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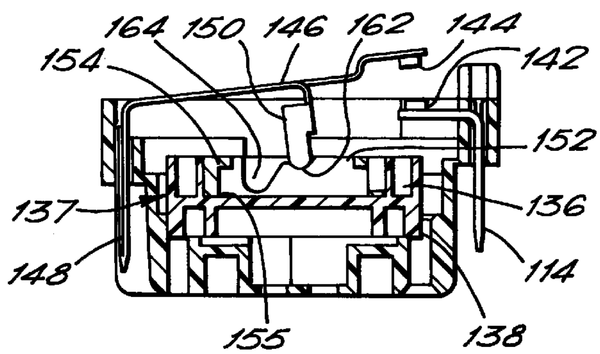
(54) Energy regulators

(57) A dual output energy regulator comprises a cam body 137 having a primary cam surface 136 for controlling the supply of energy to a load and a track 155 for receiving a collar 154 provided with an auxiliary cam surface 152 for controlling the opening of auxiliary contacts 142, 144. The collar 154 is rotatable relative to the body 137 and has detents 162,164 for retaining an auxiliary cam follower 150 in one of the positions in which the contacts 142,144 are either open or closed. A lost motion mechanism allows the cam member 137 to rotate by about 300° from its original position without turning the collar at which point, dog teeth 166,168 on the collar 154, and cam member 137 engage to move the collar to its other position. Movement of the cam member 137 in the other direction does not result in movement of the collar until the dog teeth 166,168 again engage and return the collar 154 to its original position.

FIG. 4.



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Description

The present invention relates to energy regulators for controlling the supply of electrical energy to electrical loads such as cooker hot plates or grills.

Typically, energy regulators comprise a microswitch having a set of switch contacts arrangeable in the electrical supply circuit to the electrical load, a snap-acting switch contact arm operatively associated with a bimetallic actuator, and electrically energisable heating means associated with the bimetallic actuator. In such constructions, electrical power is initially supplied to the load and to the heating means which may be connected either in parallel or in series with the load. The heating means heats the bimetallic actuator, causing it to deform to the point where it causes snap-action of the contact arm to open the switch contacts and interrupt the power supply to both the load and the heating means. The bimetallic actuator then cools and deforms in the opposite direction to the point where the contact arm undergoes reverse snap-action to close the contacts once more, whereupon the cycle recommences. Thus such regulators operate on the principle of supplying power to the load over a proportion of an operating cycle, the proportion being settable by control means coupled in use to a user actuated control member e.g. a knob or spindle. The control means normally comprises a rotary control cam member, against which a cam follower, for example provided on an ambient compensating bimetal coupled to the bimetallic actuator, abuts. Such constructions are for convenience hereinafter referred to as "energy regulators of the kind described".

Frequently it is desired to provide a "full load" or "part load" facility in an electrical appliance, for example a "split ring" or "split grill" in a cooker to allow a portion of a hot plate to be used for heating a small saucepan or for using a part only of the grill to grill a small amount of food. In such a case, a dual output is provided from the energy regulator. The first output is connected to a primary load which is intended to be energised whether the load is on a "full load" or "part load" setting. The second output, however, is connected to an auxiliary load which is intended to be energised in addition to the primary load only in the "full load" setting through an auxiliary set of switch contacts. The position of the auxiliary contacts is controlled by an auxiliary cam surface engaged by an auxiliary cam follower, and when the auxiliary contacts are closed, the auxiliary load will also be energised.

Such energy regulators will hereinafter for convenience be referred to as "dual output energy regulators of the kind described".

In one known construction, an auxiliary cam surface is provided on the same cam body as the main control cam surface to rotate therewith, the auxiliary cam surface being profiled such that over one half of the arc of movement of a control knob from an 'off' position, the auxiliary contacts are open, such that only the primary load is energised and over the other half of the arc, on the opposite side of the 'off' position, the auxiliary contacts are closed so that both the primary and auxiliary loads are energised. This arrangement has the disadvantage that the full range of the control must be fitted into 180° of movement of the control knob rather than 360°. Thus say on a cooker, a particular angular setting of a control knob can represent different power settings depending on whether or not the heater plate being controlled is a "split ring", This is not ideal.

In another known system, the auxiliary switch contacts are provided in a completely separate switch unit which is mounted to and electrically connected to the energy regulator. A separate auxiliary control cam body having a cam surface on its radially outer edge is provided in the unit, and coupled to the control shaft of the regulator through a lost motion mechanism. When the control knob is moved from the 'off' position to a maximum position, say 330°, from the 'off' position, the auxiliary cam remains stationary and the auxiliary contacts remain open thus leaving the auxiliary load de-energised. At the maximum position, however, the cam is moved to a position wherein the auxiliary contacts close. Movement in the opposite direction, by virtue of the lost motion leaves the cam in that position, so that the auxiliary contacts remain closed and both primary and auxiliary loads are controlled in dependence on the setting of the control knob. Thus if it is desired to have a 'full' load, the control knob is first twisted through a maximum angle and then turned back to the desired lower setting. In this way, a full scale control can be provided for both "full load" and "part load" settings. However, this system is very cumbersome and expensive.

The present invention seeks to provide a dual output energy regulator of the kind described which is compact and which allows a full scale control for both "full load" and "part load" settings.

In accordance with a first aspect of the invention, therefore, there is provided a dual output energy regulator of the kind described wherein the cam member of the regulator comprises a primary cam surface for setting the operating point of the regulator and an auxiliary cam surface movable relative to said primary cam surface, for controlling the opening and closing of the auxiliary set of contacts, and a lost motion mechanism arranged between the control means of the regulator and the auxiliary cam surface such that over movement of said control means in one direction from a first predetermined position to a second predetermined position said auxiliary cam surface remains in a first angular position wherein said auxiliary contacts are in a first state, movement of said control means in the same direction beyond said second predetermined position to a third predetermined position moving said auxiliary cam surface into a second angular position so as to move said auxiliary contacts to a second state, whereafter over movement of said control member and cam member in the opposite direction over a predetermined range, said auxiliary cam surface remains in said second position and said auxiliary contacts remain in said second state.

Thus in accordance with the invention, an auxiliary cam surface is provided on the cam member of the regulator which is movable relative to the main control cam surface to allow selective opening and closing of the auxiliary set of contacts. This is a compact construction which allows a full size scale to be used for both 'full' and 'part' load conditions.

When the control member and cam body are rotated beyond the aforementioned predetermined range, the auxiliary cam surface moves back to its first angular position, to return to the original configuration of the contacts.

The cam member may be integrally formed with the control member, for example by moulding, or may be coupled thereto by suitable means. It may also be formed as one or more elements suitably coupled together.

Preferably the auxiliary cam surface is formed on a collar member which is rotatably mounted on the cam member. The collar member may be mounted on an outer edge of the cam member, with the auxiliary cam surface facing radially outwardly of the cam member. Preferably, however, the collar member is mounted on a face of the cam member such that the auxiliary cam surface faces in a direction generally parallel to the axis of rotation of the cam member. In one embodiment, the collar is received in a circular track formed in the face of the cam member. Normally the main control cam surface of the cam member is formed in such a surface and in a particularly preferred arrangement, the auxiliary cam surface and main cam surface are provided on the same face of the cam body.

Preferably the lost motion mechanism comprises cooperating members, such as dog teeth, one tooth provided on each of the collar and the control member or cam member, with a groove or slot formed in either to accommodate the relative movement of the members.

The collar member may be retained in position on the cam member by the auxiliary cam follower, to avoid the need for further location means, but in a preferred embodiment, additional means may be provided for this purpose, for example a retaining tooth provided on or coupled to the control member and which overlies an upper surface of the collar member.

Preferably the auxiliary cam surface is arranged radially inwardly of the main cam surface. In such an arrangement, the collar may be provided with a cam surface portion and a dog tooth extending radially inwardly therefrom for engagement with an outwardly directed dog tooth coupled to rotate with the control member of the regulator.

The auxiliary cam surface preferably comprises detent portions, corresponding to the two states of the auxiliary switch contacts, and in which the auxiliary cam follower engages. In a simple arrangement, the detents may comprise depressions of differing depth in the collar, such that the auxiliary cam follower can assume two different positions. The detents should be so shaped that the auxiliary cam follower will be retained in the desired position as the cam member rotates, the auxiliary cam follower essentially holding the collar in its first position until the collar is rotated by the interengagement of the dog teeth to its alternative position, in which the auxiliary cam follower is moved into the other detent.

It will be appreciated that the provision of a lost motion auxiliary cam surface on a cam member of an energy regulator of the kind described will allow the selective actuation of an auxiliary set of switch contacts, for whatever purpose, not merely for activating or deactivating a split load as described above, or indeed actuation of any other device.

From a further broad aspect, therefore, the invention provides an energy regulator wherein a cam member of the regulator comprises a primary cam surface for controlling a first function of the regulator and an auxiliary cam surface movable relative to said primary cam surface for controlling a further function of said regulator, and a lost motion mechanism arranged between the control member or cam member of the actuator and the auxiliary cam surface to accommodate such relative movement.

Such an energy regulator may of course also have preferred features as described above.

From a yet further aspect, the invention provides a dual output energy regulator comprising a primary cam surface for controlling a first function of the regulator and an auxiliary cam surface movable relative to said primary cam surface for controlling a second function, and a lost motion mechanism arranged so as to accommodate such relative movement, wherein said surfaces are positioned closely with respect to one another, preferably adjacent one another.

From a yet further aspect, the invention provides an energy regulator comprising a primary cam surface for controlling a first function of the regulator, and an auxiliary cam surface for controlling a further function of the regulator, said cam surfaces being movable in response to rotation of a control member of the regulator, a lost motion mechanism operative to permit said primary and auxiliary surfaces to rotate relative to one another, said auxiliary cam surface being formed on a member mounted within the regulator housing.

A preferred embodiment of the invention will now be described by way of example only with reference to the following drawings in which:

Fig. 1 is a perspective view of a dual output energy regulator;

Fig. 2 is a plan view of a dual output energy regulator in accordance with the invention;

Fig. 3 is a section along line A-A of Fig. 2;

Fig. 4 is a section along line B-B of Fig. 2;

Fig. 5 is a top plan view of the collar of the regulator of Figs. 2 to 4;

Fig. 6 is a bottom plan view of the collar of the regulator of Figs. 2 to 4;

Fig. 7 is a section along line Y-Y of Fig. 5; and

Fig. 8 is a development of part of the cam profile of the collar of Figs. 5 to 7.

With reference to Fig. 1, an energy regulator 2 (shown with its lid removed) comprises a snap-acting microswitch 4 having a contact arm 6 pivotally mounted on the free end of a bimetallic actuator 10. A snap acting "C" spring 12 is released from the contact arm 6 and engages in a fulcrum provided in an output tab 14. A movable contact 16 is mounted on the free end of the contact arm 6, and a fixed contact 18 is provided on the upper face of an input tab 20.

An electrical circuit to a primary load such as a first section of a grill element, not shown, is established through the input tab 20, the contacts 16,18, the spring 12, and the output tab 14.

A ceramic substrate heater 22 is mounted on the root end of the bimetallic actuator 10, and when energised, causes the actuator 10 to deflect, to open the contacts 16,18 with a snap-action after a predetermined deflection. The electrical supply to the heater 22 is made via the input tab 20, the contacts 16, 18, the contact arm 6, the bimetallic actuator 10, a tongue 24 released therefrom, and a resilient connection 26 connected to a tab 28. Thus when the contacts 16,18 open the load and the heater are de-energised, allowing the actuator 10 to cool and deflect in the other direction, to close the contact once again.

The actuator 10 forms one arm of a bimetallic member 30, the other arm 32 of which acts as an ambient temperature compensator in a manner well known in the art. It is provided with a cam follower 34 which engages in a cam track 36 formed in a cam member 37 having a cam body 38.

The cam member 37 is of plastics and attached to, or formed with, a control member or spindle 40, to the top end of which may be attached a knob, not shown. As the spindle 40 is rotated, the cam track 36 is rotated, with the follower 34 moving up and down accordingly. As it does so, the free end 8 of the actuator 10 is also moved up or down, so changing the amount of deflection necessary to open or close the switch contacts 16,18. Thus the operating point of the regulator is set by the angular position of the spindle

The output tab 14 is also provided with a fixed auxiliary contact 42. A movable auxiliary contact 44 is mounted on the free end of a resilient conductive member 46 which is provided with an auxiliary output tab 48 which in use is connected to an auxiliary load such as a second section of a grill pan element. The conductive member 46 is provided with an auxiliary cam follower 50 which engages an auxiliary cam surface 52 provided radially inwardly of the cam track 36. Depending on the auxiliary cam profile, the auxiliary contacts 42,44 will be either open or closed. When open, no current will flow to the auxiliary load, but when closed, a current will flow from the tab 14 via the contacts 42,44, the member 46 and auxiliary output tab 48. However, a current will only flow when the microswitch contacts 16,18 are closed. Thus when the auxiliary contacts 42,44 are closed, both the primary and auxiliary loads are controlled by the opening and closing of the contacts 16,18, and in dependence on the position of the spindle 40.

With reference to Figs. 2 to 8, there is shown a dual output energy regulator in accordance with the invention, with certain parts removed for clarity. The general arrangement of the regulator is the same as that of Fig. 1, although the form of the member 46 is slightly different and, as will be described in further detail below, the auxiliary cam arrangement is different.

Referring to Figs. 2 to 4, the regulator 100 comprises a primary output tab 114 which mounts a fixed auxiliary contact 142. A movable auxiliary contact 144 is mounted on the free end of a resilient electrically conductive member 146 which has an auxiliary output tab 148 at its other end. An auxiliary cam follower 150 formed on the member 146 extends downwardly onto an auxiliary cam surface 152 formed in a cam body 138 of a cam member 137 which is formed integrally with a control member or spindle 140.

The auxiliary cam surface 152 is formed on a collar member 154 which is rotatably slidably mounted in a circular track 155 of the cam body 138 radially inwardly of a primary cam track 136 which receives the cam follower of the compensating bimetal (not shown) for controlling the operating point of the regulator as described above.

As can be seen from Figs. 5 to 8, the collar member 154 is formed with a cylindrical wall 156, having an inwardly directed flange 158 at its top. A slot 160 is formed in the upper surface of the wall 156 and is provided with two detents in the form of two depressions, 162,164 of different depths. The detents are shaped so as to retain the lower end of the auxiliary cam follower 150. The first detent 162 will retain the follower 150 in a raised position in which the auxiliary contacts 142,144 will be held open, and the second detent 164 will retain the follower 150 in a lowered position in which the auxiliary contacts 142,144 will be closed. The side wall 161 of the slot 160 will restrain and locate the auxiliary cam follower 150 laterally.

As will be seen from Fig. 6, a dog tooth 166 is formed on the inner surface of the wall 156. As shown in Fig. 2 (where the flange 158 of the collar 154 has been removed for clarity) the spindle 140 is provided with a dog tooth 168 for engagement with the dog tooth 166 of the collar under the flange 158. Furthermore, the outer edge of the cam body 138 is provided with a dog tooth 170 which engages against a stop 172 provided on the regulator housing in its extreme rotational positions.

In the position shown in Fig. 2, the auxiliary cam follower 150 is engaged in the first detent 164 and the auxiliary contacts 142,144 are open. The regulator is in the 'off' position and no power is supplied to the primary or auxiliary loads. As the control member 140 and cam body are rotated clockwise from this position, the cam follower of the compensating bimetal will be raised or lowered by the outer cam profile 136 to control the supply to the primary load. However, the collar member 154 stays in the position shown, by virtue of the engagement of the auxiliary cam follower 150 within the first detent 162. The shape of the detent 162 and resilience of the member 146 overcome any moment applied to the cam follower 150 by frictional forces between the collar 154 and track 155 which would tend to push the cam follower out of the detent 162.

Thus the collar 154 rotates within the track 155 relative to the outer cam track 136, the dog tooth 168 rotating with clearance under the flange 158. The auxiliary contacts 142,144 thus stay open, and no power is supplied to the auxiliary load.

When the control member 140 has rotated through approximately 300°, the dog tooth 168 abuts the dog tooth 166 on the collar 154, and further rotation of the control member 140 over a further 30° will cause the collar 154 to rotate with the control member 140. In so doing, the auxiliary cam follower 150 will be pushed over the ridge 174 between the detents 162 and 164 and into the second detent 164, whereupon the auxiliary contacts 142,144 close, so that power will be supplied to the auxiliary load as well as the primary load.

The control member 140 is prevented from rotating any further clockwise than the position in which the auxiliary cam follower is received in the second detent 164 by engagement of the teeth 170,172 on the cam body and housing respectively. This position represents a 'maximum' power setting of the control and as the control member 140 is turned anti-clockwise from this position, the power setting reduces.

It will be clear that as the control member 140 is rotated anti-clockwise from this position, the collar 154 will remain in the position with the auxiliary cam follower 150 in the second detent 164, the dog tooth 168 rotating freely under the flange 158. Thus as the control member is turned back from the maximum position, the auxiliary contacts 142,144 remain closed whereby power is supplied to the primary and auxiliary loads, in dependence upon the setting of the control member.

Once the control member 140 has rotated back through about 300°, the dog teeth 158,168 interengage, and further anti-clockwise rotation of the control member 140 will cause rotation of the collar 154, so as to move the auxiliary cam follower 150 into the upper detent 162, and so open the auxiliary contacts 142,144. The components are thus returned to the 'off' position shown in Fig. 2.

In this way, a full 330° control movement is obtained for both full and part load operation.

Although in the embodiment shown the collar 154 is retained in track 155 by the auxiliary cam follower 150, to provide a more positive retention, separate retention means may be provided. One suitable arrangement would comprise a lug 180 (shown schematically in dotted lines in Figs. 2 and 3) formed on the outer surface of the control member 140 which overlies the upper surface of the collar 154 to prevent it moving upwardly. The collar 154 is formed with a complementary slot (not shown) to allow the collar to be slipped over the control member 140 on assembly, the collar then being turned so as to move the slot and lug out of alignment. The relative positions of the slot and lug are chosen such that substantially over the normal range of operation of the regulator they do not become aligned once again. The slot may be formed slightly smaller than the lug so that the collar must be push fitted over the lug, so that even if they do become realigned, the collar could not inadvertently slip back over the lug.

It will be appreciated that the auxiliary cam follower 150 need not be coupled to a set of contacts controlling the supply of power to an auxiliary load. It could, in broad terms merely be used as an actuator to provide an actuating movement of any member for example a further movable contact.

Claims

1. An energy regulator comprising a cam member (137) having a primary cam surface (136) for controlling a first function of the regulator in response to rotation of a control member (140) of the regulator and an auxiliary cam surface (152), movable relative to said primary cam surface (136) for controlling a further function of the regulator in response to rotation of said control member (140) of the regulator, and a lost motion mechanism which permits said relative movement of said cam surfaces.

2. An energy regulator for controlling the supply of electrical energy to a load, comprising microswitch means (4) arrangeable in the electrical supply circuit to said load and having a set of primary contacts (16, 18), a bimetallic actuator (1) operatively associated with said microswitch, electrical heating means (22) for heating said actuator to the point where it deflects sufficiently to open said primary contacts, a control means comprising a rotary cam member (137) for determining the degree of deflection of said actuator required to operate said switch, said regulator further having a first output (114) for connection to a primary load and a second output (148) for connection to an auxiliary load, intended to be energised selectively in addition to said primary load in dependence on the condition of auxiliary contacts controlled by an auxiliary cam surface (152), through an auxiliary cam follower (150) characterised in that the cam member (137) of the regulator comprises a primary cam surface (136) for setting the operating point of the regulator and an auxiliary cam surface (152) movable relative to said primary cam surface, for controlling the opening and closing of the auxiliary set of contacts, and a lost motion mechanism arranged between the control means of the regulator and the auxiliary cam surface such that over movement of said control means in one direction from a first predetermined position to a second predetermined position said

auxiliary cam surface (152) remains in a first angular position wherein said auxiliary contacts are in a first state, movement of said control means in the same direction beyond said second predetermined position to a third predetermined position moving said auxiliary cam surface into a second angular position so as to move said auxiliary contacts to a second state, whereafter over movement of said control member and cam member in the opposite direction over a predetermined range, said auxiliary cam surface remains in said second position and said auxiliary contacts remain in said second state.

3. An energy regulator as claimed in claim 1 or 2 wherein the auxiliary cam surface (152) is formed on a collar member (154) which is rotatably mounted on the cam member (137).

4. An energy regulator as claimed in claim 3 wherein the collar member (154) is mounted on a face of the cam member (137) such that the auxiliary cam surface (152) faces in a direction generally parallel to the axis of rotation of the cam member (137).

5. An energy regulator as claimed in claim 4 wherein the collar (154) is received in a circular track (155) formed in the face of the cam member (137).

6. An energy regulator as claimed in any of claims 3 to 5 wherein the auxiliary cam surface (152) and primary cam surface (136) are provided on the same face of the cam member (137).

7. An energy regulator as claimed in claim 6 wherein the auxiliary cam surface (152) is arranged radially inwardly of the primary cam surface (136).

8. An energy regulator as claimed in any preceding claim wherein the lost motion mechanism comprises members (166,168) which cooperate to cause the primary and auxiliary cam surfaces to move together in response to the movement of the control member over a given range with a groove or slot which accommodates the relative movement of said members outside said range.

9. An energy regulator as claimed in claims 7 and 8 wherein the collar (154) is provided with a cam surface portion and a dog tooth (166) extending radially inwardly therefrom for engagement with an outwardly directed dog tooth (168) coupled to the control member of the regulator.

10. An energy regulator as claimed in any of claims 3 to 7 wherein the collar member (154) is retained in position on the cam member (137) by a retaining member overlying said collar member.

11. An energy regulator as claimed in any preceding claim wherein auxiliary cam surface comprises detent portions (167,164) in which an auxiliary cam follower (150) engages for selectively retaining said auxiliary surface in two desired positions.

12. An energy regulator as claimed in claim 10 as dependent upon claim 3 wherein said detent portions comprise depressions (166, 168) formed to differing depths in said collar (154), the profiles of said depressions being such that the auxiliary cam follower (150) will be retained in a respective depression to maintain the collar in a desired rotational position during rotational movement of the cam member (137), until said collar (154) is rotated by interengaging means provided on the cam member (137) and collar (154) to a position in which the auxiliary cam follower (150) moves into further depression.

13. An energy regulator comprising a primary cam surface (136) for controlling a first function of the regulator and an auxiliary cam surface (152) movable relative to said primary cam surface (136) for controlling a further function the regulator, and a lost motion mechanism arranged to facilitate such movement, said surfaces being arranged close to one another.

14. An energy regulator comprising a primary cam surface (136) for controlling a first function of the regulator, and an auxiliary cam surface (152) for controlling a further function of the regulator, said cam surfaces being movable in response to rotation of a control member (140) of the regulator, a lost motion mechanism operative to permit said primary and auxiliary surfaces to rotate relative to one another, said auxiliary cam surface (136) being provided on a member mounted within the regulator housing.

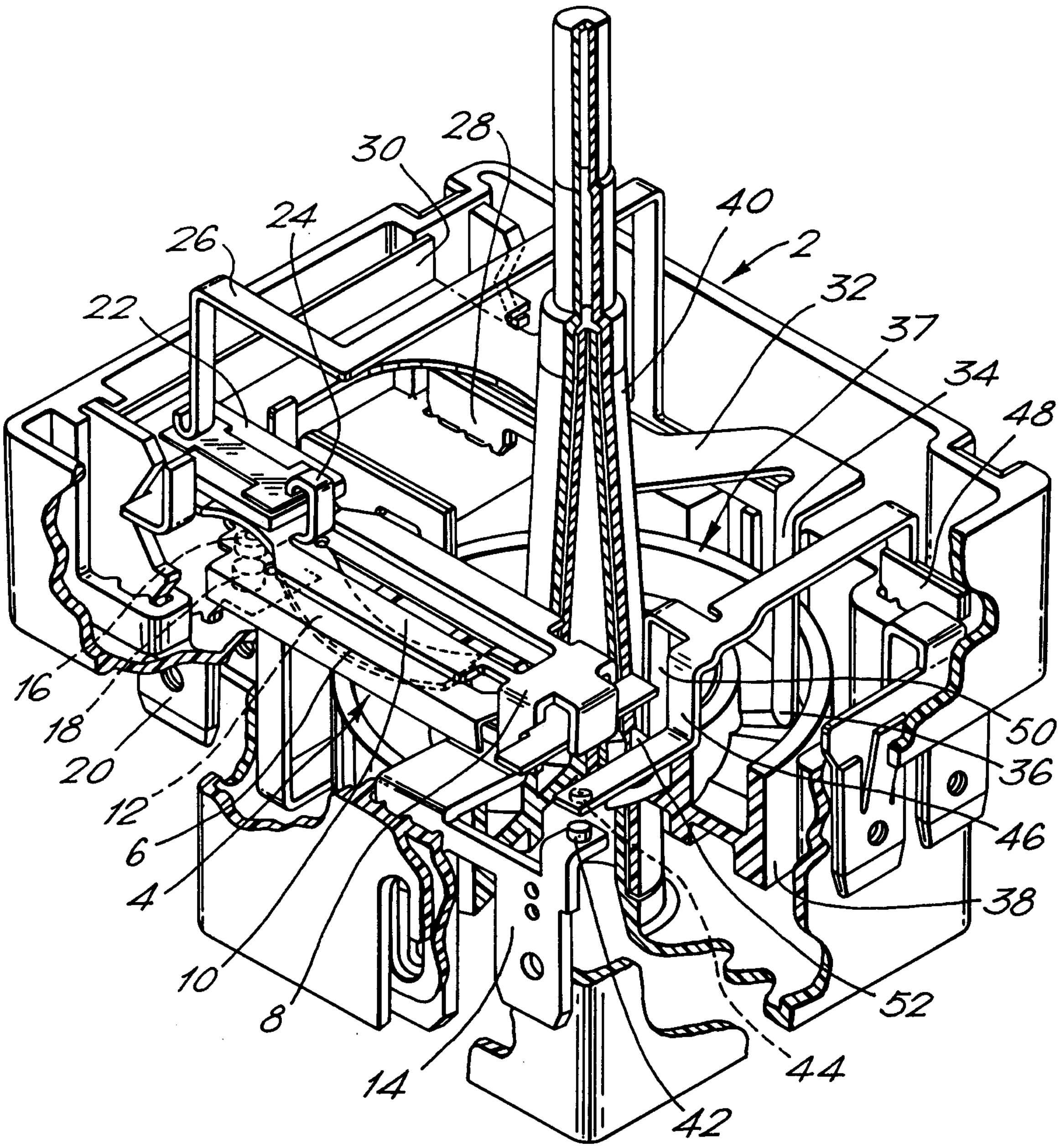
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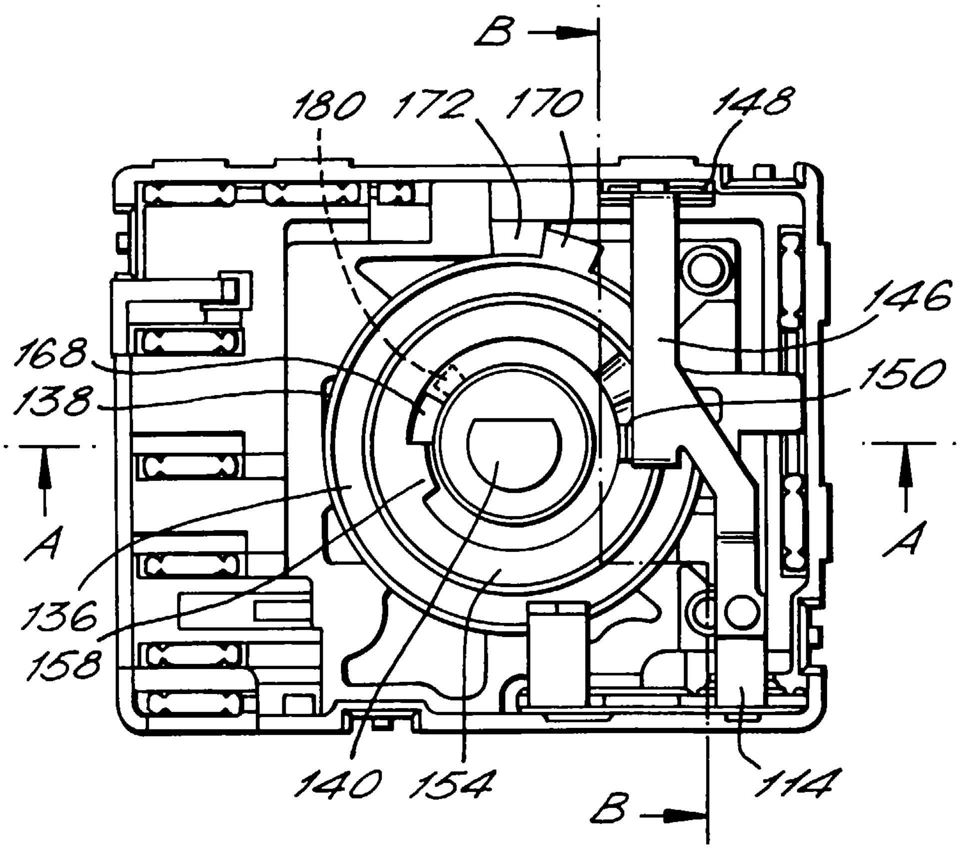
FIG.1.

FIG. 2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168
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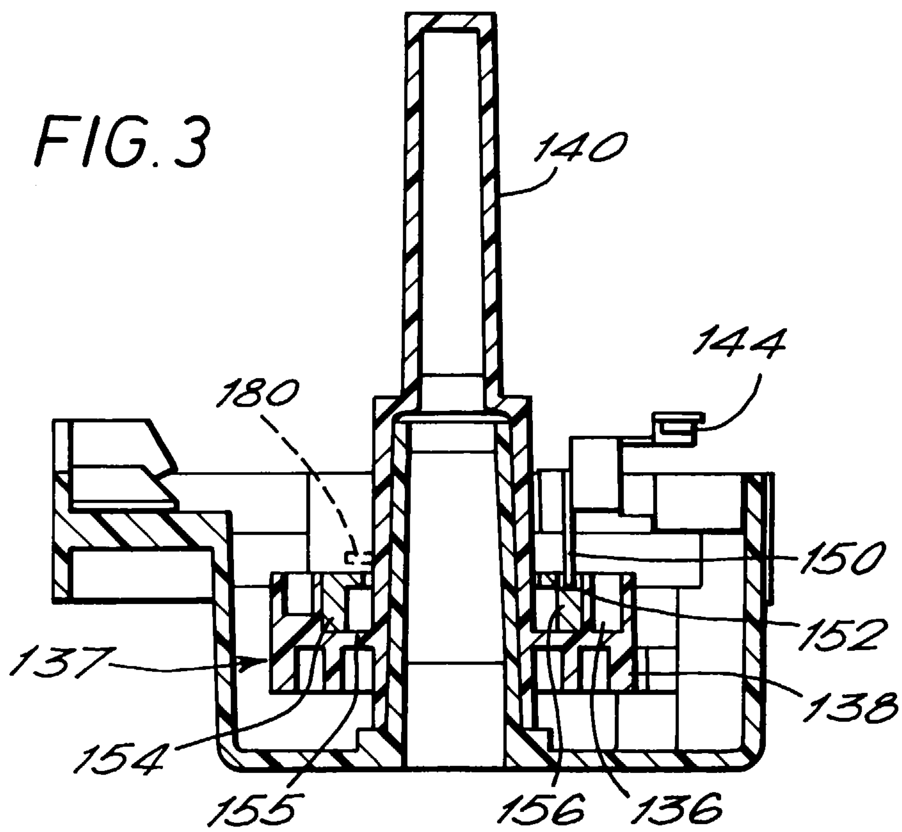
136
158
140
154
114
B

FIG. 3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180
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152
137
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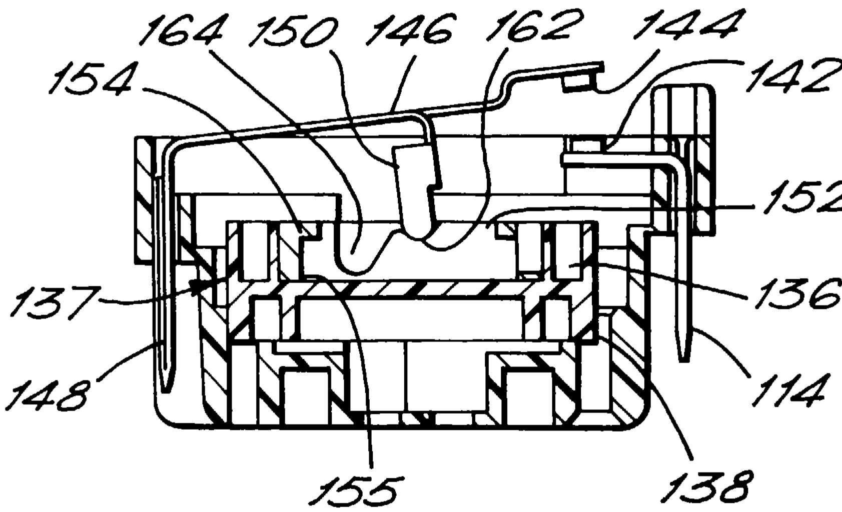
154
155
156
136

FIG. 4.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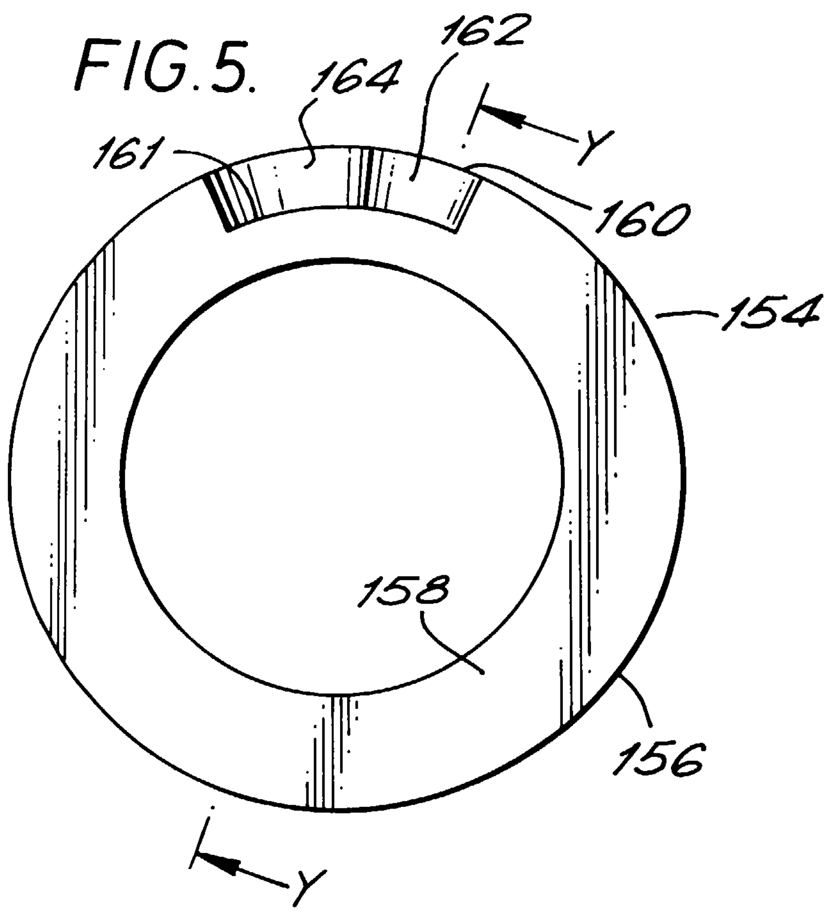
155
138

FIG. 5.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156
Y

FIG.6.

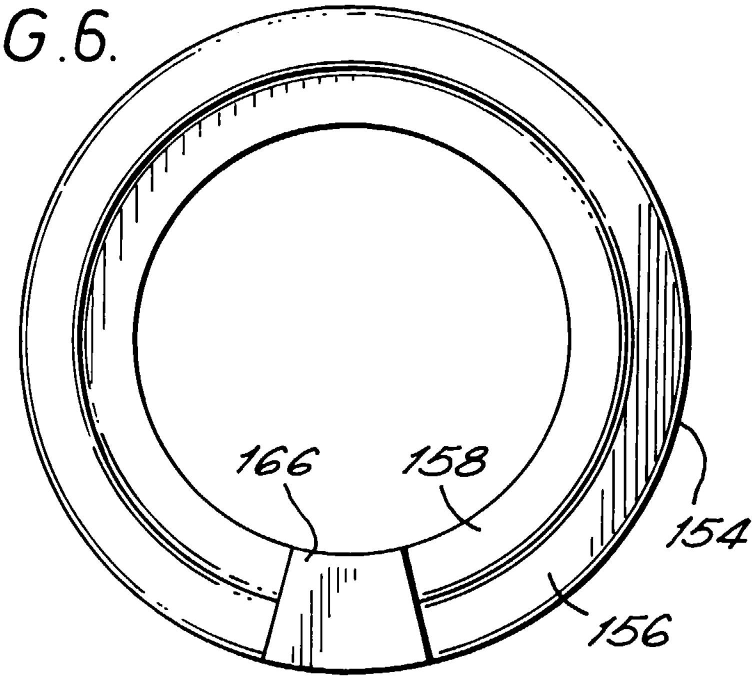

FIG.7.

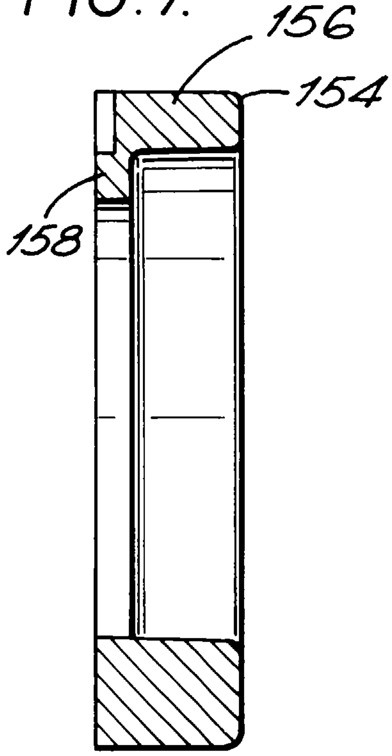

FIG.8.