C. S. DU BELLE.

SOLENOID.

APPLICATION FILED MAR. 29, 1910.

1,195,449.

Patented Aug. 22, 1916.

2 SHEETS—SHEET 1.

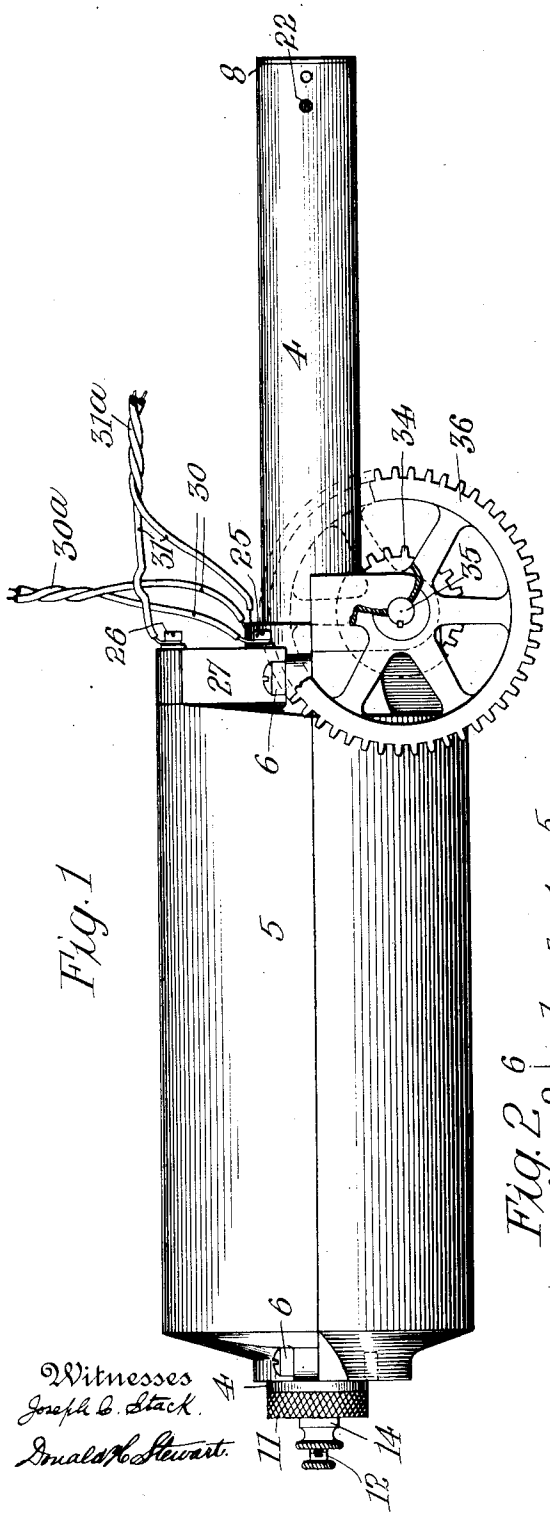


Fig. 1

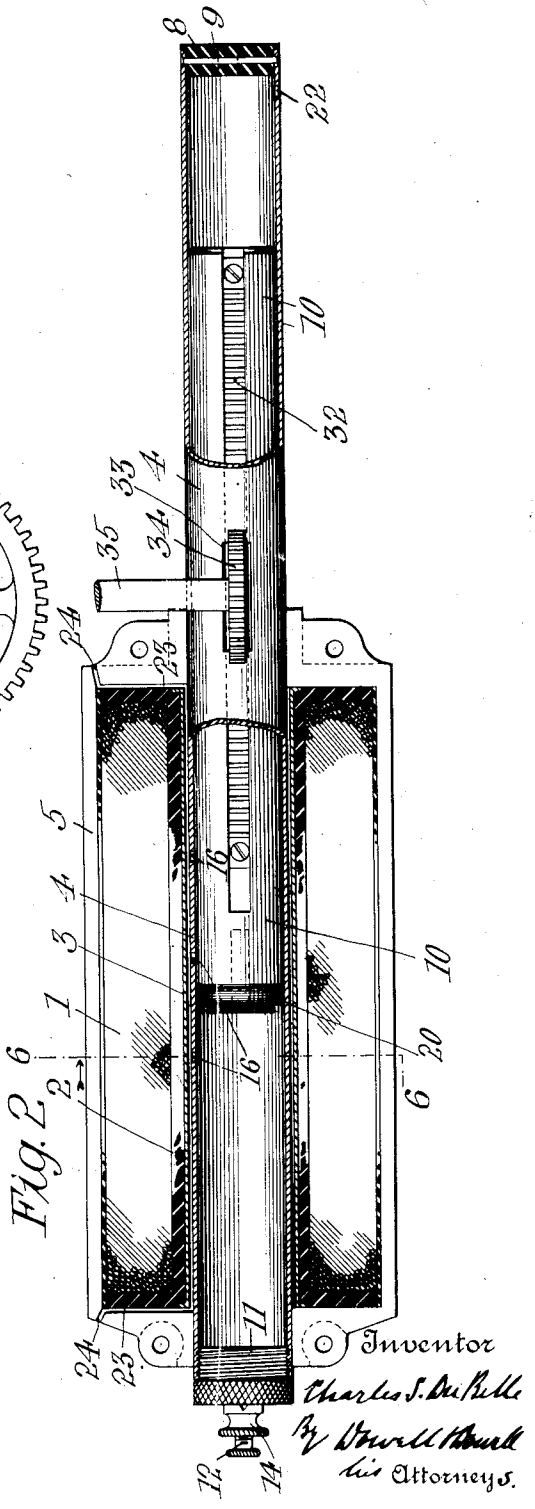


Fig. 2

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2 SHEETS—SHEET 2.

Fig. 3

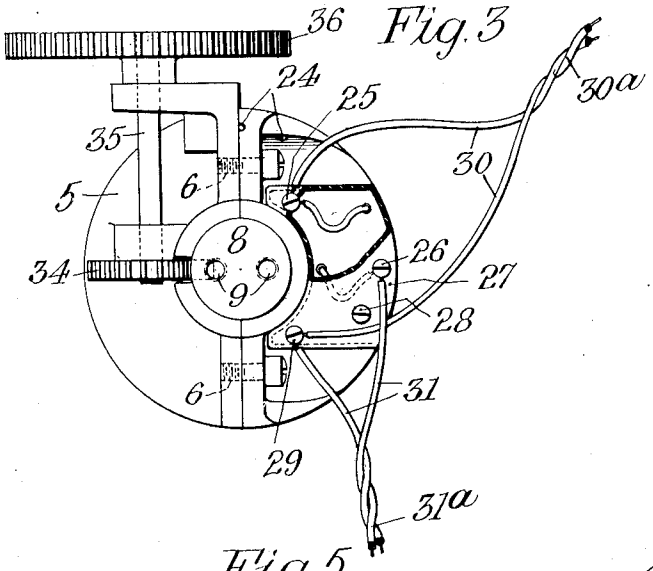


Fig. 4

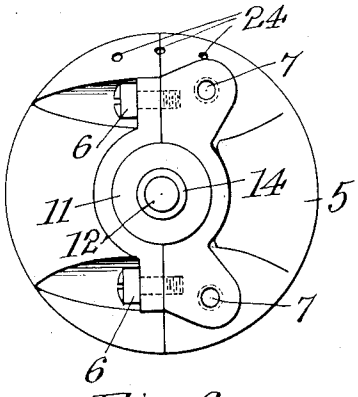


Fig. 5

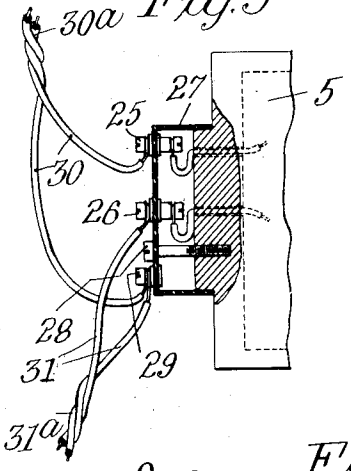


Fig. 6

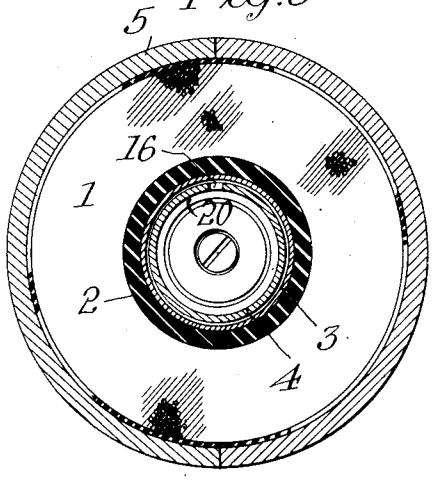


Fig. 7

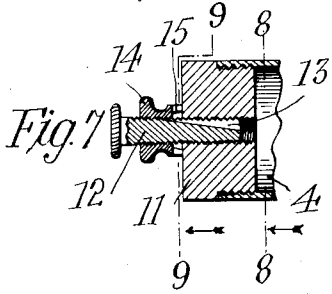


Fig. 8

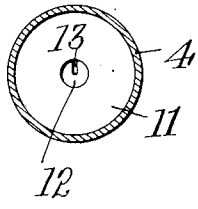


Fig. 9

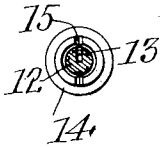


Fig. 10

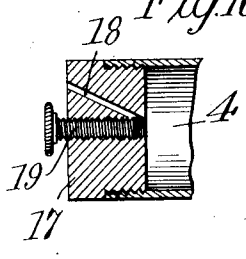
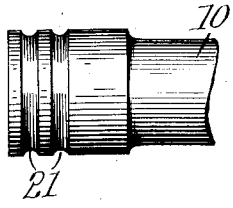


Fig. 11



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UNITED STATES PATENT OFFICE.

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SOLENOID.

1,195,449. Specification of Letters Patent. Patented Aug. 22, 1916.

Original application filed June 8, 1909, Serial No. 500,817. Divided and this application filed March 29, 1910. Serial No. 552,280.

To all whom it may concern:

Be it known that I, CHARLES S. DU BELLE, a citizen of the United States, residing at Williamsport, in the county of Lycoming and State of Pennsylvania, have invented certain new and useful Improvements in Solenoids, of which the following is a specification.

This invention, for which the present application is filed as a division of my application Serial Number 500,817, filed June 8, 1909, for improvements in electrically-operated typewriters, relates to an improved solenoid which is shown and described in my said former application as the motive means for returning the typewriter-carriage to starting position, but is adapted for many other purposes for which solenoids are or may be used.

The main object of the invention is to provide a solenoid in which the core or armature, when attracted into the coil, will have a quick or unimpeded movement for the major portion of its stroke but will be air-cushioned at the latter part of the stroke and brought gently and silently to a full stop; thereby providing a reliable and efficient means for effecting a quick shift or movement of the carriage of a typewriter or other machine and stopping the same accurately and noiselessly, without shock, jar or vibration, and without tendency to rebound.

A further object is to provide for ventilating and cooling the solenoid by causing a circulation of fresh air around the coil at every inward movement of the armature, and venting the heated air, thus preventing the coil from becoming unduly heated and thereby damaged.

Other objects are to provide improved means for housing and supporting the solenoid, for transmitting motion from the armature to the carriage or other instrumentality or mechanism operated thereby, and for conveniently making electrical connections with the source of electrical supply.

The invention will be hereinafter described with reference to the accompanying drawings, and particularly pointed out in the claims annexed to this specification.

In said drawings: Figure 1 is a plan view of an apparatus embodying my improvements. Fig. 2 is a longitudinal vertical sectional elevation thereof. Fig. 3 is an end view. Fig. 4 is the opposite end view. Fig. 5 is a cross section through the box supporting the electrical connections, which is shown in Fig. 4. Fig. 6 is a cross-section of the solenoid on line 6—6 of Fig. 2, the coil and its casing being diagrammatically indicated. Fig. 7 is a detail sectional view of the plug closing one end of the tube containing the core or armature, showing the air-controlling screw and its lock-nut. Fig. 8 is a cross-section on line 8—8 of Fig. 7. Fig. 9 is a detail sectional view of the air-screw and lock nut taken on line 9—9 of Fig. 7. Fig. 10 is a detail sectional view of the aforesaid plug with a modified form of air-controlling means. Fig. 11 is a detail view of the head end of the armature, showing a different form of plunger-head from that shown in Fig. 2.

1 denotes an electromagnetic helix or solenoid suitably insulated and wound of wire of suitable gage adapted for connection with a source of electric supply, either a battery or power circuit. The coil is wound upon a spool 2 of insulating material, said spool being fitted on a sleeve 3 preferably of non-magnetic metal and having end flanges between which the spool is confined. Within the sleeve 3 is a tube 4, also preferably of non-magnetic metal, which projects through and beyond one end of the solenoid to provide a support and guide for the core or armature as the latter is drawn out by the movement in one direction of the mechanism to which it is connected, as, for example, by the feed movement of a typewriter carriage under the action of its spring.

As shown the solenoid is contained in and held by a two-part case 5, from which it is suitably insulated; said case comprising semi-circular half-parts bolted together at their ends by the screw-bolts 6. The tube 4, which in this preferred embodiment of my invention is of slightly smaller outside diameter than the inside diameter of the sleeve 3, is secured in and centered by the hub-like ends of the case. At the end of the case opposite the projecting portion of the tube, the respective half-parts of the case are or may be provided with tapped holes 7 to receive fastening screws for attachment to any suitable supporting bracket; while the far end of the tube 4 is or may be closed by a plug 8, preferably of non-metallic or insulating material, having similar holes 9 for a like purpose. This makes an excellent con-

struction for housing and supporting the solenoid and adapting it for attachment to a typewriter or other machine.

The core or armature 10 may be operatively-connected with the mechanism to be actuated thereby by any appropriate means, but preferably by a direct gear connection as hereinafter described, especially when the solenoid is employed for shifting the carriage of a typewriter or other machine, or any reciprocatory part.

To provide an air cushion for the core or armature which will be inactive thereto during a part of its inward movement and active for the remainder of the stroke, and yet allow the core to finish its stroke before coming to a stop, the following construction is provided: That end of the tube 4 toward which the core moves when attracted into the coil is closed by a plug 11, preferably a detachable screw-plug, having a longitudinal threaded bore in which is inserted a screw 12. Said screw has a slit or channel 13 therein for the admission and exit of air into and from the cushion end of the tube. A lock-nut 14, having a slit or channel 15 in communication with the air-passage 13 in the screw 12, is or may be screwed upon the latter to adapt it to be adjusted and locked in different positions so as to vary and control the volume of air admitted into the tube as the core is drawn out; the screw 12 thus constituting an adjusting valve for controlling the effectiveness of the air cushion, in order to secure the best results under varying conditions in practical use. As before mentioned, the tube 4 is of somewhat smaller outside diameter than the inside diameter of the sleeve 3, leaving an air space between them, which is in communication with the atmosphere; and within the solenoid the tube is provided with a series of apertures or ports 16 establishing communication between said air space and the interior of the tube. Said ports are located a suitable distance from the closed end of the tube and properly spaced to render the air cushion inactive or ineffective during a portion of the inward movement of the core and active for the remainder of the stroke; so that, when the core is attracted into the solenoid, the air which has filled the tube will be expelled through both the screw 12 and the several ports 16 until the core reaches the port nearest the screw, whereupon the air confined in the imperforate portion of the tube is prevented from escaping fast enough to avoid compression and brings the solenoid, and thereby the carriage or other mechanism connected to it, gently and silently to a full stop, without shock or jar.

The form of the air-screw 12 may be varied, and, instead of providing a passage in the screw itself and a lock-nut thereon, as shown in Fig. 7, the plug 17 may be provided with an air passage 18 extending at an angle to and communicating with the threaded opening through the plug in which a plain screw 19 may be inserted for regulating the admission and escape of air, as shown in Fig. 10.

The head of the core may be in the form of any ordinary piston-head, or it may be air-packed in the same manner that the pistons of pumps are water-packed. In Fig. 2 the head of the core is shown provided with a cupped washer 20, affixed thereto preferably by a leather disk and screw. The leather disk or washer serves a two-fold purpose: first, it is put on just the right size to keep the cupped packing washer out in position to catch the air properly; second, it acts as a bumper and prevents the two metal parts, the armature and the plug, from coming in contact; without this the armature and plug, being charged with electricity after a few operations, would stick together and it would require quite a strong pull to separate them. The screw head is sunk in the leather washer or disk. Instead of leather any other suitable non-magnetic material may be used. In Fig. 11 the core, made smaller than the bore of the tube, has an enlarged head provided with annular grooves 21 for air-packing purposes; it being understood that as the core completes its stroke, and the air pressure increases in the air pocket at the end of the tube, a certain amount of air will escape around the edges and find its way into the grooves 21 and air-pack the head. Assuming, for example, that the core of the solenoid is operatively-connected with a typewriter carriage, then as the core is slowly drawn out by the intermittent feed movement of the carriage, as its actuating-spring is released by depression of the keys, air will be admitted into the tube 4 through the passage in the screw 12, and also through the ports 16 as they are successively uncovered by the receding head of the core; and no air resistance is encountered, since sufficient air may enter freely behind the core, and the air in front of the core may escape through a slot in the tube hereinafter referred to and also through a vent hole 22 at the outer end of the tube. When it is desired to return the carriage, the solenoid is energized by closing a switch (not shown) in circuit therewith, whereby the core or armature is attracted into the coil and moves back rapidly, expelling the air both through the screw 12 and the ports 16 until the head of the core passes the last of the ports, after which the air confined in the imperforate portion of the tube can escape only in regulated quantity through the small passage in the screw 12, thus cushioning the core while at the same time regulating the air pressure so as to check its movement gently and bring the core, and thereby the

carriage, quickly and accurately to a full stop without shock, jar or rebound.

The air ports 16 in the tube 4 and the slit 13 in the screw 12 are so proportioned as to permit a rapid in-stroke of the sliding core until within the last second of its travel, whereupon the air cushion becomes effective to gently check and stop its movement; thus insuring a quick return of the carriage and stoppage at the desired point without noise or vibration. The construction of the solenoid and its housing also provides for automatic air-cooling or ventilation of the solenoid by causing a circulation of fresh air around the coil at every operation; the air space between the tube 4 and sleeve 3 being in communication with the spaces 23 between the heads of the spool 2 and ends of the case 5, which spaces 23 are provided with vent holes 24 preferably at the top of the case; so that on the outward movement of the core or armature air is drawn into the tube through the ports 16, being taken from the holes 24; and on the return stroke the air is forced out through the ports 16 into the annular space between the tube and sleeve and passes thence into the spaces between the solenoid and its case, circulating around the solenoid and escaping through the holes 24; thus causing the heated and foul air to pass off and a fresh supply to be drawn in at each operation, which prevents the coil from becoming unduly heated and thereby damaged. While the ports 16 in Fig. 2 are for convenience shown at the top side of the tube, in practice such ports are preferably located in the side of the tube, so that the air escaping therethrough will circulate around the tube inside the sleeve 3 and finding its way toward both ends will escape through the air space between the ends of the solenoid and inner walls of the case, and thence at the top of the case through the holes 24, and also through the crevice between the adjoined half-parts of the case if not finished to a ground joint; and in the latter event additional holes may be provided if desired along the line of separation by forming confronting notches in the edges of the half-boxings of the case.

For operating the solenoid, any suitable electrical connection may be employed, including a switch to open and close the circuit through the solenoid; but I prefer the construction shown in Figs. 3 and 5, wherein the two binding posts 25 and 26, with which the terminals of the coil are connected, are attached to and extend within a box or cap 27, preferably of rubber, detachably affixed upon the end of the case 5 by a cap-screw 28. Said cap also carries a binding post 29, and the wires 30 of a cord 30^a, leading from the source of electric supply, are connected respectively to the binding posts 25 and 29, while the wires 31 of a cord 31^a, leading to any suitable switch, are connected respectively to the binding-posts 26 and 29. This permits a direct attachment by a cord and plug to any ordinary electric lamp socket.

To provide a direct positive gear connection between the core or armature and the carriage of a typewriter or other machine to be shifted thereby, a rack 32 is placed in a longitudinal slot therefor in the core, being secured thereto by set screws; and through a short slot 33 in the tube 4 the said rack engages with a pinion 34 on a stub-shaft 35 which is journaled in bracket-bearings therefor on the case 5 and carries a gear wheel 36 for engagement by a rack (not shown) on the carriage. This makes a very efficient and compact construction, the gears being arranged close to the solenoid; and power can thus be transmitted directly from the armature to the carriage operated by the solenoid when the latter is located immediately behind, above or beside the carriage; so that the transmission mechanism, in conjunction with the means for supporting the solenoid, adapts the device for mounting directly upon a typewriter or other machine in a compact and practicable manner.

As changes may be made in the details of construction and arrangement of parts without departing from the principle and scope of my invention, I do not restrict myself to the specific construction herein selected for illustration.

I claim as my invention and desire to secure by Letters Patent:

1. A solenoid having a tube for the reciprocatory core which is provided with an end closure and with apertures spaced from said closure, leaving the tube imperforate for a part of its length, and a chamber external to said tube communicating with the atmosphere and with the interior of the tube through said apertures, for the purpose described.

2. A solenoid having a tube for the reciprocation of the core or armature and provided with an air space around said tube in communication with the atmosphere, said tube having an end closure and provided with a series of ports spaced at different distances therefrom, substantially as and for the purpose described.

3. A solenoid having a tube for the reciprocation of the core or armature and provided with an air space around said tube in communication with the atmosphere, said tube having an end closure provided with a restricted air passage, and the tube being provided with an air port or ports spaced from said closure and for establishing communication with said air space.

4. A solenoid having a central tube provided with a closure at one end and with perforations spaced therefrom, a sleeve en-

circling said tube and providing therebetween an air space in communication with the atmosphere and adapted to communicate with the interior of the tube through said perforations, and a core or armature working in and whose head fits said tube.

5. In combination with a solenoid having a reciprocating core, a tube of non-magnetic material in which said core is fitted, said tube having a series of perforations therein communicating with an air-space around the tube a closure for the end of the tube spaced from said perforations to provide an air-cushion, said closure consisting of a plug having an opening therethrough and an exteriorly threaded bolt screwed into said opening and slitted longitudinally to provide an air passage, together with a lock-nut on said threaded bolt having a transverse slit or air-passage in communication with the slit in said bolt, whereby the latter may be adjusted and locked in different positions for regulating the admission of air.

6. In combination with the solenoid having a piston-like reciprocating core, a tube of non-magnetic metal in which said core slides, said tube being imperforate for a considerable portion of its length near one end only and provided beyond said imperforate portion with spaced perforations and an adjustable air-screw at the end thereof farthest from said perforation for controlling the admission of air behind the piston, said air-screw being spaced from said perforations by said imperforate portion of the tube.

7. A solenoid having a non-magnetic tube in which works the core or armature, said tube provided with an end closure to furnish an air cushion for the inward stroke of the core, and air passages around the tube communicating with the atmosphere and with air ports in said tube, whereby a circulation of fresh air for cooling the coil is effected at every reciprocation of the core.

8. A solenoid having a case inclosing it and a central non-magnetic tube in which works the core or armature, said tube being provided with an end closure to establish an air cushion on the return stroke of the core, there being an air space between said tube and the spool on which the coil is wound, spaces communicating therewith between the solenoid and interior of the case, said spaces having vent openings to the atmosphere, and air ports in the tube for establishing communication between its interior and the air space surrounding it, whereby a circulation of fresh air is effected around the solenoid at every operation of its core.

9. A solenoid having a central non-magnetic tube supporting the core or armature and extending beyond one end of the solenoid and a two-part case inclosing the solenoid and comprising half-boxes and fastenings therefor, that end of the case opposite the projecting portion of the tube being provided with means for attachment to a supporting bracket, and the outer end of the projecting portion of the tube being provided with means for a like purpose.

10. A solenoid having a tube inclosed thereby and projecting beyond one end thereof and there provided with a longitudinal slot, and a core or armature movable in said tube and provided with a longitudinal rack accessible through the slot in the projecting portion of the tube.

11. A solenoid having a tube inclosed thereby and projecting beyond one end thereof, a case inclosing the solenoid, a core or armature working in said tube, a longitudinal rack on the core, and power-transmission gearing comprising a stub-shaft journaled in bearings therefor on one end of the case and having a pinion meshing with said rack through a slot in said tube.

12. A solenoid having a central non-magnetic tube for the core or armature projecting beyond an end of the solenoid, and a two-part case inclosing the solenoid comprising half-boxes and fastenings therefor, said case having hub-like ends holding, centering and securing the said tube.

13. In combination, a solenoid having an internal casing, and a core having an external casing, said core casing having end closures and fitting within said solenoid casing so as to provide an air space therebetween, and a series of air ports spaced at intervals along the wall of said core-casing.

14. In combination, a solenoid, a core, a casing for said core closed at both ends and smaller than the bore of the solenoid, an adjustable valve at one end of the casing, the latter having an air port at its other end and a series of air ports therein between its ends opening into the air space between the solenoid and the core.

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

CHARLES S. DU BELLE.

Witnesses:

F. E. BRADLEY,

A. H. BLOOMFIELD.