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DOUBLE-ACTING SOLENOID

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Fig. 1.

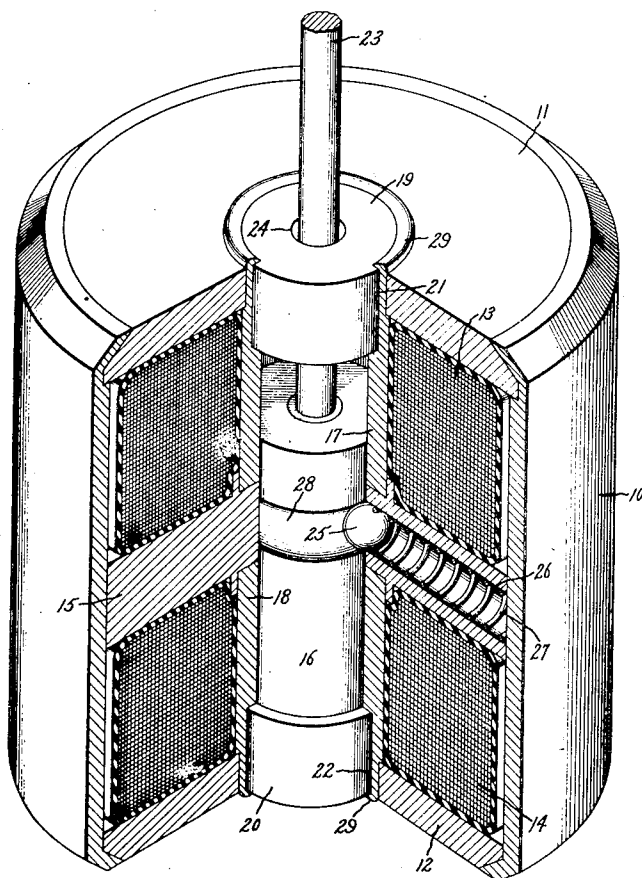
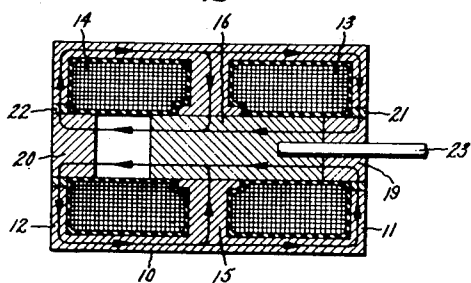


Fig. 2.



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DOUBLE-ACTING SOLENOID

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6 Claims. (Cl. 175—337)

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My invention relates to double acting solenoids and has for its object an arrangement of air gaps between the movable armature and its associated magnetic parts giving more efficient utilization of the magnetic flux.

In electromagnets permanent air gaps are introduced in the magnetic circuit primarily for the purpose of overcoming residual magnetism remaining after the coil of the magnet is deenergized, which residual magnetism tends to hold the armature in its attracted position. In a double acting solenoid, i. e., an electromagnet provided with two coils for moving an armature between two positions, the provision of a conventional permanent air gap in the common flux path between the two coils disproportionately weakens the effective magnetic flux because of the fact that the outer portion of the flux path of the coil that is deenergized forms a parallel flux path for the coil that is energized, which parallel flux path opposes movement of the armature.

In carrying out my invention in one form I provide a permanent air gap in each of the two parallel portions of the magnetic flux paths with no air gap in the flux path common to the two coils. Thus the air gap in the outer flux path for the coil which is deenergized serves to decrease the flux through this path and cause more of it to flow through the common path whereby the effective magnetic force is increased.

For a more complete understanding of my invention, reference should be had to the accompanying drawing, Fig. 1 of which is a view in perspective with a part cut away to show details of construction; while Fig. 2 is a diagrammatic view in section showing the magnetic flux paths.

Referring to the drawing, in one form of my invention I provide a cylindrical outer enclosing member 10 having at its opposite ends disc members 11 and 12, these members being made of magnet core iron and forming part of the magnetic circuits as well as an enclosure for the two coils 13 and 14 positioned in end to end axial alignment. At the middle of the cylindrical member 10, I provide a third disc-shaped member 15 made of magnetic core iron having its outer edge in engagement with the inner surface of the cylindrical member 10 so as to be in good flux conducting relation therewith.

At its center the disc 15 is provided with an aperture slightly larger than a cylindrical plunger armature 16 extending through the aperture and movable freely therein in slidable engagement with the wall of the aperture back and

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forth axially of the coils. The clearance between the plunger and the aperture in the disc is such that it presents a minimum of reluctance to the flux conducting relation between these members.

Also forming guides for the armature are two cylindrical members 17 and 18 having bores slightly larger in diameter than the armature 16 and made of a non-magnetic material such as copper or brass. These non-magnetic members extend through apertures provided for them in the end discs 11 and 12, respectively, and respectively form air gaps between the discs and short cylindrical magnet core members or plugs 19 and 20. These last-named air gaps are substantially greater in length than the length of the air gap between the plunger armature 16 and the aperture wall of the disc 15. As shown, the members 19 and 20 are seated in the countersunk outer ends of the tubes 17 and 18 thereby to leave air gaps of desired widths or lengths between them and the discs. Thus the tube 17 provides an air gap 21 at its upper end while the tube 18 provides an air gap 22 at its lower end.

It will be observed that the magnetic core members form a three-legged core having a middle leg 15 and two outer or end core legs 11, 19 and 12, 20 joined by the cylinder 10.

The armature 16 is movable back and forth between the two end plugs 19 and 20, the amount of its movement being indicated by the space between the upper end of the armature and the lower end of the plug 19. Secured to the upper end of the armature is a rod 23 which extends through an aperture 24 in the plug 19. Thus movement of the armature back and forth effects operation of a device or part connected to the rod 23.

The advantage of providing air gaps 21 and 22 in the two end flux paths only and not in the common central flux path between the disc 15 and the armature is indicated in Fig. 2. As shown in Fig. 2, the armature is in its attracted position toward the right hand, to which position it has been moved by energization of the coil 13. It will be understood that the coils may be connected selectively to a suitable source of electric supply through suitable switches (not shown) which may be manually operated. In order to move the armature toward the left, as seen in Fig. 2, back to its other attracted position, the coil 14 is energized, the coil 13 being deenergized, whereby a magnetic flux is set up by the coil in the flux paths, as indicated by the full lines, and in relative directions such as indicated by the arrows. It will be observed that neglecting

stray flux the entire flux set up by the coil 14 flows axially of the coil, across the air gap 22 and back through the end disc 12 and cylinder 10. A large portion of this flux returns to the coil through the central disc 15 and the armature, but a relatively small portion takes the parallel flux path through the right-hand end of the cylinder 10, the disc 11, across the air gap 21 and through the plug 19 and the armature back to the coil 14.

It will be observed that the air gap 21 in the parallel flux path serves very greatly to increase the reluctance of this path to the flow of magnetic flux and therefore decreases this parallel flux by causing a larger portion to pass directly through the central disc 15 to the armature. This parallel flux, it will be observed, is a disadvantage because it sets up an opposing attractive force between the plug 19 and the adjacent end of the armature 16. This force tends positively to hold the armature against movement toward the left hand.

In a similar manner, when the armature is in its left-hand position and the coil 13 is energized, the coil 14 being deenergized, to move it toward the right hand, as seen in Fig. 2, the air gap 22 serves to decrease the parallel magnetic flux and make available a larger proportion of the magnetic flux for movement of the armature.

I have also provided a latch for holding the armature in at least one attracted position, this latch comprising a ball 25 movable in a radially extending aperture 26 in the central disc 15 and forced by a helical spring 27 against the surface of the armature. A groove 28 is provided in the armature in such a position that when the armature is in its lowermost attracted position, as shown in Fig. 1, the ball moves into the groove and latches the armature in that position.

As shown, the outer ends of the non-magnetic tubes 17 and 18 are spun over at 29 and 30 onto the plugs 19 and 20 to form tight joints therewith. Also, the discs 11 and 12 are seated in countersunk holes in the ends of the cylinder 10 and the end walls of the cylinder are spun over to form tight joints.

While I have shown a particular embodiment of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A double acting solenoid comprising a unitary armature movable between two positions, a magnet core made of metallic material for said armature provided with a middle leg in engaging magnetic flux conducting relation with an intermediate portion of said armature and with an outer leg at each end of said armature selectively into abutting engagement with which said armature is movable, said outer legs being each provided with a non-magnetic gap, and two coils on said magnet core selectively energizable to move said armature from one position to the other, said middle core leg forming a common magnetic path for said coils and said air gaps in said outer legs being alternately effective to decrease the magnetic flux opposing movement of said armature.

2. A double acting solenoid comprising a unitary plunger armature, a magnet core made of metallic material for said armature supporting said armature for endwise movement between two

positions, said core being provided with a middle leg forming a slidable support for said armature and with two outer legs on opposite ends of said armature into abutting engagement with which said armature is movable, a portion made of non-magnetic material in each of said outer legs forming an air gap, and two coils on said magnet core surrounding said armature and selectively energizable to move said armature from one position to the other, said middle core leg forming a common magnetic path for said coils and said air gaps in said outer legs being effective to decrease the magnetic flux opposing movement of said armature.

3. A double acting solenoid comprising a cylindrical magnet core member made of magnetic material, a disc core member secured centrally in said cylindrical core member provided with an aperture, a unitary plunger armature slidably mounted in said aperture for endwise movement between two positions, two outer disc magnet core members in the ends of said cylinder provided with apertures, a ring air gap member made of nonmagnetic material in the apertures in each of said end core members, a plug core member of magnetic material in each of said ring members against one or the other of which said armature is brought to rest, and two magnet coils in said cylinder in axial alignment with each other respectively between said middle disc and said end discs, said middle disc forming a common magnetic path for said coils and said air gap members being effective to decrease the stray magnetic flux opposing movement of said armature.

4. A solenoid comprising two coils, a frame of magnetic material for said coils, said frame including an inner leg forming a common flux path for said coils and two outer legs, a unitary plunger armature mounted in slidable engagement with said inner leg and having a minimum nonmagnetic gap therebetween, said plunger being arranged for movement respectively toward and away from said outer legs, and means providing a non-magnetic gap in each of said outer legs, the length of said gap being substantially greater than the gap between said plunger and inner leg.

5. A double acting solenoid comprising two coils, a frame of magnetic material for supporting said coils in axial alignment with each other, said frame comprising an inner leg between adjacent ends of said coils forming a common flux path for said coils and two outer legs adjacent the opposite ends of said coils respectively, a unitary plunger armature mounted in slidable engagement with said inner leg and having a minimum non-magnetic gap therebetween, said plunger being arranged for movement axially of said coils between said end legs, and means providing a non-magnetic gap in each of said end legs, the length of said gap being substantially greater than the gap between said plunger and inner leg.

6. A double acting solenoid comprising a cylindrical magnet core member, an annular core member of magnetic material integral with said cylindrical core member and disposed centrally therein, a unitary plunger armature slidably mounted in said annular core member for endwise movement between two positions, said plunger and annular member being separated by a minimum non-magnetic gap, a second and a third annular member of magnetic material disposed respectively in the ends of said cylindrical member, said members being so disposed with respect to said cylindrical member as to provide a

minimum non-magnetic gap, a plurality of annular members of non-magnetic material disposed respectively within said second and third annular members, a plurality of plug core members of magnetic material disposed respectively within said non-magnetic annular members against one or the other of which plug core members said armature is brought to rest, and two magnet coils in said cylinder in axial alignment with each other respectively between said middle annular member and said second and third annular members respectively, said middle annular member forming a common magnetic path for said coils and said non-magnetic annular members providing a non-magnetic gap substantially greater than said previously mentioned non-magnetic gaps.

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