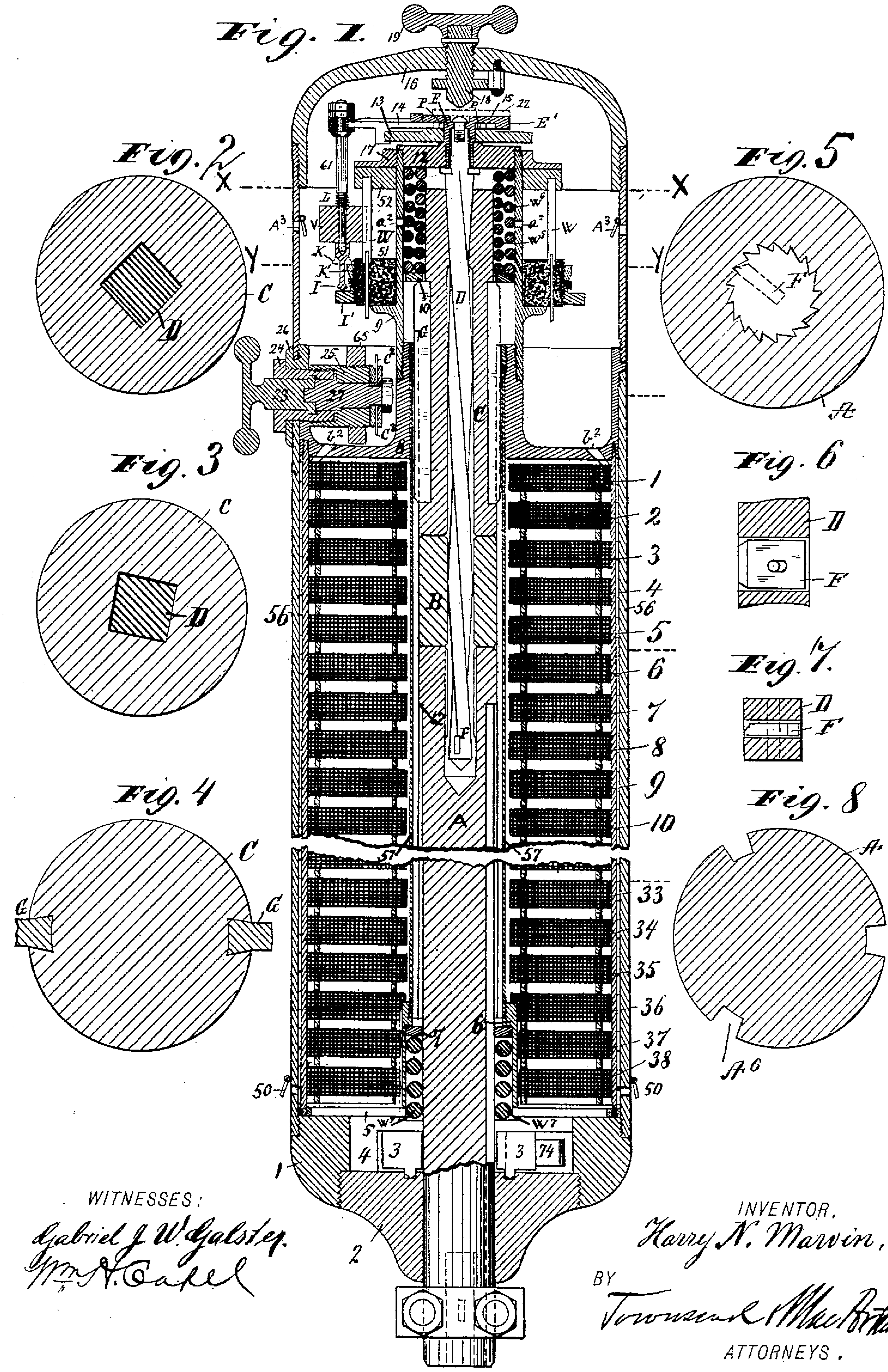
(No Model.) 3 Sheets—Sheet 1.

H. N. MARVIN.

ELECTRO MAGNETIC ROCK DRILL.

No. 395,575. Patented Jan. 1, 1889.



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(No Model.) 3 Sheets—Sheet 2.

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Fig. 15

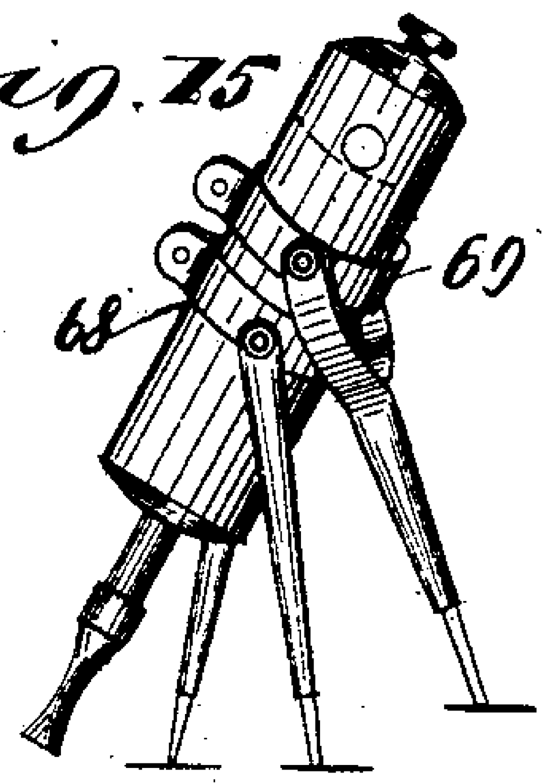

Fig. 14.

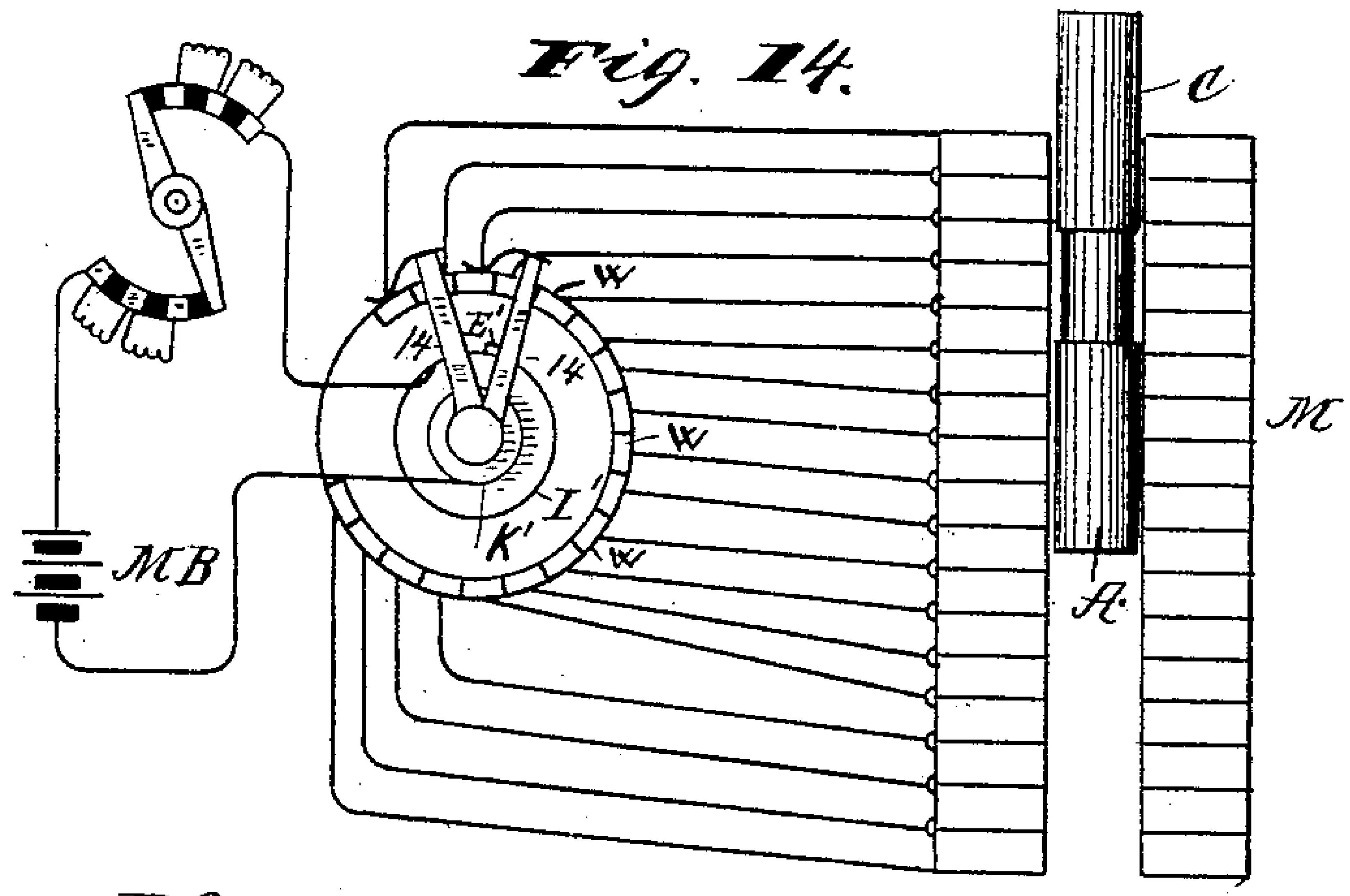

Fig. 16

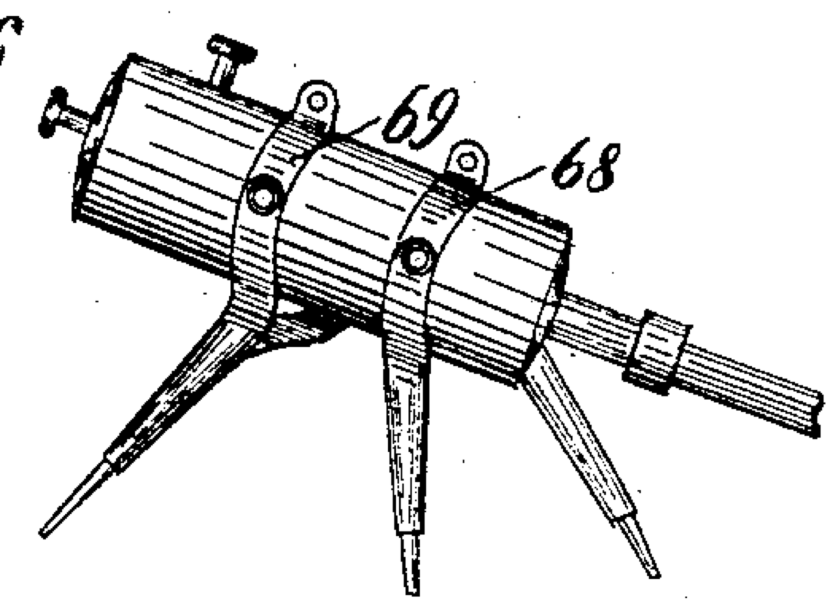

Fig. 10.

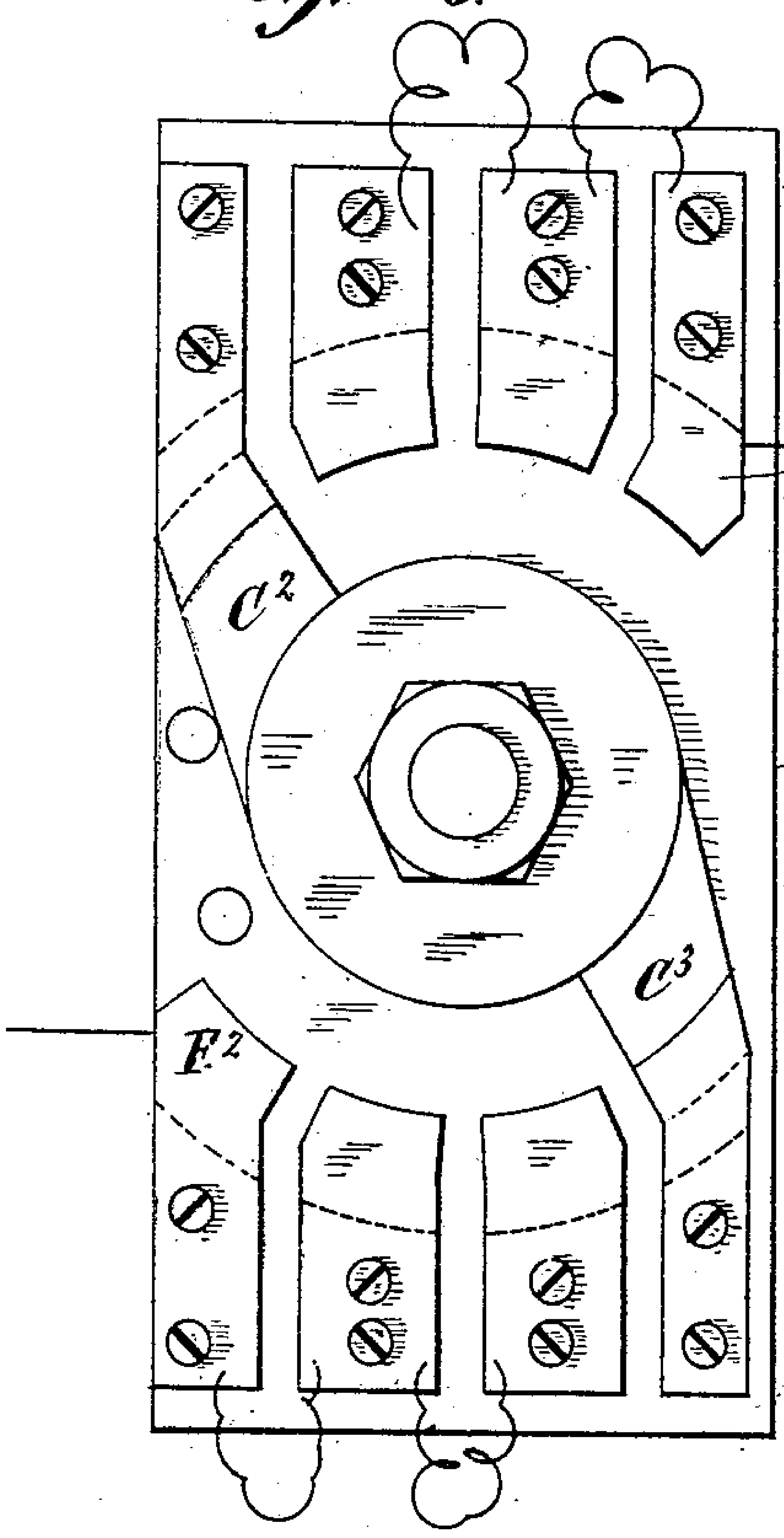

Fig. 9.

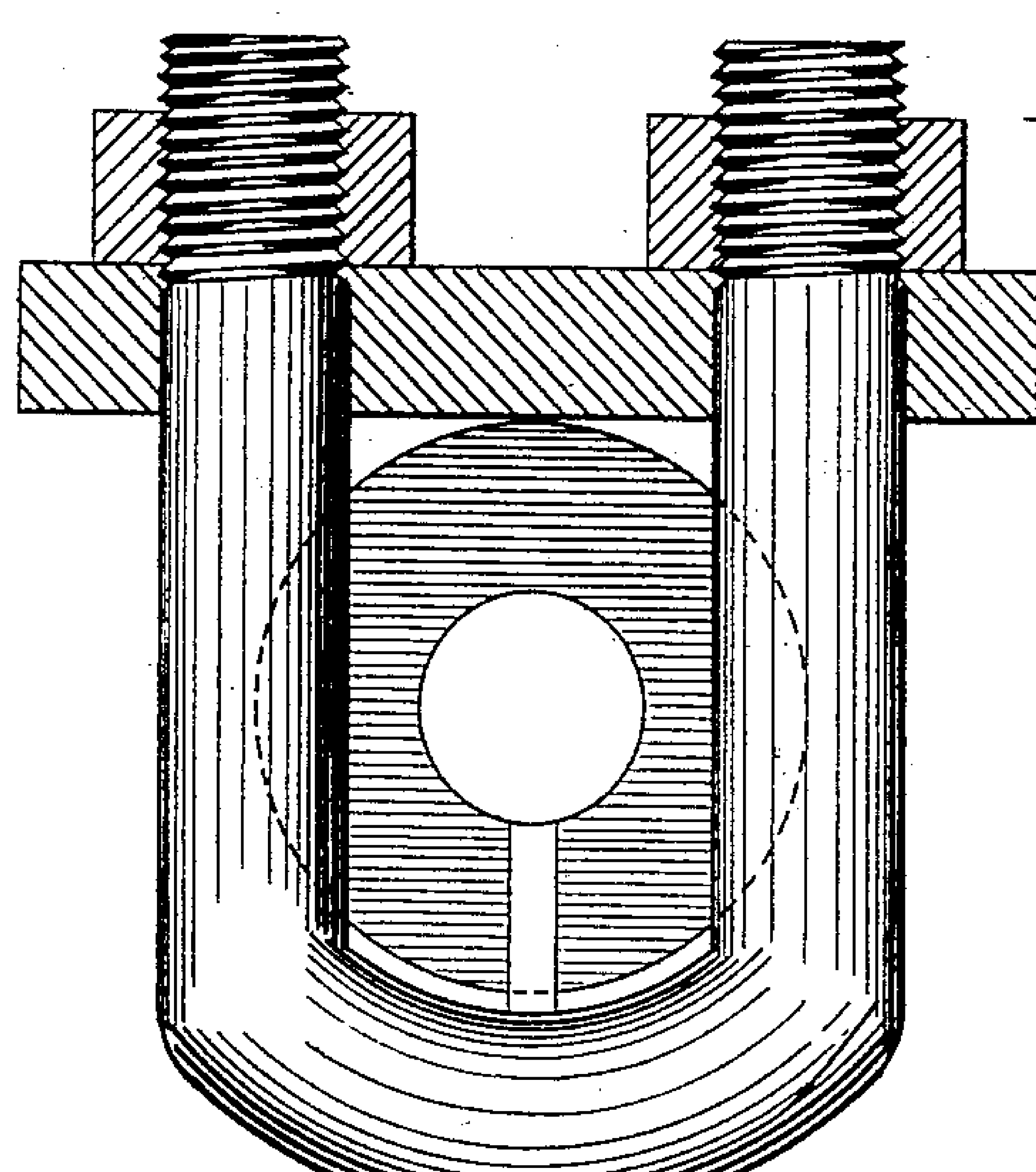

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Fig. 11.

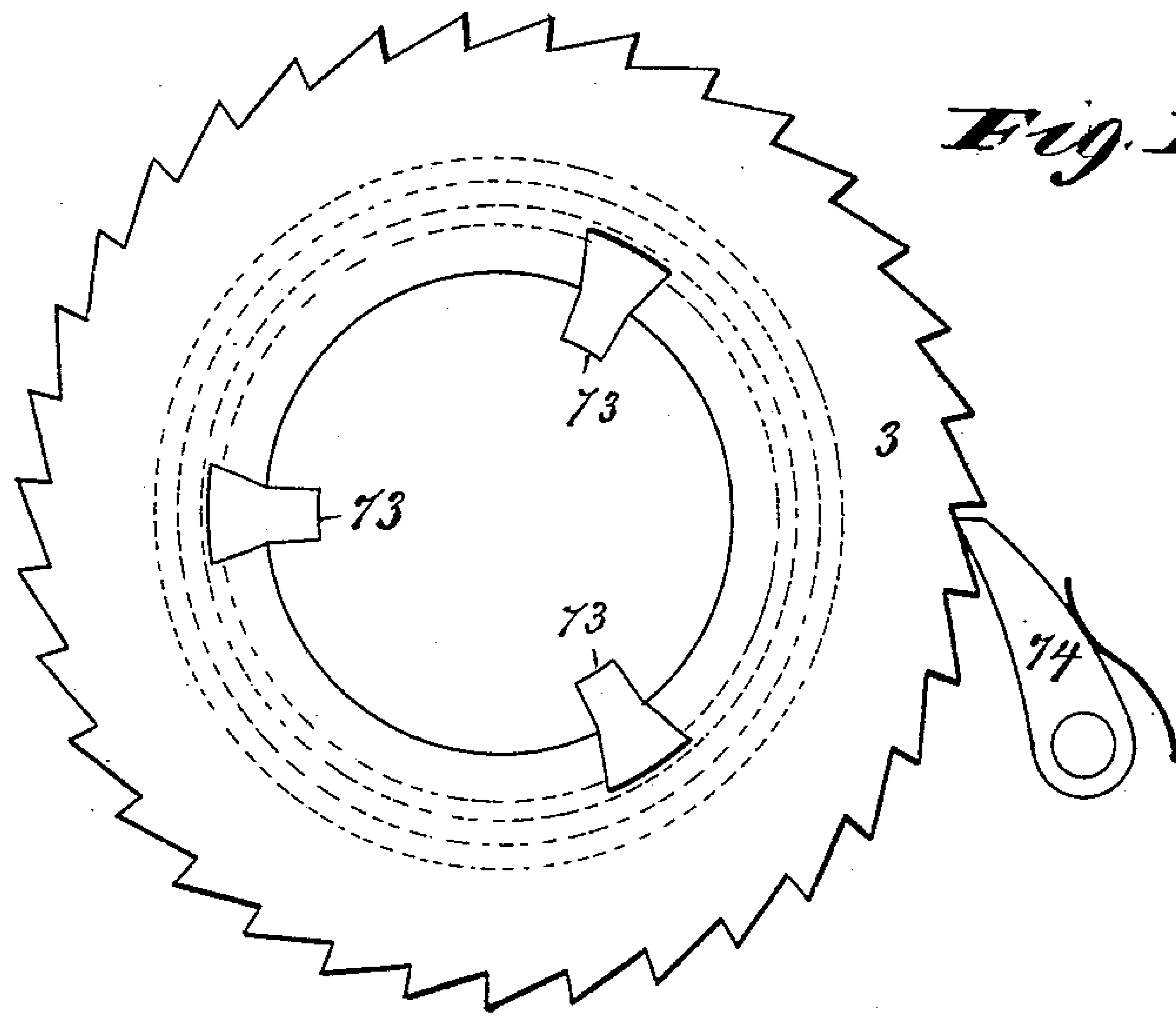


Fig. 13.

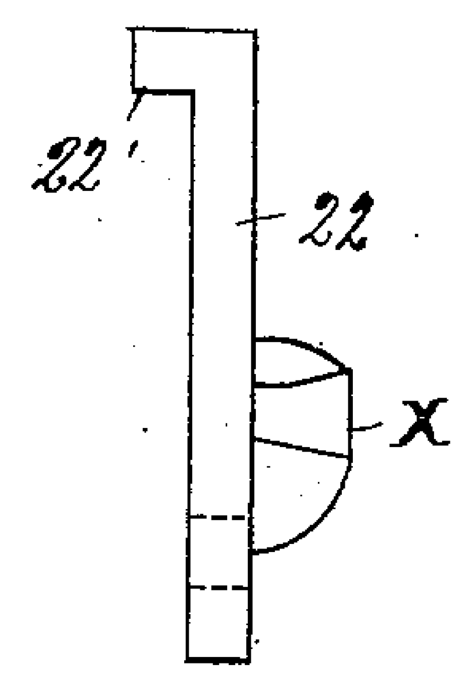
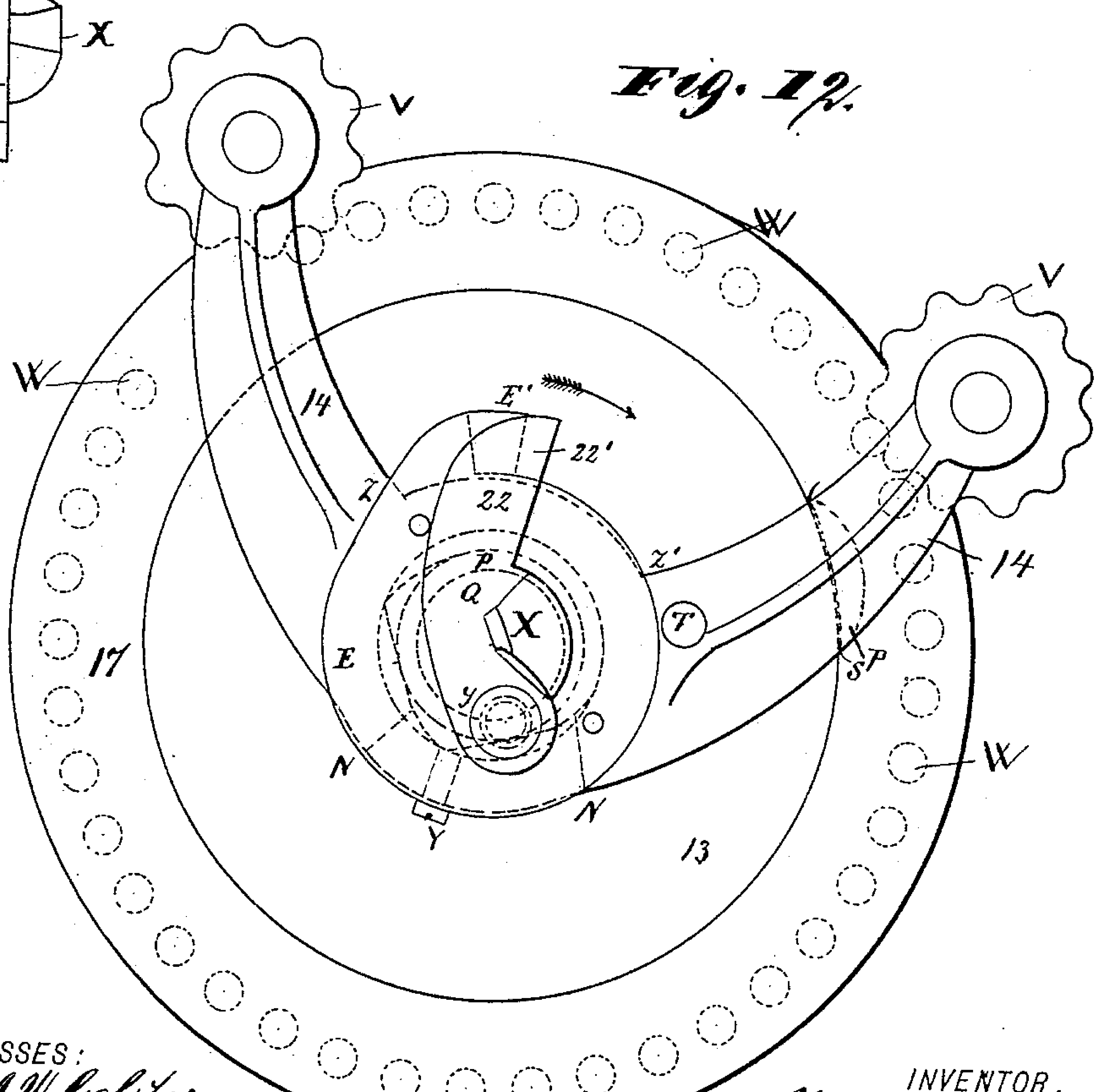


Fig. 12.



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UNITED STATES PATENT OFFICE.

HARRY NORTON MARVIN, OF SYRACUSE, NEW YORK.

ELECTRO-MAGNETIC ROCK-DRILL.

SPECIFICATION forming part of Letters Patent No. 395,575, dated January 1, 1889.

Application filed July 13, 1887. Serial No. 244,150. (No model.)

To all whom it may concern:

Be it known that I, HARRY NORTON MARVIN, a citizen of the United States, and a resident of Syracuse, in the county of Onondaga and State of New York, have invented a certain new and useful Electro-Magnetic Rock-Drill, of which the following is a specification.

My invention consists in certain improvements in the details of construction of reciprocating tools—such, for instance, as rock-drills—in which electro-magnetism is employed as the motive power.

The object of my invention is more particularly to improve the form of drill heretofore invented by me, in which I employ a series of coils acting upon one or more cores and provided with a circular commutator which is actuated by the cores.

I have herein shown my invention as applied to that form of my drill in which two reciprocating cores are employed, and some of the improvements hereinafter described are especially applicable to that form, while other details of improvement would be applicable to the form in which a single core is employed.

The improvements relate to the means for rotating the brushes of the commutator, to the devices for turning the drill, to the construction of the commutator and the manner of making connection with the movable portion of the same, to the method of controlling the force of the blow or stroke, and to other minor details, which will be described hereinafter, and then more particularly pointed out in the claims.

In the accompanying drawings, Figure 1 is a vertical central section of an apparatus embodying my invention. Fig. 2 is a cross-section of a magnet-core and rod passing through the same on the line X X, Fig. 1. Fig. 3 is a cross-section on the line Y Y, Fig. 1. Fig. 4 is a cross-section of the same core at the point where the splines are applied. Fig. 5 is a cross-section through the upper end of the lower core at the point where the ratchet-teeth are formed on said core. Fig. 6 is a vertical section through the portion of the rod where the actuating-pawl that engages with the lower core is located. Fig. 7 is a cross-section at or about the same point. Fig. 8 is a cross-section of the lower core at the point where the collar 3 engages with the same. Fig. 9 is a plan and section of the devices employed for holding a tool in place at the lower end of the lower core. Fig. 10 illustrates an electric switch employed with the apparatus. Fig. 11 is a plan of the collar 3 and its retaining-pawl. Fig. 12 is a top view of the commutator. Fig. 13 is a side view of a part of the connecting devices between the moving core and the commutator. Fig. 14 is a diagram of the circuits of the apparatus. Figs. 15 and 16 illustrate the tripod-support in two of its positions.

In order that my present invention may be more readily understood, I will make reference first to the diagram, Fig. 14, where I have shown the coils and cores, and have illustrated diagrammatically a commutator for use in connection with said core and coils in a manner heretofore invented by me.

C A indicate two cores movable together in a series of coils, M, while W W, &c., indicate a series of commutator blocks or plates disposed in the form of a cylinder. One end of the series is connected to one end of the coils M, while the other end of the series is connected to the other terminal of the coil series M. The intermediate blocks or plates, W, are connected in regular order to the junctions of the coils M, as indicated. Over the series of blocks W ride a pair of commutator-brushes mounted on arms 14, which arms and brushes are respectively in connection with the opposite poles of a galvanic battery, M B, a dynamo-machine, or other source of electricity. The arms 14 are disposed at such a distance apart as to include in the circuit between them a number of the coils M, and as the two brushes are moved together over the series of plates the current is shifted through the coils in regular order, the same number of coils substantially being always kept in action in advance of one or the other of the cores, so as to move the same continuously. The commutator-brushes receive motion from the moving cores for this purpose through any suitable mechanical device.

E′ indicates a stud, block, or arm, moving with the cores by any suitable means and adapted to play between the commutator-arms 14. In the position of the parts shown the two upper coils are in circuit, and the core C will therefore be drawn downward, carrying with it the part E′ and the commutator-brushes, through abutment of E′ upon the right-hand arm. When the core is brought to rest by the impact of the tool, the momentum of the parts will carry the arms 14 14 farther along over the series of blocks, thus shifting the current downward in the series of coils to a position where an upward attraction will be exerted upon the core A. The cores thereupon begin to rise, moving the commutator in an opposite direction, the block or piece E′ now engaging with the left-hand arm 14. When the cores are brought to rest by impact against a suitable stop, the commutator continues its movement by momentum, thus bringing the arms into the position shown in the diagram and shifting the current in the coils to a position for acting downwardly upon the cores C.

Referring now to the mechanical details of the apparatus in which my present invention is embodied, the numeral 8, Fig. 1, indicates a head-piece, between which and a bottom plate, 5, the series of coils numbered from 1 to 38, inclusive, are properly secured.

Surrounding the coils is a suitable tube or casing, 56, for protecting them from dirt and moisture, which tube or casing is preferably air-tight. Between the tube and the coils there is an air-space, as indicated, and at one end of the tube is provided a suitable valve, 50, opening outward, the purpose of which is to permit the escape of any air forced in upon the coils at the upper end of the casing.

In the head-plate are one or more openings, b^2, through which air may be delivered upon the coils for the purpose of keeping them cool. The upper coils, 1 2 3 4, of the set are spaced, as indicated, not only from one another, but from the tube 57, in which the magnet-core for the coils moves. This spacing may be continued downward through the whole series of coils and assists in the circulation of the moving air-current.

Above the casing 56, and supported by the head-plate, is a cap, the top of which is indicated at 16. This cap is preferably made air-tight, and in its sides are arranged valves A^3, adapted to open inward, so as to permit air to enter the space inclosed by the cap. The head-plate 8 also supports an interior tube or cylinder, 9, in which air-openings a^2 are formed for the passage of air.

The lower magnet-core, A, constitutes the drill-rod, and is provided at its lower end with suitable devices for fastening the tool. Above the core A and between it and the core C is a connection of brass, B, or other diamagnetic material, which is entirely free and disconnected from the cores and serves merely to keep them apart.

The magnet or core C is provided with feathers or projections G, which, by entering slots or guideways formed in the brass tube 57, in which the magnets move, prevent C from rotating. Through the core C is bored a longitudinal hole, the upper part of which is somewhat smaller than the lower. The smaller portion has a longitudinal length of two inches or more and is square. It has also a spiral twist or pitch which corresponds to the twist or pitch of a square rod, D, of brass or other non-magnetic material. The lower part of the hole in the core C is enlarged to the diagonal diameter of the rod D, so that the rod can rotate in the core. This enlarged or clearance hole extends through the brass coupling B and for some distance into the upper end of the core A, so that the rod D may extend downward to a distance corresponding substantially to the maximum throw of the core.

The rod D is suitably secured to a sleeve, E, which rides in an opening formed in the head 12, closing the upper end of tube 9. The sleeve E, whose upper end is extended out into a plate or flange, as indicated in Figs. 1 and 12, carries a projection, E′, which is adapted to engage with the arms 14 14 at the points Z Z′ of the commutator, as more clearly indicated in Fig. 12. The arms 14 are extensions of a plate which surrounds hub E, and which plate rests on a plate, 13.

The parts being in the position shown, it is obvious that a downward movement of the core C will cause the rod D to rotate, carrying with it the sleeve or plate E and the projection E′, which, by engaging with the commutator, turns the same. The rod D and the core C, into which the rod projects, might be made to engage with one another by any other device which would cause the rod D to rotate when the core C moves longitudinally. The upward movement of the core will obviously impart a reverse movement to the projection E′.

The construction of the commutator will be described further on.

The drill is rotated in the following manner: The clearance-hole in the core A, into which the end of rod D passes at the upward end of the stroke, is drifted out into ratchet-shaped grooves or teeth, as shown in section in Fig. 5. In the lower end of the rod D is a mortise-slot, in which is a loose blade, feather, or pawl, F, the extreme width of which is somewhat less than the diameter of the rod at that point. This feather or blade fits the mortise-slot loosely, and is permitted by the pin holding it in place to move out of the rod a sufficient distance to engage the ratchet-grooves in A. The feather or pawl F is of steel or other magnetic material, and since on the upward stroke of the drill the core A is magnetized this magnetism serves to attract the feather or pawl F outward and draws it into engagement with the teeth in A, as shown in Fig. 5. In this manner the rod D is locked during a portion of the upward stroke to the rod A, and since the rod D is rotating at this time under the influence of the magnet C the rod A then receives motion from D, and is rotated to a certain extent. When the motion is reversed, the core or magnet A, being no longer magnetized, easily permits the dog or pawl F to slip back into the rod D under influence of the teeth or the ratchet carried or formed in the core A, the edge of the dog or pawl being beveled to fit the teeth of A, and also being beveled at its lower side to enable it to easily find the hole in A. The rod A is locked to prevent its turning in the reverse direction in the following manner: One or more grooves (indicated at A^6, Fig. 8) are cut in the rod A longitudinally and extending almost its entire length. Embracing the rod is a collar, 3, which is mounted on the block 2, supported by the lower plate, 1. This collar carries pins, feathers, or projections 73, Fig. 11, that enter the straight slots in A, so that any rotary motion of rod A is shared by 3, while at the same time longitudinal movement of the rod through the collar is not interfered with.

On the outer circumference or any other portion of collar 3 are cut ratchet-teeth, that are engaged by one or more dogs 74. The ratchet and dogs are so arranged as to permit rotation of rod A in the direction in which it is moved by the ratchet at its upper end. Backward movement is prevented by the engagement of the dog 74 and ratchet. By these devices the rod is turned a short distance at or near the completion of each upstroke.

The commutator is constructed as follows: The commutator-cylinder is in the form of a trundle or lantern wheel, and is composed of a series of conducting rods or bars, W, which are suitably held between two blocks or rings of insulating material, (indicated at 51 and 52.) The block 51 rests on a shoulder formed on or attached to the cylinder or tube 9, while a screw-nut or washer, 17, applied to the upper end of the cylinder 9, presses upon the block 52 and clamps the parts firmly together. The rods W form the trundles or spindles of the wheel, and are severally connected to the junctions of the coils after the manner of the separate insulated conducting plates or strips of any commutator.

The brushes of the commutator consist of wheels V, of copper or other conducting material, which are adapted to mesh with the teeth of the commutator-cylinder. The wheels V are suitably mounted upon arms or spindles 61, secured to the arms 14, and rotate upon said arms 61 as axles. They are held in contact with the commutator-cylinder by devices to be presently described. As they roll around over the surface of the cylinder, they make and break connection with the commutator-rods of the wheel in succession after the manner of an ordinary commutator. The hubs of the wheels are prolonged into contact-heads I K, which bear, respectively, upon rings I′ K′, of conducting material, suitably insulated from one another upon the block 51. The neck of the contact I is longer and smaller than the neck of contact K, as indicated, so that it may bear on ring I′ without touching ring K′. The rings I′ K′ are suitably connected with the electric generator, as indicated in the diagram, and furnish current to the contact-wheels. The wheels are pressed into connection with the rings by means of springs L.

It will be understood that the contacts I K represent the extremities of different wheels mounted on the two arbors, secured, respectively, to the arms 14. The parts are shown or indicated as in line with one another in Fig. 1 simply for convenience. The brushes or wheels are pressed against the periphery of the commutator-cylinder by means of a spring, N, Fig. 12. The plate carrying the arms 14 encircles the hub or plate E, and the opening in the plate carrying arms 14 is sufficiently large to permit the plate to be moved to one side by the spring N, which latter is applied in the space between the plate and a washer, P, around the hub of plate E. The spring N tends to throw the plate or arms 14 into an eccentric position with reference to the hub and the circumference of the commutator, which latter are concentric with each other. By so doing it draws the rollers or wheels V V firmly against the commutator-bars W. A screw, Y, passing through the plate 14, serves to adjust the tension of the spring N.

It is obvious that in a drill constructed from a series of coils working in succession upon a core, as hereinbefore described, the influence of any energized set of coils upon either of the cores depends upon the relative positions in which the core and coils are maintained as the core moves and shifts the current in the coils. It is likewise apparent that the relative position of the energized set of coils to the core is determined by the position of the brushes upon the commutator, which in turn depends upon the extent to which the commutator-arms 14 and the projection E′ may move with relation to one another before coming into engagement. If, for instance, at the end of the upstroke of the cores under the influence of the coils acting on core A the arm 14, having stop Z′, be permitted to move but a short distance before engaging with the projection E′, the current will be shifted upward in the coils but a short distance, and the downward pull which would be exerted on the core C at the beginning of the next movement downward would not be at its maximum, because the core C would not be sufficiently enveloped by the coils in action to permit them to pull to the best advantage. If now the core begin to move downward, the brushes would then be maintained during such downward movement in such position that the coils would remain in advance of the position of maximum advantage, and consequently the stroke would be of inferior force. Without some means of adjustment in the connections between the core and the commutator it is obvious that the relative position of the brushes and coils to the magnets during upward and downward strokes would be always the same, and the strokes would be of equal force at all times, which force would be, presumably, the maximum force obtainable from the apparatus. If, however, we cause the commutator at the time of shifting to engage with the part moving with the core at a point earlier than it otherwise would in the period of shift, it is obvious that on the beginning of the downward movement the brushes will be in advance of the position which they would have if they had been permitted to move farther by their momentum, and that therefore the coils acting on the downward stroke will be in advance of the position of maximum advantage.

A means that may be employed for securing the adjustment described in the relation of the coils to the core consists of an adjustable block, which is mounted in the head 16, and is in the form of a screw having a conical lower end, which is adapted to engage with a conical or inclined projection, X, projecting up from a movable piece, 22, at a point over the center of rotation on the plate E. The piece 22 is a pivoted piece pivoted on and carried by the plate E, so as to rotate therewith, and carries a projection, 22′, which is adapted to engage with a pin or projection, T, on the arm 14 of the commutator having the stop Z′.

The projection 22′ is adapted to perform the function of the projection E′ at the termination of the upward stroke of the instrument, and normally the pin T would strike the same at the same time that the arm or portion of the commutator carrying pin T strikes the projection E′. When the adjustable block or screw 18 is elevated, the piece X may remain over the center of the plate E and the projection 22′ will have no effect. When, however, the screw 18 is lowered, the conical end forces the projection X to one side, thus turning the piece 22 on its pivot or axis and bringing the part 22′ in advance of the part E′, thus causing projection 22′ and pin T to engage earlier than E′ would engage arm Z′, and thus 22′ carries the brushes around in a position in advance of the position of maximum advantage and the force of the blow is diminished. By turning down the screw 18 more or less the desired force of blow can be obtained. Since in drilling I have deemed it desirable to retract the tool as rapidly as possible at all times, I have shown here an arrangement designed simply to alter the force of the forward stroke, leaving the backward stroke at all times at a maximum. I do not, however, limit myself to the application of my invention to altering the force of the forward stroke only. If applied to altering the force of both strokes, the parts would be in normal or maximum position when the projection traveling on the cone of the screw was at a central position on the cone or half-way up the incline. Motion of the screw in one direction would affect the forward stroke, while motion in the other would affect the backward.

By closing up the distance between the stops or points of engagement of arms 14 with projection E′, or by splitting the stop E′ and causing a central cone to spread the parts, the same result would be obtained—namely, to reduce the lost motion between the stop E′ and arms 14 14.

This part of the invention consists, broadly, in altering the force of the stroke in either or both directions by altering the driving connection between the driving-collar E and the brush-plate 14.

I prefer to employ suitable buffing-springs, W^5 W^6 W^7, placed at opposite ends of the drill, as indicated. The springs at the upper end of the drill are included between the head 12 and a washer, 10, which is adapted to move with the core C by engaging with the splines G on the side of the same. The spring W^7 at the bottom of the drill rests upon the head plate or block 4 between the same and a washer, 7, with which a shoulder (indicated at 62) upon the core A is adapted to engage in case the core is thrown below its normal limit of movement. The spring W^7 is designed to protect the machine from injury in case the point of the tool should not meet any obstruction.

The spring or springs at the top of the apparatus is preferably made double, and is preferably arranged not only to act as a buffer, but when made sufficiently long and elastic to perform a function as follows: In the case of a stiff spring, when the magnet system moves upward it does so with considerable velocity, and when the core engages the washer 10 the springs W^5 W^6 are compressed to a much greater extent than they would be by a simple pull of the coils upon the lower core, A. Through acquired momentum the brushes are carried around to a distance somewhat farther than they would be carried if the core were moved upward slowly, and by this shifting of the core the position of the coils in action is raised so that they will act upon the upper core. This would be the action if the springs were made quite stiff, so as to check the drill quickly and allow the inertia of the brushes to carry them around. If, however, the core is brought to rest gradually, the parts of the commutator moving therewith will not necessarily move beyond the point where the core stops, and especially will not do so if the commutator has considerable friction. When a spring of this kind is employed, it will react and throw the magnet downward, and if the construction of the mechanism be such that the commutator has not shifted to any extent independently of the core at the end of the stroke it is obvious that the brushes will not begin immediately to move with the core C as the latter begins to move downward, because there is considerable lost movement before the part E′ or its equivalent would engage with the commutator; hence the shifting of the current in the coils does not begin, although the core C moves, and said core may therefore move down into the field of the energized coils, while at the same time the lower core moves out of the field. It is therefore possible, as will be seen, to make the drill reverse at the upper end of the stroke without relying upon the inertia of the brushes to carry them around after the magnets come to rest; hence the character of the spring at the top of the drill will affect very materially the action of the apparatus in reversal. If this spring is rigid and checks the core quickly, the inertia of the commutator will move the position of the exciting-coils upward from the position where they will act on the lower core to a position where they will draw downward upon the upper core; but if the spring is flexible the shift by inertia will not take place, but the magnet C, through the compressed spring, will be forced downward into the field of the coils which last acted upon the lower core, the brushes meantime remaining stationary. The feature of a spring adjusted to allow such an action to take place, thus causing reversal without shift of the commutator by inertia, is not herein claimed, but will be made the subject of a separate application.

The current may be turned on and off the machine by means of a switch, (shown in Fig. 10,) which may be mounted in any suitable position on the drill.

C^2 C^3 is a copper switch-lever operated by a wheel, 23, outside of the drill. Block E^2 is in connection with the line-block D with the drill. The switch is shown in position when current is interrupted. On moving the switch current is gradually admitted to the drill through the resistances.

It is to be observed that C^3 strikes its blocks before C^2 strikes its own. Thus the four coils are thrown in and out in succession. These coils may be parts of the drill-coils or may be separate coils.

Another important feature of the machine is the utilization of the magnet-core as the plunger of an air-pump, which may be employed for producing circulation of air about the coils. When the magnet system moves downward and the plunger or magnet A runs out of the machine on the forward stroke, the internal air capacity of the machine is to that extent increased. Therefore air enters by the valves A^3 in the outer shell, air gaining access to the interior of the brass plunger or magnet-tube through the holes a^2, &c. When the piston or magnets return, the same amount of air is forced out of the machine through the valves 50 50 at the lower part of the machine. Thus the magnets act as a pump. The air forced out of the plunger-cavity is delivered into the coils through the openings b^2.

The tripod-support of the drill consists of two bands, 68 69, encircling the casing-tube of the machine and provided with clamps for clamping them in any desired position. One band carries two legs, while the upper band carries but one. These legs are independently adjustable on their axes. Each leg is independent, and is held firmly in any desired position by nuts that draw up the shoulders of the leg against the face of the band, the surfaces thus drawn together being properly serrated or notched. When their clamps are loosened, the bands may be adjusted both circumferentially and longitudinally and then set in their new adjusted position. The chief item in this arrangement is the use of the double band, whereby greater rigidity is obtained, and likewise greater adaptability and stability, than in the usual forms of tripod.

What I claim as my invention is—

1. In an electro-magnetic drill, the combination, with the reciprocating magnet-core, of the actuating pawl or dog carried thereby, and a magnet for throwing the same into engagement with a ratchet connected with the drill-tool, as and for the purpose described.

2. The combination, with the magnet A, provided with ratchet-teeth, of a pawl of magnetic material mounted, as described, so as to be capable of moving into and out of engagement by the magnetism of the magnet when the magnet and pawl come into proximity.

3. The combination, with the magnet-core A, of a pawl of magnetic material mounted on a non-magnetic support independent of the core, and a ratchet carried by the core, as and for the purpose described.

4. The combination, with the reciprocating magnet-core, of the rod of non-magnetic material, whose end is adapted to enter a cavity in the head of the core, and a loose pawl of magnetic material mounted on the end of the rod, and a ratchet connected with the drill-tube.

5. In an electro-magnetic drill or similar tool having a reciprocating core, magnet-coils spaced as described, to permit circulation of air between the coils and guide-tube for the reciprocating core.

6. The combination, with the reciprocating magnet-core, of a commutator actuated thereby and having the plane of its cylinder transverse to the line of movement of the core, said cylinder consisting of a fixed trundle or lantern wheel whose bars or teeth are insulated from one another, and a commutator-brush-holding arm connected with the reciprocating core and carrying a conducting-wheel adapted to gear with the lantern-wheel, as and for the purpose described.

7. The combination, with the cylindrical commutator, of a rotary brush-supporting plate loosely pivoted on its support concentrically with the commutator-cylinder, and a spring exerting a transverse pressure on said plate, whereby the brushes may be held in contact with the commutator-bars, as and for the purpose described.

8. The combination, with the reciprocating drill-rod, of a reciprocating core or rod, a ratchet and pawl for connecting the latter with the drill-rod, and a collar engaging with the drill-rod provided with a dog or pawl arranged to permit said rod to rotate when con

nected with the reciprocating and rotating rods, but arranged to prevent rotation of the collar in the opposite direction.

9. A combined reciprocating magnet-core and air-pump in which the guide-tube for the core serves as the cylinder of the pump, in combination with an air-delivery passage leading from said pump and arranged to deliver a current of air upon the magnet-coils, as and for the purpose described.

10. The combination, with the commutator-actuating devices, of the attached rod D and the reciprocating core having a longitudinal hole which receives the rod, said rod and core being connected together by devices, as described, whereby the reciprocation of the core may impart a rotary movement to the rod.

11. The combination, with the series of coils and the rotary commutator adapted to rotate in a plane parallel to the plane of the coils, of the actuating-core and the rod D, extending through or into the core and rotated thereby as said core reciprocates.

12. The combination, with the magnet-core and a series of actuating-coils, of a commutator and connections between the core and commutator for imparting movement positively to said commutator by the core on its downstroke, said connections being of adjustable length or extent, as and for the purpose described.

13. The combination, with a magnet-core and a series of actuating-coils, of a commutating device actuated thereby, but movable independently thereof at the end of the upstroke, and an adjustable stop in the connections between the core and commutator, whereby the position of the actuating set of coils with relation to the core on the downstroke will be varied according to the force of stroke desired.

14. The combination, with the reciprocating core, of the rotary commutator-driving arm moving with the core, and an adjusting device engaging with said arm for changing the relation of the same with regard to the portion of the commutator upon which the arm abuts.

15. The combination, with the two reciprocating cores and their actuating-coils, of a commutator actuated by the core through devices having an adjustable lost motion, whereby the extent of the shift of current in the series of coils in an upward direction may be determined, and the consequent force with which the upper core is impelled on the downstroke may be varied.

16. The combination, with the rotary arm 22, adapted to engage with the commutator and adjustably mounted on its support, of the adjusting-block 18, engaging with the arm at or about the center of rotation of the support, as and for the purpose described.

17. The combination, with the drill, of the switch arranged between two sets of resistance-coils, and having its contacts at either side arranged with reference to one another and the two sides of the switch, as described, to throw the coils of each set into circuit singly but alternately with the coils of the other set.

18. The combination, with the drill, of the two bands, one of which carries one adjustable leg, while the other carries two legs adjustable independently of one another, means for clamping the bands upon the drill, and nuts independent of said clamping devices for clamping the shoulders of the legs against the face of the bands, as and for the purpose described.

19. The combination, with the reciprocating magnet-core A, of a mechanism engaging with said core for rotating the same on its longitudinal axis, and a simultaneously-reciprocating core, C, connected with said rotating mechanism, as and for the purpose described.

20. The bodily-moving commutator-wheels carrying contacts I K, in combination with the fixed conducting-rings I′ K′.

21. In an electro-magnetic reciprocating tool, the combination, with the reciprocating core, of a buffer-spring, W^7, the superposed washer, and the shouldered core or drill-holder, as and for the purpose described.

22. The combination, with the drill, of a buffer-spring, W^7, consisting of a coiled spring resting upon the lower head-plate and surrounding the drill-rod, said spring being engaged by said rod in case the rod is thrown below its normal limit of movement.

Signed at Syracuse, in the county of Onondaga and State of New York, this 11th day of July, A. D. 1887.

HARRY NORTON MARVIN.

Witnesses:

W. J. Gillett,

Jas. B. Hitchcock.