Aug. 3, 1948. R. A. WITTMANN 2,446,353

TEMPERATURE RESPONSIVE CONTROL DEVICE

Filed Feb. 19, 1945

Fig. 1

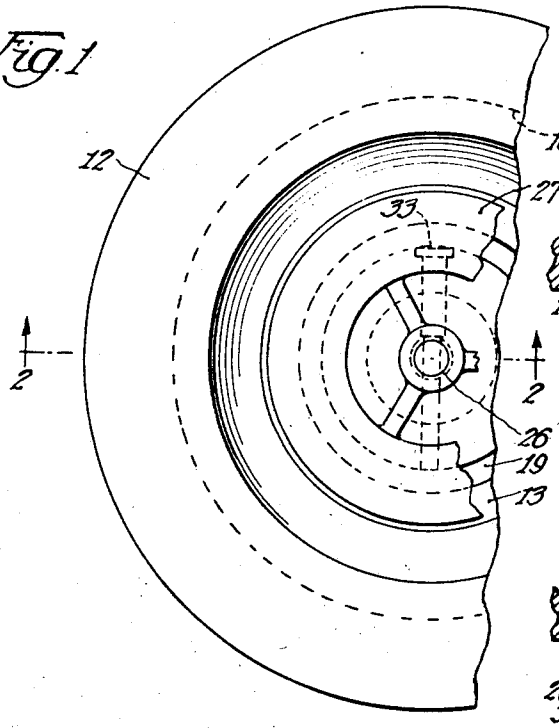


Fig. 3

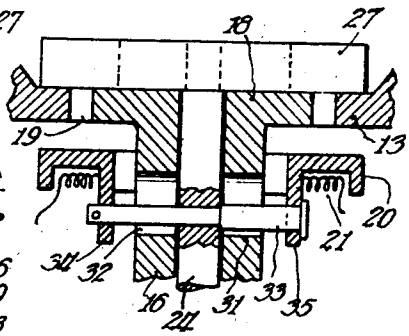


Fig. 4

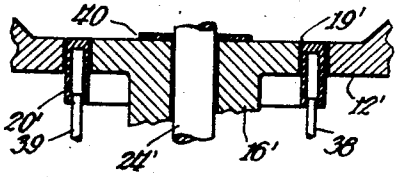
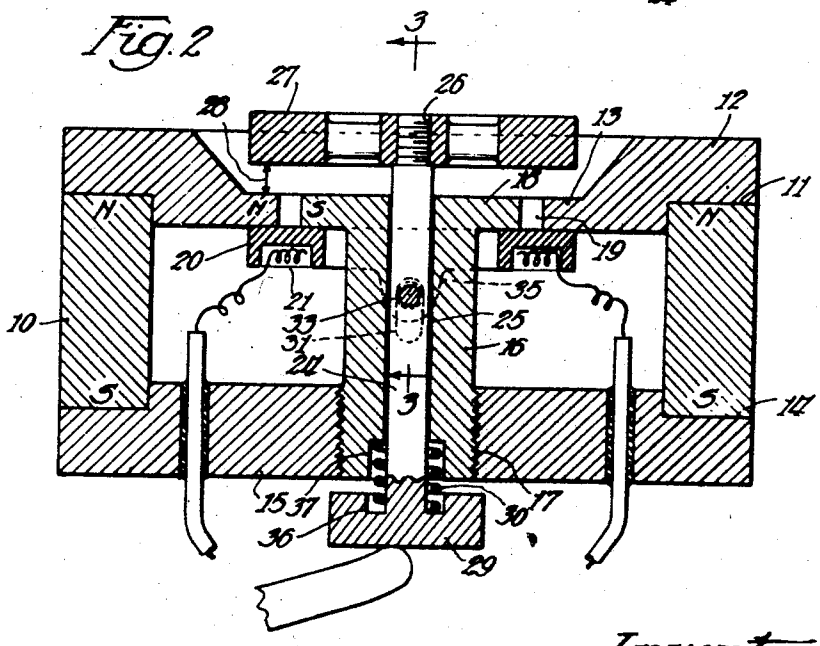


Fig. 2



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TEMPERATURE RESPONSIVE CONTROL DEVICE

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7 Claims. (Cl. 175—336)

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The present invention relates to a novel means of producing a mechanical movement by employing a magnetic field with a Curie point armature to bridge a gap in the field until the armature is heated above its Curie point and then employing the magnetic field to attract another armature into the magnetic field.

It is also the purpose of this invention to provide means to apply the lines of force of a magnet to hold a Curie point armature in a given position and to utilize the magnetic flux of the magnet to drive the Curie point armature away from the place where it was held with an increasing force when the Curie point armature has been heated through its Curie point temperature.

It is also a purpose of this invention to provide means whereby the magnetic lines of force of a magnet are utilized efficiently to hold a Curie point armature in one position where the armature is a part of the path of the magnetic lines of force until the armature has been heated through its Curie point temperature, then to drive the armature to a new position where the magnetic lines of force are not so attractive to it but may still attract it when the armature has cooled below its Curie point temperature and is again in a ferromagnetic state, and holding armature by means of magnetic lines of force against return to its original position except by means of application of external force.

It is well known that there are many metals and alloys having ferromagnetic properties to varying degrees. These metals and alloys may or may not contain iron. Upon heating one of these metals or alloys which has ferromagnetic properties a temperature is reached at which its ferromagnetic properties disappear. This temperature is technically known as the Curie point of the metal or alloy. When the metal or alloy is at a temperature above its Curie point it is often said to be paramagnetic since it does not possess the ferromagnetic properties which it has at ordinary temperatures. Upon cooling a material in the paramagnetic condition it will regain its ferromagnetic properties. It is possible to obtain a wide range of desired Curie point temperatures by the proper selection and alloying of materials. See the examples stated in my Patents 2,232,501 and 2,232,502. This enables one to utilize the material in various ways for control means responsive to temperature conditions, regardless of how the temperature is produced. Thus one may apply the temperature to a Curie point material by friction, by electrical current, by flame, or by conduction from a fluid or gas which carries heat

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or has heat generated therein by physical or chemical action. The manner in which the Curie point material is heated or cooled is immaterial to the present invention. My invention concerns itself with the utilization of magnetic lines of force in combination with the Curie point material to produce a control operation manifested as a comparatively powerful movement of the control armature with respect to the magnetic lines of force with or without necessitating subsequent replacement by an exterior force.

The nature and advantages of my invention will appear more fully from the following description and the accompanying drawings wherein a single embodiment of the invention is shown. It is to be understood, however, that the drawings and description are illustrative only and that they should not be taken as limiting the scope of the invention except insofar as it is limited by the claims.

In the drawings:

Figure 1 is a fragmentary plan view of a device embodying my invention;

Figure 2 is a sectional view taken on the line 2—2 of Figure 1;

Figure 3 is a fragmentary sectional view taken on the line 3—3 of Figure 2; and

Figure 4 is a fragmentary sectional view of a modification of the construction shown in Figures 1 to 3 inclusive.

Referring now to the drawings, the present invention utilizes a magnet 10 which may be either an electromagnet or a permanent magnet. This magnet for the specific construction shown is preferably ring shaped, but may be of any other suitable shape. A suitable material for a device of this character is a permanent magnet of an alloy which retains its characteristics as a permanent magnet over a long period of time with little decrease after an initial aging period. The north and south poles of the magnet have been marked to facilitate ready understanding of the mechanism. One end of the magnet has a metal ring 12 secured thereto with a close fitting joint 11. The ring 12 is generally of relatively pure iron from an ingot or powder. An alloy of either ingot or powder may also be used. The ring is hollowed out at the top so as to leave a narrow portion 13 adjacent its inner edge. At the end of the magnet opposite the ring 12 is a second ring 15 of like material making a tight joint 14 with the magnet. The ring 15 is threaded by threads 17 to receive a cylinder 16 which is also of a like material. A suitable material for the parts 12, 15 and 16 is a substantially pure iron. Alloyed ma-

terials having desirable magnetic properties are also used. The cylinder 16 has its upper end flanged outwardly to provide a portion 18 that is aligned with the portion 13 but separated therefrom by a gap 19.

The structure thus far described provides a relatively large magnet 10 of high magnetic strength with a construction that concentrates and directs the magnetic lines of force with a minimum loss to the small annular gap 19. I utilize the high concentration of magnetic lines of force at the gap 19 for effecting the desired mechanical movement.

On one side of the gap there is a ring 20 made of a Curie point metal of relatively low Curie point temperature, for example, a metal, the Curie point of which is approximately 152° F. The ring 20 is adapted to be thermally coupled to the control device, that is to say, the ring 20 is responsive to a heat condition of a bearing, an electrical resistance, or some other heat producing means. For the sake of illustration, the ring 20 is shown as being heated by a heating coil 21, the terminals of which are connected to a suitable source of electrical current.

The mounting of the ring 20 comprises a plunger 24 of non-magnetic material extending through a bore 25 of the cylinder 16. This plunger has a pin 33 mounted in it, and there are two vertical slots 31 and 32 through the core 16 for receiving the pin 33. The pin extends through two downwardly projected ears 34 and 35 on the ring 20.

The plunger 24 has a threaded end 26 on which a ring 27 of suitable ferromagnetic properties is secured. It will be noted that the ring 27 is held a slight distance away from the top of the parts 13 and 18 when the ring 20 is attracted, this distance being indicated by the numeral 28. I may also use a spring 30 to aid in pushing the ring 20 away from the gap 19. The spring 30 is mounted in two recesses 36 and 37 in the cylinder 16 and a head 29 on the plunger. The ring 27 preferably is of the same inner and outer circumferences as the ring 20 but it is composed of a material having a much higher Curie point, for example pure iron.

In normal operation the ring 20 is placed in the position shown in Figure 2 so that it spans the gap 19 and engages with the inner surfaces of the parts 18 and 13. The concentrated force of the magnet will hold the ring 20 very securely. In other words, it will more or less lock ring 20 in place. Now, however, if the member 20 is heated up in response to a temperature change, or any other change which is reflected as a temperature change of the ring 20, to the Curie point temperature of the ring, this ring 20 will then lose its magnetic property, that is, it will enter its paramagnetic state. The force of the spring 30 and the attraction of the ring 27 have been held in check by the attraction of the ring 20 to the parts 18 and 13, but when this attraction no longer exists due to the change in state of the ring 20, the ring 27 is drawn toward the gap 19 and this in turn forces the ring 20 away. Heating of the ring 20 beyond its Curie point destroys it as a bridge for the magnetic lines of force so these lines of force now tend to go to the ring 27 and across the gap 19. As the ring 27 approaches the gap 19 the closing power is rapidly increased until the ring 27 is in contact with the parts 13 and 18. In other words, the gap 28 is reduced to zero. This drives the Curie point ring 20 to the position shown in Figure 3.

The movement of the rod 24 in the manner just described may be used to correct the change reflected by the heating of the Curie point metal 20. Since the force exerted by the spring 30 is greatest initially when the ring 20 starts away from the parts 18 and 13 and the force of the ring 27 is greatest when the ring is brought into engagement with the parts 18 and 13, the ring and the spring cooperate to give a maximum force moving the rod 24 to the position indicated in Figure 3. The movement may be used to actuate any suitable kind of device for the purpose intended. For example, it may be used to close an electrical circuit if an alarm is to be given in that way, or it may be used to open a valve or to close a valve. The movement is non-recurring until two things have happened. One of these is the cooling of the ring 20 until it is again below Curie point temperature, and the other is the application of a suitable force to move the ring 27 back to its original point. If an exterior force is applied to bring the ring 20 against the parts 18 and 13 before it has cooled below its Curie point temperature, the ring will not stay in place. Therefore, it is impossible to re-set the device until the condition which heated the ring 20 is remedied. The ring 20, however, cannot return of its own accord to the position shown in Figure 2. It must be pushed back by an exterior force overcoming the attraction of the ring 27 to the parts 18 and 13.

This particular device has the advantage that it is extremely rugged and that it can be placed in almost any kind of position without regard to gravity or other forces because the magnetic attraction of a keeper sealed across the gap 19 is so great that jolting, vibration and rough usage normally would have no effect thereon. If the whole unit is immersed in or carried by the temperature producing material it will still operate to move the plunger 24. Thus the device is capable of being used under various conditions that normally rule out a great many controls.

In Figure 4 of the drawings, I show a modified construction wherein the necessity for moving the Curie point member no longer exists. In this form of the invention the various parts remain the same except for the fact that the Curie point member is placed directly in the gap 19, and the movement of this member is not a part of the operation of the device. The Curie point member 20' in this form of the invention is shown as heated by fluid which is supplied to the member and taken from it by conduits 38 and 39. In addition I provide for certain purposes a spacing member 40 around the plunger 24' to prevent the armature 27 from moving into contact with the surfaces of the parts 12' and 16' and "freezing" in that position.

The operation of the device shown in Figure 4 is essentially the same as that shown in the other figures with the exception that the Curie point member 20' is stationary which acts as a valve on the magnetic lines of force across the gap 19'. When the member 20' is in a ferromagnetic state the lines of force across the gap pass through the armature and have no tendency to jump to the armature 27. However, if the member 20' is heated above its Curie point, it no longer serves as a good path for the lines of force, and the lines of force, therefore, jump to the next best available path which is through the armature 27, and in so doing they attract the armature 27 thus effecting operation of the plunger 24' to perform any control function that

may be desired. The ring 40 around the plunger 24' is used whenever it is desired to have the armature 27 held out of freezing relation with respect to the adjacent portions of the magnetic structure. This ring 40 may be of dielectric material or of a paramagnetic metal. It is evident that if the ferromagnetic state of the member 20' is returned after the armature 27 has been attracted most of the lines of force will have an easier path through the member 20' than through the armature 27, and if this armature is properly spaced from the gap 19', it will return to its original non-attracted position. It is, of course, necessary to have some means to normally hold the armature 27 in its non-attracted position. This may be a spring means, the weight of the armature itself, or any desired equivalent means. If the device is so arranged that the armature 27 will automatically return to its normal position when the member 20' is returned to its ferromagnetic state, the device then becomes an automatic re-set device that does not require any manual control. It is believed to be evident that by proper balance of the force the device can be made manual or automatic merely by the removal or insertion of the ring 40.

From the foregoing description it is believed that the nature and advantages of my invention will be clear to those skilled in this art.

Having thus described my invention, I claim:

1. A re-set type heat responsive actuator for indicating or control means capable of operation in gas or liquid environment and positive in its operation, comprising a magnet, a highly permeable circuit therefor comprising two ferromagnetic concentric members constituting opposite poles for said magnet and separated from each other by a narrow circular gap, two armatures, one on each side of said gap and fixed to each other, means mounting said armatures for movement axially with respect to the gap whereby either of said armatures may be brought into close juxtaposition to the members and become a magnetic shunt across the gap, one of said armatures having a Curie point much lower than the other, and re-set means for moving the last named armature to engagement with said members.

2. A re-set type heat responsive actuator for indicating or control means capable of operation in gas or liquid environment and positive in its operation, comprising a magnet, a highly permeable circuit therefor comprising two ferromagnetic concentric members constituting opposite poles for said magnet and separated from each other by a narrow circular gap, two armatures, one on each side of said gap and fixed to each other, means mounting said armatures for movement axially with respect to the gap whereby either of said armatures may be brought into close juxtaposition to the members and become a magnetic shunt across the gap, one of said armatures having a Curie point much lower than the other, and re-set means for moving the last named armature to engagement with said members, and spring means under tension between the core and the carrier, and tending to move the first armature away from the gap.

3. A heat responsive actuator for indicating, control, and similar purposes comprising a ring magnet, and highly permeable rings at opposite sides of said ring magnet, one of said rings having an inner flange of reduced thickness providing a narrow annular pole face, a core on the other ring having a flange providing a narrow annular face in opposition to the first named pole face and spaced therefrom to provide a definite gap in the magnetic circuit of said magnet, two armatures, one on each side of the gap between said pole faces and fixed to each other at a distance apart substantially greater than the pole face thickness whereby when one armature is in juxtaposition with the flanges the other is spaced therefrom sufficiently to concentrate the magnetic lines of force in the closer one, one of said armatures being of a material the Curie point of which is at a temperature which, if the other armature were heated to such temperature would not seriously impair the ferromagnetic properties of the other armature.

4. A heat responsive actuator for indicating, control, and similar purposes comprising a ring magnet, and highly permeable rings at opposite sides of said ring magnet, one of said rings having an inner flange of reduced thickness providing a narrow annular pole face, a core on the other ring having a flange providing a narrow annular face in opposition to the first named pole face and spaced therefrom to provide a definite gap in the magnetic circuit of said magnet, two armatures, one on each side of the gap between said pole faces and fixed to each other at a distance apart substantially greater than the pole face thickness whereby when one armature is in juxtaposition with the flanges the other is spaced therefrom sufficiently to concentrate the magnetic lines of force in the closer one, a non-magnetic stem slidable endwise in said core and carrying said armatures, one of said armatures being of a material the Curie point of which is at a temperature which, if the other armature were heated to such temperature would not seriously impair the ferromagnetic properties of the other armature.

5. In combination an annular permanent magnet, ferromagnetic rings fixed to the ends thereof and extending inward, a ferromagnetic core secured to one of said rings and extending into the other ring, said core having a peripheral flange within the other ring forming a gap therewith, a non-magnetic stem in said core and slidable endwise, and two armatures, one on each side of said gap carried by said stem, one of said armatures having a lower Curie point than the other.

6. A temperature responsive device adapted for use as a control or indicating means comprising in combination a magnet, a highly permeable circuit for said magnet including a centrally disposed core and a ring about said core, the ring and core having oppositely disposed faces providing a main gap in the magnetic circuit, a Curie point member mounted in close juxtaposition with the ring and core at said gap whereby to establish a magnetic shunt across said gap when the member is at a temperature below its Curie point, an armature adjacent to said gap and positioned to be attracted and moved toward the gap upon the member losing its ferromagnetic properties, and a mounting stem of non-magnetic material fixed to the armature and slidable in the core to guide the armature.

7. A temperature responsive device adapted for use as a control or indicating means comprising in combination a magnet, a highly permeable circuit for said magnet including a centrally disposed core and a ring about said core, the ring and core having oppositely disposed faces providing a main gap in the magnetic circuit, a Curie

point metal armature fixed in close juxtaposition with the ring and core in said gap whereby to establish a magnetic shunt across said gap when the armature is at a temperature below its Curie point, a second armature adjacent to said gap and positioned to be attracted and moved toward the gap upon the first armature losing its ferromagnetic properties.

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