J. TEN EYCK HILLHOUSE.

ELECTROPNEUMATIC TOOL.

APPLICATION FILED JULY 26, 1908.

979,164.

Patented Dec. 20, 1910.

2 SHEETS—SHEET 1.

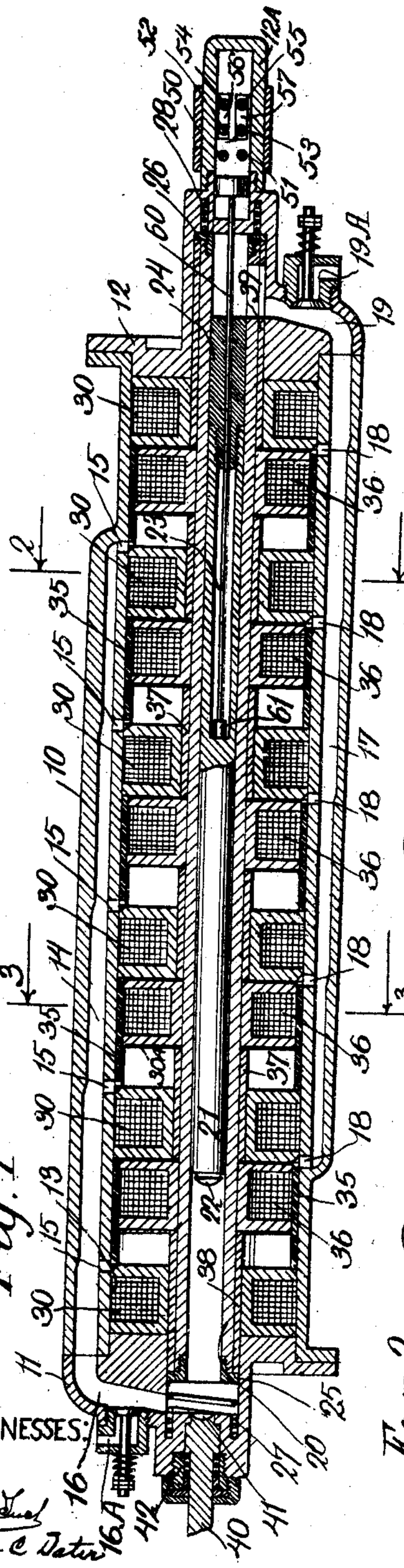

Fig. 1

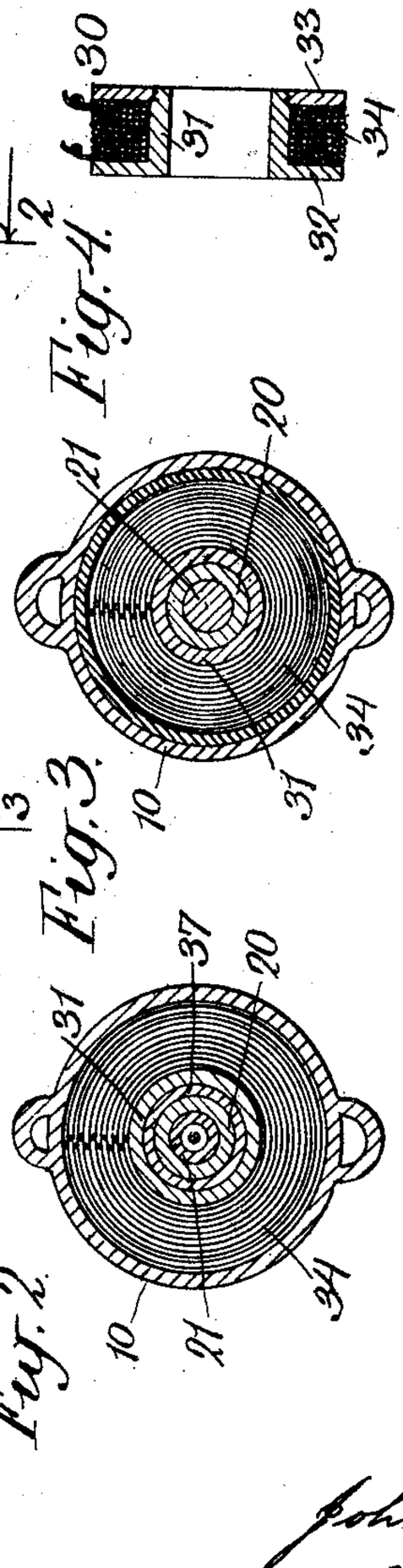

Fig. 2

Fig. 3

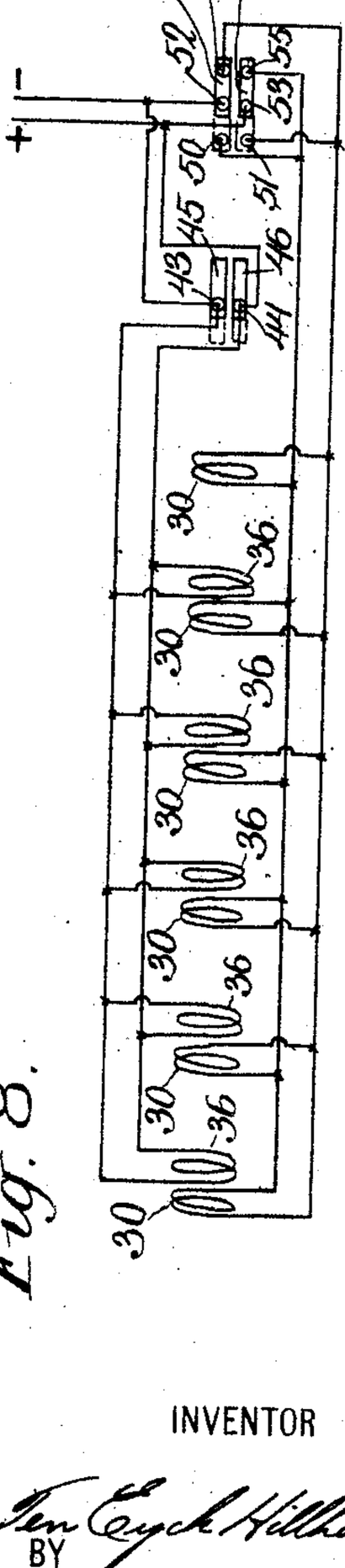

Fig. 4.

Fig. 8.

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2 SHEETS—SHEET 2.

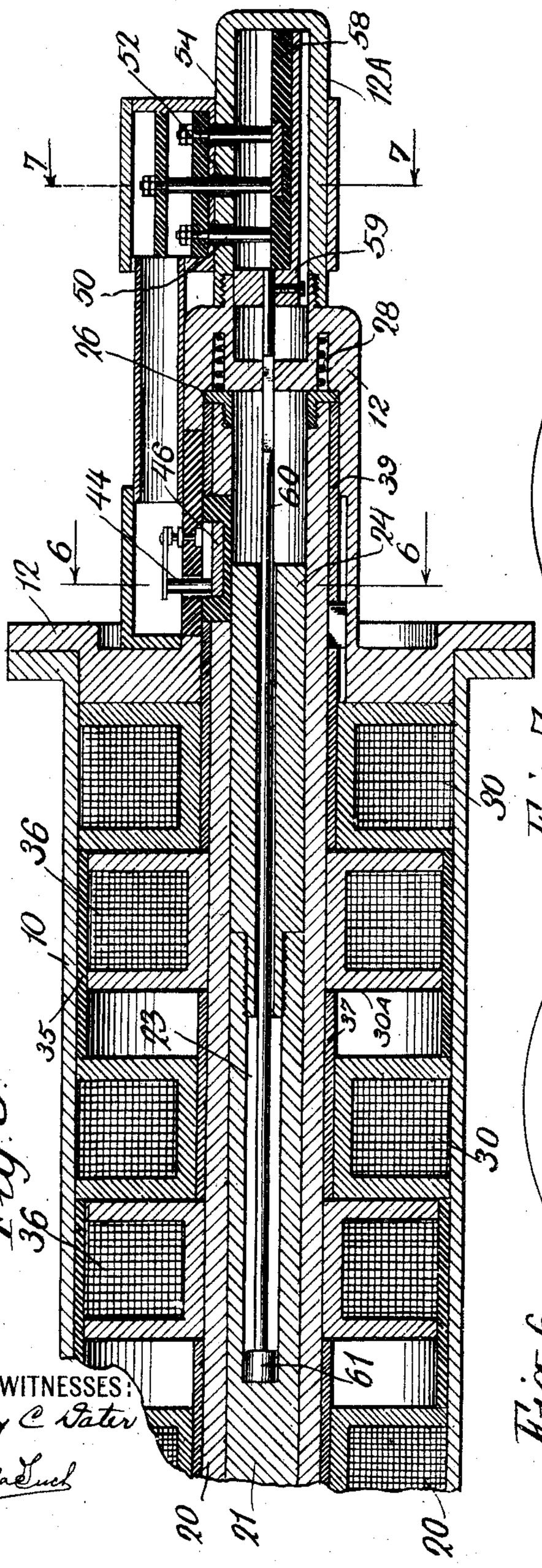

Fig. 5.

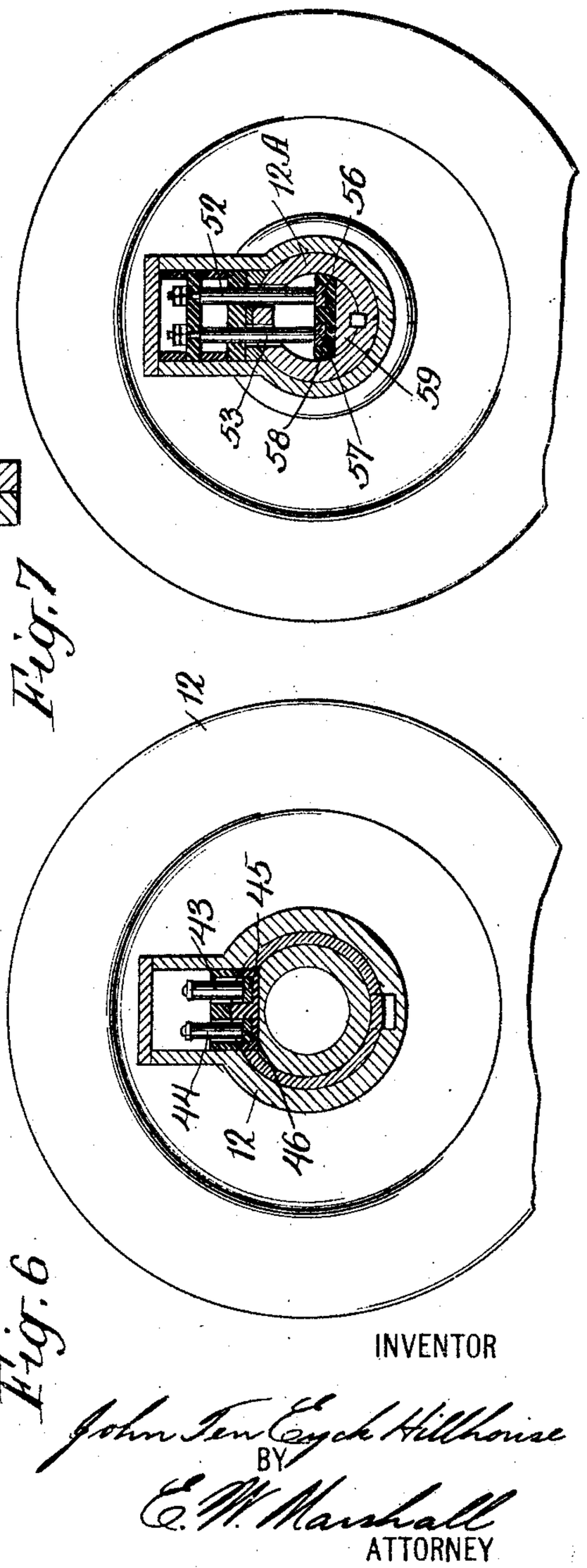

Fig. 7.

Fig. 6.

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ELECTROPNEUMATIC TOOL.

979,164. Specification of Letters Patent. **Patented Dec. 20, 1910.**

Application filed July 25, 1908. Serial No. 445,347.

To all whom it may concern:

Be it known that I, JOHN TEN EYCK HILLHOUSE, a citizen of the United States, and a resident of the city of New York, in the county of New York and State of New York, United States of America, have invented certain new and useful Improvements in Electropneumatic Tools, of which the following is a specification.

My invention relates to improvements in electropneumatic tools, especially to that type of tools or other mechanisms in which a reciprocatory or vibratory motion is used. Its object is to improve upon structures of this kind and to provide a tool which is simple in construction and efficient in operation.

To these ends my invention resides in the construction and arrangement of parts which I will describe in the following specification and the novel features of which I will set forth in appended claims.

Referring to the drawings, Figure 1 is a sectional plan view of a riveting tool or hammer embodying my invention. Figs. 2 and 3 are sectional end views of this device, the sections being taken, respectively, on the lines 2—2 and 3—3 of Fig. 1. Fig. 4 is a sectional side elevation of one of the magnets which is used in carrying out the invention. Fig. 5 is a sectional side elevation, on a somewhat larger scale, of a portion of the tool shown in the previous figures. Fig. 6 is a sectional end view of the tool, the section being taken on the line 6—6 of Fig. 5, and showing somewhat in detail a sliding contact arrangement which is used in carrying out my invention. Fig. 7 is a similar sectional view taken through the line 7—7 of Fig. 5 and illustrating the construction of a pole changer or reversing switch. Fig. 8 is a diagram of the electrical parts and their connecting circuits.

Like characters of reference designate corresponding parts in all of the figures.

10 designates a casing which incloses nearly all of the working parts of the apparatus. 11 and 12 are the heads of this casing.

20 is a cylinder centrally disposed within the casing. 21 is a reciprocatory piston within this cylinder 20. One end of this piston is provided with a striking head 22. Its other end is bored out to form a chamber 23 which is closed by a hollow cylinder 24 which forms the other end of the piston.

The inner portion of casing 10 is bored out as at 13 so that it forms a hollow cylinder. Between this surface and the outside of cylinder 20 a plurality of electromagnets are arranged in the manner which will now be pointed out.

30, 30, &c., designate a plurality of fixed or stationary electromagnets. Each of these comprises a body portion 31, having a fixed flange 32 and a removable flange 33, and is made into the shape of a spool or reel. 34 is a wire coil upon this spool. The outer peripheries of the flanges 32 and 33 are arranged to fit closely against the inner surface 13 of the casing 10.

35 designates a plurality of finished annular spacing collars fitting closely against the surface 13 and against the peripheries of the flanges of adjacent movable magnets which are designated by 36, 36, &c. The movable magnets fit closely between the outer surface of cylinder 20 and the inner surface of the spacing collars 35. Annular spacing collars 37, which fit over the outside of cylinder 20, are provided between the movable magnets, and other collars 38 and 39 of the same diameter are placed over the cylinder 20 at the ends of the outer movable magnets.

25 and 26 are flanges screwed onto the ends of cylinder 20 and arranged to lock the cylinder 20, the movable magnets 36, and the spacing collars 37 together. The cylinder 20 and the parts which are thus connected with it are so arranged that they may move together freely back and forth longitudinally as a unit.

27 and 28 are buffer springs arranged, respectively, between the flange 25 and the casing head 11, and the flange 26 and the casing head 12. These buffer springs are arranged to cushion and arrest the longitudinal movement of the cylinder 20.

After the parts above described are assembled, the heads 11 and 12 are affixed to the casing 10, and these engaging with the first and last of the fixed magnets, hold them with their spacing collars rigidly together with the casing 10.

14 designates an air duct which may be

provided in the casing 10 as shown, or which may be in the form of a pipe connected with the casing. At the left-hand end of the travel of the movable magnets 36, openings 15, 15, &c., are provided from the spaces between the movable magnets and the stationary magnets into the air duct 14.

16 designates an air passage in the head 11 connecting the duct 14 with one end of cylinder 20. 16A is an air inlet valve connected with this air passage 16. 17 designates a similar air duct which may be arranged at the opposite side of the casing 10 and connected by means of ports 18, 18, &c., with the spaces between the right-hand side of the movable magnets and the stationary magnets. 19 is an air passage in head 12 connecting the duct 17 with the opposite end of the cylinder 20.

19A is an air inlet valve in the passage 19.

At the end of the casing head 11 and projecting through it is a riveting tool 40. Its inner end is constructed to form an anvil 41 against which the striking head 22 is arranged to strike. A spring 42 is arranged to press the riveting tool inward. At the opposite end of the device and supported by the casing head 12 are a pair of contact brushes 43, 44 which bear, respectively, upon sliding contact strips 45 and 46 which are insulated from but mounted upon the cylinder 20 so that they move with it.

12A is a housing screwed onto the head 12 and arranged to support the pole changing device or reversing switch which I will now describe. This comprises six stationary brushes 50, 51, 52, 53, 54 and 55 which are insulated from each other. A pair of movable contact strips 56 and 57 are mounted upon the block 58 of insulating material which is affixed to a sliding frame 59. 60 designates a rod which is connected with this sliding frame 59 and which is carried though the end 24 of piston 21 into the chamber 23 where it terminates in an enlargement 61.

In Fig. 8 I have shown a way in which the magnets, the brushes and contacts above described may be electrically connected. In this figure + and — designate mains from a suitable source of electrical supply. The positive or + main is connected with the brushes 52 and 44. The negative or — main is connected with the brushes 52 and 43. All the magnets of one set, for example, the fixed or stationary magnets 30, are connected with the brushes of the reversing switch in the following manner: The leads from the left-hand side of every other one of these magnets 30, and all the leads from the right-hand side of the intervening stationary magnets are connected together and to the contact brushes 51 and 54. The opposite leads of these magnets 30 are similarly connected together and to contact brushes 50 and 55. The movable magnets 36 are connected with the right-hand lead of one and the left-hand lead of the next connected together and to one of the sliding contact plates 45, 46, and with their other leads connected together and to the other of these contact plates.

The various parts of the mechanism shown in the drawings have been pointed out and I will now proceed to describe their operation. Current passes from brush 44 and plate 46 to opposite sides of alternate movable magnets 36 and back through plate 45 and brush 43 so that it flows through every other one of them in an opposite direction, but its direction through any one of them is always the same. Consequently their polarity remains the same. But the polarity of adjacent stationary magnets 30, which is also in opposite directions, is arranged to be changed or alternated. This alternation of polarity is accomplished by the pole changer or reversing switch. It has been shown that the windings of adjacent stationary magnets are connected together in opposite directions and to the contact brushes 51, 54 and 50, 55. When the movable magnets are at one end of their travel, for example, to the left as they are shown in Fig. 8, the contact strips 56 and 57 may be moved over to the right as shown in full lines in this figure in a manner which will be presently described. When in this position the contact strip 56 will bridge and connect contacts 52 and 54, and the contact strip 57 will bridge and connect contacts 53 and 55. The connections with the magnets are so made that with the parts in this position the polarity of the right-hand faces of magnets 30 will be the same as that of the left-hand faces of movable magnets 36, and consequently will repel the movable magnets and drive them away. At the same time the polarity of the left-hand faces of stationary magnets 30 will be opposite to that of the right-hand faces of movable magnets 36 so that the movable magnets will be attracted on that side. This repulsion and attraction will cause the movable magnets to move together to the right until they reach some such position as that which is shown in Figs. 1 and 5. The movable contact strips 56 and 57 are then moved to the left in the position indicated by the dotted lines in Fig. 8, when they will bridge brushes 52, 50 and 53, 51, respectively. This will reverse the current through the stationary magnets 30 so that they will repel and attract the movable magnets 36 in the opposite direction and drive them back again. The brushes 43 and 44 are so arranged that they always remain upon their respective sliding contact strips 45 and 46 so that the polarity of the mov-

able magnets always remains in the same direction. It is evident that the polarity of the stationary magnets may be made constant and that of the movable magnets reversed if desired.

In moving from the left to the right the movable magnets will compress the air or other fluid which is between them and the stationary magnets to their right. The fluid pressure thus obtained will pass through ports 18 into duct 17, and through passage 19 into the end of cylinder 20. This pressure acting upon the end of piston 21 will drive it to the left out of the position shown in the drawings until its striking head 22 strikes against anvil 41. While the movable magnets are thus creating a pressure at their right-hand sides they are making a corresponding rarefaction at their left-hand sides. This rarefaction or partial vaccum will cause the fluid in cylinder 20 to the left of piston 21 to be drawn out away from this end of the piston, which, of course, will assist in the actuation of the piston. When the piston has thus been moved away to the left the inner end of its portion 24 will strike against the enlargement 61 on the rod 60 and will move it and its connected sliding frame 59 over to the left until the movable contact strips 56, 57 are moved out of contact with brushes 54, 55 and into contact with brushes 50, 51. The central brushes 52, 53 always remain in contact with these movable contact strips. Now the polarity of the stationary magnets will be reversed and the movable magnets driven to the left. The piston 21 will then be driven to the right by the compression and rarefaction created by this movement of the magnets. When the piston moves to the right the bottom of chamber 23 will engage with the enlargement 61 and push it and its connected parts over to the right, thus again reversing the polarity of the stationary magnets. Thus the movement of the movable magnets 36 in either direction will drive the piston 21 in the opposite direction, and the movement of the piston will be used to actuate the pole changer or reversing switch. If it is desired to have the piston move in the same direction as that of the magnets it will only be necessary to interchange the leads of ducts 14 and 17.

The mechanism as shown is designed to operate with air and in order to insure a full supply of air within the casing 10, the air inlet valves 16^A and 19^A may be provided. These are ordinary check-valves arranged to allow intake of air but to prevent it from flowing out.

I have not shown in detail the riveting tool or hammer 40 as this forms no part of the invention, and especially as I do not mean to limit my invention to a riveting tool. It is in fact adaptable for use in connection with nearly any mechanism wherein a reciprocatory vibratory movement is desired. Rock drills and pumps are examples of such mechanisms. The advantages of using compressed air for such devices is well known. In many localities, however, a supply of compressed air is not available, and it is one of the objects of this invention to overcome this difficulty.

The mechanism which I have invented is self-contained and may be used in any place where an electrical power supply may be obtained.

It is well known that the pull on electromagnets is much stronger when the air-gap between them is short. It is also well known that to obtain a satisfactory pressure for actuating such a piston as that herein described a comparatively long stroke is required. By connecting together a plurality of movable members, each acting through a comparatively short distance of travel, and adding together the volume of compressed air created by them, this difficulty is removed. A greater or lesser number of movable magnets and their associated stationary magnets than those shown in the drawings may be used, according to the requirements of the specific mechanism to which this invention is applied.

The construction of the parts illustrated is a preferred design as the apparatus is self-contained and is built up about a central axis with nearly all of its parts concentrically arranged, but, of course, other arrangements and designs of the mechanism may be made without departing from the spirit of the invention. The fluid in the spaces between the magnets acts as a cushion and assists in the reversal of movement of the movable magnets. In order to prevent the magnets sticking together or "freezing" at the ends of their strokes, washers 30^A of non-magnetic material may be provided. I am aware that polarized magnetic members have been arranged to alternately attract and repel each other, but I believe that the arrangement which is herein disclosed is the first in which more than three of such members have been arranged to have this mutual action.

What I claim is:—

1. A plurality of magnets, an inclosing casing closely fitted about said magnets, circuits arranged to effect the energization of the magnets to cause adjacent magnets to be moved toward and from each other to thereby cause a difference of fluid pressure within the casing, and a piston within the casing arranged to be actuated by said fluid pressure.

2. An inclosing casing, a plurality of fixed electromagnets therein, a magnetic member

arranged to be moved back and forth within the casing between the electromagnets by said fixed magnets, to thereby create a difference of fluid pressure, a piston within the casing arranged to be actuated by said fluid pressure, and means actuated by the piston for controlling said electromagnets.

3. An inclosing casing, a plurality of fixed electromagnets therein, a magnetic member arranged to be driven back and forth within the casing between the fixed electromagnets by said magnets to thereby create a difference of fluid pressure, a piston within the casing arranged to be actuated by said fluid pressure, and means actuated by the piston for controlling said electromagnets.

4. An inclosing casing, a set of fixed electromagnets therein, a set of movable magnets arranged to be driven back and forth within the casing between the fixed electromagnets to thereby create a difference of fluid pressure, a piston within the casing arranged to be actuated by said fluid pressure, and a pole changer for one of the sets of said magnets.

5. An inclosing casing, a plurality of fixed electromagnets therein, a plurality of movable magnets arranged to be driven back and forth within the casing between the fixed electromagnets to thereby create a difference of fluid pressure, a piston within the casing arranged to be actuated by said fluid pressure, means for energizing the electromagnets, a pole changer for the fixed electromagnets, and a mechanical connection between the piston and the pole changer.

6. An inclosing casing, a plurality of stationary electromagnets affixed to said casing, a cylinder within said stationary electromagnets, a plurality of movable magnets about said cylinder and arranged to be driven back and forth in unison between the fixed electromagnets to thereby create a difference of fluid pressure, a piston within the cylinder arranged to be actuated by said fluid pressure, means for energizing the electromagnets, a pole changer for reversing the polarity of the stationary electromagnets, and a mechanical connection between the piston and the pole changer.

7. An inclosing cylindrical casing, a plurality of stationary electromagnets affixed to said casing, a movable cylinder centrally disposed within said stationary magnets, a plurality of movable magnets affixed to said cylinder and arranged to be driven back and forth between the stationary electromagnets to thereby create a difference of fluid pressure at the opposite ends of the cylinder, a piston within the cylinder arranged to be actuated by said fluid pressure, means for energizing the electromagnets, a pole changer for reversing the polarity of the fixed electromagnets, a sliding contact device for the movable electromagnets, and a mechanical connection between the piston and the pole changer.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

JOHN TEN EYCK HILLHOUSE.

Witnesses:

ERNEST W. MARSHALL,

ELLA TUCH.