

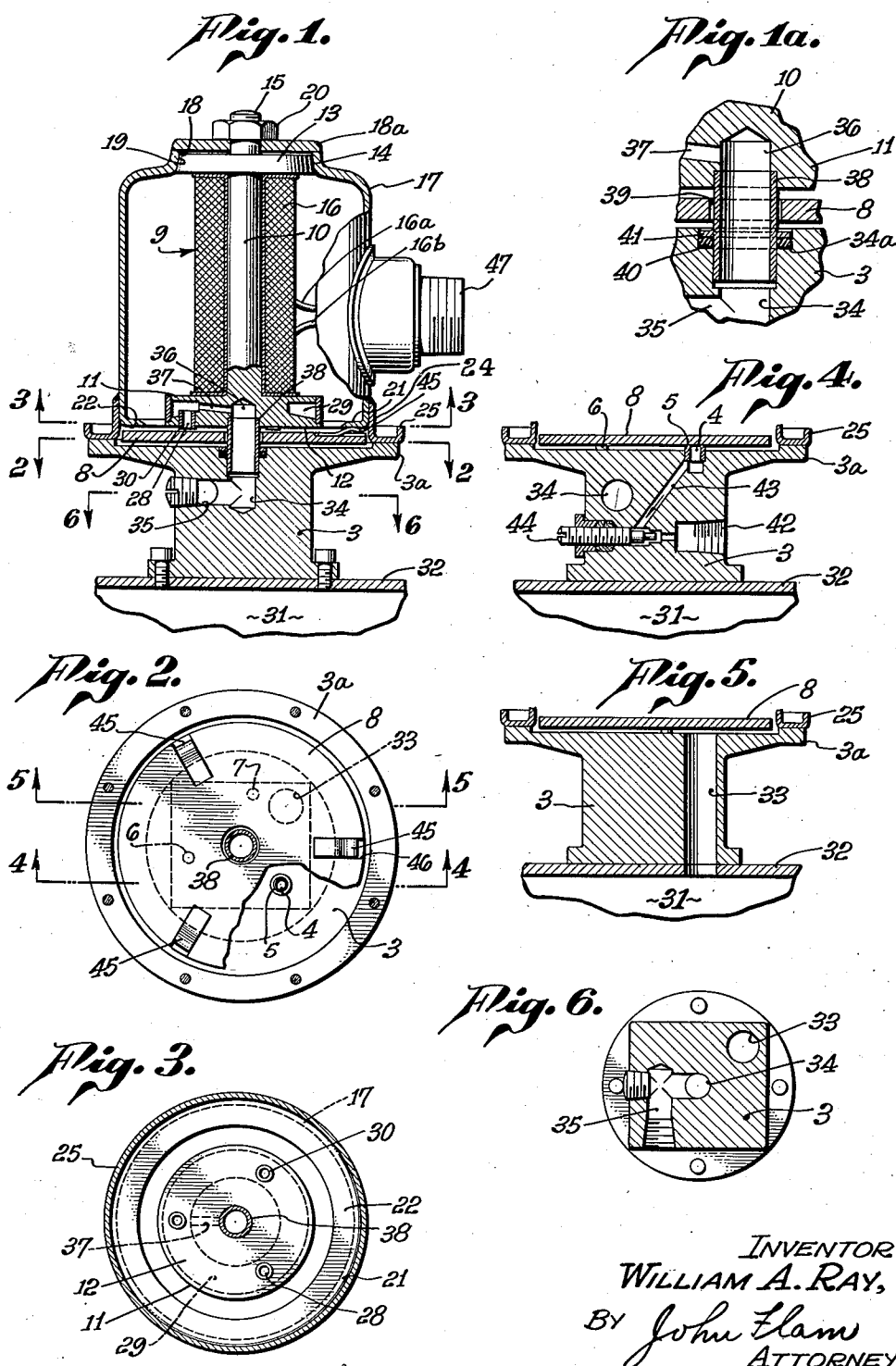
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ELECTROMAGNETIC VALVE

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ELECTROMAGNETIC VALVE

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7 Claims. (Cl. 137—139)

1

This invention relates to electromagnetically operated mechanisms, and particularly to those capable of responding to small electric currents. Such mechanisms are especially useful in gas burner control systems in which the controlling current is obtained by thermoelectricity or photoelectricity.

In an application filed in the name of William A. Ray on September 4, 1944, under Serial Number 552,647, now Patent No. 2,550,297, and entitled "Electromagnetically Operated Valve," a device is shown and described wherein the polar area of the operating magnet is made large and the magnetic path is carefully designed to ensure that the reluctance thereof is low, whereby the device is capable of operation by a very small current.

It is an object of this invention to provide a device of improved construction incorporating these features.

It is another object of this invention to provide a reliable device which requires an electric current of small magnitude only for consistent operation, such, for example, as may be provided by a thermoelectric generator, or an electron multiplier tube.

It is another object of this invention to provide a novel electromagnet structure.

It is another object of this invention to provide an electromagnetically operated three-way valve of improved construction.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of one embodiment of the invention. For this purpose there is shown a form in the drawings accompanying and forming part of the present specification. The form will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of this invention is best defined by the appended claims.

In the drawings:

Figure 1 is an axial section through a valve incorporating the invention;

Fig. 1-a is a fragmentary section, similar to Fig. 1, on an enlarged scale;

Figs. 2 and 3 are cross sections, taken as indicated by correspondingly numbered lines on Fig. 1;

Figs. 4 and 5 are transverse sections, taken as indicated by correspondingly numbered lines on Fig. 2;

Fig. 6 is a cross section, taken as indicated by line 6-6 on Fig. 1.

2

Referring to the drawings, a valve is shown by way of example, incorporating the features of the invention. The valve comprises a body 3 with a port 4 opening into the upper face of the body, and arranged to be controlled by a closure member 8. For this purpose, the port 4 is formed by an upwardly facing valve seat 5 adapted to be engaged by the closure 8 to close the port. For reasons which will appear hereinafter, the port 4 is located unsymmetrically of the body 3 and the closure 8. Accordingly, projections 6 and 7 are provided in the body 3 for supplementarily supporting the closure 8 when on the valve seat 5.

An electro-magnet structure 9 is provided for operating the closure 8 to open and to close the port 4. For this purpose, the closure member 8 must be of magnetic material. When the magnet structure 9 is energized the closure member 8 is raised from seat 5 opening port 4; upon deenergization, the member 8 is released and returns to its seat, closing the port. The magnet structure 9 will now be described.

As pointed out in the above mentioned application, the ampere turns required by an electromagnet to produce a definite intensity of magnetization depend mainly on the magnetic density and the reluctance of the magnetic path, while the pull exerted by the magnet is a function of the polar area as well as of the magnetic density. Thus by increasing the polar area, the pull of the magnet may be increased, and by arranging that the reluctance be low, the pull may be further increased, without an increase in the number of ampere turns. The reluctance may be reduced by eliminating as many joints in the magnet circuit as is possible, ensuring that in such joints as exist the surfaces are sufficiently large and in intimate contact and by providing the smallest possible air gap. Additionally, the magnet core should be of small diameter, so that the mean length of a turn of the magnet winding, and hence the total wire required, is reduced.

Referring to Fig. 1, the magnet 9 comprises a cylindrical core 10 of relatively small diameter, with an enlarged pole piece 11 at its lower end providing a large polar area 12 for attracting the closure member 8. The upper end of the core 10 is provided with a large circular head 13 having a tapered exterior surface 14 and a threaded extension 15. The pole piece 11 and the head 13 both are integral with the core 10. An energizing coil 16 is wound on the core 10 and is adapted to be connected through leads 16-a and 16-b with a source of electric energy, such as a

3

thermoelectric generator or an electron multiplier tube (not shown).

An inverted cup or shell 17, which may be formed of sheet metal having good magnetic qualities, is secured on core 10 in a manner to provide a joint of low reluctance. For this purpose the top of the shell 17 is provided with a reduced tapered opening 18, closed by a cap 18-a secured as by welding to the shell 17, and forming a recess 19 for accommodating the head 13.

A nut 20 threaded on the extension 15 serves, by engagement with the cap 18-a, to urge head 13 tightly into engagement with the wall of the recess 19.

The lower end portion of the shell 17 forms an annular polar surface extending about the pole piece 11 and cooperating therewith to attract the magnetic closure member 8. The area of this polar surface may be increased so as to be substantially as large as the polar area 12, by providing an inturned edge or flange 21 on the lower end of shell 17. The parts are so proportioned that, when the shell 17 is secured tightly in the core 10, the lower surface 22 of flange 21 lies in the plane of the polar surface 12. The closure member 8, in released position on seat 5, is positioned quite closely to the magnet faces 12 and 22, for example from $\frac{1}{16}$ " to $\frac{3}{32}$ " away, so that upon energization of the winding 16, the member 8 is attracted toward these faces. As is well understood, the core 10 and shell 17, as well as the closure 8, are formed of material which does not remain magnetized after deenergization of the winding 16. Hence upon deenergization of the coil 16, the closure 8 is released substantially immediately to return to seat 5 by gravity.

The shell 17 has an exterior extension 24 at its lower end secured to the shell as by welding, and providing an outwardly directed annular flange 25 by which the shell is secured in fluid-tight relation to a flange 3-a on the body 3. In this way the shell 17 forms a fluid-tight chamber into which the port 4 opens.

Referring in detail to the structure of Fig. 1, a three way valve is shown. Thus one or more ports 28 are provided, which are arranged to be closed by the closure 8 when port 4 is uncovered, and vice versa. These ports 28 are formed in the pole piece 11 by openings through the polar face 12, into an annular chamber 29 formed in the pole piece. Each port 28 is provided with a short tube or nozzle 30 which extends by a small distance, such as .005", beyond the pole face 12 to provide a seat for cooperating with the closure member 8. A single nozzle 30 and pins for supporting the closure member 8 may be provided in the pole piece 11, in a manner similar to seat 5 and pins 6 and 7, or, as shown, three nozzles 30 may be provided, as desired. The seats provided by these nozzles 30 lie in a common plane closely spaced to the pole face 12 as above pointed out, so that, when the closure 8 is attracted by the magnet 9, the closure 8 will seat accurately on the nozzles 30 and effectively close all the ports 28. At the same time only a very small air gap remains between the closure 8 and the magnet faces 12 and 22. This ensures against sticking of the armature or closure 8 after the magnet is deenergized.

The interior of the shell 17 is in free communication with a pressure space 31 or the like, defined in part by a wall, a fragment of which is shown at 32, by a passage 33 extending vertically through the body 3. The port or ports on one

4

side of the closure 8 then serve to admit fluid pressure to the chamber 31, while the port or ports on the opposite side serve to release such pressure.

In the present instance, ports 28 serve to admit fluid. For this purpose, a port 34 coaxial with the core 10 and closure 8 is provided in the body, and is adapted to be connected with a suitable source by a conduit (not shown) and the passage 35. A shallow bore 36 is formed in pole piece 11 (see Fig. 1-a) aligned with the port 34 and is connected with annular chamber 29 by one or more radial ports 37. A short tubular member 38 of non-magnetic material passing through a clearance aperture 39 in the closure 8, serves to connect the bore 36 with the port 34.

To facilitate the assembly of the magnet structure 9 on the body 3, the tube 38 with the closure 8 in place thereon is fixed in the bore 36 of pole piece 11. The tube 38 is freely slidable in port 34 so as to be readily inserted therein when the magnet structure is mounted on the body 3. To prevent leakage about the tube 38, port 34 has a counter bore 34-a, for accommodating a resilient packing ring 40, which is compressed into sealing relation by a shoulder 41 on the tube 38 (see Fig. 1-a) when the parts are assembled.

The port 4 serves to permit discharge of fluid from the pressure space and, for this purpose, is connected with a threaded opening 42 in the body 3, by a passage 43. Valve means 44 may be provided for controlling the rate of discharge.

To ensure return of the closure 8 to its initial position when the electro-magnet 9 is deenergized, a plurality of upwardly flexed light leaf springs 45 are provided in recesses 46 on the upper side of the closure 8 angularly spaced about its edge. These springs continuously engage the flange 21, urging the closure downwardly. When the magnet 9 is energized, the closure 8 moves upwardly against the face of the springs 45, the springs being flattened into the respective recesses 46.

One element of a conventional connector may be provided at 47 in the shell 17 to facilitate connection of the leads 16-a and 16-b to the cable or conductor leading to the thermocouple or other source of electric current.

When the coil 16 is deenergized, closure 8 closes port 4. Fluid from inlet 35 then can pass through ports 34 and 28 and the space in shell 17, into the outlet 33, but not to outlet 42. When closure 8 is lifted upon energizing coil 9, fluid from inlet 35 can pass, as before, to the shell 17, and out through port 4 to outlet 42, but flow to outlet 33 is interrupted by closure of port 28.

The inventor claims:

1. In an electromagnetic valve: a valve body providing a support; an electromagnet having a core mounted on said body with one pole face of said core spaced above said support; means forming a port in said core opening through said face, spaced from the axis of the core and surrounded by a valve seat; a magnetic closure member interposed between said support and said seat for movement toward and away from said seat to control said port in accordance with the energization and deenergization of said magnet; and means forming a passage connected with said port, including a tubular member extending axially of said core to said body and passing through said closure.

2. In an electromagnetic valve: a valve body having a port surrounded by a seat; means mounted on said body and defining therewith a

5

closed space, said means including an electro-magnet having a core with one pole face spaced above and facing said seat, there being a port in said core opening through said face and surrounded by a seat facing oppositely with respect to the seat in the body; a magnetic closure member movable between said seats in accordance with energization or deenergization of said magnet to control said ports; means forming a passage communicating with the port in the core, including a hollow member extending between the body and the core, and passing through an opening in the closure member; there being a passage connected with said space.

3. In an electromagnetic valve: a valve body providing a port surrounded by a seat; means mounted on said body and defining therewith a closed space, said means including an electromagnet secured on said body having a core with one pole face spaced above and facing said seat, there being a port in said core opening through said face and surrounded by a seat facing oppositely with respect to the seat in the body, the axis of the core being offset laterally from the ports; a magnetic closure member movable between said seats in accordance with energization or deenergization of said magnet, to control said ports; means forming a passage communicating with the port in the core including a tubular element extending axially of the core between the body and the core, and freely accommodated in an axial opening through the closure member; there being a passage connected with said space.

4. In an electromagnetic valve: a valve body providing a port surrounded by a seat; means mounted on said body and defining therewith a closed space, said means including an electromagnet secured on said body having a core with one pole face spaced above and facing said seat, there being a port in said core opening through said face and surrounded by a seat facing oppositely with respect to the seat in the body, the axis of the core being offset laterally from the ports; a magnetic closure member movable between said seats in accordance with energization or deenergization of said magnet, to control said ports; means forming a passage communicating with the port in the core including a tubular element projecting axially from the core and secured thereto, there being an opening in said body for slidably accommodating said element, means sealing between said element and the body; and means forming a passage communicating with said space.

5. In an electromagnetic valve: an electro-magnet having a core provided with a pole face; means forming a port in said core opening through said face and surrounded by a valve seat; a magnetic closure member movable toward and away from said seat to control said

6

port in accordance with the energization and deenergization of said magnet; and means passing through said closure and extending into said core to form a passage connected with said port.

6. In an electromagnetic valve: a valve body having a port surrounded by a seat; an electro-magnet having a core with one pole face spaced from said seat, there being a port in said core opening through said face and surrounded by a seat facing oppositely with respect to the body seat; a magnetic closure member movable between said seats in accordance with energization or de-energization of said magnet to control said ports; and means extending into said core and passing through said closure member to form a passage communicating with the port in the core.

7. In an electromagnetic valve: a valve body having a port surrounded by a seat; an electro-magnet having a core with one pole face spaced from said seat, there being a port in said core opening through said face and surrounded by a seat facing oppositely with respect to the body seat; a magnetic closure member movable between said seats in accordance with energization or de-energization of said magnet to control said ports; means extending into said core and passing through said closure member to form a passage communicating with the port in the core; and means in said body for controlling the flow of fluid through said body port.

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