No. 894,782. PATENTED JULY 28, 1908.

G. H. ROWE.

ELECTROMECHANICAL DEVICE.

APPLICATION FILED OCT. 15, 1906.

3 SHEETS—SHEET 1.

Fig. 1.

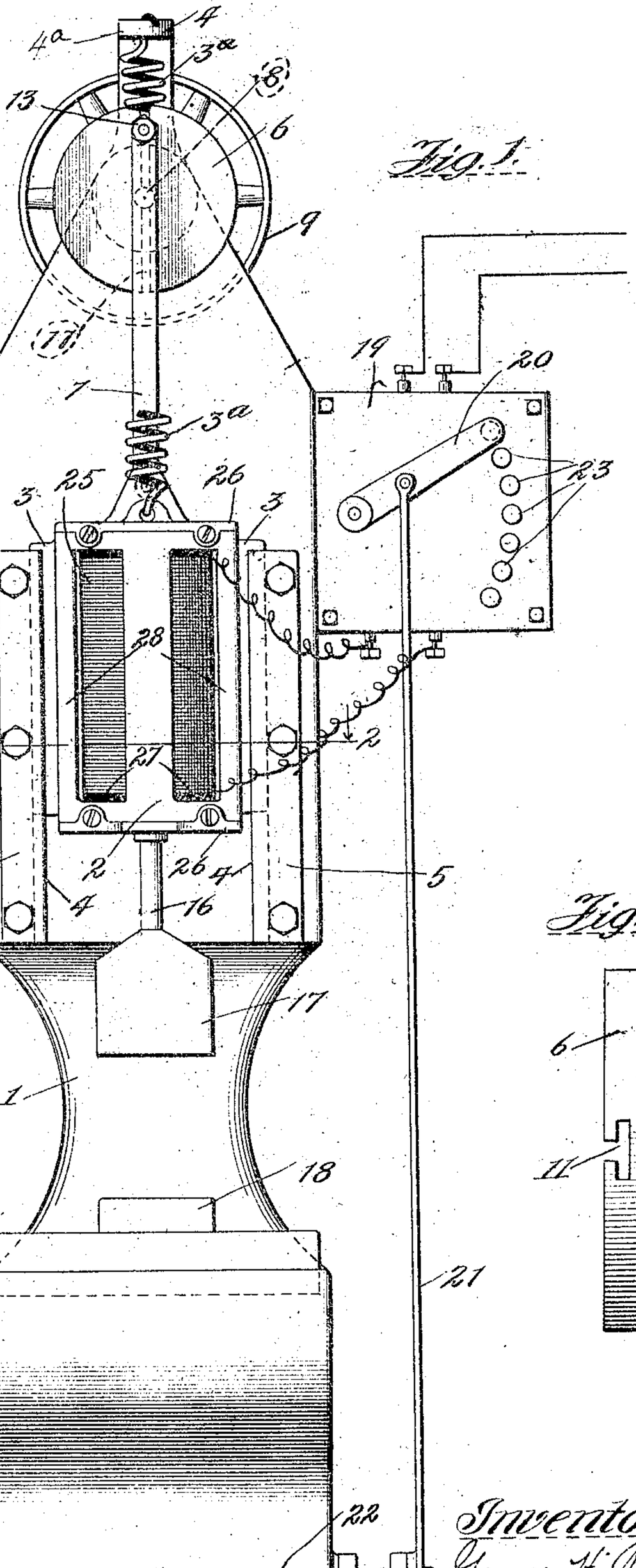

Fig. 6.

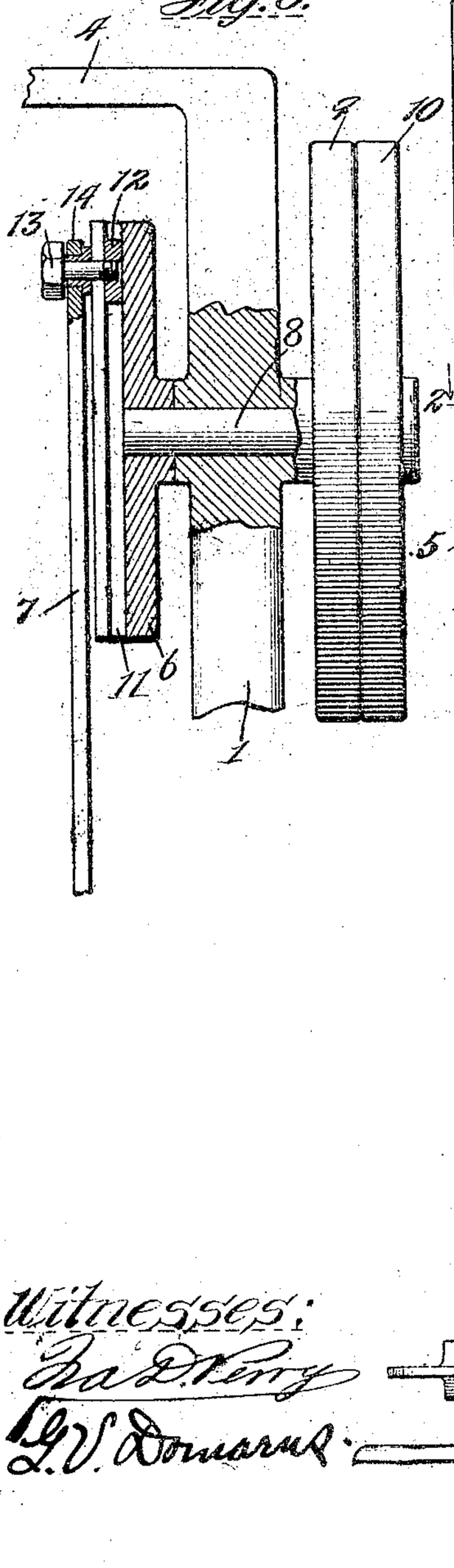

Fig. 7.

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3 SHEETS—SHEET 2.

Fig. 3.

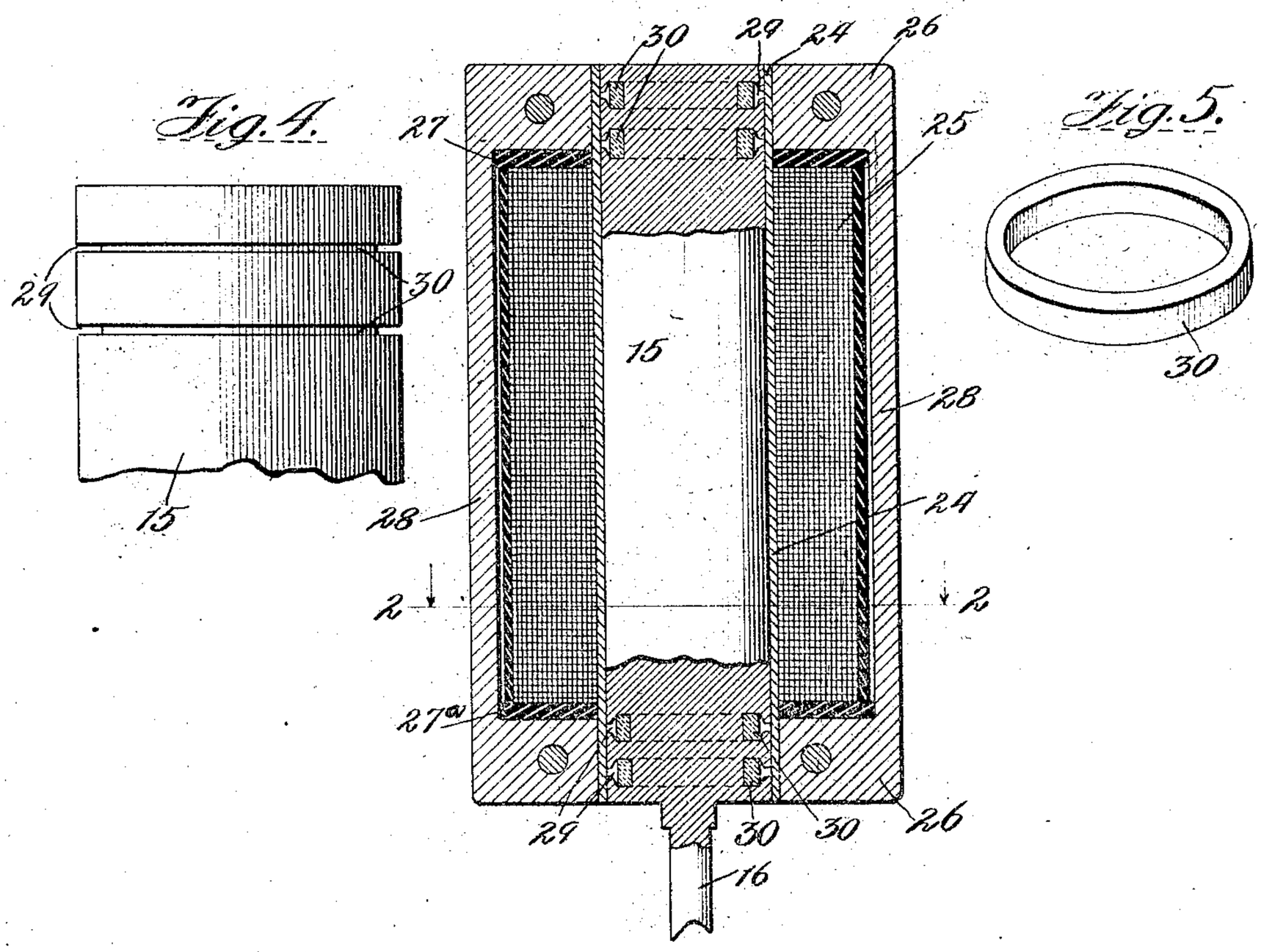
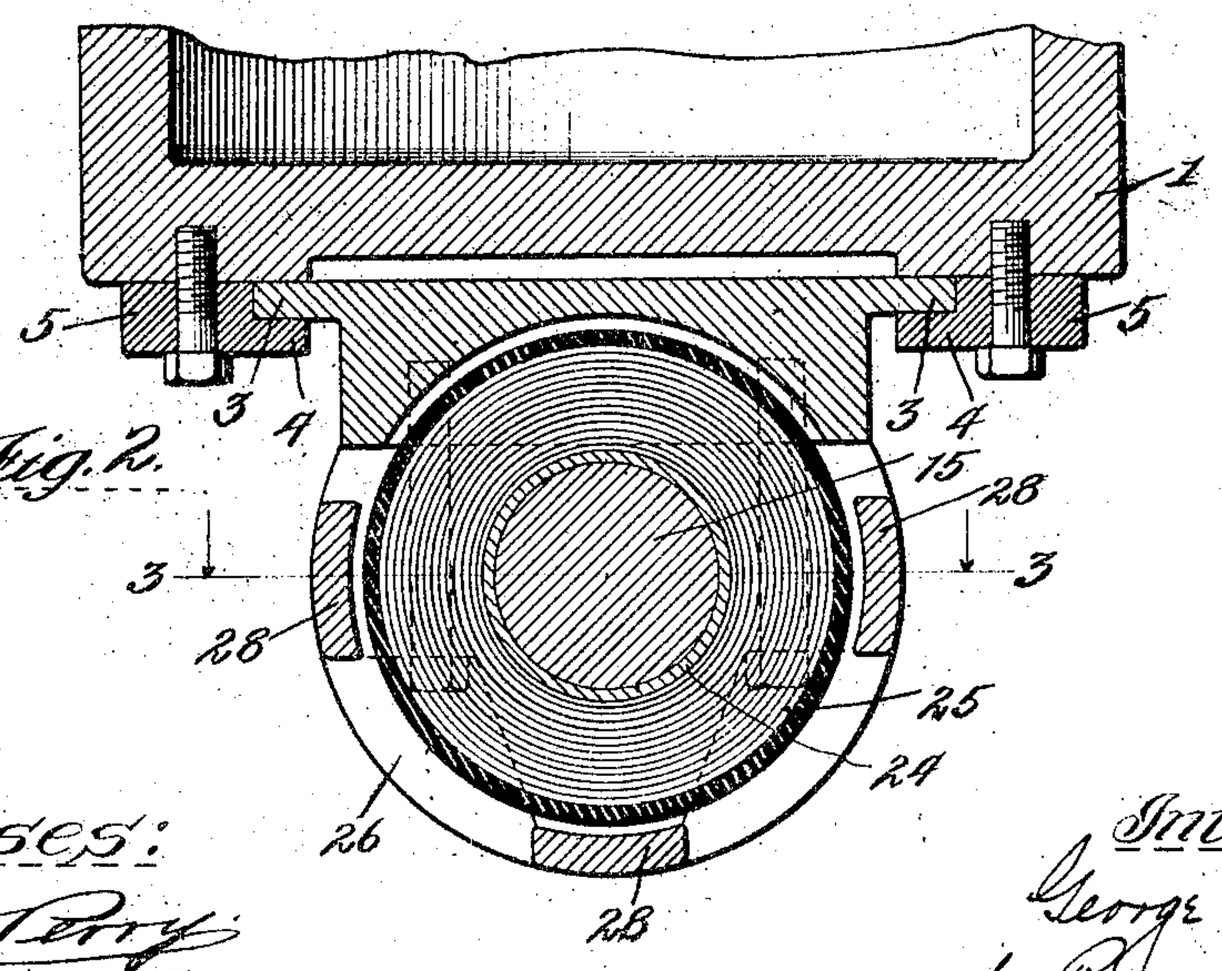


Fig. 4.

Fig. 5.

Fig. 2.



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3 SHEETS—SHEET 3.

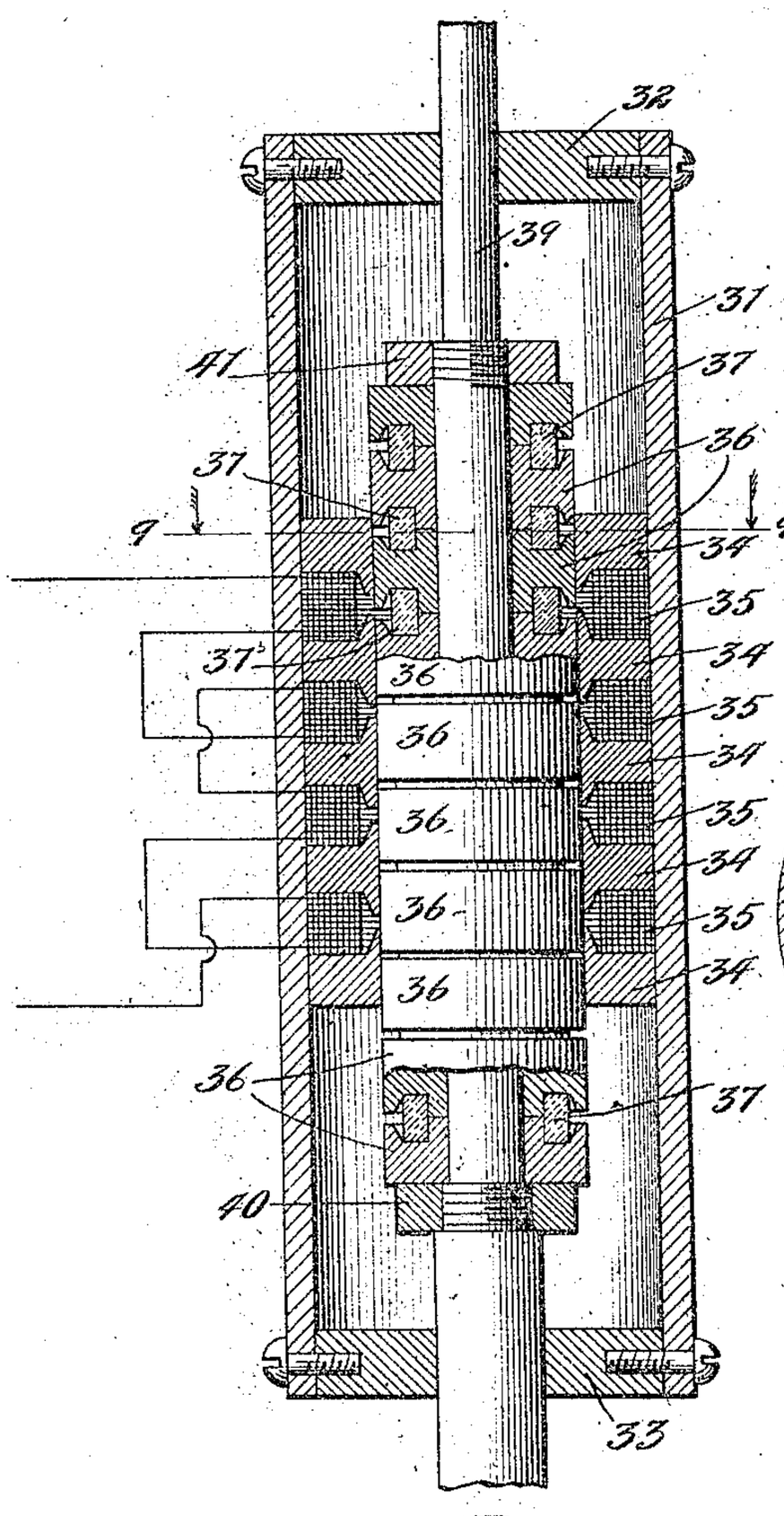


Fig. 9.

Fig. 10.

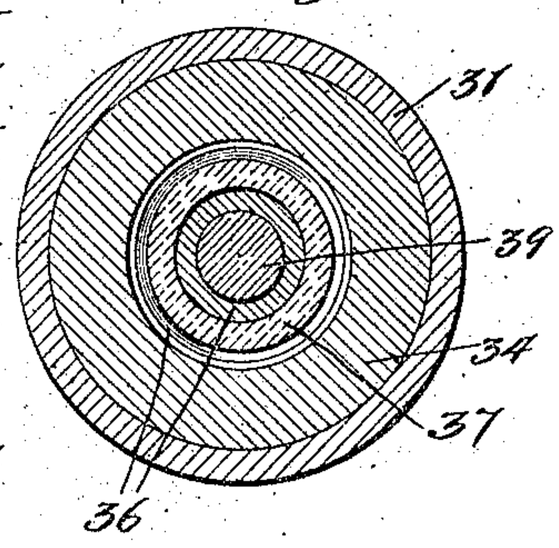


Fig. 11.

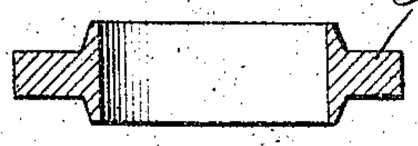


Fig. 12.

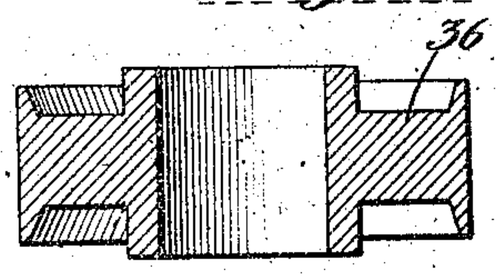
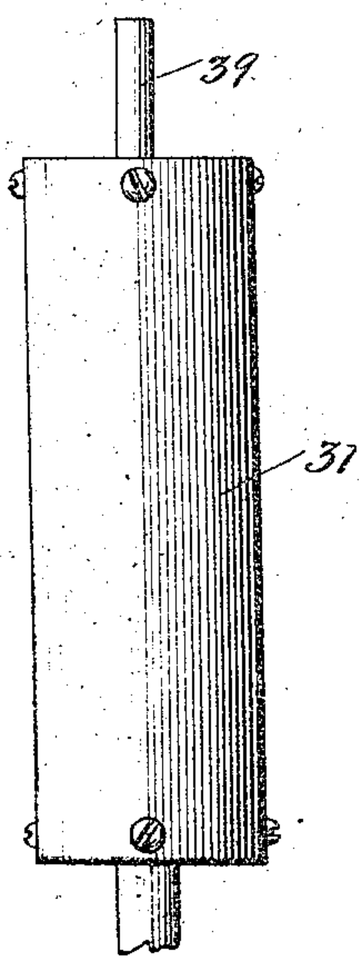


Fig. 8.



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UNITED STATES PATENT OFFICE.

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ELECTROMECHANICAL DEVICE.

No. 894,782. Specification of Letters Patent. Patented July 28, 1908.

Application filed October 15, 1906. Serial No. 339,123.

To all whom it may concern:

Be it known that I, GEORGE H. ROWE, a citizen of the United States, residing at Riverside, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Electromechanical Devices, of which the following is a specification.

This invention relates to improvements in electromechanical devices, the generic object being the provision of means for cushioning a blow resulting from the movement of a mechanically reciprocated member. In the practice of my invention this object is accomplished electro-magnetically by utilizing the attraction of an electro-magnet for its armature, and by means hereinafter explained, this electro-magnetic action may be automatically graduated in proportion to the weight of the blow which is to be cushioned. Preferably the electro-magnet and armature will be given the form of a coil and core, though the invention, broadly regarded, contemplates the use of any form of electro-magnet and armature that is adaptable to this purpose.

My invention is adapted to be embodied in various forms and applied to a variety of uses, one of which is illustrated in the accompanying drawings, in which

Figure 1 is a front elevational view of an electro-mechanical hammer embodying my invention. Fig. 2 is an enlarged cross-sectional view of the same, the section being taken on the line 2, 2 of Fig. 1. Fig. 3 is a longitudinal sectional view of a solenoid and core employed in this machine, the section being taken on the line 3, 3 of Fig. 2 looking in the direction indicated by the arrows. Fig. 4 is a further enlarged detail in elevation of an end of the core. Fig. 5 is a perspective view of a ring forming a short-circuited conductor and used upon the core to increase the magnetic action and the resultant tractive effect of the moving solenoid upon the core. Fig. 6 is a detail of the upper portion of the machine, principally in section, showing means for reciprocating the solenoid. Fig. 7 is an elevational edge view of a crank-disk used in this machine. Fig. 8 is an elevational view of a modified form of solenoid. Fig. 9 is an enlarged central longitudinal section of the same. Fig. 10 is a cross section of the same on the line 9, 9 of Fig. 9. Fig. 11 shows in section one of the annular pole-pieces used with the form of solenoid shown in Fig. 9. Fig. 12 shows in section on a larger scale one of the annular pole-pieces used in making up the core employed with this form of solenoid.

In the several figures of the drawings, 1 is the frame of the machine.

2 is a solenoid arranged upon the frame of the machine so as to have a reciprocating movement and to be guided in such movement. Extending vertically upon opposite sides of the solenoid are wing-like flanges 3. Each of these flanges 3 is confined between the frame of the machine and the overhanging lip 4 of a guide-plate 5, these guide-plates being bolted or otherwise secured to the frame of the machine. Reciprocating (and in this type of machine, vertical) movement is imparted to the solenoid by means which may conveniently consist of a revolving crank-disk 6, and a pitman or connecting-rod 7, connecting the disk 6 with the frame of the solenoid 2. The disk 6 is mounted upon one end of a shaft 8 revolving in a suitable bearing at the upper portion of the machine. Upon the opposite end of this shaft is secured a driving pulley 9 for a belt and a loose pulley 10, onto which the belt may be shifted when the machine is not running. The disk 6 is formed with a T-shaped groove 11 in which is arranged a slidable block 12. A bolt 13 is adapted to be inserted through an opening in the end of the connecting-rod 7 and through a sleeve 14 into a screw-threaded opening in the block 12. By the tightening of this bolt the sleeve 14 is secured to the disk 6 at any desired point in the length of the slot 11. By loosening this bolt and adjusting the block 12 and sleeve 14, along the slot 11, to the desired position, and then tightening said bolt, any desired amount of longitudinal movement or throw may be imparted to the solenoid 2 during the rotation of the disk 6.

Within the solenoid 2 is arranged a core 15 having a stem 16 extending downwardly and to the lower end of which is secured a hammer 17. During the running of the machine the solenoid is constantly reciprocated, the core being dragged along and caused to reciprocate with said solenoid by reason of the tendency of this form of core to assume and maintain a central position relative to the

solenoid whenever an electric current passes through the solenoid. When the work that is to receive the blow is placed upon the anvil 18, the blows will be "cushioned" as between the hammer or core and the solenoid, and thus all injurious shocks to the mechanically-operated parts of the machine are avoided because of the substitution of the yielding magnetic connection between the hammer and the positively-operating parts of the mechanism in place of the positive connections which are used in purely mechanical hammers.

The tendency of the core, in the type of structure now being described, to return to a central position with relation to the solenoid, results in a spring-like action which returns the core to its normal position after each blow. The force of the blow struck by the hammer may thus be regulated by varying the strength of the current within the solenoid. Where, for example, the length of the stroke or travel of the solenoid is less than that of the core which carries the hammer, the momentum of the core and hammer acquired during their downward travel with the solenoid, will tend to carry the hammer and core further than the distance traveled by the solenoid, thereby producing a sharp blow. In proportion as this momentum is resisted by the magnetic pull of the solenoid, the resulting blow will, in such structure, be lightened, and since the strength of the magnetic pull varies with the changes in the current passing through the solenoid, the efficiency of the blow can be varied as stated by varying such current. On the other hand, if the device be so constructed that the travel of the core is the same as, or less than, that of the solenoid, then an increase in the magnetic pull by an increase in the current will tend to increase the efficiency of the blow and the lessening of the current will tend to decrease the force of the blow. The advantage of being thus able to vary the force of the blow struck during the running of the machine, and the advantage of preventing injurious shocks to the mechanism are apparent.

The means by which I vary the strength of the current flowing through the coil of the solenoid is as follows: Secured to the frame of the machine is a rheostat or resistance-box 19. To the arm 20 of the rheostat is secured one end of a rod 21, the lower end of which is secured to a lever 22, this lever forming a treadle adapted to be pressed downward by the foot of the operator. When the lever 22 is moved downward the lever 20 is moved over the contact points 23 of the rheostat and the current passing into the coil of the rheostat is gradually increased so that the tractive effect of the solenoid upon the core 15 is increased. Obviously, when the current flowing in the coil is at its maximum, the blow struck by the hammer may be very heavy if the solenoid and hammer are of considerable weight, and if the objective is arranged to be struck before the solenoid has completed its stroke. With this arrangement a light blow may be struck by the same machine by so regulating the current that a greater slip is permitted between the core and the solenoid. On the other hand, where the momentum of the core is utilized to increase the weight of the blow, a lighter current will give the greater efficiency because with such an arrangement the less magnetic pull there is on the core, the less interference there is with the momentum of the core and hammer and vice versa. My machine, of course, may be so built, if desired, as to permit the regulation of the speed and stroke, as well as permitting the regulation of the force of the blow struck by increasing or decreasing the strength of the current employed in the solenoid.

To assist the solenoid in its return and to relieve the disk 6 and connecting-rod 7 of some of the strain exerted upon them in uplifting the solenoid after the blow has been struck, a spring 3^a may be employed, if desired, having its lower end secured to the frame of the solenoid 3 and its upper end secured to a boss 4^a upon the frame of the machine.

The form of electro-magnet used may be varied without departing from the spirit of my invention, and I have shown in the accompanying drawings two forms of electro-magnet and armature well adapted for this purpose. In the form of electro-magnet and core shown in Figs. 2, 3, 4 and 5, the solenoid consists of a tube 24 preferably of copper or brass or other non-magnetic but conducting material, around which is wound a coil 25. At each end of the coil is a pole-piece 26 consisting of a ring of iron or steel separated from the coil by insulation 27, 27^a. The pole-pieces 26 are connected by yokes 28 in a familiar manner. The core 15 may consist of a plain cylindrical bar of iron, and satisfactory results are obtained with such a core, but better results are obtained with a core made up as shown in the drawings. In this form of core annular slots 29 are provided, adjacent the ends of the core, and in these slots are placed short-circuited or annular conductors consisting of copper rings 30, two or more of these rings being employed at each end of the core. According to well known laws of physics, currents are induced and caused to travel around a core when it is moved through a solenoid, the strength of these currents being proportional to the speed of relative movement between the core and the solenoid. By inserting these copper rings there is provided a path of increased capacity for the induced currents and thereby the strength of such currents and the resultant magnetizing of the core is increased.

Rotating currents are similarly induced in the tube 24 and add their effect to that of the currents induced in the rings.

Suppose now the solenoid be given a downward throw: The tendency of the core, by reason of its inertia and that of the hammer, is to lag behind the solenoid as the latter moves downward so that there is a movement of one of these parts relatively to the other. This movement creates induced currents in the rings 30, these currents flowing in the proper direction to produce poles at the ends of the core of opposite polarity to that of the adjacent pole-pieces 26, the attractive force between the pole-pieces 26 and the core 15 being thus very materially increased. The descending solenoid accordingly draws with it the core and the hammer carried thereby and a blow is struck by the hammer upon the work which is laid upon the anvil 18. The hammer is then suddenly arrested in its downward movement, while the solenoid continues to move downwardly a short distance. The quick downward movement of the solenoid relative to the core causes a sudden and great increase in the induced currents flowing in the rings 30, or, when such rings are not employed, in the iron which these rings are designed to displace, with a correspondingly increased pull upon the core, and a heavy blow upon the work is the result, or else the parts are so adjusted that the solenoid reaches the end of its stroke before the hammer strikes, whereupon the acquired momentum of the hammer carries it sharply against the article to be struck. In such case, the blow is increased by lessening the current. Upon the upward movement of the solenoid the direction of movement of the solenoid relative to the core is suddenly reversed, this reversal resulting in powerful induced currents being set up which cause the core to be instantly picked up and carried upward with the solenoid. In Figs. 8. 9. 10. 11 and 12 is shown another form of electro-magnet and core adapted for this purpose, and in detail some of the parts that are used in making up the same. In this form of electro-magnet I employ an outer casing consisting, for example, of an iron or steel tube 31 closed at its ends by the rings 32 and 33. Arranged within the tube 31 is a series of pole-pieces 34 separated by coils 35, the direction of winding of which is such that the pole-pieces 35 are of alternately north and south polarity. The core is so constructed as to provide a series of poles 36, having a ring-like form and alternating with short-circuited copper conductors in the form of rings 37. These pole-pieces and rings are fitted onto a shaft or stem 39 and are secured together and to the shaft or stem by compression nuts 40 and 41. The pole-pieces are so proportioned and distributed through the length of the core and the length of the solenoid, that the pole-pieces upon the core will always mismate with the pole-pieces upon the solenoid so as to avoid having any one point of maximum "pull" between the core and solenoid poles. When the solenoid is given a movement in either direction, currents are induced in the copper rings by reason of the fact that these rings and the pole-pieces of the core tend, by the inertia of these parts and the hammer carried thereby, to be moved relatively to the pole-pieces of the solenoids. These currents induced in the copper rings 37 magnetize the pole-pieces of the core and cause the latter to be attracted by the pole-pieces of the solenoids.

Because the inertia of the core at the beginning of each upward and downward movement of the solenoid carrier will cause the core to drag behind the solenoid carrier, the lines of force will be cut at right angles at the beginning of each movement, causing resulting induced currents which in accordance with well known laws will vary in intensity in proportion to the rapidity with which the lines of force are so cut, and the resulting magnetic "pull" will be accordingly varied automatically, so as to overcome the inertia of the core and also increase the force of the blow, while at all times maintaining the core in proper operative position within the solenoids.

The above described embodiment of my invention is equally useful for drills or other percussion implements, while obviously my invention can be adapted for use as a dash pot, or a door cushion, where either the core or the solenoid is held against longitudinal movement.

The invention may be said to consist broadly in combining with a reciprocable device or tool, means for imparting reciprocating motion thereto through mechanical means, and a magnetic device to vary or qualify the movements of the tool resulting from the mechanical application of force. By describing the reciprocation of the tool as being effected by mechanical means, I refer merely to the immediate application of the force to the tool. The ultimate source might be derived from any sort of driving device or natural force. This force may be applied directly to the tool or tool-carrying member, or it may be applied indirectly thereto. I have shown and described a device in which the mechanical force is applied indirectly to the tool-carrying member through the magnetic relationship between such member and the electro-magnet to which the force is actually applied. It will be clear that other arrangements might be devised which would accomplish the same results in the same general manner and by the application in a different embodiment of the broad features of my invention.

The invention involves the use of two members having the relation of magnet and armature. One of these members carries the tool or other device to be reciprocated. In the form of apparatus here shown, the tool is carried by the armature and, since the mechanical force is applied to the magnet, it is clear that both of these members must be capable of reciprocation together. Such need not be the case if a different arrangement of the parts were utilized in carrying out the invention as, for example, if the mechanical force were applied directly to the armature or the tool carried by the magnet. Any form of magnet, electro-magnet or permanent magnet, might be used.

In view of the above, it will be clear that I do not wish to be limited to the exact devices and arrangements herein shown and described, as above suggested or other obvious modifications will occur to persons skilled in the art.

I claim:

1. The combination with a reciprocating device, of a driving device for the same, and cushioning means arranged to operate upon the reciprocating device in opposition to the momentum produced by the driving device, said cushioning means comprising an electrically energized coil and a core for said coil, one of the same connected with the reciprocating device.

2. The combination with a reciprocating device, of an electrically energized coil, a core for said coil, one of the same being connected with the reciprocating device, and a driving device operating to drive said reciprocating device against the attractive force existing between the coil and the core.

3. The combination with an electro-magnet, of means for reciprocating the same, an armature arranged to reciprocate within the field of said magnet, and percussion means carried by said armature, all so arranged that while the attraction of the magnet for said armature will cause the armature to travel with the magnet, the momentum thus acquired by the armature will cause it to travel farther than the distance covered by the stroke of the magnet, but without losing magnetic connection with the magnet.

4. The combination with a reciprocating member adapted to impart a blow to a stationary object, of means for cushioning said blow, said means comprising an electro-magnet and an armature therefor adapted to assume a given position relative to each other and to be moved from said position by the force of impact.

5. The combination with a reciprocating device, of a driving device for the same, and cushioning means arranged to operate upon the reciprocating device in opposition to the momentum produced by the driving device, said cushioning means comprising an electrically energized coil and a core for said coil, one of the same connected with said driving device.

6. The combination with a mechanically-reciprocated solenoid, of a percussion device carried by an armature for said solenoid in the form of a core adapted to be reciprocated within said solenoid, all so arranged that the momentum of the armature and percussion device carried thereby will give the armature a relative movement with relation to the solenoid.

7. The combination with a mechanically-reciprocated solenoid, of a percussion device carried by an armature for said solenoid in the form of a core adapted to be reciprocated within said solenoid, all so arranged that the momentum of the armature and percussion device carried thereby will give the armature a relative movement with relation to the solenoid, and means for varying the current supplied to the solenoid, whereby the electro-magnetic effect of the solenoid on the armature will be varied.

8. The combination with an electro-magnet, of an armature adapted to reciprocate therein and carrying an impact device and means other than said electro-magnet for imparting reciprocating movement to said device, all so constructed and arranged that while the armature may be reciprocated within the electro-magnet, the magnetic action of the electro-magnet will tend to return the armature to its initial position.

9. The combination with an electrically energized coil, of a core adapted to be reciprocated with said coil, and mechanically operating means connected with said coil and arranged to reciprocate the same.

10. The combination with a percussion tool, of tool-carrying means with which the tool is connected, a driving device to drive the tool-carrying means alternately in opposite directions, and cushioning means in opposition to which the tool-carrying means is moved, said cushioning means comprising an electro-magnet and its armature.

11. The combination with a mechanically-reciprocated percussion device, of means for cushioning the shock of impact, said means comprising an armature and solenoid tending to assume a given position relative to each other and adapted to be moved out of said position against said tendency by the force of the blow delivered.

12. The combination of an electro-magnet, an armature, said members movable together, a driving device connected with one of said members adapted to drive the same alternately in opposite directions, and an impact device carried by the other of said members.

13. The combination of an electro-magnet, an armature for said electro-magnet, said magnet and armature movable together, a

driving device connected with the armature adapted to drive the same alternately in opposite directions, and a tool carried by said armature.

14. The combination of a mechanically-reciprocated electro-magnet, an armature arranged to reciprocate with the magnet and to be in the field of said electro-magnet, and a percussion tool carried by said armature.

15. The combination of a mechanically-reciprocated electro-magnet, an armature arranged to reciprocate with the magnet and to be in the field of said electro-magnet, a tool carried by said armature, and means for varying the strength of the electro magnet during the reciprocation thereof so as to vary the movements of the magnet and armature relative to each other.

16. The combination of a mechanically reciprocated electro-magnet, a core for the same of magnetic material, a tool carried by said core, and a plurality of short-circuited conductors around the core having greater conductivity than the body of the core, whereby the attractive force between the coil and core is increased by their relative movements.

17. The combination of a mechanically-reciprocated electro-magnet, an armature free to reciprocate with the electro-magnet and tending to maintain a given position relative to said electro-magnet, percussion means carried by said armature, and means for varying the pull of the electro-magnet upon the armature.

18. The combination with an electro-magnet and its armature, of means for reciprocating one of said members the other being free to reciprocate therewith, percussion means carried by the other of said members, and means for varying the pull exerted by one of said members upon the other during the running of the machine.

19. The combination with an electro-magnet and its armature, of means for reciprocating one of said members the other being free to reciprocate therewith, percussion means carried by the other of said members, means for varying the pull exerted by one of said members upon the other during the running of the machine, and means for adjustably varying the length of the stroke of the mechanically-reciprocating part.

20. The combination with a solenoid and core said solenoid and core free to move together, of percussion means carried by one of said members, means for reciprocating the other of said members, and means for varying the current in the solenoid.

21. The combination with a solenoid and core, of a percussion device connected with one of said members, and driving means connected with the other of said members adapted to drive said last-named member alternately in opposite directions, the member carrying the percussion device being connected with the driving means only through the attractive force existing between the solenoid and the core.

22. The combination with two members adapted to have reciprocating movement relative to each other, of means for imparting movement to one of said members, means for varying the amplitude of vibration of one of said parts past the other, said means comprising an electro-magnet carried by one of said members and an armature therefor, carried by the other of said members, and means for varying the strength of the electro-magnet.

23. The combination with an electro-magnet and armature free to move together, of means for reciprocating one of said parts, an impact tool carried by the other of said parts, and short-circuited conductors on said armature adapted to have currents induced therein by the movements of the electro-magnet and armature relative to each other, said currents increasing the tractive effect of the reciprocated part upon the tool-carrying part.

24. The combination with a solenoid and core free to move together, of means for reciprocating one of said parts, impact means carried by the other of said parts, and short-circuited rings in said core adapted, by the movements of the core within the solenoid, to create induced currents which increase the attraction between the core and the solenoid.

25. The combination of a solenoid, a core of magnetic material reciprocating in said solenoid, and rings surrounding said core, said rings being composed of material of greater electrical conductivity than the material of the core, and having currents induced within themselves by the changes of position of the core and solenoid relative to each other, whereby the pull exerted by one of said parts upon the other is increased.

26. The combination with a shell of magnetic material adapted to provide pole-pieces at its end, of a solenoid arranged to magnetize said pole-pieces, a tool-carrying armature arranged within the magnetic field of said pole-pieces and adapted to be reciprocated within said shell and past said pole-pieces alternatively, and means for reciprocating said shell.

27. The combination with a shell of magnetic material adapted to provide pole-pieces at its end, of a solenoid arranged to magnetize said pole-pieces, a tool-carrying armature arranged within the magnetic field of said pole-pieces and adapted to be reciprocated within said shell and past said pole-pieces, said core being provided with rings of higher electrical conductivity than the body of said

core, which rings are mounted upon said core at a point adjacent to said pole-pieces, and means for reciprocating said shell.

28. A device of the class described comprising a plurality of solenoids with pole-pieces of alternating polarity interposed therebetween, a core adapted to be reciprocated within the magnetic fields of said pole-pieces, said core being provided with a plurality of pole-pieces alternating with bands of material of higher electrical conductivity than said pole-pieces, the pole-pieces on said core being of different superficial area from the pole-pieces between said solenoids, and means for simultaneously reciprocating said solenoids.

29. An electro-mechanical device comprising the combination of an electro-magnet composed of a plurality of solenoids connected to each other and secured together, with alternating pole-pieces of a cylindrical core adapted to reciprocate within said electro-magnet, said core being of greater length than said electro-magnet, a tool carried by said core, and means for reciprocating said electro-magnet, all so arranged that the core and the tool carried thereby will be reciprocated by the pull of the electro-magnet on said core, while said core will be given a movement relative to said magnet by its acquired momentum due to the reciprocation of said magnet.

30. An electro-magnetic spring consisting of an electrically energized solenoid, and a core, mechanical driving means whereby said core is caused to reciprocate against the attractive force of the solenoid but within the influence thereof, so as always to be returned to an initial position by the magnetic attraction therefor of said solenoid.

31. The combination with a reciprocable device, of means for imparting reciprocating movement to said device through the application of mechanical force, and a magnetic device to vary the effect on the reciprocable device of the mechanically applied force.

32. The combination with an electro-magnet and armature, of a tool carried by one of said members, and means for reciprocating said tool-carrying member in opposition to but within the sphere of influence of the attractive force of the magnet through the application thereto of mechanical force.

33. The combination with an electro-magnet and armature, of a tool carried by one of said members, means for reciprocating said tool-carrying member through the application thereto of mechanical force, and means for varying the strength of the electro-magnet during the reciprocations of the tool.

34. The combination with an electro-magnet and armature, of a tool carried by the armature, and means for reciprocating the magnet and armature together, the armature being provided with a plurality of short-circuited conductors of greater conductivity than the body of the armature, whereby the attractive force between magnet and armature is increased through the currents induced in said conductors by relative movement of said core and armature.

35. The combination with an electro-magnet and armature, of a tool carried by one of said members, means for reciprocating said tool-carrying member through the application thereto of mechanical force, and short circuited conductors on the armature to increase the tractive force of one of said members upon the other.

36. The combination with a reciprocating device, of a driving device therefor, and an electro-magnetic device in opposition to the attractive force of which the reciprocating device is driven, whereby the resultant movement of the reciprocating device is modified.

37. The combination with a tool, of a tool-carrier comprising two members connected so that one is capable of movement of reciprocation with respect to the other, a driving device adapted to drive said carrier back and forth, and an electro-magnetic device, the magnet and armature of which are connected respectively with the two members of the tool-carrier, whereby an elastic connection is effected between the tool and the driving device.

38. The combination of a driving part, a driven part and a cushioning magnetic connection between the same.

39. The combination of a driving part, a tool reciprocated by said part, and a cushioning magnetic connection between said part and said tool.

40. The combination of an electric driving part, a tool reciprocated by the same, and a cushioning magnetic connection between said tool and said part.

41. The combination of an electric driving part comprising a coil, a tool reciprocated by said coil, and a cushioning magnetic connection between said tool and said coil.

42. The combination with the rotor of an electric driving part comprising the coil driven by said rotor and the tool received in and reciprocated by said coil, the parts being so arranged as to form a cushioning magnetic connection between the said tool and the said coil.

GEO. H. ROWE.

Witnesses:
C. L. HOPKINS,
G. Y. SKINNER.