April 14, 1970 R. J. NEFF ET AL 3,505,689

ELECTRIC VALVES

Filed Oct. 17, 1966

FIG-1

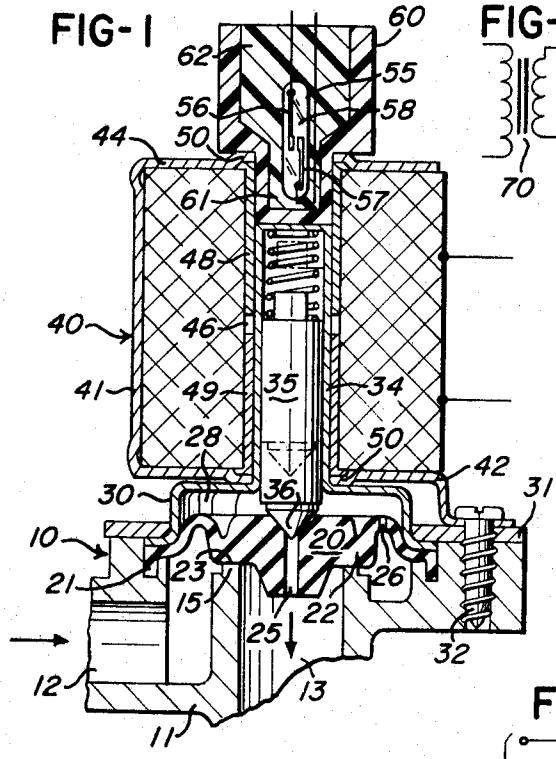


FIG-2

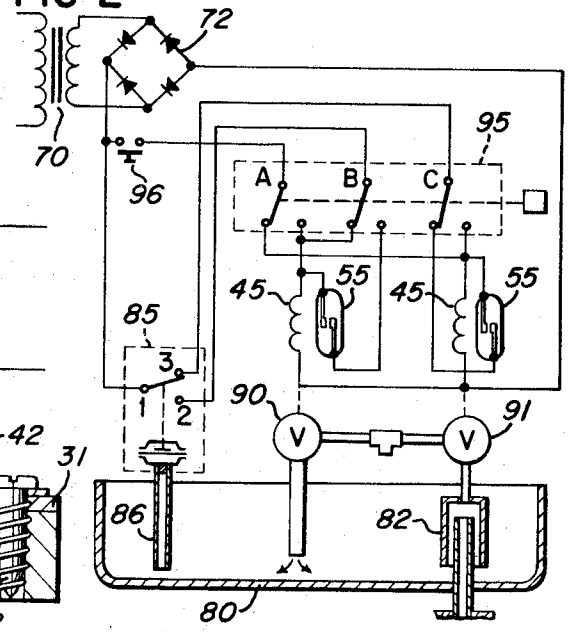


FIG-3

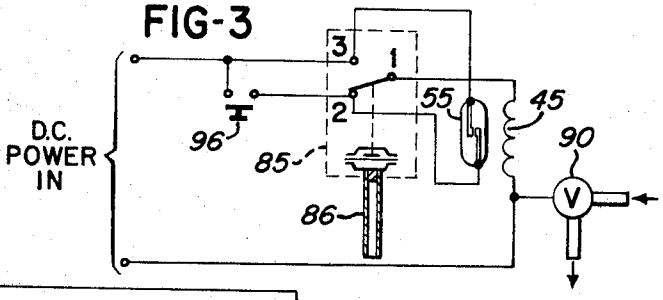


FIG-4

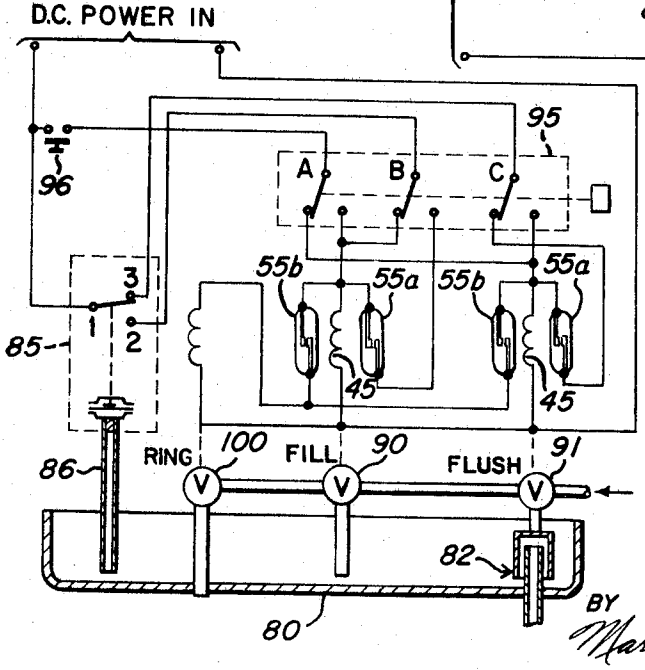
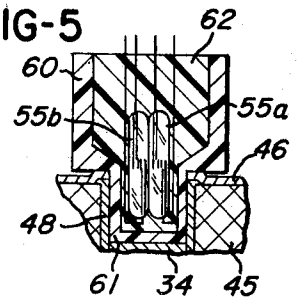


FIG-5



INVENTORS
ROBERT J. NEFF &
GEORGE W. ARMSTRONG

BY
Marechal, Biddle, Franck & Bugg
ATTORNEYS

United States Patent Office 3,505,689
Patented Apr. 14, 1970

3,505,689

ELECTRIC VALVES

Robert J. Neff, R.R. 1, Medway, Ohio 45341, and George W. Armstrong, 284 E. Dayton Drive, Fairborn, Ohio 45324

Filed Oct. 17, 1966, Ser. No. 587,132
Int. Cl. E03d *13/00*
U.S. Cl. 4—100 3 Claims

ABSTRACT OF THE DISCLOSURE

Electric solenoid valves for operation on low voltage DC current are controlled with holding circuits employing magnetic reed switches magnetically associated with the solenoid coils. A non-magnetic insert is received within the axially open end of the coil and one or more reed switches are inserted therein. Also, electric toilet circuits are disclosed employing reed switches magnetically associated with the solenoid-operated flush and/or fill valves.

This application relates to electric solenoid-operated valves and more particularly to such valves and control circuits for such valves which include a reed switch magnetically associated with the valve solenoid.

The electric solenoid valves and circuits of this invention are particularly adapted for use where low maintenance and low cost are desired, and where it is desired to maintain a valve in an operated state over a period of time without the use of conventional relays or timing switches. The invention has particular applicability for use with the valves and circuits shown and claimed in the U.S. patent of Armstrong et al. 3,082,433 issued Mar. 26, 1963 and entitled Water Closets.

It is accordingly an important object of this invention to provide a direct-current operated electric flow control valve and circuit in which a reed switch is magnetically associated with the solenoid coil of the valve and which may be connected to provide a holding circuit for the valve.

A further object of this invention is the provision of a circuit including a magnetically-operated, reed-type switch which is connected in a holding circuit for a D.C. operated solenoid valve with which it is magnetically associated, and in which the reed switch carries only the current necessary to maintain the operation of the valve and is therefore not subject to the inductive breaking voltage developed by the solenoid coil.

A still further object of this invention is the provision of a solenoid-operated flow control valve which incorporates a reed switch.

A more specific object of this invention is the provision of a solenoid-operated flow control valve in which a reed switch is positioned and supported within a non-magnetic insert which, in turn, is received within the hollow of the solenoid, for supporting the reed switch in a region of high magnetic flux.

A further specific object of this invention is the provision of circuits particularly adapted for the control of electric toilets of the general types disclosed in the above-identified U.S. Patent 3,082,433.

More specifically, an object of this invention is the provision of simplified operating circuits for electric toilets in which the need for timing switches or holding relays is eliminated.

A further object of this invention is the provision of an electric toilet control circuit which is particularly adapted for promoting flushing of low profile toilets in which a portion of the water tank may be positioned below the level of the bowl.

These and other objects and advantages of the present invention will be apparent from the following description, the accompanying drawings and the appended claims.

In the drawing:

FIG. 1 is an enlarged vertical section of a solenoid-operated flow control valve constructed according to this invention;

FIG. 2 is a wiring diagram of an electric toilet control circuit using two valves;

FIG. 3 is a further wiring diagram of an electric toilet control circuit in which one valve is used;

FIG. 4 is a further wiring diagram of an electric toilet circuit in which three valves are used for operation with low profile toilets; and

FIG. 5 shows a modified form of the reed switch retaining assembly used in the circuit of FIG. 4.

Referring to the figures of the drawings which illustrate preferred embodiments of the invention, an electric solenoid-operated valve which may control the flow of liquid or a gas is shown at **10** in FIG. 1 as having a body forming a fluid inlet **12** and an outlet **13**. The valve **10** is of the needle or pilot-operated type in which a pilot valve controls the flow between the inlet **12** and the outlet **13**. The valve body **10** may be formed of molded metal or plastic material, and forms an annular land **15** in surrounding relation to the outlet **13**.

The valve further includes an elastomeric diaphragm **20** which is positioned in flow-stopping relation to the outlet **13**, and includes an outer annular flange portion **21** which forms a fluid tight seal with the body **10** and an inner enlarged central portion **22** which has a lower surface **23** movable into closing relation with the annular land or sealing surface **15** of the body **10**. Further, the diaphragm **20** is formed with a central metering orifice **25** and one or more bleed orifices **26**, as shown in FIG. 1.

The chamber or space **28** formed above the diaphragm **20** is sealed and closed by a suitable non-magnetic housing or sleeve **30** which has its lower flanged end secured in sealing relationship with the diaphragm **20** at the annular flange portion **21** and which is secured in place on the body by an annular keeper plate **31** and a series of screws **32**. The housing **30** has an elongated upper extension **34** which forms means for guiding and retaining an elongated pilot valve member **35** for movement between a raised flow-permitting position, as shown in broken lines in FIG. 1, and a lower position in which the conical tip **36** is in flow-stopping relation to the metering orifice **25**. The valve member **35** is, in effect, a needle valve and when it is in the raised position, flow is permitted from the inlet **12** to the outlet **13** by the force of the fluid at the inlet causing the diaphragm **20** to rasie off its seat **15**. However, when the valve member **35** closes the metering orifice **25**, a differential pressure is established across the diaphragm by reason of the force of the fluid entering the chamber **28** through the bleed opening **26**, causing the diaphragm to close against the annular seat **15**.

An electric solenoid structure indicated generally at **40** in FIG. 1 is employed for operating the valve member **35** from a suitable source of D.C. power. The structure includes an iron or ferrous frame **41** which is generally C-shaped in profile and has a lower flange **42** supported on the body **11** by the screw **32**. The frame **41** receives therein an electric solenoid coil **45** positioned between an upper frame flange **44** and the lower flange **42**. The coil **45** is annularly wound and forms an axially open core **46** within the ends of which are inserted steel cylindrical bushings **48** and **49**. The bushings are received within annularly indented or raised portions **50** formed in each of the upper and lower flanges of the frame **41** and retain the coil **45** in aligned position on the valve **10**. In this

position, the elongated upper extension **34** of the non-magnetic housing **30** is received within the interior of the bushings **48** and **49** coaxially within the coil **45**, but extending only partially the length of the central opening **46** formed on the coil **45**.

The valve of this invention further includes a reed switch **55** which is magnetically associated with the flux produced by the coil **45**. The reed switch **55** has leaves **56** and **57** encapsulated within a glass envelope **58** forming normally open contacts which close under the influence of the magnetic field produced by the coil **45**. The reed switch **55** is positioned in closely coupled magnetic relation with the coil **45** by an insert **60** which supports and isolates the reed switch **55**. The insert **60** may be formed of non-magnetic material, such as polyvinyl chloride and has a lower depending portion **61** received within the coil **45** in the upper bushing **48**. The reed switch **55** is positioned within a hollow formed in the lower depending portion **61** in closely coupled relation to the magnetic structure formed by the frame **41** and the coil **45**, and is retained in place by suitable potting compound **62** filling the interior of the insert **60**. Suitable reed switches for electric solenoid water valves may, for example, be the minature "Form A" manufactured by Hamlin, Inc., Lake Mills, Wisc.

The valve **10** with the associated reed switch **55** is preferably employed in an electric circuit in which the reed switch forms part of a holding circuit for the valve **10**. For this purpose, the valve coil **45** is operated from a source of D.C. power, preferably a low voltage source such as 24 volts D.C., for example.

Two valves **10** constructed according to this invention are shown in FIG. 28 as applied for the control of the flow of water in an electric toilet control circuit. A transformer **70** may be provided as shown in FIG. 2 with a full wave rectifier bridge **72**, as well known in the art forming a source of 24 volt D.C. power. Also, as shown in FIG. 2, a fragment of a water closet tank **80** is shown including a co-axial ejector **82** for emptying the water from the tank into a toilet boil, not shown, in the manner described and claimed in the above-identified Armstrong et al. Patent 3,082,433. Similarly, the tank **80** may be provided with a liquid level-responsive switch **85** which is connected to a downwardly extending pipe **86** extending into the interior of the tank, and which is responsive to upper and lower liquid levels within the tank, as described in the above-mentioned patent.

The circuit shown in FIG. 2 in which two of the valves as shown in FIG. 1 are employed is particularly useful in place of the circuit shown in FIG. 10 of the Armstrong et al. patent for operation on low voltage D.C., and in which there is a fill valve **90** for admitting water into the interior of the tank **80** and a separate flush valve **91** for initiating flushing operation by discharging into the injector **82**. This circuit also includes a mode selector switch **95**, corresponding to the switch **65** disclosed in that patent, and a momentary push button **96** for initiating a flushing operation, corresponding to the switch **50** therein.

Referring to FIG. 2, when the push button switch **96** is momentarily energized it applies power through section A of switch **95**, in the position shown, to operate the solenoid **45** of the flush valve **91**. The associated reed switch **55** is closed with the energization of the coil **45**. This switch is in a circuit connected to the power source **72** through section C of the selector switch **95** and the raised or upper portion of the liquid level switch **85** to the solenoid coil **45**, forming a parallel holding circuit for the valve **91**. However, since the starting current to the coil **45** is applied by the push button **96**, only the holding current flows through the reed switch **55**. For example, with solenoid valves which have coils **45** adapted for operation from a direct current source of 24 volts, it has been found that the reed switch **55** need carry only 0.3 ampere of current.

The reed switch **55** of the valve **91** accordingly forms a holding circuit which is not interrupted until the water level has reached a predetermined low position at which time the liquid level switch moves to its second position thereby interrupting the holding circuit to the valve coil, closing the valve **91**. The inductive voltage at opening is carried by the contacts of the level switch **85** and not by the reed switch **55**.

The fill valve **90** is then operated by the closed contacts of the level switch **85** which occur at the lower level, applying power directly to the solenoid coil of this valve through section B of the selector switch **95**, and will continue to operate until interrupted by the movement of the switch **85** to its first position, signaling that the tank **80** has been filled. The mode selector **95**, which is shown in the full tank mode in FIG. 2, operates in the manner described for the corresponding switch **65** in the Armstrong et al. patent. In the moved position of this switch, the operation of the push button **96** applies energizing power directly to operate the fill valve **90**, resulting in the closing of a holding circuit through its associated reed switch **55** and contacts B of the switch **95** until the tank is filled, at which time the holding circuit is interrupted by the movement of the switch **85** to the first position shown. At this time, the switch **85** then applies power to the flush valve **91** through section A which is not interrupted until the tank is again empty.

In the circuit of FIG. 2, only one of the reed switches **55** is used at any one time, depending upon the position of the switch **95**. The circuit is reliable in operation and eliminates the need for separate holding relays or timing devices. The reed switches **55** carry only the holding current, and therefore have a long service life.

The circuit of FIG. 3 shows an arrangement using a single valve **90** for both flushing and filling, and as wired, operates in the normally empty mode. The valve **90** performs both a filling action to a tank and a flushing action by flooding the coaxial ejector in the manner described in connection with the single-valve embodiment shown in FIG. 6 of the Armstrong et al. patent. The reed switch **55** of FIG. 3 forms part of a parallel holding circuit through the lower set of level switch contacts, as shown, maintaining the operation of the valve **90** during flushing and filling. This circuit accordingly shows a highly simplified and low cost version which is nevertheless reliable in operation.

FIG. 4 is a modified circuit based upon the circuit of FIG. 2, in which the parts are designated with like reference numerals. The circuit of FIG. 4 is particularly adapted for use with modern low-profile water closet installations, in which the bottom of the water tank may, in some instances, be below the water level within the bowl. In such cases, it has been found highly desirable to add a ring valve **100** which operates during flushing and preferably during filling as well, to augment the water supply in the bowl. In FIG. 4, the solenoid-operated ring valve **100** is shown as being connected electrically in parallel with both the flush valve **91** and the fill valve **90**, to achieve maximum benefit from the ring valve so that it may add make-up water to the bowl during filling as well as to augment the flushing action and to wash down the bowl during flushing. For this purpose, pairs of reed switches **55**, such as the switch **55***a* and **55***b* are positioned within the non-magnetic insert **60**, as shown in FIG. 5, and are potted in place by the compound **62**. Thus, each of the pair of reed switches **55***a* and **55***b* are closed magnetically coupled to the flux produced by the solenoid coil **45**.

For the purpose of providing an energizing circuit for the valve **100**, the switches **55***b* are each connected in common with its associated switch **55***a*, to the associated coil **45**. The reed switches **55***a* each operate in the manner described in connection with the circuit of FIG. 2. The switches **55***b* are each connected to apply energizing power to the coil of the ring valve **100** so that the valve **100** is

operated at any time that either the fill valve **90** or flush valve **91** is operated. While the switches **55***b* in this embodiment carry the starting currents for the valve **100**, the starting current on a coil operating from a D.C. source is not particularly destructive of contacts as compared to the interrupting voltage across the coil. Again, in this embodiment, as in the preceding circuit embodiments, the reed switches are not subject to the interrupting voltage but this is taken by the electrical contacts in the liquid level switch **85**. Again, as in the circuit of FIG. 2, the mode selector switch **95** provides selection between normally filled and normally empty tank operation.

It will therefore be seen that this invention provides a solenoid operated flow control valve which incorporates a magnetically operated reed switch within its magnetic structure. Such valves are particularly useful in circuits, such as disclosed herein, in which the reed switch which is associated forms a holding circuit for the valve until interrupted by the occurrence of a circuit change elsewhere. While such valves are particularly useful with the electric toilets disclosed and claimed in the Armstrong et al. patent, they may obviously be used elsewhere, such as in other home appliances, where safe and dependable operation is desired, with the elimination of the need for holding relays.

While the forms of apparatus herein described constitute preferred embodiments of the invention, it is to be understood that the invention is not limited to these precise forms of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. A solenoid-operated toilet fill and flush valve circuit adapted for operating an electric toilet or the like from a source of low voltage DC comprising a two-position water level switch responsive to the level of water supply to such toilet having one position corresponding to a low water level and a second position corresponding to a high water level, a water fill valve having an operating solenoid, a momentary switch connected to apply power from said source to said fill valve, a magnetically operated reed switch magnetically associated with said fill valve solenoid and connected to apply power from said source to said fill valve solenoid through one of said switch positions of said water level switch for continuing the operation of said fill valve until interrupted by the operation of said water level switch, a solenoid-operated flush valve for said toilet, and a further said reed switch magnetically associated with the solenoid of said flush valve and connected to apply power from said source to said flush valve through said water level switch.

2. The circuit of claim **1** further comprising a solenoid-operated ring valve adapted to apply flushing water directly to the bowl of such toilet, and circuit means connecting said ring valve for operation concurrently with one of said fill or flush valves.

3. The circuit of claim **2** in which said circuit means connecting said ring valve for operation concurrently with one of said fill or flush valves includes a further said reed switch magnetically associated with the solenoid of said one valve.

References Cited

UNITED STATES PATENTS

2,487,052	11/1949	Hastings	335—151 X
3,373,449	3/1968	Rusnok	4—100
3,082,433	3/1963	Armstrong et al.	4—44

FOREIGN PATENTS

477,661	1/1938	Great Britain.

ROBERT K. SCHAEFER, Primary Examiner

T. B. JOIKE, Assistant Examiner

U.S. Cl. X.R.

137—391; 307—118; 317—137