July 18, 1961 R. L. PERSONS 2,993,149

ELECTRO-MAGNETIC CONTROLS

Filed March 10, 1958

FIG. 1

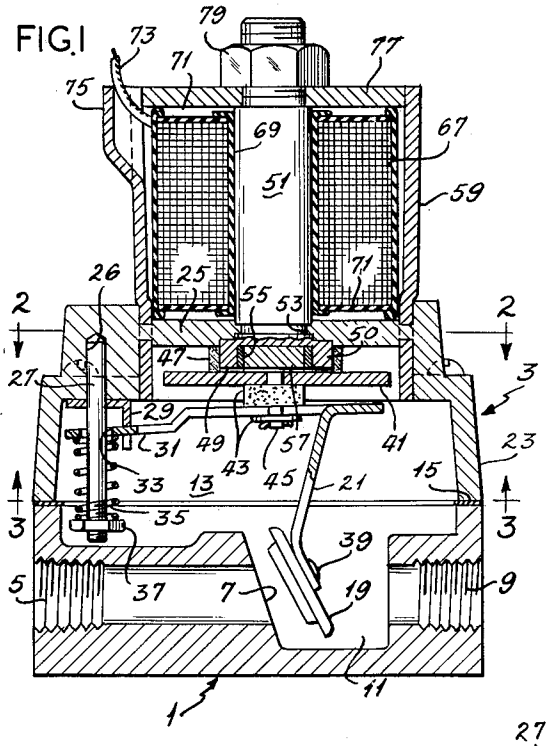


FIG. 2

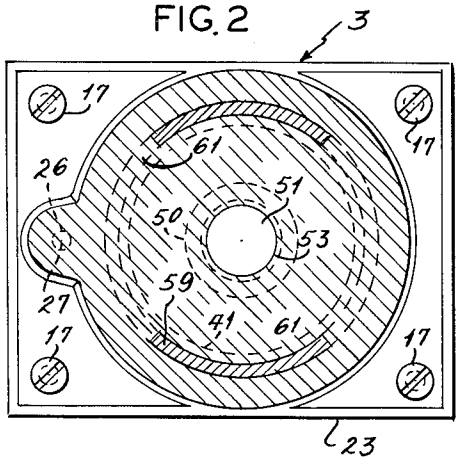


FIG. 3

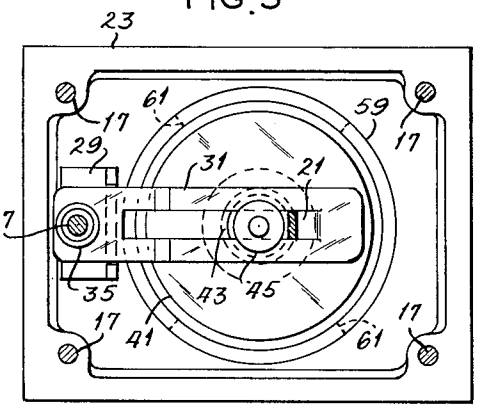


FIG. 4

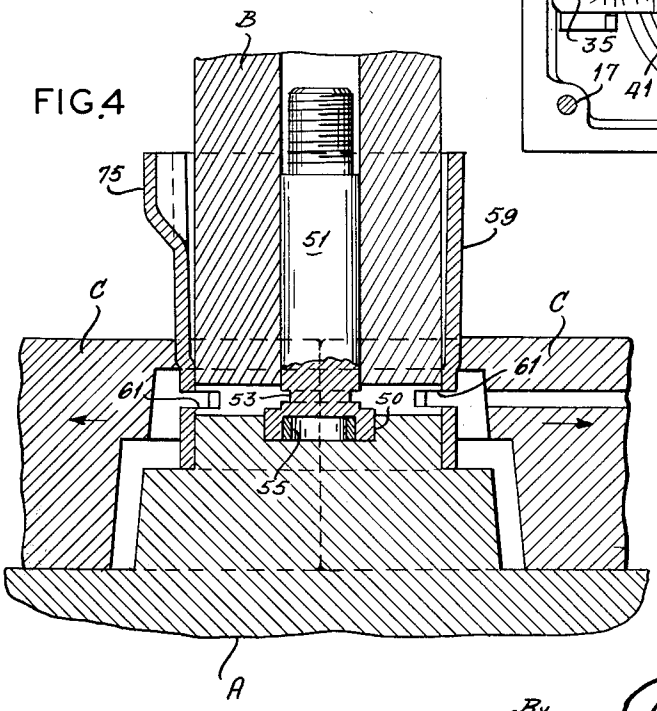
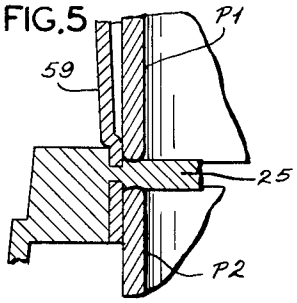


FIG. 5



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ELECTRO-MAGNETIC CONTROLS

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This invention relates to small electro-magnetic controls and relays, and more particularly to electro-magnetically controlled gas valves of the type used in space heaters, furnaces, clothes dryers and other gas appliances.

The art is competitive, hence considerable effort is directed toward reducing the manufacturing cost while still providing a quiet device having little of the sixty cycle A.C. current "hum" or "buzzing," and minimizing the adverse condition which occurs after the coil is de-energized when an armature tends to remain or "stick" against its opposite pole due to residual magnetism. Satisfactory performance requires a level of magnetic pull sufficiently high to mechanically stabilize the armature against vibration while in its energized position, yet allow an opposing spring or gravity bias of strength adequate to assure breaking the armature away from the pull of residual magnetism. In effect, one force is thus fighting the other, hence a narrower differential between them is likely to result in unsatisfactory performance.

Both noise and residual pull are factors related to cost, since competitive designing in any given application imposes size limitations, particularly on the costly electrical coil itself. A reduction in size to reduce coil cost normally results in marginal magnetic force which, in turn, aggravates such inherent problems. Since electro-magnetic force (or specifically, magnetic flux density) varies directly with coil current, and inversely to its temperature rise (or resistance), it is apparent that effective heat dissipation is one of the basic and critical factors determining ultimate performance. This is particularly true of continuous duty coils which have an unlimited "on" period in which they rise to a peak temperature. In short, as temperature rises, so does resistance, current then falling off and the magnetic pull with it. Thus, it follows, that with a high heat dissipation factor, a comparatively small coil with high current input may nevertheless be effective, provided of course there is means of increasing the heat dissipation in an economical design.

At the same time, it must be borne in mind that electro-magnetic devices are subject to Underwriters' Laboratories standards wherein temperature characteristics are of critical importance. Gas valves additionally must be approved by the American Gas Association, which imposes similar conditions. The matter is therefore more than entirely a question of competitive design and performance alone.

Accordingly, one of the objects of the invention is to provide a design for electro-magnetic controls, such as relays and control valves, in which the heat dissipation is improved so as to permit use of a less expensive coil.

Another item of manufacturing expense and potential noise is the assembly of the magnetic and non-magnetic parts of the control. For example, it has been customary to make most of the non-magnetic supporting parts of the magnet from stainless steel stampings, the stampings then being fastened to a main housing, as by soldering or by screws with gaskets interposed for sealing effect. If the assembly of such a control is not carefully finished, the parts may work loose during operation and create a noise problem. Also, when gaskets are employed for sealing effect, they tend to isolate the different portions of the device in the sense of thermal conductivity, with

the result that the operating temperature tends to be higher.

Accordingly, another object of the invention is to provide a manufacturing process wherein the assembly costs are reduced substantially, wherein the magnetic and non-magnetic members are secured in a fashion such that they cannot work loose, and wherein the several members are in metal-to-metal contact with one another so as to have superior heat-radiating or conducting properties.

While other features of the invention will be apparent in the detailed description, briefly, the invention contemplates a magnetic control having a housing section formed of non-magnetic metal of low melting temperature (such as die casting aluminum) as compared with magnetic materials (such as steel). The magnetic pole-forming members more particularly are constituted by a core upon which the coil is received and a sleeve or return yoke. A special die is employed to hold the two pole-forming members in spaced relationship while a non-magnetic body section is die cast thereabout. The mold for the body is further designed to provide a skirt or outer portion forming a part of the main housing and a web portion extending inwardly between the two spaced magnetic members intermediate their ends. The magnetic sleeve may have an opening cut in its wall so that the non-magnetic metal or other material may flow therethrough to form a non-magnetic supporting web or plate for the core.

Preferably, the armature is in the form of a disk of somewhat smaller diameter than the inside dimension of the sleeve, and the end of this sleeve projects beyond the edge of the core so that the armature may move within the sleeve toward the core pole-face. In order to eliminate noise and avoid a residual problem, a nylon or other non-magnetic sleeve is fitted around the end of the core so as to project a slight distance beyond the core and support the armature in spaced relationship from the face of the core. However, in lieu of the nylon sleeve, the die cast web or supporting member for the core may be continued up around the core head in collar fashion, like the nylon sleeve, to provide this spacing. In A.C. magnets requiring a shading ring, the end of the core is counterbored. A copper or other electrically conductive ring is then closely fitted within the counterbore and a magnetic plug is press fitted within the copper ring.

Both the core and sleeve of magnetic material project a substantial distance outwardly from the non-magnetic web. As such, the sleeve forms a part of the housing as well as a return path for the magnetic circuit. A pre-wound coil may be slipped over the core, and an outer magnetic washer completes the magnetic circuit and enclosure for the coil. The lead-in wires for the coil may extend between this washer and the sleeve, the sleeve or washer having a bulge formed therein to accommodate the lead-in wires.

In the case of a gas valve or a relay wherein the contacts are to be sealed or isolated from the coil, the non-magnetic web would be continuous so as to define a sealing diaphragm or plate. In any case, the two pole-forming members are secured in metal-to-metal bond in the non-magnetic material of the housing. The invention contemplates that the iron or steel magnetic parts may be dip-soldered or otherwise treated in order to improve this bond.

Other features of the invention will be in part apparent from and in part pointed out in the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a sectional view illustrating a control valve embodying the invention;

FIG. 2 is a cross sectional view taken on the line 2—2 of FIG. 1;

FIG. 3 is a cross sectional view taken on the line 3—3 of FIG. 1;

FIG. 4 is a diagrammatic view illustrating the die casting mold with the magnetic components of the controls supported therein preparatory to injection of non-magnetic metal; and

FIG. 5 is a diagrammatic sectional view illustrating a further step in processing the die casting of this invention.

Referring to the drawings, FIG. 1 illustrates an electromagnetic valve, such as might be used in controlling the flow of gas to an appliance. The valve is made with a lower body section 1 and an upper body or housing section 3. The lower section 1 is formed with an outlet 5, a valve seat 7 and an inlet port 9 leading to an inlet cavity 11. The cavity 11 opens upwardly into a cavity 13 formed in the upper section 3, and the two sections are adapted to be secured in sealed relationship with a gasket 15 by means of screws 17. The cavities 11 and 13 define a chamber containing the movable valve parts of the assembly, which include a poppet 19 and supporting arm 21. The poppet 19 is molded from rubber with a knife rim formed to seat in sealing relationship against the valve seat 7.

The upper body section 3 is formed with an outer skirt portion 23 and an inner web or diaphragm-like section 25 for supporting the fixed components of the magnet. The upper housing section 3 also supports the movable parts including the armature and poppet parts. As shown in FIG. 1, a hole 26 is formed to receive a pin 27, which is press fitted or forced within the hole. A fulcrum bracket 29 is secured by the pin to support a lever 31 pivotally, the lever 31 having an opening 33 formed therein through which the pin 27 extends. A spring 35 is adjustably secured on the pin by a nut 37 so as to bias the lever in a clockwise direction, as viewed in FIG. 1, thereby tending to close the poppet. The nut is threaded onto the pin. The poppet-supporting arm 21 may be bent from the lever 31 as an integral part thereof, and the poppet is secured, as by a rivet 39 thereto.

A movable magnetic armature in the form of a steel disk 41 is also secured to the lever 31 by means of rubber cushions 43 and a fastener 45. It will be understood that FIG. 1 illustrates the armature in its actuated position wherein the coil is energized and the valve opened. In the actuated position, the armature 41 is drawn against the end of a nylon sleeve 47, which projects slightly beyond the pole face 49 of a magnetic core 51. This core 51 is formed of magnetic steel relay stock with a somewhat enlarged head 50 and an undercut groove 53 interlocked with the web 25 of the upper body section. Also, the pole end of the core is counterbored to receive a copper shading ring 55 and magnetic plug 57. The shading ring is necessary for an A.C. operation, and while the ring might be inserted within a circular channel cut in the pole face 49, it has been found that a preferred arrangement is to counterbore the entire hole and insert the plug 57, the several parts having a press fit with one another. It may also be noted that the circular imbedded shading ring is preferred for this type of magnetic circuit.

The magnetic circuit is completed by means of a sleeve-like section 59 of magnetic material. This sleeve has slots 61 cut therein opposite the web portion 25 of the upper body, and a portion of the sleeve extends below the web 25 while the main portion thereof projects upwardly as a case for a coil 67. The coil 67 is pre-formed on a fiber tube 69 with fibrous end washers 71. The lead-in wires 73 for the coil are adapted to extend through a bulged section 75 of the sleeve, while the end is closed by a magnetic washer 77 secured with a nut 79 on the core.

As illustrated in FIG. 1, the lower end or pole face 47 of the central core 51 is disposed above the lower

end of the encircling magnetic sleeve 59, and the disk-like armature 41 is adapted to move within the lower portion of the sleeve. Accordingly, the magnetic circuit, in the energized position of parts is through the core, outwardly through the disk-like armature, upwardly through the sleeve 59 and then through the end-closure washer 77 back to the core. In the deenergized position, the armature is spring biased downwardly and at least a portion thereof may move beyond the lower end of the sleeve 59. As the armature is drawn upwardly upon energization of the coil, it is prevented from contacting the core by the nylon sleeve 47 and is also cushioned. The cushioning action minimizes noise and the slight air gap between the core and armature is advisable in order to avoid sticking of the armature under the forces of residual magnetism. The rubber cushions or washers 43, which support the armature on the lever 31, further minimize noise.

While the construction is deemed novel, an important aspect of the invention is the method of manufacture. First, the sleeve-like section 59 of magnetic material may be readily formed from tube stock, the operations all being conventional and well understood to those skilled in the art. The core can be similarly manufactured at relatively low cost. Necessarily, the armature and end closure disk can be standard items of commerce. Accordingly, the magnetic components are inexpensive.

Referring now to FIG. 4, the two fixed magnetic pole members 51 and 59 are secured to the main body section 3 of the control in a novel manner. This body section 3 is formed of die cast aluminum along with the lower body section 1, and the mold is constructed so that the two pole members are received within the mold and secured by casting the body section therearound. For example, the mold may be formed with a base section A and a top plug B which are relatively movable toward and away from one another. The mold is then completed by a pair of side forming members C which are movable toward and away from one another into clamping relationship with the sleeve 59. With the mold parts open, the core 51 and sleeve 59 are inserted, whereupon the mold is closed and the molten material for forming the housing section 3 is injected under pressure. Preferably, die casting aluminum material is employed but any non-magnetic die casting material may be used, although it is preferred that a metal be utilized for this purpose. The metal flows though the slots 61 into intimate interlocking relationship with the groove 53 in the core so as to complete an impervious diaphragm from the skirt portion of the body through the sleeve 59 to the core. This web or diaphragm thereby seals the chamber 13 from the coil. Also, the parts are automatically secured in position so that they cannot work loose during subsequent use of the control. In order to facilitate the bond between the die casting aluminum and the magnetic parts 51 and 59, the latter may be initially tinned, covered with a light coating of solder, hot-dipped in aluminum or electroplated with a metal (such as tin, zinc or cadmium) whose melting temperature is lower than that of the die casting aluminum. Although a key structure is shown, the adhesion may be strong enough to permit elimination of such key grooves.

The control is then completed by attaching the armature and poppet assembly by press fit of the pin 27, attaching the die cast lower body portion 1, inserting the coil, and fastening the end closure gap 75. In other words, the final assembly operation involves only a few steps, hence is a low cost process.

The reduction in cost over comparable controls is considerable. Also, better heat transfer characteristics are achieved, because the core 51 is intimately connected by the diaphragm 25 to the sleeve 59 and housing section 3. An aluminum body necessarily has relatively high thermal conductivity, hence will carry off the heat at a rapid rate. The improved heat transfer character-

istics, in turn, permit the use of a smaller and hence less expensive (although somewhat hotter) coil, thereby affording a further reduction in cost. The gas-sealing effect of the membrane is particularly desirable in a gas valve which must withstand an extreme temperature of 800 degrees F. under an A.G.A. test without loss of the sealing feature. Necessarily, this safety test is to assure that gas will not be released should the valve be subjected to a high temperature, as in a fire. It will be apparent that the disclosed valve will hold its seal substantially up to the melting temperature of aluminum (1100 degrees F.)

It will be understood that in making a valve, a leak-proof seal should exist between the non-magnetic web **25** and the magnetic pole members **51** and **59**. One of the difficulties in die casting the aluminum around the magnetic pole parts is that the aluminum or other die-casting material tends to shrink away from the magnetic pole parts, perhaps creating an opening through which leakage could occur. This shrinkage problem is sometimes overcome by tinning and heating the pole parts before the die-casting step. In accordance with the present invention, this problem is economically resolved by squeezing the relatively soft non-magnetic metal (after die-casting) at areas adjacent the pole parts, thereby forcing the aluminum into tight leak-proof engagement with the iron. For example, FIG. 5 illustrates how the magnetic web **25** may be squeezed between a pair of ring-like pressure members **P1** and **P2** adjacent the inner periphery of the steel tube **59**, thereby creating a leak-proof point. The members **P1** and **P2** might be planishing dies, one being a fixed anvil and the other then being struck with a hammer. The leakage problem does not seem to be as serious adjacent the core **51**, but the same technique can be utilized here, if necessary.

From the foregoing description, it is apparent that those skilled in the art will understand the structure, function and mode of operation of the invention herein disclosed, and appreciate the advantages thereof. Although one embodiment has been disclosed in detail, it is to be understood that the invention is not limited thereto, but the drawings and description thereof are to be understood as being merely illustrative. For example, various features of the invention may be utilized in constructing a magnetic relay, particularly where the contacts thereof are to be enclosed or isolated from the coil. It is realized that many modifications and variations will present themselves to those skilled in the art without departing from the spirit of this invention or the scope thereof as set forth in the appended claims.

Having thus described the invention, what is claimed and desired to be secured by Letters Patent is:

1. A casting for a magnetic control of the character disclosed comprising a pair of pre-formed magnetic pole members imbedded within a non-magnetic casting, said two pole members being in spaced relationship from one another in said non-magnetic casting, and opposite end portions of each pole member projecting on opposite sides of the non-magnetic casting.

2. A magnetic control of the character disclosed comprising first and second body sections formed of non-magnetic material, said body sections being secured together in abutting relationship and defining a chamber therewithin, a magnetic armature mounted for movement within said chamber, a first magnetic pole member extending through one of said body sections to said armature and having a recess formed therein in interlocking relationship with said body section so as to be held thereby, said first pole member projecting outwardly of said body section and a coil mounted thereon outwardly of the body, and a second magnetic pole member extending through said body to said armature, said second pole member being in spaced relationship to said first pole member and also having a recess formed therein in interlocking relationship with the body, so as to be held thereby, said second pole member forming a return path for the magnetic circuit from said first pole member and armature.

3. In a magnetic control of the character disclosed having a pair of relatively fixed magnetic pole members and a relatively movable magnetic armature; the improvement that comprises one of said pole members being formed as a sleeve of magnetic material open at both ends, said other pole-forming member being formed as a magnetic core centrally disposed within said sleeve, and a pole-supporting body formed of non-magnetic material with an outer skirt portion encircling said sleeve and a web portion extending integrally therefrom between said sleeve to said core, said web portion being secured directly to said sleeve and core thereby to form a non-magnetic support for said core, said core projecting at least in part on each side of said web member, a coil disposed around said core member on one side of said web, said armature being mounted adjacent said core on the other side of said web, and said sleeve projecting on opposite sides of said web to encircle the coil and adjacent said armature.

4. A magnetic control as set forth in claim 3, wherein said sleeve has a slot cut therein opposite its area of engagement with the body, said body extending integrally through said slot in the sleeve and said sleeve having integral portions on both sides of said slot locking with the body.

5. A magnetic control as set forth in claim 3, wherein said armature is of an outline similar to but of a dimension smaller than that of the sleeve adjacent the armature, the adjacent end of the core being disposed inwardly of the adjacent end of the sleeve so that the armature may move within the sleeve, and said sleeve being continuous about the armature.

6. A magnetic control of the character disclosed comprising first and second body sections formed of non-magnetic metal, said body sections being secured together in abutting relationship and having cavities defining a chamber therein, a magnetic armature mounted for movement within said chamber, said second body section being formed with an outer skirt and an integral inner web, a magnetic core extending through and sealed with said web, the inner end of said core being adjacent said armature, a coil encircling the outwardly projecting portion of said core, and a magnetic sleeve extending through and sealed with said web, said sleeve having an inner end portion disposed adjacent said armature and an outwardly projecting portion encircling said coil.

7. A magnetic control as set forth in claim 6, wherein the inner end portion of said core is counterbored, an electrically conductive ring engaged within said counterbore and a magnetic plug engaged within said ring.

8. A magnetic control as set forth in claim 6, further comprising a non-magnetic collar formed about the inner end of said core, said collar projecting at least slightly beyond the inner end of said core, thereby to prevent engagement of the armature with said core, said armature being mounted for movement toward and away from the inner end of said core.

9. A magnetic control as set forth in claim 8, wherein the inner end of said sleeve is generally cylindric and projects inwardly beyond the inner end of said core, said armature being in the form of a disk whose outer diameter is less than the inner diameter of said sleeve at its inner end, said armature being mounted for movement into the space defined by the inner end of said sleeve.

10. In an electro-magnetic gas control valve, the improvement comprising a valve body section formed of die cast metal, a magnetic core extending through said body section and interlocked therein with a metal-to-metal bond, said core in part projecting within said body section and in part projecting outwardly therefrom, a coil coaxially disposed upon the outer portion of said core, a coaxial magnetic sleeve also extending through said body

and interlocked therein with a metal-to-metal bond, said sleeve in part projecting within said body section and in part projecting outwardly therefrom in surrounding relationship with said coil, a magnetic plate secured in bridging relationship with the outer ends of said core and sleeve, a magnetic armature mounted in bridging relationship adjacent the inner ends of the core and sleeve

11. A control as set forth in claim 10, further including a non-metallic collar formed over the inner end of said core, said collar having one end engaged against the non-magnetic body and the other end of said non-metallic collar projecting inwardly beyond the inner end of said core.

12. A control as set forth in claim 10, wherein the inner end of said core is formed with a counterbore, an electrically conductive ring fitted within said counterbore and a magnetic plug fitted within said ring.

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