July 24, 1956 A. B. BROERMAN 2,756,305

TIME DELAY SWITCH

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Fig. 1.

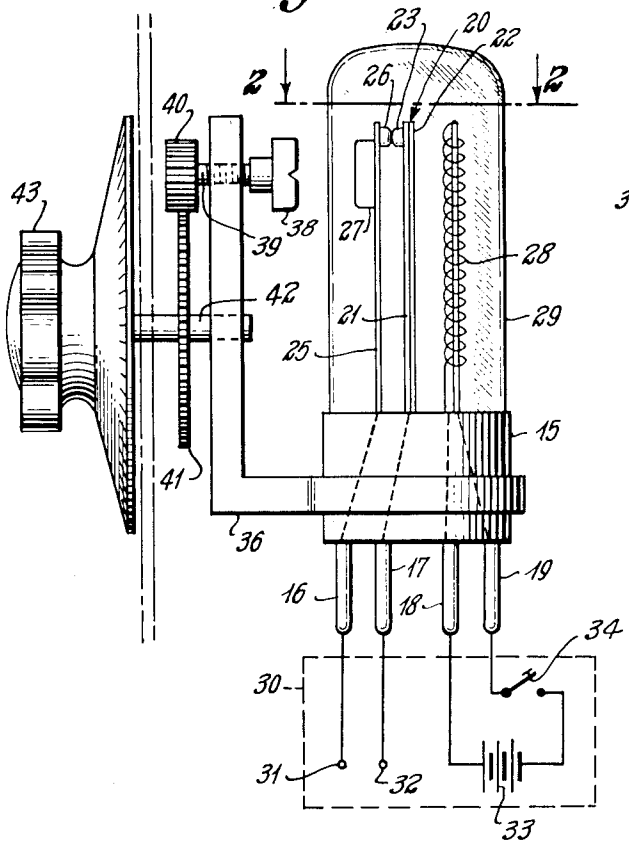


Fig. 2.

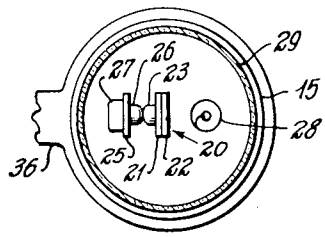


Fig. 3.

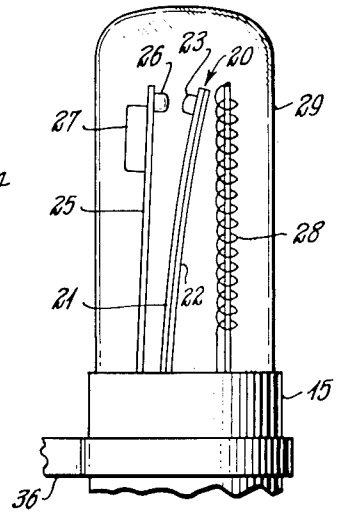
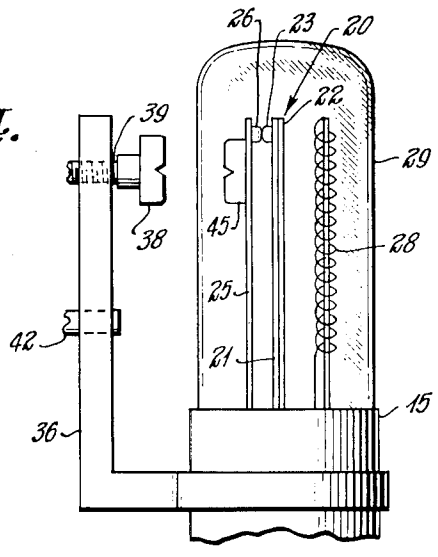


Fig. 4.



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Fig. 5.

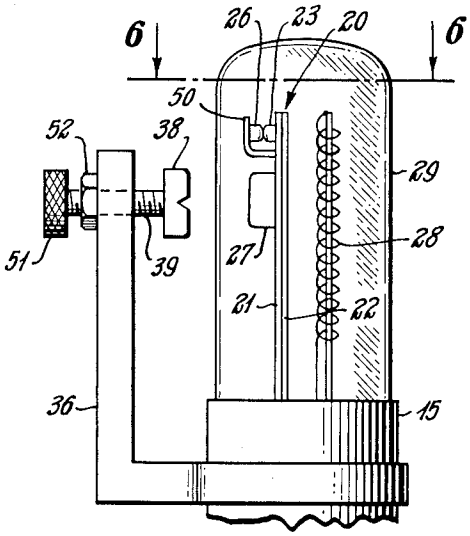


Fig. 7.

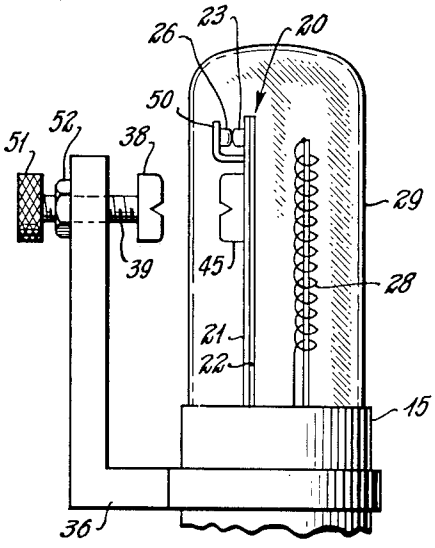


Fig. 6.

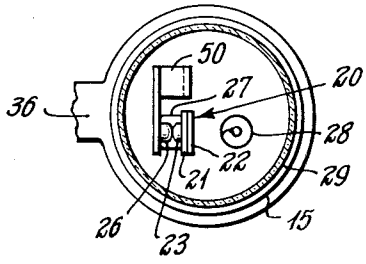


Fig. 8.

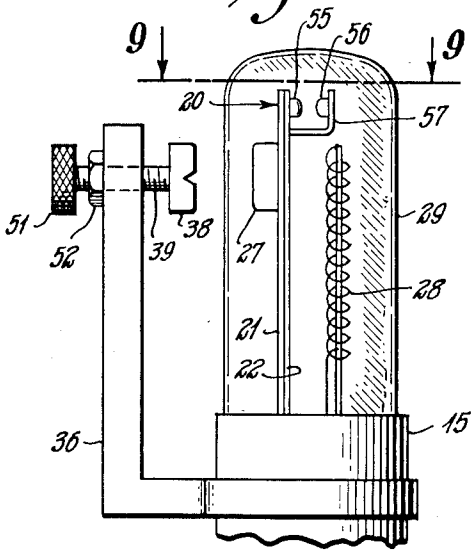
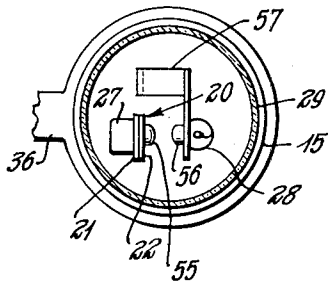


Fig. 9.



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Fig. 10.

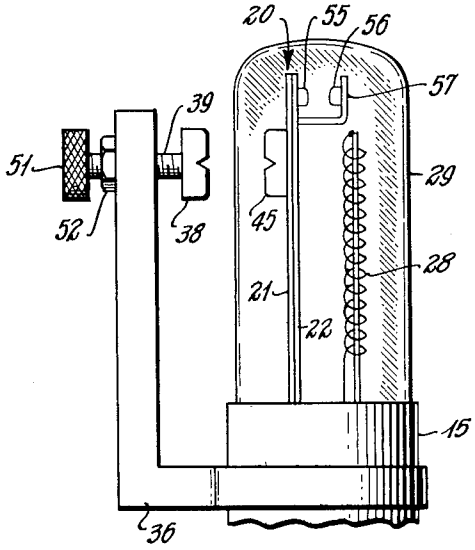


Fig. 11.

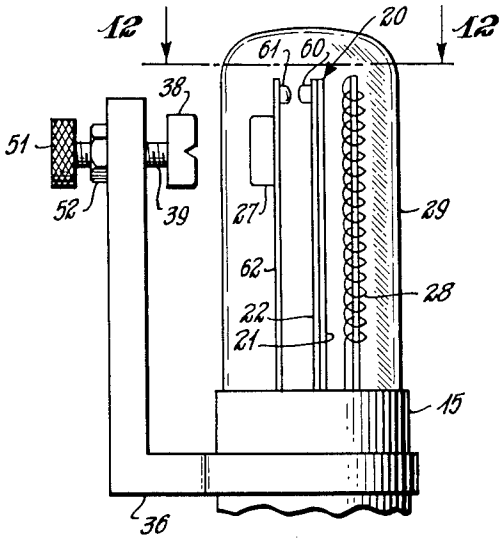


Fig. 13.

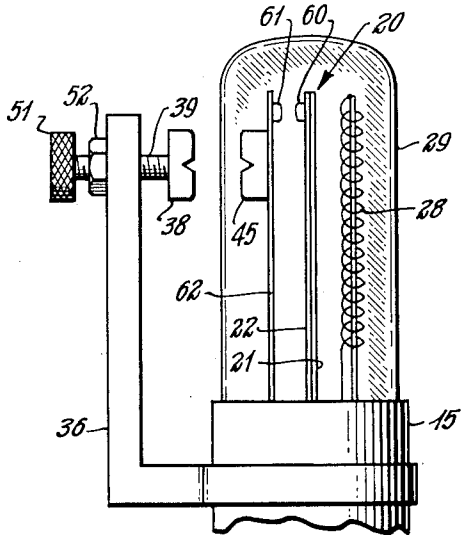
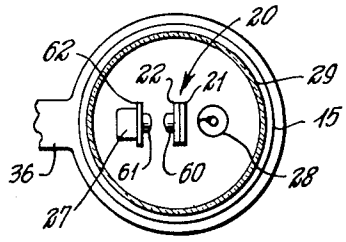


Fig. 12.



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2,756,305

TIME DELAY SWITCH

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Application June 22, 1953, Serial No. 363,086

17 Claims. (Cl. 200—122)

This invention relates to time delay switches. In one specific aspect it relates to time delay switches which are adjustable with regard to the period of delay.

In various fields of electrical control there is a need for time delay switching means whereby a first circuit can be operated at a predetermined time interval following operation of a second circuit. To provide such means numerous forms of switching mechanism have been designed which vary widely both in accuracy and in complexity of construction. One particular type of such switch that has been found to be satfactory for many applications utilizes a thermostatic element under control of an independent heater circuit. Energization of the heater circuit results in current being supplied to a heater coil which in turn heats the thermostatic element to open or close the associated electrical contacts. While switches of this type are useful for many purposes they generally are constructed with a predetermined time delay, which for the most part is constant. Therefore, if variable time delays are needed it is necessary to provide separate switches for each desired delay time. The present invention is directed toward providing a time delay switch incorporating a thermostatic element together with simplified magnetic means to vary the time delay setting.

Accordingly, it is an object of this invention to provide an adjustable time delay switch.

Another object is to provide an adjustable time delay switch with either normally open or normally closed contacts.

A further object is to provide a time delay switch including adjustable magnetic means to vary the delay time.

A further object is to provide an adjustable time delay switch of simplified construction, which is readily adjustable and one wherein the contact elements are hermetically sealed.

The time delay switching mechanism constructed in accordance with this invention comprises generally a first electrical contact button mounted on a bimetallic strip and a second electrical contact button mounted on a support adjacent the bimetallic strip. A heating element is positioned in close proximity to the bimetallic element. If a normally closed switch is desired the two contact buttons initially are in electrical contact, while if a normally open switch is desired the two contact buttons initially are out of contact with one another. An armature of magnetic material is attached either to the support or to the bimetallic strip and a magnet is adjustably mounted in spaced relation with the armature to exert an attractive force thereon. This attractive force either opposes movement of the bimetallic strip in response to heat applied thereto or positions one contact button initially with respect to the other, thereby adjusting the time delay which results from movement of the bimetallic strip responsive to heat being applied thereto. In another embodiment of this invention the armature is replaced by a second magnet which is either attracted to or repelled by the first magnet depending upon the relative positions of the poles of the two magnets. This latter

configuration also serves to position one of the contact buttons with respect to the other.

Various other objects, advantages and features of this invention will become apparent from the following detailed description taken in conjunction with the accompanying drawing in which:

Figure 1 is an elevational view of a first embodiment of the time delay switch of this invention together with a schematic electrical control circuit;

Figure 2 is a sectional view taken along the lines 2—2 of Figure 1;

Figure 3 illustrates the switch in Figure 1 in its second operative position;

Figure 4 is a modified embodiment of the switch of Figure 1;

Figure 5 is an elevational view of a second embodiment of the time delay switch of this invention;

Figure 6 is a sectional view taken along line 6—6 in Figure 5;

Figure 7 is a modified embodiment of the switch of Figure 5;

Figure 8 is an elevational view of a third embodiment of the time delay switch of this invention;

Figure 9 is a sectional view taken along line 9—9 of Figure 8;

Figure 10 is a modified embodiment of the switch of Figure 8;

Figure 11 is an elevational view of a fourth embodiment of the time delay switch of this invention;

Figure 12 is a sectional view taken along line 12—12 in Figure 11; and

Figure 13 is a modified embodiment of the switch of Figure 11.

Referring now to the drawing in detail and to Figure 1 in particular there is shown an annular base 15 having a plurality of prongs 16, 17, 18 and 19 depending therefrom. A bimetallic strip 20 which is constructed of two metallic plates 21 and 22 having different temperature coefficients of expansion is attached to base 15 and extends upward therefrom. A cantilever spring support 25 also is attached to base 15 and extends upward therefrom adjacent strip 20. A first electrical contact button 23 is attached to strip 20 near the upper end thereof and a second electrical contact button 26 is attached to support 25 near the upper end thereof. An armature 27 of magnetic material is attached to the opposite side of support 25 also near the upper end thereof. Spring support 25 is positioned such that contact button 26 normally presses against contact button 23. A heater coil 28 is attached to base 15 and extends upward therefrom in close proximity to bimetallic strip 20. Strip 20, support 25 and coil 28 are enclosed in a glass envelope 29 which is hermetically sealed to base 15 and which preferably is filled with an inert gas at a predetermined pressure. A schematic electrical control circuit 30 is illustrated in conjunction with this time delay switch. Circuit 30 includes a pair of output terminals 31 and 32 which are connected to respective prongs 16 and 17, terminals 31 and 32 being connected to the external circuit under control. A battery 33 is connected across prongs 18 and 19 through a switch 34. Prongs 16 and 17 are electrically connected through base 15 with respective support 25 and strip 20, and prongs 18 and 19 are electrically connected through base 15 with the end terminals of heater coil 28. A bracket 36 is attached at its lower end to base 15 and extends generally upward therefrom adjacent envelope 29. A small magnet 38 is attached to a threaded shaft 39 which extends through bracket 36 such that magnet 38 opposes armature 27. A spur gear 40 is attached to the end of shaft 39 and a second spur gear 41 is in engagement therewith. Gear 41 rotates with a shaft 42 which is supported by bracket 36. A dial 43

is attached to shaft 42 whereby rotation of dial 43 rotates shaft 39 to move magnet 38 inwardly or outwardly with respect to armature 27.

The time delay switch thus far described is operated by closure of switch 34 which results in current being supplied to heater coil 28. This in turn heats bimetallic strip 20 which results in the strip being deformed to the position illustrated in Figure 3. Spring support 25 normally presses toward strip 20 so as to tend to follow movement of bimetallic strip 20 thereby keeping contact buttons 23 and 26 in engagement. However, magnet 38 exerts an attraction force on armature 27 which tends to oppose this movement of support 25. It should be apparent that the closer magnet 38 is positioned to armature 27 the stronger is the attraction force and hence the stronger the retaining force which tends to prevent support 25 from following bimetallic strip 20. Thus, rotation of dial 43 positions magnet 38 with respect to armature 27 and thereby establishes the break-away position of contact buttons 23 and 26. Dial 43 can be calibrated in terms of delay time considering the spring constant of support 25 and the amount of current supplied to heating coil 28. The use of glass envelope 29 is desirable but not essential to satisfactory operation of the time delay switch of this invention. Envelope 29 eliminates such problems as dust and moisture accumulation on the contact buttons and permits uniform operation under any atmospheric conditions.

In Figure 4, there is illustrated a modified form of switch which is identical to that illustrated in Figure 1 except that armature 27 of Figure 1 is replaced by a second small magnet 45. It should be apparent that if magnets 38 and 45 are aligned such that the north pole of one opposes the south pole of the other in a first position and vice versa, an attractive force results between the two. If on the other had, the two magnets are aligned such that the north pole of one opposes the north pole of the other and the south pole of one opposes the south pole of the other in a second position, a repulsive force results. Therefore, by orienting magnet 38 with respect to magnet 45 any desired degree of attraction can be obtained. Rotation of magnet 38 through an angle of 180° results in progressively increasing the attractive force between magnets 38 and 45 if the two magnets are aligned initially so as to repel one another with a maximum force. It should be apparent that operation of the switch illustrated in Figure 4 is substantially the same as the operation of the switch in Figure 1. In Figure 4 a variance in the attractive force between two magnets replaces the variance in attractive force between a magnet and an armature. Otherwise, the two switches function in the same manner.

In Figures 5 and 6 there is illustrated a second embodiment of a normally closed contact switch. This switch is generally similar to that illustrated in Figure 1 and corresponding parts are designated by like reference numerals. In the embodiment of Figure 5, however, contact button 26 is attached to a rigid support member 50 which in turn is attached to base 15 and extends upward therefrom. Furthermore, armature 27 is attached to plate 21 of bimetallic strip 20 rather than to the support of contact button 26. A second embodiment of magnet adjustment is illustrated wherein shaft 39 is rotated directly by an adjustment knob 51 attached to the outer end thereof. A lock nut 52 is provided on shaft 39 to retain the assembly in fixed position. The application of current to heater coil 28 heats bimetallic strip 20 to force the strip to a deformed position such as illustrated in Figure 3. However, armature 27 is attracted by magnet 38, and this in turn exerts a second force on bimetallic strip 20 which tends to retain the contact buttons 23 and 26 in engagement. The magnitude of this retaining force exerted by magnet 38 on armature 27 tends to establish the time at which the contact buttons break away from one another. This retaining force is varied by movement

of magnet 38 inwardly and outwardly with respect to armature 27 in response to rotation of shaft 39 as previously described.

The switch assembly illustrated in Figure 7 is a modified form of the switch assembly shown in Figures 5 and 6. The construction of the two assemblies is identical except that armature 27 of Figure 5 is replaced by a second magnet 45 in Figure 7. The retaining force exerted on bimetallic strip 20 is adjustable by varying the relative position of the two magnets 38 and 45 in the manner previously explained in conjunction with Figure 4. Otherwise the operation of the switch in Figure 7 is identical to the operation of the switch illustrated in Figures 5 and 6.

In Figures 8 and 9 there is illustrated a time delay switch arrangement which is provided with normally opened contact buttons. In this particular configuration armature 27 is mounted on plate 21 of bimetallic strip 20 and a first electrical contact button 55 is mounted on plate 22 of strip 20. A second electrical contact button 56 is mounted on a rigid support 57 so as to be in spaced relation with contact button 55 prior to the application of current to heater coil 28. The application of current to heater coil 28 tends to deform bimetallic strip 20 to the right as illustrated in Figure 3 whereby contact button 55 engages contact button 56. However, this movement of bimetallic strip 20 is opposed by the adjustable retaining force exerted on armature 27 by magnet 38. This retaining force serves to regulate the time interval it takes contact button 55 to move a sufficient distance to engage contact button 56 after current is supplied to heater coil 28.

The apparatus illustrated in Figure 10 is identical to that shown in Figures 8 and 9 except that armature 27 is replaced by a second magnet 45. The attraction force between magnets 38 and 45 is adjustable by rotation of magnet 38 in the manner previously described in conjunction with Figure 4.

In Figures 11 and 12 there is shown a second embodiment of a time delay switch having normally open contacts. A first contact button 60 is mounted on plate 22 of bimetallic strip 20. It should be noted that bimetallic strip 20 is positioned on base 15 in a direction opposite to that previously described, that is, plate 22 is on the left and plate 21 is on the right. The application of current to heating coil 28 has the effect of distorting strip 20 such that it bends leftward. A second contact button 61 is mounted on a flexible support member 62 which is positioned such that there normally is an air gap between contact buttons 60 and 61. Armature 27 is mounted on support 62 adjacent magnet 38. Movement of magnet 38 inwardly or outwardly with respect to armature 27, therefore, has the effect of positioning support 62 initially such that contact button 61 is at a predetermined distance from contact button 60. This distance in turn regulates the time needed for contact button 60 to move into engagement with contact button 61 following application of current to heater coil 28. In this particular embodiment the time delay is adjusted initially by the positioning of contact button 61.

The apparatus illustrated in Figure 13 is identical to that shown in Figure 11 except that armature 27 is replaced by a magnet 45. The adjustment of the attraction between magnets 38 and 45 takes place in substantially the same manner as previously described in conjunction with Figure 4.

From the foregoing description, it should be apparent that there is provided in accordance with this invention an improved time delay switch wherein the time delay is adjustable by magnetic means associated therewith. These magnetic means are either in the form of a magnet and an associated armature or a pair of opposing magnets. While the invention has been described in conjunction with present preferred embodiments thereof it should be apparent that the invention is not limited thereto.

What is claimed is:

1. A time delay switch comprising a thermostatic support element, a first electrical contact mounted on said thermostatic element, means separately supported and spaced from said thermostatic element for applying heat to the latter to cause deflection thereof and movement of said first contact, a second support element, a second electrical contact mounted on said second support element, said second support element being positioned such that said first and second contacts are adapted to come into engagement, a body of magnetic material secured to one of said support elements, a magnet mounted adjacent said body of magnetic material whereby said magnet exerts a force on said body, and means to vary the position of said magnet with respect to said body of magnetic material and thereby the force exerted on said body of magnetic material by said magnet.

2. The combination in accordance with claim 1 wherein said body of magnetic material comprises a magnet positioned with its poles opposing the poles of said mounted magnet whereby the north pole of one of said magnets opposes the south pole of the other of said magnets in a first position and the north pole of said one magnet opposes the north pole of said other magnet in a second position, said mounted magnet being rotated 180° between said first and second positions.

3. The combination in accordance with claim 1 wherein said first and second contacts are in engagement with one another prior to application of heat to said thermostatic element.

4. The combination in accordance with claim 1 wherein said first and second contacts are out of engagement with one another until after a predetermined time interval following application of heat to said thermostatic element.

5. The combination in accordance with claim 1 wherein said means for applying heat to said thermostatic element comprises an electrical heating element positioned adjacent said thermostatic element.

6. The combination in accordance with claim 5 further comprising a hermetically sealed envelope enclosing said thermostatic element, said second support element, said first and second electrical contacts and said heating element.

7. A time delay switch comprising a base, a bimetallic element mounted on said base, a first electrical contact secured to said bimetallic element, an electrical heating element mounted on said base adjacent said bimetallic element whereby the application of current to said heating element results in said bimetallic element being deflected and said first contact being displaced, a flexible support member mounted on said base, a second electrical contact secured to said support member, means biasing said support member whereby said second electrical contact tends to remain in engagement with said first electrical contact notwithstanding movement of said bimetallic element responsive to heat being applied thereto, a body of magnetic material secured to said support member, a magnet mounted adjacent said body of magnetic material whereby said magnet exerts a force on said body which opposes said biasing means, and means to vary the position of said magnet with respect to said body of magnetic material and thereby the force exerted on said body of magnetic material by said magnet.

8. The combination in accordance with claim 7 wherein said body of magnetic material comprises a magnet positioned with its poles opposing the poles of said first-mentioned magnet whereby the north pole of one of said magnets opposes the south pole of the other of said magnets in a first position and the north pole of said one magnet opposes the north pole of said other magnet in a second position, said first-mentioned magnet being rotated 180° between said first and second positions.

9. A time delay switch comprising a base, a bimetallic element mounted on said base, a first electrical contact

secured to said bimetallic element, an electrical heating element mounted on said base adjacent said bimetallic element whereby the application of current to said heating element results in said bimetallic element being deflected and said first contact being displaced, a cantilever spring member mounted on said base, a second electrical contact secured to said spring member, said spring member being positioned such that said second electrical contact tends to remain in engagement with said first electrical contact notwithstanding movement of said bimetallic element responsive to heat being applied thereto, a body of magnetic material secured to said spring member, an envelope hermetically sealed with said base and enclosing said first and second contacts, said bimetallic element, said spring member and said body of magnetic material, a magnet mounted adjacent said body of magnetic material outside said envelope whereby said magnet exerts a force on said body of magnetic material which opposes the force of said spring member tending to retain the contacts in engagement, and means to vary the position of said magnet with respect to said body of magnetic material and thereby the magnitude of the force exerted on said body of magnetic material by said magnet.

10. A time delay switch comprising a base, a bimetallic element mounted on said base, a first electrical contact secured to said bimetallic element, an electrical heating element mounted on said base adjacent said bimetallic element whereby the application of current to said heating element results in said bimetallic element being deflected and said first contact being displaced, a rigid support member mounted on said base, a second electrical contact atached to said support member whereby said first and second contacts are in engagement in the absence of heat being applied to said bimetalic element, a body of magnetic material secured to said bimetallic element, a magnet mounted adjacent said body of magnetic material whereby said magnet exerts a force on said body which tends to prevent said bimetallic element from being deflected by heat being supplied thereto, and means to vary the position of said magnet with respect to said body of magnetic material and thereby the magnitude of force exerted on said body of magnetic material by said magnet.

11. The combination in accordance with claim 10 wherein said body of magnetic material comprises a magnet positioned with its poles opposing the poles of said first-mentioned magnet whereby the north pole of one of said magnets opposes the south pole of the other of said magnets in a first position and the north pole of said one magnet opposes the north pole of said other magnet in a second position, said first-mentioned magnet being rotated 180° between said first and second positions.

12. A time delay switch comprising a base, a bimetallic element mounted on said base, a first electrical contact secured to said bimetallic element, an electrical heating element mounted on said base adjacent said bimetallic element whereby the aplication of current to said heating element results in said bimetallic element being deflected and said first contact being displaced, a rigid support member mounted on said base, a second electrical contact attached to said support member whereby said first and second contacts are in opposing spaced relation in the absence of heat being applied to said bimetallic element, a body of magnetic material secured to said bimetallic element, a magnet mounted adjacent said body of magnetic material whereby said magnet exerts a force on said body which tends to prevent said bimetallic element from being deflected by heat being supplied thereto, and means to vary the position of said magnet with respect to said body of magnetic material and thereby the magnitude of force exerted on said body of magnetic material by said magnet.

13. The combination in accordance with claim 12 wherein said body of magnetic material comprises a magnet positioned with its poles opposing the poles of said first-mentioned magnet whereby the north pole of one of

said magnets opposes the south pole of the other of said magnets in a first position and the north pole of said one magnet opposes the north pole of said other magnet in a second position, said first-mentioned magnet being rotated 180° between said first and second positions.

14. A time delay switch comprising a base, a bimetallic element mounted on said base, a first electrical contact secured to said bimetallic element, an electrical heating element mounted on said base adjacent said bimetallic element whereby the application of current to said heating element results in said bimetallic element being deflected and said first contact being displaced, a flexible support member mounted on said base, a second electrical contact secured to said support member, a body of magnetic material secured to said support member, a magnet mounted adjacent said body of magnetic material whereby said magnet exerts a force on said body which tends to position said support member, and means to vary the position of said magnet with respect to said body of magnetic material whereby said support member is positioned initially such that there is a predetermined spacing between said first and second electrical contacts in the absence of heat being supplied to said bimetallic element.

15. The combination in accordance with claim 14 wherein said body of magnetic material comprises a magnet positioned with its poles opposing the poles of said first-mentioned magnet whereby the north pole of one of said magnets opposes the south pole of the other of said magnets in a first position and the north pole of said one magnet opposes the north pole of said other magnet in a second position, said first mentioned magnet being rotated 180° between said first and second positions.

16. A time delay switch comprising a base, a bimetallic element mounted on said base, a first electrical contact secured to said bimetallic element, an electrical heating element independently mounted on said base adjacent said bimetallic element whereby the application of current to said heating element results in said bimetallic element being deflected and said first contact being displaced, a flexible support member mounted on said base, a second electrical contact secured to said support member, means biasing said support member whereby said second electrical contact tends to remain in engagement with said first electrical contact notwithstanding movement of said bimetallic element responsive to heat being applied thereto, a body of magnetic material secured to said support member, a magnet mounted adjacent said body of magnetic material whereby said magnet exerts a force on said body which opposes said biasing means, a gear mechanism, and time delay calibrated means whereby the rotation of same causes said gear mechanism to vary the position of said magnet with respect to said body of magnetic material and thereby the force exerted on said body of magnetic material by said magnet.

17. The combination in accordance with claim 16 wherein said body of magnetic material comprises a magnet positioned with its poles opposing the poles of said first-mentioned magnet whereby the north pole of one of said magnets opposes the south pole of the other of said magnets in a first position and the north pole of said one magnet opposes the north pole of said other magnet in a second position, said first-mentioned magnet being rotated 180° between said first and second positions.

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