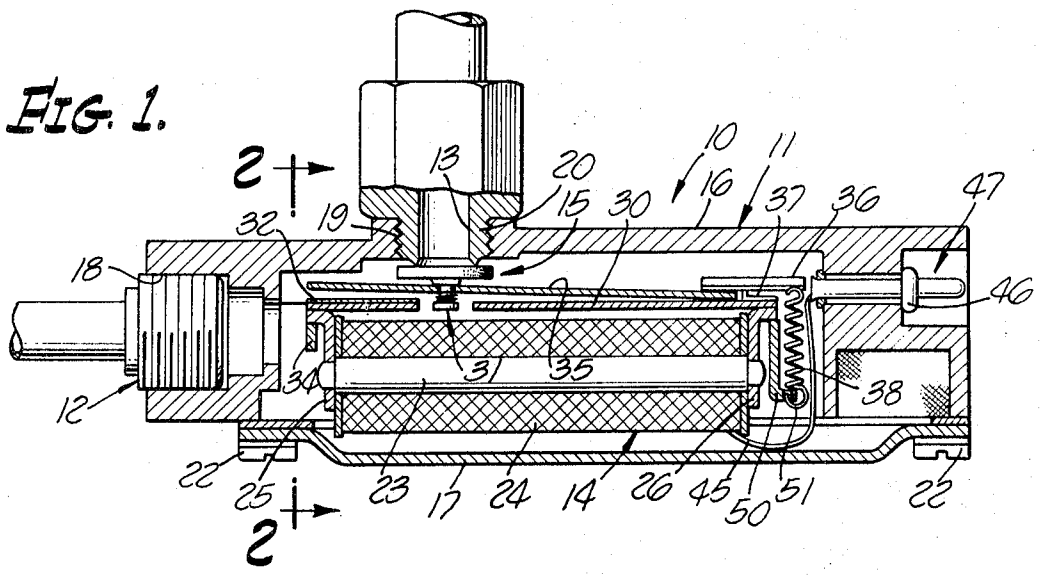
Sept. 15, 1970 R. D. GRAYSON 3,528,639

MAGNETIC VALVE WITH LOST MOTION CONNECTION

Filed Jan. 2, 1968

FIG. 1.



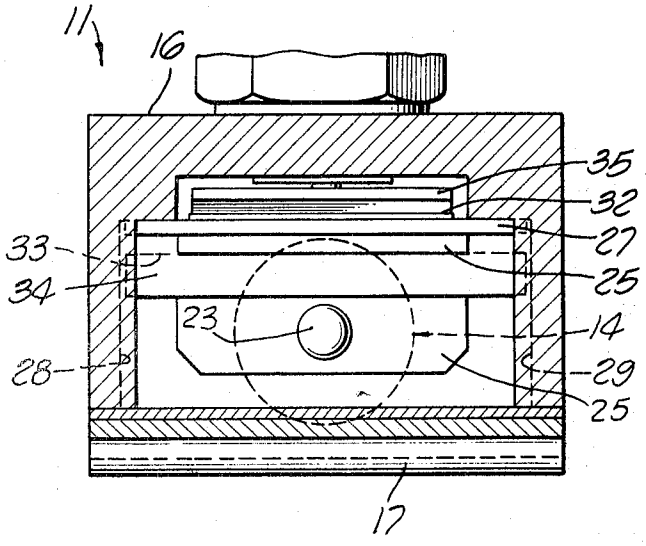


FIG. 2.

FIG. 3.

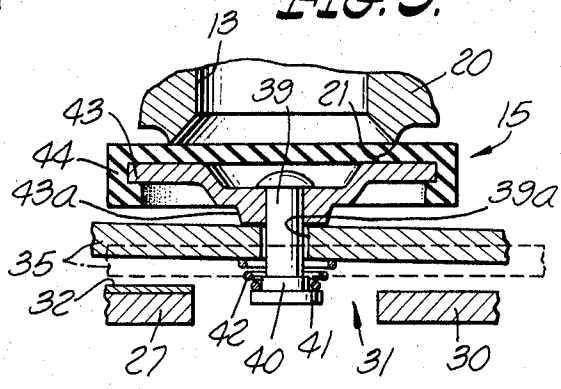
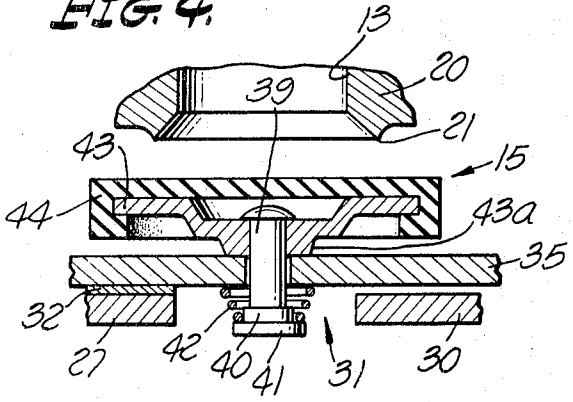


FIG. 4.



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MAGNETIC VALVE WITH LOST MOTION CONNECTION

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Int. Cl. F16k *31/06*

U.S. Cl. 251—75 5 Claims

ABSTRACT OF THE DISCLOSURE

A magnetic valve in which a valve member is connected through a lost motion connection to an armature which is controlled by magnetic actuating means. Means is provided for recapturing lost motion between the armature and valve member after the latter is unseated from its valve seat so that total armature movement is utilized to produce an equal valve movement. An improved electromagnetic actuating assembly is disclosed which is operable by very low electric signals, such as from a thermocouple type pilot generator.

This application is a continuation-in-part of my copending application Ser. No. 617,786, filed Feb. 20, 1967, now Pat. No. 3,387,537 assigned to the assignee of the present application. The benefit of the filing date of said co-pending application is therefore hereby claimed for this application.

BACKGROUND OF THE INVENTION

The present invention relates generally to a magnetic valve and, more particularly, to a magnetic valve directly actuatable by low level electric signals to control the flow of a low pressure fluid.

In the field of heating control and particularly in the control of home heating units, it is desirable that means for controlling the flow of heating fuel to the burner can be actuated rapidly, in a sure and reliable manner, by relatively low-level electric voltage signals. For example, it would be highly beneficial to be able to use the output of a pilot generator, consisting of a series of thermocouples, for directly controlling the fuel valve. More particularly, a satisfactory valve means for this purpose should be capable of operating from a source voltage of 125 millivolts approximate minimum and against a gas back pressure of approximately ½ p.s.i.

It is, therefore, a primary object of the invention to provide a magnetic valve actuatable by low level electric signals in a sure and reliable manner.

A further object of the invention is the provision of a magnetic valve actuatable by electric signals of as low as 125 millivolts.

Another object is the provision of an improved magnetic valve of the described character that is straight forward in design and inexpensive to manufacture.

SUMMARY OF THE INVENTION

According to the principal aspect of the present invention, there is provided an electromagnetically operated fluid control valve in which the armature that carries a valve closure member is disposed within the range of magnetic influence of a magnetic actuating device. The valve closure member is connected through lost motion connecting means to the armature so that upon initial movement of the armature towards the magnetic actuating means, when the latter is energized, armature movement is relatively unrestrained. As the armature approaches the magnetic actuating device, its pulling strength is substantially increased. At this time, the armature engages a limit-stop on the valve closure member to withdraw the latter from the valve seat. Spring means is provided for recapturing the lost motion, which results from the initial movement of the armature with respect to the valve closure member, after the valve is opened so that total armature movement is utilized to produce an equal valve movement. As a consequence, only a relatively low-level electric signal is required in the present invention to produce substantial valve movement.

According to another aspect of the invention, there is provided an improved electromagnetic actuating structure which includes an elongated helical coil assembly wound about a core. Core extensions providing relatively flat surface areas connect the core ends and are disposed along the same long side of the coil. A commensurate long armature is disposed slightly spaced from the core extensions and carries a valve closure member for sealing engaging a valve seat and closing the same when the coil is de-energized.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational sectional view of the magnetic valve of the invention.

FIG. 2 is a sectional view taken along the line 2—2 of FIG. 1.

FIGS. 3 and 4 are greatly enlarged views of the special valving member of the invention shown in the closed and open positions, respectively.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference now particularly to FIG. 1, the magnetic valve **10** of the invention is seen to include in its major elements an enclosure **11** with an inlet **12** and an outlet **13**, valve controlling means **14**, and closure member **15**. In general operation, the valve controlling means **14** is selectively actuatable to relate the closure means **15** to the outlet **13** in such manner as to permit a fluid, fuel gas for example, provided at the inlet **12** to pass therethrough to burner apparatus (not shown) located downstream. Upon deenergization of the means **14**, the closure means is returned to the closed position shown in FIGS. 1 and 3, stopping fluid flow.

The enclosure **11** is fundamentally an elongated three-sided, rectangular body member **16** having its open side closed by a cover **17**. Preferably it is of cast construction of a nonmagnetic material and sufficiently rugged to withstand the shocks and vibrations associated with its normal use. The fluid inlet **12** is made at a threaded opening **18** in one end of the body member **16**. The outlet **13** is provided at a similarly threaded opening **19** formed in the side wall of the enclosure **11** opposite the open side and at a point located displaced slightly from the midpoint in a direction toward the inlet. A fitting **20** received within the outlet opening **19** has a continuous, raised circular portion **21** that serves as a valve seat and onto which the closure member **15** bears to close off fluid flow. The cover is secured over the open side of the enclosure by any suitable means such as screw members **22**.

Valve controlling means **14** includes a cylindrical magnetic core **23** provided with a helically wound coil **24**. The ends of the core extend slightly without the coil and are turned down to a smaller diameter. Each end of the core extension plate, **25** at the left and **26** at the right, received thereon through a suitable opening formed in the plate. These extension plates have a generally J-shape in the cross-section shown in FIG. 1, with the leg of the J being directed away from the coil and disposed inwardly away from the open side of the enclosure. A good low magnetic reluctance connection is provided between the extension

plates and respective ends of the core **23** by arc welding, for example.

A first pole **27** of generally rectangular platelike construction has its long side portions received within slots **28** and **29**, respectively, formed on the inner surfaces of the side walls of the enclosure **11**. A second pole **30**, identically constructed to pole **27** except longer as seen in FIG. 1, is also mounted in slots (not shown) on the inner wall surfaces of the enclosure so as to be coplanar with the first pole, but spaced laterally as at **31**.

For a purpose that will be made clear later, the upper surface of the first pole **27** includes a relatively thin nonmagnetic spacer **32**. It may be made of any of a number of different plastics or nonferrous metals. Excellent results have been obtained with such a spacer made of stainless steel, which not only is nonmagnetic but also wears exceptionally well.

Referring now to both FIGS. 1 and 2, a support plate **33** is secured to the lower portions of the enclosure side walls and has inwardly directed extensions **34** and **50** for engaging the respective legs of core extension plates **25** and **26**. When fully assembled the support plate serves to hold the extension plates in good surface contacting relation to the lower surface of the poles **27** and **30**, as well as secure against sideward movement as shown in FIG. 2. Additionally, the support plate, includes an opening **51** adjacent the end supporting core extension plate **26** for securing one end of a coil spring as will be discussed later.

A magnetically attractable armature **35** is disposed between the poles and the inner wall surface of the enclosure **11**. The armature is of substantially the same thickness as the poles, but less wide and shorter in length. Cantilever mounting of the armature to the second pole **30** is made via a mounting plate **36** welded to the armature and a U-shaped spring clip **37** suitably secured to both the plate **36** and pole **30**. A coil spring **38** is secured at the opening **51** in the support plate **33** and a similar opening in the plate **36** thereby resiliently urging the free end of the armature toward the outlet **13**.

Considering FIGS. 1, 3 and 4 simultaneously and the detailed structure of the closure member **15**, it is seen that this member includes a rivetlike pin **39** freely received within an opening **39***a* in the armature that is substantially centrally located over the space **31** and aligned within the axis of the outlet. The pin includes a first shoulder **40** of diameter larger than that of the pin. The shoulder **40** provides a limit stop engageably by the walls of the armature adjacent the opening therein when the armature moves downwardly with respect to the pin. A second shoulder **41** immediately adjacent the first shoulder, and serving as one terminus of the pin, has a diameter larger than that of the first shoulder. A conical compression spring **42** is mounted on the pin **39** with one end bearing against the second shoulder **41** and the other end bearing against the lower surface of the armature **35**.

The other end of the pin is received on the opposite side of the armature through an axially located opening in a somewhat bell-shaped plate **43**, and secured thereto by peening, for example. The plate **43** includes a downwardly extending boss **43***a* which is normally engaged by the upper surface of armature **35** due to the force of spring **42** against the lower surface of the armature. A cap **44** of a flexible resilient material, such as silicone rubber for example, is received over the bell-shaped plate **43**, with the margins thereof folded over and under those of the plate in generous overlapping relationship. It is the outer major surface of this cap that is brought into contact with the raised portion **21** to effect valve closure.

Electrical connector for the coil **24** is made to external energizing circuits by coil lead wires **45**, and pin connectors **46** of a conventional female plug **47**.

When the magnetic valve described herein is disposed in the valve-closed condition as shown in full lines in FIG. 3 (no energizing voltage on the coil **24**), the restoring force in the coil spring **38** urges the free end of the armature upwardly, thereby urging the closure member **15** into sealing relationship with the valve seat **21**. In this position of the armature and closure member, when the coil **24** is energized, the power of the armature to unseat the valve element **15** is relatively weak, due to the substantial distance between the armature and the poles **27** and **30**. As a consequence, if the closure member **15** were fixedly mounted to the armature, the valve could not be opened against high gas pressure in the enclosure **11** since the affect of the pressure on the closure member would prevent movement of the armature toward the magnetic poles.

However, due to the lost motion connection between the valve closure **15** and armature **35**, movement of the armature toward the poles **27** and **30**, upon energization of the coil **24**, is generally unrestrained except for the relatively weak spring **42**. Thus, the armature moves through a limited travel independent of closure member **15** until it engages the shoulder **40** on the pin **39**, as shown in phantom lines in FIG. 3. After the armature has moved this distance, it is capable of exerting a much stronger pull because of the reduced space between the armature and the poles **27** and **30** of the magnet. The additional pulling force on the armature makes it possible to lift the valve closure member **15** off the seat **21** by exerting force directly against the shoulder **40** on pin **39**. After the valve member **15** lifts off the seat, the excessive gas pressure which had held the valve closed is relieved. As a consequence, the relief in pressure permits the spring **42** to return the valve member **15** to its normal position relative to the armature **35**, as seen in FIG. 4, thereby recapturing the lost motion which occurred during the initial movement of the armature with respect to the valve element. This spring **42** thereby permits full advantage to be taken of the total armature movement to produce an equal valve movement. Without the spring **42**, it would be possible for the gas pressure within the envelope **11** to seat the valve member against the valve seat **21** even after the armature has been moved toward the magnetic pole **27** and **30**, particularly if the entire valve structure **10** were mounted on its end, which is its normal position in practice, or if it were in an inverted position. Since the spring **42** permits full advantage to be taken of the total armature movement, it is seen that relatively short armature movement is required to actuate the valve and, hence, only low-level electrical signals are required for actuating the armature.

When full attracted, the armature is held very slightly spaced from the opposed pole faces by spacer **32**. This spacer prevents "sticking" or continued adherence of the armature and poles that could otherwise result on de-energization due to remanence in the poles.

It is seen, therefore, that in the practice of the present invention, a magnetic valve is provided which can operate directly from a pilot generator furnishing voltage signals as low as 125 millivolts and against a fluid pressure of at least 0.5 p.s.i. The improved performance is achieved in part through use of an elongate large-area armature magnetically coupled to a magnetic core by extensions and poles of correspondingly large area, and with a closure member resiliently carried by the armature through a lost-motion connection. A valve of the character described has exceptionally long life, is fast acting, and highly reliable with the valve closure member being able to compensate for wearing as well as a certain degree of variation in parts encountered during normal manufacturing.

While the invention has been described in connection with a specific form, it is to be understood that numerous other embodiments could be made without departing from the spirit of the invention.

What is claimed is:

1. In an electromagnetically operated fluid control valve having magnetic actuating means, a magnetically attractable armature disposed within range of magnetic influence of said actuating means, and a closure member carried by the armature for selectively closing the outlet

of an enclosure provided with pressurized fluid when the actuating means is de-energized and opening the same upon energization of the actuating means, the improvement comprising: lost motion connecting means between said closure member and said armature, said connecting means allowing initial, relatively unrestrained movement of said armature toward said actuating means and relative to said closure member until said armature is closely adjacent to said actuating means, and causing withdrawal of said closure member from said outlet upon further movement of said armature toward said actuating means, thereby opening the same, and said connecting means including means for recapturing, during said further movement of said armature, the lost motion between said closure member and said armature which results from the relative movement of said armature with respect to said closure member during said initial movement of said armature, said magnetic actuating means including a magnetic core, a winding inductively related to the core, first and second pole extension means arranged in separate, low magnetic reluctance relation to the respective opposite ends of the core, the extension means each having an end portion angularly formed toward the other forming a single pole plane with the ends of the end portions spaced from one another whereby when an energizing signal is supplied to the winding, the armature is attracted toward the pole plane, and said lost motion connecting means including pin means on said closure member passing through an opening in said armature, which opening registers with the space between said end portions.

2. A fluid control valve as in claim 1, in which a relatively thin nonmagnetic spacer is secured onto one of the extension means end portions to lie substantially in the pole plane whereby the armature can be attracted closely

to the pole plane and yet remain sufficiently spaced therefrom as not to be held by remanence when the winding is deenergized.

3. A fluid control valve as in claim 1, in which the end portions are separate from the remainder of the extension means, and support means to hold the remainder of the extension means in good bearing contact with the end portions.

4. A fluid control valve as in claim 3, in which the remainder of the extension means include a pair of platelike means of substantially J-shape cross-section, each platelike means having an opening for receiving the respective core end therein, the core ends and walls defining the openings in the platelike means being welded to form a low magnetic reluctance junction.

5. A fluid control valve as in claim 4, in which the support means engages the J cross-leg of the platelike means and forces it into contact with the respective end portions of the extension means.

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U.S. Cl. X.R.

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