal movement but prevents independent rotative movement of either the gear or shaft. The hub of this gear is provided with an annular groove in which fits a collar 85 having projecting lugs 86 that are connected to the carriage 61 by a series of longitudinal bars 87, so that the gear 82 and the carriage are maintained in precisely the same position with respect to each other under all conditions. The two uppermost bars 87 carry brackets 88 for the reception of a shaft 89 that is provided at one end with a pinion 90 in constant mesh with the gear 82. On the opposite end of the shaft 89 is a gear 91 that meshes with a gear

92 carried by a shaft 93 that finds bearings in the motor frame and in a small or auxiliary bracket 94. This shaft 93 also carries a gear 96 that is in constant mesh with the motor pinion 76. The latter pinion meshes with pinion 76′ through which movement may be imparted to the nut gear 70. In addition to these gearing connections provision is made for locking the nut and shaft together for simultaneous rotative movement. For this purpose, the shaft is provided with a groove 97 parallel with the axis of the shaft, while the nut carries a number of lugs 98, any one of which may be made to enter the groove 97. The lugs 98 are each carried by a handled stem 99 that is slidable in a small bracket 100 secured to the nut, and the corresponding lug is normally forced inward by a small compression spring 101. From each lug projects a small pin 102 which may pass upward through a key-hole slot 103 in the bracket when the respective lug is lifted out of engagement with the shaft groove 97. By turning the handled stem until the pin is out of alinement with the slot, the lug will thus be locked in idle position. When the handle is turned until the pin alines with the slot, the spring 101 will force the lug downward until said lug enters the groove 97 and locks the nut and shaft for mutual rotative movement.

Where the head and shaft are to be rotated without any feeding movement, a lug 98 is allowed to engage with the groove 97 in the shaft and the two gears 77 and 80 are moved to idle position, both out of mesh with the nut gear 70. Movement is then transmitted from the pinion 76 to gear 96, pinion 92, gear 91, pinion 90 and gear 82, thus revolving both the shaft and the nut without allowing any independent longitudinal movement of said shaft and nut. If the feed is to progress at the normal rate, the gears 77 and 80 are allowed to remain in idle position, and the lug 98 is moved out of engagement with the shaft. The friction band 72 is now tightened, for the purpose of holding the nut from rotative movement, and motion is imparted in the same manner as previously described to the gear 82, thus transmitting movement to the shaft and causing said shaft and the drill head to move forward as well as to rotate. During this operation, the carriage 61 is held from longitudinal movement.

Should it be desired to increase the rate of forward movement of the drill head, as when readjusting the machine after a previous withdrawal from working position, the frame 78 is so adjusted as to move the gear 80 into mesh with the nut gear 70, while the movement through the train of gears to gear 82 still continues. As a result, movement is also transmitted from the gear 76 through pinion 76′, small gears 77 and 80 to the nut gear 70, thus rotating the latter in a direction opposite to that in which the threaded shaft is rotated, and, consequently, effecting a material increase in the rate of longitudinal movement of the shaft.

As the drilling operation progresses, it becomes necessary to advance the carriage 61 in the direction of the carriage 10, and when this is to be done, the gear 77 is moved into mesh with the nut gear 70, thus rotating the nut in the same direction as the screw, but at a speed much faster than that at which the screw is moved, owing to the reducing train between the armature shaft and the gear 82. This results in a forward travel on the nut and, consequently, of the carriage 61 in the direction of the carriage 10.

When it is desired to retract the drill head and drills in order that a workman may enter in advance of the drills, the friction band is tightened, the gears 77 and 80 are thrown to idle position, and the motor is reversed.

The air for operating the drills is supplied through a pipe 110 which may be supported at intervals along the wall of the tunnel, and at the end of the pipe is an inwardly directed branch 111 which communicates with a cylindrical box 112. This box has an outwardly directed annular flange 113 which enters a recess formed in the end of the shaft and against this flange bears a packing ring 114 that is held in place by an annular gland 115. In order to minimize leakage of air, the box 112 carries an annular band 116 formed of flexible material and arranged to be held outward over the joint between the meeting ends of the box and shaft by the pressure of air.

The water supply pipe 45 passes centrally through the air duct and extends through a suitable stuffing block 118 at the end of the box or casing 112 and is coupled at a point outside the box to a water supply pipe.

I claim:—

1. In a tunneling machine, a revoluble and forwardly movable drill supporting head, and means for signaling when a predetermined distance between the head and the end wall of the tunnel has been reached.

2. In a tunneling machine, a revoluble and forwardly movable drill supporting head, means for limiting the advance of the head, and means for signaling when a predetermined distance between the head and the end wall of the tunnel has been reached.

3. In a tunneling machine, a revoluble and forwardly movable drill supporting head, limiting rods carried by said head and arranged to engage the end wall of the tunnel, and a signaling device connected to one of said rods.

4. In a tunneling machine, a revoluble and forwardly movable drill supporting head, a yieldably mounted endwise movable limiting rod supported by the head, and a signaling member connected to said rod.

5. A revoluble and forwardly movable drill supporting head, drills carried thereby, and curved plates independent of the drills and carried by the head concentric to the axis thereof and provided with helical flanges for feeding the drill-cuttings rearward.

6. In a tunneling machine, a revoluble head, drills supported thereby, a curved plate independent of the drills and extending forward from the periphery of the head concentric with the axis thereof, and helical ribs carried by the plate and arranged to feed the drill cuttings rearwardly.

7. A revoluble head having an opening therein, drills supported by said head, a curved plate bridging the opening and disposed substantially in alinement with the periphery of the head, and a helical rib carried by said plate for feeding the drill cuttings rearward.

8. In a tunneling machine, a revoluble head having a pair of side openings therein, a pair of curved plates bridging said openings and disposed substantially in alinement with the periphery of the head, said plates having helical ribs for feeding the drill cuttings rearward.

9. In a tunneling machine, a revoluble head, drills supported thereby, means for feeding the drill cuttings rearward of the head, a head supporting carriage, a casing mounted on the carriage and arranged to receive said cuttings, a conveyer, and buckets carried by the head and arranged to successively traverse the casing and deliver the cuttings onto the conveyer.

10. In a tunneling machine, a revoluble head, drills supported thereby, a screw shaft carrying the head, two relatively movable carriages supporting the shaft, adjustable rearward legs for each of said carriages, and pivotally mounted struts arranged to lock said carriages from either forward or rearward movement at will.

11. In a tunneling machine, a revoluble head, drills supported thereby, a screw shaft carrying the head, two relatively movable carriages supporting the shaft, supporting legs for each carriage, pivotally mounted struts for each carriage movable to lock the carriage against either forward or rearward movement, and pivoted arms carried by the leg side of each carriage for anchoring the respective carriage against movement.

12. In a tunneling machine, a revoluble drill carrying head, a threaded shaft for imparting rotative and longitudinal movement thereto, a shaft operating means, a nut with which the shaft engages, and means for locking the nut and shaft together to prevent longitudinal movement while permitting rotative movement.

13. In a tunneling machine, a revoluble drill-carrying head, a threaded shaft for imparting rotative and longitudinal movement thereto, said shaft having a longitudinal groove therein, shaft-operating means, a nut with which the shaft engages, and lugs carried by the nut and movable into and out of the groove in the shaft.

14. In a tunneling machine, a revoluble drill carrying head, a threaded shaft for imparting rotative and longitudinal movement thereto, a nut with which the shaft engages, means for rotating the shaft, and means for independently rotating the nut in the same direction but at greater speed than the shaft.

15. In a tunneling machine, a revoluble drill carrying head, a threaded shaft connected thereto, a carriage in which the forward end of the shaft is journaled, a nut engaging the shaft, a rear carriage in which said nut is revolubly mounted, a gear feathered to the shaft, a motor supported by the rear carriage and operatively connected to the gear, means for locking the nut and shaft for mutual rotative movement, and means for holding the nut from movement while permitting independent rotative movement of the shaft.

16. In a tunneling machine, a revoluble drill carrying head, a threaded shaft connected thereto, a front carriage supporting the front end of the shaft, a rear carriage, a shaft engaging nut revolubly mounted in the rear carriage, an adjustable friction band for engaging and holding the nut from rotative movement, means for locking the nut to the shaft, a gear carried by the nut, a gear feathered to the shaft, means for preserving a uniform distance between the latter gear and the rear shaft, a motor, a train of gearing connecting the motor to the feathered gear, and a second train of gearing connecting the motor to the nut gear, the gears of the second train being adjustable to render the nut gear idle or to effect rotative movement of the same in either direction.

In testimony that I claim the foregoing as my own, I have hereto affixed my signature in the presence of two witnesses.

JOSEPH RETALLACK.

Witnesses:
JNO. E. PARKER,
JAS. M. WALKER.