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L. O. FRENCH

1,879,165

ELECTROMAGNETICALLY OPERATED VALVE

Filed Aug. 25, 1930

Fig. 1

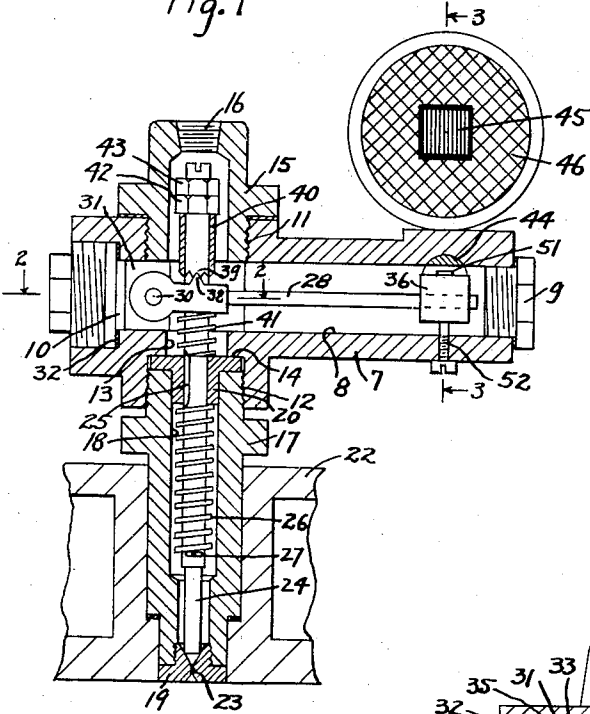


Fig. 3

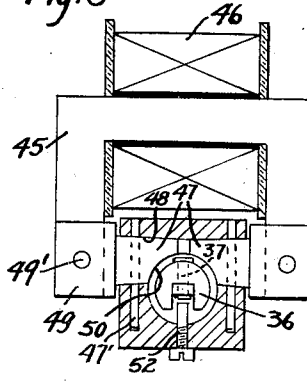


Fig. 2

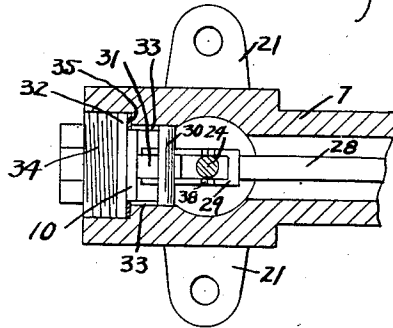


Fig. 4

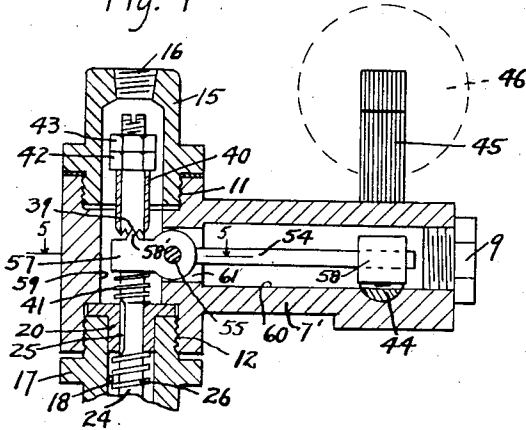
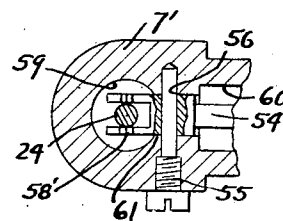


Fig. 5



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ELECTROMAGNETICALLY-OPERATED VALVE

Application filed August 25, 1930. Serial No. 477,489.

The invention relates to electromagnetically-operated valves, and more particularly to an electromagnetic valve suitable for use as a valve in the fuel feeding or fuel injection systems of internal combustion engines to control directly or indirectly the fuel supplied to the engines and in some instances the amount thereof.

Electromagnetic valves of the type above set forth to meet the conditions exacted in service have to be capable of very fast operation and in the case of fuel injection systems, operate under high pressure. It is also desirable to reduce the work imposed upon the magnet and thus reduce the electrical energy necessary to operate the valve and thus reduce arcing at the control switch and also promote high speed operation of the magnet. These conditions can be obtained where the valve is operated by a multiplying lever having an armature associated with the electromagnet and operating freely in the fluid-containing casing containing the valve and further the lifts of the valve may be extremely small so that very small quantities of fuel may be handled even though the pressure of the fuel be at a thousand or several thousand pounds per square inch. Since the pressures are high, the valve structures should be designed to handle such pressures efficiently and since the lifts may be very small only close cooperation of the parts make their use possible.

One object of the invention is to provide an electromagnetic valve to satisfy the above requirements wherein prompt action of the valve with extremely small lifts by its operating lever is assured by taking up any lost motion between these parts.

A further object of the invention is to provide an electromagnetic valve suitable for high pressure work in which the magnet has a laminated core preferably arranged exteriorly of the valve casing and associated with the pole pieces in sealed engagement with the casing and in this connection the present application is a continuation in part of my prior application Ser. No. 455,683 filed May 26, 1930.

The invention further consists in the sev-

eral features hereinafter set forth and more particularly defined by the claims at the conclusion hereof.

In the drawing; Fig. 1 is a vertical sectional view through a valve embodying the invention;

Fig. 2 is a detail horizontal sectional view taken on the line 2—2 of Fig. 1;

Fig. 3 is a detail vertical sectional view taken on the line 3—3 of Fig. 1;

Fig. 4 is a detail vertical sectional view, similar to Fig. 1 showing certain modifications, parts being broken away;

Fig. 5 is a detail horizontal sectional view taken on the line 5—5 of Fig. 4.

Referring to Figs. 1 to 3 of the drawing, the numeral 7 designates a casing section of suitable non-magnetic material such as bronze or Monel metal provided with a bore 8 open at both ends and suitably sealed at these ends by plugs or caps 9 and 10, the cap 9 having threaded engagement therewith. The casing 7 also has axially aligned threaded bores 11 and 12 extending at an angle to the bore 8, and a bore 13 cooperating with the bore 12 to provide a shoulder 14.

The threaded bore 11 is closed off by a hollow cap nut 15 in sealed engagement with the casing and provided with an opening 16 for connection with any suitable source of fuel supply.

A metal casing section 17 is threaded at its upper end to engage the threaded bore 12 and has a bore 18 threaded at its lower end to receive the threaded end of a valve seat member 19 and adapted to receive a flanged valve guide and sealing member 20 in its upper end, said member being of brass, bronze or other suitable material so that when the flange thereof is clamped between the shoulder 14 and the member 17 it will seal this joint against leakage.

Where the valve is used as a fuel injector, apertured lugs 21 are provided on the casing 7 to receive suitable bolts or studs to secure the valve to an engine cylinder 22 and the passage 23 in the member 19 forms a fuel discharge orifice to spray the fuel, controlled by the valve, into said cylinder, though it will be understood that the features

of construction described herein are not to be limited to use only on fuel injectors.

A control valve 24, preferably a needle valve, is slidably mounted in the member 20 and its pointed end engages the valve seat member 19 and controls the flow of fuel through the passage 23. The valve may have one or more grooves 25 formed therein to permit the free passage of fuel between the casing sections 7 and 17.

In addition to the fuel pressure acting on the valve, a spring 26, interposed between the lower end of the member 20 and a stop 27 formed by a cotter pin, is also provided to urge the valve to its seat.

A multiplying lever 28 is mounted to work entirely within the casing and is operatively connected to the valve. As herein shown, the forked end 29 of said lever that straddles a portion of the valve stem is mounted on a pivot pin 30 that is carried in a pin bearing and lever guide extension 31 of the plug 10 so that said lever and its pivotal support may be assembled outside of the casing and introduced into the same, the plug 10 having a sealing flange portion 32 and the pin 30 being slightly longer than the diameter of the bore 8 with its extended ends engaging in slots 33 communicating with the bore 8 so as to prevent turning of said plug by a clamping screw 34 which is in threaded engagement with this end of the bore 8 and forces said flange portion 32 in sealing engagement with the casing or a gasket 35 interposed between it and said casing. The lever 28, which may be formed of steel or any suitable metal, has an armature 36 of soft iron secured thereto at the outer end thereof as by a brass rivet or pin 37 and it has diametrically disposed hardened points 38 adapted to cooperate with similarly disposed notches 39 formed in the lower end of a stop sleeve 40 of hardened steel adjustably mounted on the stem of the valve.

A spring 41 is interposed between the casing sections 7 and 17 and acts upon the lever 28 to normally urge the same against the stop sleeve 40 whose position on said valve stem may be varied by adjusting the nut 42 and the lock nut 43 associated therewith, said spring being lighter than the valve closing spring 26.

The operating electromagnet may be of any suitable construction so as to provide pole portions within the casing with which the armature is adapted to cooperate but the construction shown herein embodying the pole pieces 44 having a fluid tight fit within the casing and associated with a laminated core 45 upon which the energizing coil 46 is mounted outside the casing is preferred.

The pole pieces 44 have tapered ends 47 having a fluid tight fit with similar bores 48 in the casing intersecting the bore 8 adjacent the armature 36, are locked in place by pins

47' and are provided with suitably slotted heads 49 in which the ends of the core 45 are mounted and secured in any suitable manner as by rivets 49'. These pole pieces are spaced a short distance apart at their inner ends 50 which are curved or otherwise suitably formed to cooperate with the cylindrical or otherwise suitably formed armature 36, it being noted that the head 51 of the pin or rivet 37 may act as an anti-freeze member when using direct current.

The range of movement of the lever 28 and hence the lift of the valve may be maintained within certain limits by a non-magnetic stop pin 52 mounted in the casing and engageable with the outer end of said lever when in its release position.

The construction shown in Figs. 4 and 5 is generally similar to the above described construction except for the specific construction of the multiplying lever and its pivotal mounting in the casing and accordingly similar parts have been similarly numerated and the changes will only be specifically referred to. In this form the multiplying lever 54 is pivotally mounted intermediate its ends upon a pin 55 extending through a bore 56 in the casing section 7' and having a threaded end in sealed engagement with said casing. One arm 57 of said lever is forked and provided with projections 58 to engage the stop sleeve 40 and the other arm has the armature 58 mounted thereon in the reverse position to that shown in Fig. 1 and cooperates with the pole pieces 44 which are also reversed.

The casing section 7' is generally similar to the casing section 7 except that angularly disposed bores 59 and 60 are connected by a passage 61 whose sides are broached to a rectangular shape to guide and accommodate the lever 54.

With either of the above described constructions when the electromagnet 46 is energized the armature 36 or 58 will be attracted thereto and move either the lever 28 or 54 toward it which action through the connection of said lever with the valve 24 will act to open the valve. Owing to the fact that the distance through which the outer end of the lever moves may be made as small as the direct acting magnet and the leverage may be five or six to one the actual lift of the valve may be made extremely small so that very small quantities of fuel may be handled even though this fuel be at high pressure. Furthermore the actuating lever is free to move within the liquid in the enclosing casing and by the use of the spring 41, the armature associated with the lever may be brought to the desired adjusted position relative to the pole pieces by the movement of the sleeve 40 under the action of the nuts 42 and 43. Furthermore the spring 41 takes up all lost motion between the lever and the valve and it also enables a heavier and hence livelier spring 26 to be

used to close the valve as it may be used to counteract a portion of the pressure exerted by the spring 26 on the valve.

It will also be noted that removal of the sleeve 40 and nuts 42 and 43 permits the withdrawal of the valve 24 from the casing 7 without disassembly of the lever 28 so as to readily grind or otherwise service the valve.

I desire it to be understood that this invention is not to be limited to any particular form or arrangement of parts except in so far as such limitations are included in the claims.

What I claim as my invention is:

1. In an electromagnetic valve, the combination of a casing adapted to contain fluid under pressure, a control valve working in said casing and controlling the passage of fluid therethrough, a multiplying lever pivotally mounted to work wholly within said casing and having a part engageable with said valve to open the same, means to constantly hold said lever and valve in engagement and prevent lost motion between the same, means to close said valve, an armature associated with said lever, and an operating electromagnet including pole members disposed in said casing in operative relation to said armature.

2. In an electromagnetic valve, the combination of a fluid containing casing, a control valve working in said casing and controlling the passage of fluid therethrough, a multiplying lever pivotally mounted to work wholly within said casing and connected to said valve, spring means constantly acting to maintain the connection between said lever and valve, spring means to close said valve and move said lever to release position, an armature associated with said lever, and an operating electromagnet including pole members disposed in said casing in operative relation to said armature.

3. In an electromagnetic valve, the combination of a fluid containing casing, a valve working in said casing, a multiplying lever working in the said casing and engaging said valve to operate the same, means to constantly maintain the engagement between said lever and valve, an armature carried by said lever, spaced pole pieces having fluid tight engagement with the casing and faces disposed adjacent said armature, a laminated core, exterior of said casing, connecting said pole pieces together, and an energizing coil mounted on said core.

4. In an electromagnetic valve, the combination of a fluid containing casing, a control valve working in said casing and controlling the release of fluid therefrom, a multiplying lever pivotally mounted to work wholly within said casing and operatively connected to said valve to open the same, means to close said valve, an armature associated with said lever, spaced pole pieces having fluid tight engagement with said casing

and curved faces disposed adjacent said armature, a laminated core, exterior of said casing, connecting said pole pieces together, and an energizing coil mounted on said core.

5. In an electromagnetic valve, the combination of a casing section having angularly disposed passages, a casing section detachably secured to said first named section and having a valve receiving passage aligned with one of said passages, a valve working in said aligned passages, a valve actuating lever pivotally mounted in said first named casing section, guide means for said valve, a spring disposed between said guide means and lever to constantly hold said lever in engagement with said valve, means to close said valve, an armature on said lever, and an operating electromagnet including pole members disposed in said casing in operative relation to said armature.

6. In an electromagnetic valve, the combination of a casing section having angularly disposed passages, a casing section having a valve receiving passage aligned with one of said passages and having detachable connection with said first named section, a valve working in said aligned passages, a valve actuating lever pivotally mounted in said first named casing section, guide means for said valve clamped between said casing sections, a spring disposed between said guide means and lever to constantly hold said lever in engagement with said valve, a spring disposed between said guide means and a part of said valve to normally urge said valve to closed position, an armature on said lever, and an operating electromagnet including parts disposed in said casing in operative relation to said armature.

7. In an electromagnetic valve, the combination of a casing including casing sections detachably secured together, a valve working in said casing and removable with one of said casing sections, a multiplying lever pivotally mounted in the other casing section, a stop member adjustably mounted on said valve, and engaging said lever, said stop member having removable connection with said valve to permit removal of said valve from the casing section containing said lever without removing said lever, an armature associated with said lever and an operating electromagnet including parts disposed in said casing in operative relation to said armature.

8. In an electromagnetic valve, the combination of a fluid containing casing, a control valve working in said casing and controlling passage of fluid therethrough, a multiplying lever pivotally mounted to work wholly within said casing and engageable with a part of said valve, guide means for said valve, a spring disposed between said guide means and lever to constantly hold said lever in engagement with said valve, a spring to close the valve, an armature on said lever, and an

operating electromagnet arranged in operative relation to said armature.

9. In an electromagnet valve, the combination of a fluid containing casing having separable parts, a control valve working in said casing and controlling passage of fluid therethrough, a valve actuating lever pivotally mounted within said casing, separable guide means for said valve clamped between parts of said casing, a spring disposed between said guide means and lever to constantly hold said lever in engagement with said valve, a spring disposed between said guide means and a part of said valve to normally urge said valve to closed position, an armature on said lever, and an operating electromagnet arranged in operative relation to said armature.

10. In an electromagnetic valve, the combination of a fluid containing casing having an opening at one end, a valve working in said casing and controlling passage of fluid therethrough and having a stem projecting beyond said opening, a multiplying lever pivotally mounted to work wholly within said casing, a stop sleeve mounted on the stem of said valve, means on said stem exterior of said opening to adjust the position of said sleeve relative to said stem, a cap connected to said casing to enclose the projecting end of said stem and said sleeve adjusting means, a spring acting to hold said lever constantly against said sleeve, a spring to close the valve, an armature on said lever, and an operating electromagnet arranged in operative relation to said armature.

11. In an electromagnetic valve, the combination of a casing of non-magnetic material having tapered bores and a bore intersecting the inner ends of said tapered bores, spaced pole pieces having tapered ends in fluid-tight engagement with said tapered bores adjacent said intersecting bore and recessed adjacent thereto to provide pole faces, a casing secured in fluid tight engagement with said first named casing, a control valve mounted in said last named casing, an armature associated with said valve and cooperating with said pole pieces, a laminated core connecting said pole pieces together, and an energizing coil mounted on said core.

12. In an electromagnet valve, the combination of a casing having a part formed of non-magnetic material provided with oppositely disposed tapered bores and a bore intersecting the inner ends of said tapered bores, a valve working in said casing, spaced pole pieces having tapered ends in fluid tight engagement with said tapered bores adjacent said intersecting bore, means for locking said pole pieces in position, an armature associated with the valve and cooperating with said pole pieces, a core connecting said pole pieces together exterior of said casing, and an energizing coil mounted on said core.

13. In an electromagnetic valve, the com-

bination of a casing having a part formed of non-magnetic material having tapered bores extending into the interior of said casing, a valve and an armature operatively associated with the valve working in said casing and controlling the passage of fluid therethrough, spaced pole pieces having fluid tight engagement with said tapered bores with their inner ends arranged in operative relation with said armature, a core connecting said pole pieces together exterior of said casing, and energizing means mounted on said core.

In testimony whereof, I affix my signature.

LOUIS O. FRENCH.