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H. E. HARTIG

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BALANCED RELAY

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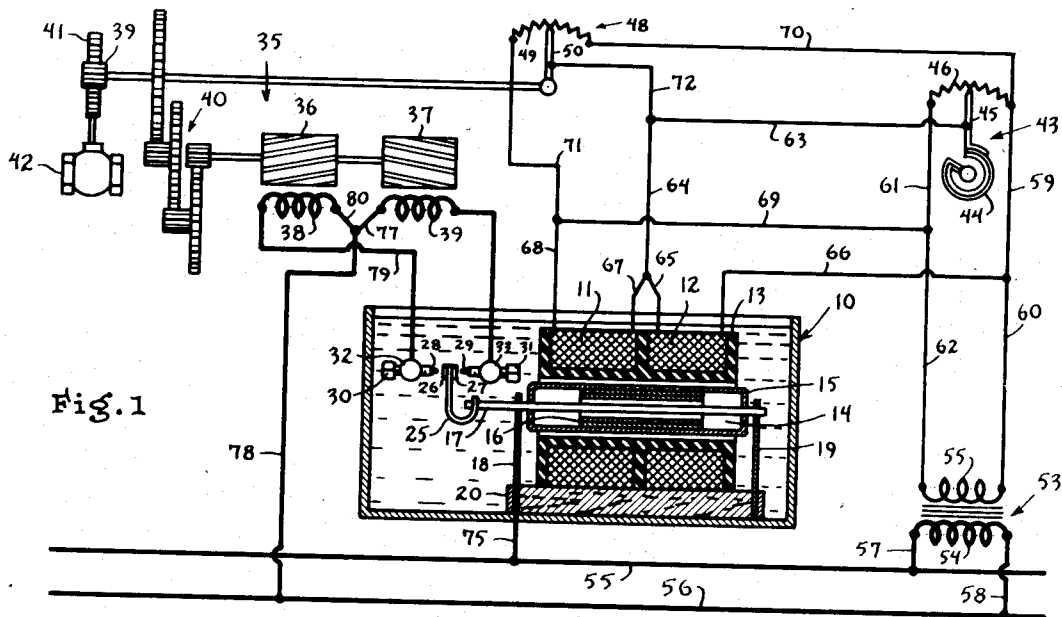


Fig. 1

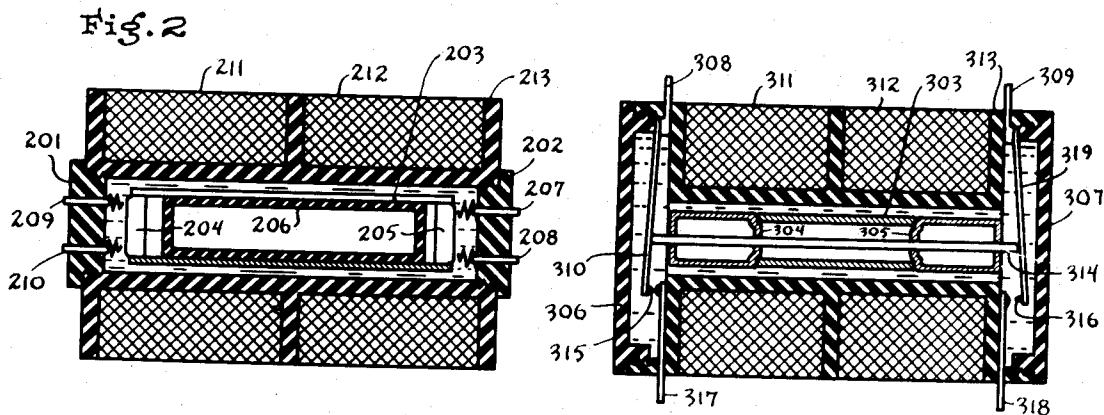


Fig. 3

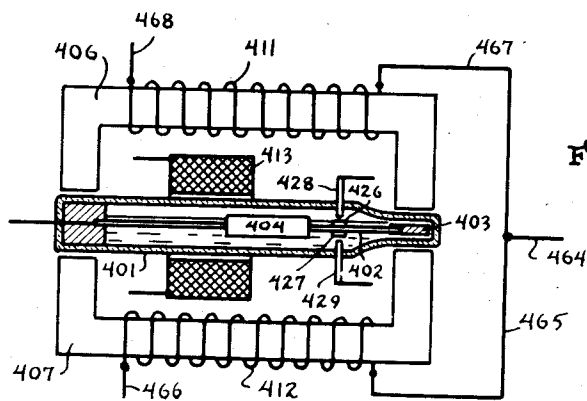


Fig. 4

Inventor
Henry E. Hartig

By *George H. Fisher*
Attorney

UNITED STATES PATENT OFFICE

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BALANCED RELAY

Henry E. Hartig, Robbinsdale, Minn., assignor to
Minneapolis-Honeywell Regulator Company,
Minneapolis, Minn., a corporation of Delaware

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19 Claims. (Cl. 200—100)

My invention relates to improvements in balanced relays and comprehends specifically improved constructions and forms of balanced relays to improve their sensitivity and to produce other advantages.

An object of my invention is to provide an armature and supporting means so arranged that the armature is movable substantially without friction.

Another object is to provide a relay having an armature disposed in a state of equilibrium.

Another object is to provide a sensitive balanced relay including armature means disposed in a liquid and having substantially the same density as the liquid.

Another object is to provide a sensitive balanced relay including an armature means immersed in a liquid and comprising magnetic means associated with buoyant means, the armature means as a whole having the same density as the liquid so as to be in a state of equilibrium.

Another object is to provide a sensitive balanced relay including an armature suspended or guided by very delicate members but having its weight supported by a liquid, the arrangement being such that in any position, the liquid supports the armature so as to avoid placing a strain on the suspension or guide members.

Another object is the provision of a balanced polarized relay having an armature supported by buoyant means and enclosed within a sealed container, the control windings and polarizing windings being external of the container.

Another object is the provision of a sensitive balanced relay having an armature arranged in neutral equilibrium in combination with control means and a device controlled by the relay embodying rebalancing means.

Figure 1 is a sectional view of a preferred form of my improved balanced relay embodied in a proportioning control system,

Figure 2 is a sectional view of a modification of the relay,

Figure 3 is a sectional view of another modification, and

Figure 4 is a view of a polarized relay embodying my invention.

In Figure 1 of the drawing, I have shown a simplified proportioning control system embodying a preferred form of my invention wherein the balanced relay is bodily disposed within a vessel of liquid. Numeral 10 designates a container or tank filled with a liquid which may preferably be mineral oil. The relay windings 11 and 12 are wound upon a spool 13 which may

be of a suitable composition such as Bakelite. There is a cylindrical opening through the center of the spool 13 and disposed in this opening is the armature assembly 14. The armature assembly comprises a very thin brass tube 15 the ends of which are sealed so as to make it fluid tight, and a tightly rolled cylinder of silicon steel sheet 16 fitted within the central portion of the tube 15. A rod 17 extends all the way through the tube 15 and forms a part of the armature assembly. Connected to the rod 17 at opposite ends of the tube 15 are a pair of very thin brass strips or leaves 18 and 19, the lower ends of which are secured to a wooden base plate 20 which supports the spool 10 and the windings 11 and 12. The strips 18 and 19 are very weak and would not be able to support the weight of the armature, the weight of which is supported practically entirely by the liquid in which it is immersed. That is, when the tank is filled with oil the armature assembly takes a position as shown, by reason of its buoyancy, with the strips 18 and 19 acting to some extent to constrain or limit somewhat the movement of the armature assembly as far as up and down movement is concerned. It is to be seen however that the armature assembly has great freedom of movement longitudinally, that is in the direction of its longitudinal axis because there is no friction between the tube 15 and the interior of the spool 13.

Fastened to the left end of the rod 17 is a contact carrying bracket 25 carrying contacts 26 and 27. The bracket 25 is movable between a pair of contacts 28 and 29 forming part of contact screws 30 and 31 extending through terminal posts 32 and 33, respectively. The contacts 28 and 29 are of a tapering conformation having a contacting surface of relatively small area. I have found that by forming the contacts in this manner the tendency towards sticking contacts is inhibited. With contacts having a relatively large cross-sectional area there is a tendency for bubbles of liquid to form between the contact surfaces and this tends towards sticking of the contacts. With the tapered contacts there is more freedom for the bubbles to escape from between the contact surfaces and rise to the surface of the liquid.

The proportioning system shown in Figure 1 is a simplified form of the proportioning system disclosed in detail in the patent to D. G. Taylor 2,028,110. The system includes an electric motor designated generally at 35 adapted to be controlled by my balanced relay. The motor in-

cludes an armature 36 and an armature 37 and windings 38 and 39 cooperating with respective armatures. One of the armatures and its associated winding are for the purpose of operating in one direction and the other armature and its associated winding are for the purpose of operating in a reverse direction as is well known in this type of system. The motor drives a pinion gear 39 through a train of gears 40 and the pinion gear 39 cooperates with a rack 41 attached to the stem of a valve 42. The valve 42 is of course exemplary of other mechanism which might be driven and controlled by the system and in this particular instance might be a valve controlling a flow of heating medium, heating the interior of a building or other space.

The balanced relay is arranged to be controlled by a proportioning type thermostat designated at 43 and comprising a bimetal element 44 arranged to move a blade 45 over a variable resistance 46. The proportioning thermostat 43 controls the relative energization of the windings 11 and 12 and when the energization of the two windings has been unbalanced, rebalance is brought about by a rebalancing potentiometer 48 comprising a variable resistance 49 and a blade 50 arranged to slide over the variable resistance 49. The blade 50 is driven by the same shaft which drives the pinion gear 39.

Power for operation of the balanced relay is supplied by a step-down transformer 53 comprising a primary winding 54 and a secondary winding 52, the secondary winding having a fewer number of turns than the primary winding. The primary winding 54 is connected to a pair of line conductors 55 and 56 by wires 57 and 58, respectively. The resistance 46 is connected across the secondary winding 52 by wires 59 and 60 and wires 61 and 62. The winding 12 is connected between the blade 45 of thermostat 43 and the right end of winding 52 by wires 63, 64, 65 and wires 66 and 60. The winding 11 is connected between blade 45 and the left end of winding 55 by wires 63, 64, 67, and wires 68, 69, and 62. As is well known, in proportioning systems of this type the thermostat 43 acts in the manner of a voltage divider and adjusts the relative amount of voltage applied to the two windings 11 and 12. The right end of resistance 49 of the rebalancing potentiometer 48 is connected to resistance 46 by a wire 70 and the left end of resistance 49 is connected to resistance 46 by wires 71, 69, and 61. The blade 50 of the rebalancing potentiometer is connected to blade 45 by wires 72 and 63.

When blade 45 is at the mid point of resistance 46, the coils 11 and 12 are equally energized and the armature assembly 14 is in the position shown in Figure 1. If a change of temperature should cause the proportioning thermostat to move the blade 45 to the left on resistance 46, a greater amount of resistance 46 would thus be connected in parallel with coil 12 and accordingly the energization of coil 12 would preponderate over that of coil 11. The increased energization of coil 12 would cause the armature assembly to move to the right bringing contacts 27 and 29 into engagement. This would complete a circuit for motor winding 39 as follows: from line conductor 55 through a wire 75, strip 18, rod 17, bracket 25, contacts 27 and 29, wire 76, winding 39, wire 77, wire 78 back to line conductor 56. Energization of winding 39 would cause the motor 35 to drive valve 42 in such a direction as to tend to cause the temperature

in the vicinity of the proportioning thermostat 43 to return to its original value. As pointed out above by reason of the absence of friction of the armature assembly only a very slight change in the relative energization of the coils 11 and 12 is required to cause one of the pairs of contacts actuable by the armature assembly to become engaged. The effect of the oil in which the armature assembly is immersed is to tend to dampen out vibrations and thereby permit of closer spacing of the contacts inasmuch as the dampening effect of the oil will prevent chattering of the relay contacts. The special formation of the contacts which I have described whereby sticking is inhibited additionally promotes the feasibility of closer contact spacing.

When the proportioning thermostat has caused unbalancing of the balanced relay, rebalance is brought about by movement of blade 50, which is driven by the motor in a direction to equalize the energization of coils 11 and 12 so that the armature assembly again assumes the position shown in Figure 1.

Upon a change in temperature in the opposite direction of sufficient magnitude, contacts 26 and 28 would become engaged and winding 38 of motor 35 would be energized through the following circuit: from line conductor 55 through wire 75, strip 18, rod 17, bracket 25, contacts 26 and 28, wire 79, winding 38, wire 30, and wire 78 back to line conductor 56. The valve 42 would now of course be operated in the opposite direction so as to tend to return the temperature in the vicinity of the proportioning thermostat 43 to its original value.

In Figure 2 I have shown a second preferred embodiment of my invention wherein the relay is not bodily immersed in a liquid but wherein the armature assembly alone is immersed in liquid. The windings 211 and 212 correspond to the windings of Figure 1 and the spool or core 213 on which the coils or windings are wound has a cylindrical center opening the ends of which are closed by suitable plugs 201 and 202. The spool 213 and the end plugs may be formed of Bakelite or other suitable composition. The armature assembly in the present embodiment comprises a hollow iron plunger 203 which may be slotted to reduce eddy currents and the ends of which comprise suitable iron members 204 and 205. The plunger 203 is fitted over an air tight-insulating shell 206 made of Bakelite. The elements making up the armature assembly of Figure 2 are so relatively proportioned that the armature assembly as a whole has the same density as the liquid in which it is immersed, the liquid being the same as the liquid used in Figure 1. In other words, by reason of the air tight shell 206 the armature assembly has a certain amount of buoyancy and the amount of this buoyancy is just sufficient to support or balance the weight of the armature assembly as a whole when it is immersed in the liquid. It is to be seen therefore that the armature assembly of Figure 2 is in equilibrium, that is, it is free to be moved without resistance to the movement thereof. The state of equilibrium of the armature assembly may be compared to the state of equilibrium in which a cone is when the cone is lying on its side. The armature assembly 203 tends to float neutrally without bearing against any part of the spool 213.

The balanced relay of Figure 2 may of course be connected in the system as shown in Figure 1. Electrical connections may be made when the

armature assembly moves to the right by means of conductors 207 and 208 extending through the plug 202 each of which has a small coil spring at its inner end, the coil springs being arranged to be bridged by the iron end member 205 of the armature assembly. The end plug 201 has conductors 209 and 210 extending therethrough with corresponding coil springs attached to their inner ends.

In Figure 3 I have shown a further modified form of my invention wherein the armature assembly may be mechanically supported but wherein a liquid is provided to buoy up the armature and prevent it from placing a strain on the supporting members. The armature assembly in the present embodiment comprises an iron plunger 303, to the opposite ends of which are attached cylindrical float members 304 and 305. The members 304 and 305 may be made of a material which floats in the liquid in which the armature assembly is immersed or that may be hollow air tight elements having buoyancy by reason of their displacement. The spool 313 of the present embodiment is slightly different from that of previous embodiments, having recessed end members 306 and 307 of substantially the same diameter cooperating therewith. Extending into the chambers within the recessed end members 306 and 307 are a pair of contact brackets 308 and 309 which carry armature supporting and contact carrying members 310 and 319. The members 310 and 319 are made of thin flexible material and are attached to the ends of a rod 314 which extends entirely through the armature assembly. At the lower ends of the members 310 and 319 are electrical contacts 315 and 316. The contacts 315 and 316 cooperate with associated contacts carried by contact brackets 317 and 318 extending into the chambers within the end members 306 and 307.

In Figure 4 I have shown a further modified form of my invention wherein its principles are adapted to a polarized relay. In Figure 4 numeral 401 designates a glass envelope partially filled with a liquid corresponding with the liquid of the previous embodiments. Mounted within the envelope 401 is a weak centering spring 402, the left end of which is fixed and the right end of which carries an armature 403. Fastened to an intermediate point of the centering spring 402 is a float 404, the buoyancy of which supports the weight of armature 403. The centering spring 402 carries contacts 426 and 427 cooperating with fixed contact members 428 and 429 extending through the glass envelope.

The right end of the glass envelope 401 within which the armature 403 is disposed is somewhat tapered and adjacent this tapered portion are pole portions of core members 406 and 407. Wound on the core members 406 and 407 are coils 411 and 412, respectively. The connections to the coils 412 and 411 are the same as shown in Figure 1, it being apparent that these coils might be connected in the same type of system. Surrounding the glass envelope 401 is a polarizing winding 413. Polarizing winding 413 may be connected to the source of electricity which supplies the coils 412 and 413 or it may be connected to a separate source of alternating current or electricity. The polarizing winding 413 changes the polarity of the armature 403 synchronously with the alterations in direction of flow of current in the windings 411 and 412 so that if the energization of windings 411 and 412 becomes unbalanced the ar-

mature 403 is continuously attracted by the pull of either the core member 406 or 407. The operation of polarized relays generally is well known in the art and need not be described in further detail.

In the modification of Figure 4 the float 404 supports the weight of the armature 403 so that only a slight unbalancing of the energization of windings 411 and 412 is required to cause contact to be made between one or the other of the pairs of contacts.

From the foregoing the advantages and utility of my invention will be apparent to those skilled in the art. By practising my invention a very sensitive balanced relay may be produced but it is not of an undesirably delicate or fragile construction. By floating an armature or arranging it in a state of neutral equilibrium friction is entirely eliminated and there are no delicate mounting or supporting means or antifriction arrangements.

The various embodiments of my invention which I have disclosed are exemplary preferred forms which have been disclosed to illustrate preferred modes of practising the invention. My invention is therefore not to be limited by my representative disclosures but only by the appended claims.

I claim as my invention:

1. In an electrical device, in combination, means forming a coil winding, armature means substantially axially associated with said winding, means whereby said armature means is supported by a liquid, said armature means being arranged to have sufficient buoyancy to balance the effect of gravity thereon, and said armature means being movable in response to variations in the electrical energization of said coil winding, said armature means being so arranged that the movements thereof do not disturb the condition of balance between gravity acting thereon and the buoyancy thereof.

2. In an electrical device, in combination, means forming a coil winding, armature means substantially axially associated with said winding, means whereby said armature means is supported by a liquid, said armature means having substantially the same density as said liquid whereby said armature means is in a state of equilibrium, and said armature means being movable in response to variations in the electrical energization of said coil winding without disturbing said state of equilibrium.

3. In an electrical device, in combination, means forming a coil winding, armature means substantially axially associated with said winding, said armature means being arranged and buoyantly supported so as to be in a state of equilibrium, and said armature means being movable in response to variations in the electrical energization of said coil winding without disturbing said state of equilibrium.

4. In an electrical device, in combination, means forming a coil winding, armature means substantially axially associated with said winding, means for supporting said armature means, said supporting means being disposed in a liquid, said supporting means having sufficient buoyancy to balance the effect of gravity on said armature means, and said armature means being movable in response to variations in the electrical energization of said coil winding, said supporting means being so arranged that movements of the armature means do not disturb the aforesaid con-

dition of balance between the effect of gravity and the buoyancy of the supporting means.

5. In an electrical device in combination, means forming a coil winding, an armature substantially axially associated with said winding, supporting means for said armature, said supporting means being immersed in a liquid, said supporting means having sufficient buoyancy to balance the effect of gravity on said armature and supporting means, and said armature being movable in response to variations in the electrical energization of said winding without substantially disturbing the aforesaid condition of balance between the effect of gravity and the buoyancy of said supporting means.

6. In an electrical device, in combination, means comprising coil windings, armature means substantially axially associated with said windings, said armature means being arranged and buoyantly supported so as to be in a state of equilibrium, and said armature means being movable in response to variations in the relationship between the energization of said coil windings, said armature means being capable of movement and reverse movement while remaining in a state of equilibrium.

7. In apparatus of the character described, in combination, means forming a sealed container, a liquid in said container, means comprising an electrically energizable coil winding associated with said container, an armature within said container, buoyant means in said liquid for supporting said armature, said coil winding means being exterior of said container, and electrical contacting means in said container operable by said armature, said armature being movable in response to variations in the energization of said winding means.

8. In an electrical device, in combination, means forming a coil winding having an opening therethrough, means associated with the coil winding so that said opening forms part of a closed chamber, said chamber being substantially filled with a liquid, armature means disposed in said chamber, said armature means having the same density as said liquid whereby the armature means is in a state of equilibrium and is free to move unrestrainedly in said chamber, said armature means being adapted to move in response to variations in the electrical energization of said coil winding.

9. In an electrical device, in combination, means forming a coil winding having an opening therethrough, means associated with the coil winding so that said opening forms part of a closed chamber, said chamber being substantially filled with a liquid, armature means disposed in said chamber, said armature means having the same density as said liquid whereby the armature means is in a state of equilibrium and is free to move unrestrainedly in said chamber, said armature means being adapted to move in response to variations in the electrical energization of said coil winding, and electrical contacting means in said chamber actuable by said armature means.

10. In apparatus of the character described, in combination, means forming a container, a liquid in said container, means comprising an electrically energizable coil winding associated with said container, an armature substantially axially associated with said winding within said container, guide members associated with said armature effective to limit its range of movement, buoyant means in said liquid in the container and arranged to buoy up the armature, and said ar-

mature being adapted to move in response to variations in the electrical energization of said coil winding.

11. In an electrical device, in combination, means forming coil windings, armature means substantially axially associated with said windings, means for supporting said armature means, said supporting means being disposed in a liquid, and having sufficient buoyancy to balance the effect of gravity on said armature means, and said armature means being movable in response to variations in the electrical energization of said coil windings, said supporting means being so arranged that said condition of balance between the effect of gravity and the buoyancy of the supporting means is maintained when the armature means is moved.

12. In a balanced relay, in combination, means forming coil windings, armature means substantially axially associated with said windings, means including a liquid for supporting said armature means, said armature means having substantially the same density as said liquid, said armature means being movable in response to variations in the electrical energization of said coil windings, and electrical contacts associated with said armature means and actuatable in response to movement thereof, said contacts being immersed in said liquid.

13. In a balanced relay, in combination, means forming coil windings, armature means substantially axially associated with said windings, means including a liquid for supporting said armature means, said armature means having substantially the same density as said liquid, said armature means being movable in response to variations in the electrical energization of said coil windings, means for restraining movements of said armature means to a substantially fixed path axially of said windings, and electrical contacts associated with said armature means and actuatable in response to movement thereof, said contacts being immersed in said liquid.

14. In a balanced relay, in combination, means forming coil windings, armature means substantially axially associated with said windings, means including a liquid for supporting said armature, said armature means having substantially the same density as said liquid and being immersed therein, said armature means having sufficient buoyancy to entirely balance the effect of gravity thereon and being movable in response to variations in the electrical energization of said coil windings, and electrical contacts associated with said armature means actuatable in response to movements thereof, said contacts being immersed in said liquid.

15. A sensitive relay device, comprising in combination, a pair of coil windings having aligned openings therethrough, a closed chamber including said openings, a liquid medium substantially filling said chamber, and an armature means buoyantly supported in said chamber having a magnetic portion of greater density than said liquid and a buoyant portion of less density than said liquid, the density of said armature means as a whole being substantially the same as that of said liquid, whereby said armature means is maintained in equilibrium, said armature means being freely movable upon a change in the relative energization of said coils, said liquid medium damping the movements of said armature means so that it tends

to remain in any position as long as said relative energization remains unchanged.

16. A sensitive relay device, comprising in combination, a pair of coil windings having aligned openings therethrough, a closed chamber including said openings, a liquid insulating medium substantially filling said chamber, and an armature means buoyantly supported in said chamber having a magnetic portion of greater density than said liquid and a buoyant portion of less density than said liquid, the density of said armature means as a whole being substantially the same as that of said liquid, whereby said armature means is maintained in equilibrium, said armature means being freely movable upon a change in the relative energization of said coils, said liquid medium damping the movements of said armature means so that it tends to remain in any position as long as said relative energization remains unchanged, movable contact means attached to said armature means, and a pair of stationary contacts selectively engageable by said movable contact means upon movement of said armature means in opposite directions, said contact means and said contacts being within said chamber and immersed in said liquid insulating medium.

17. Armature means for an electromagnet, comprising in combination, a chamber substantially filled with a liquid medium, and an armature means buoyantly supported in a portion of said chamber, said armature means having a magnetic portion of greater density than said liquid and a buoyant portion of less density than

said liquid, the density of said armature means as a whole being substantially the same as that of first said liquid.

18. An electromagnetic device, comprising in combination, electrical winding means, a chamber adjacent said winding means and substantially filled with a liquid medium, an armature means buoyantly supported in a portion of said chamber, said armature means having a magnetic portion of greater density than said liquid and a buoyant portion of less density than said liquid, the density of said armature means as a whole being substantially the same as that of said liquid, an element attached to said armature means to be actuated thereby, said element being in said chamber and immersed in said liquid, said liquid serving to damp movements of said armature means and element.

19. An electromagnetic switch, comprising in combination, electrical winding means, a chamber adjacent said winding means and substantially filled with a liquid insulating medium, an armature means buoyantly supported in a portion of said chamber, said armature means having a magnetic portion of greater density than said liquid and a buoyant portion of less density than said liquid, the density of said armature means as a whole being substantially the same as that of said liquid, movable contact means attached to said armature means, and stationary contact means for engagement therewith, both said contact means being in said chamber and immersed in said insulating medium.

HENRY E. HARTIG.