Oct. 16, 1945. A. E. DODD 2,387,127

ELECTRICAL RELAY

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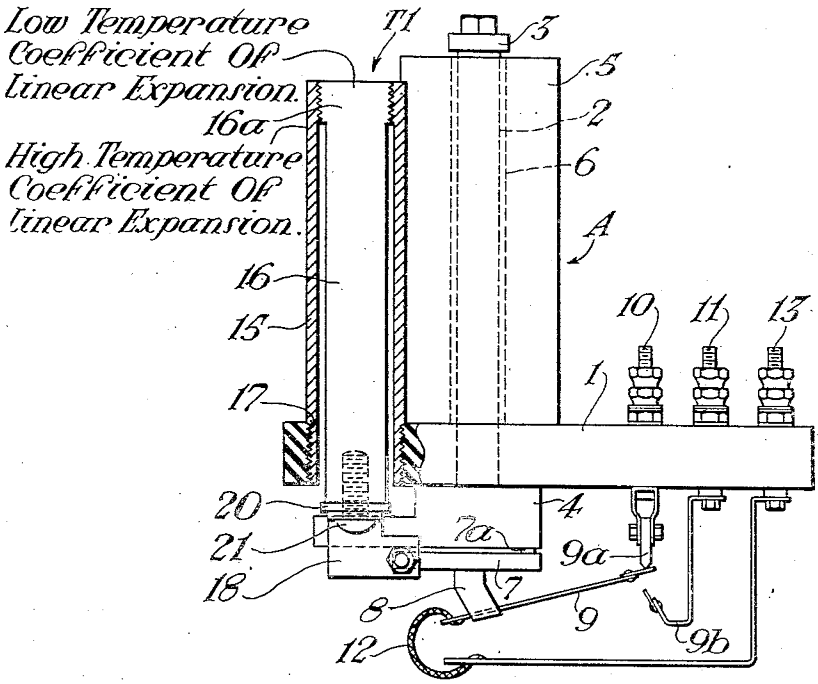


Fig. 1.

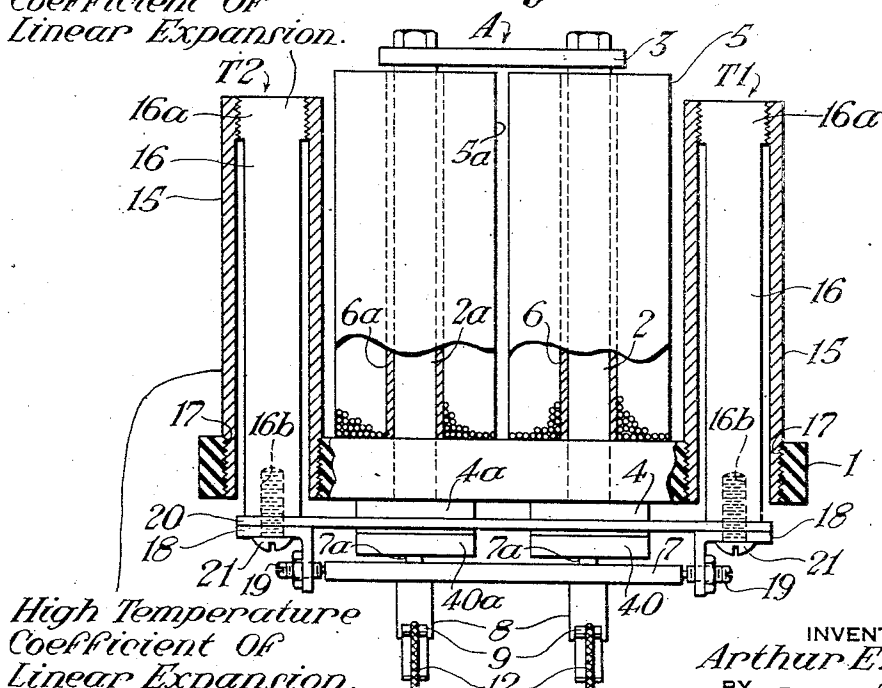


Fig. 2.

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ELECTRICAL RELAY

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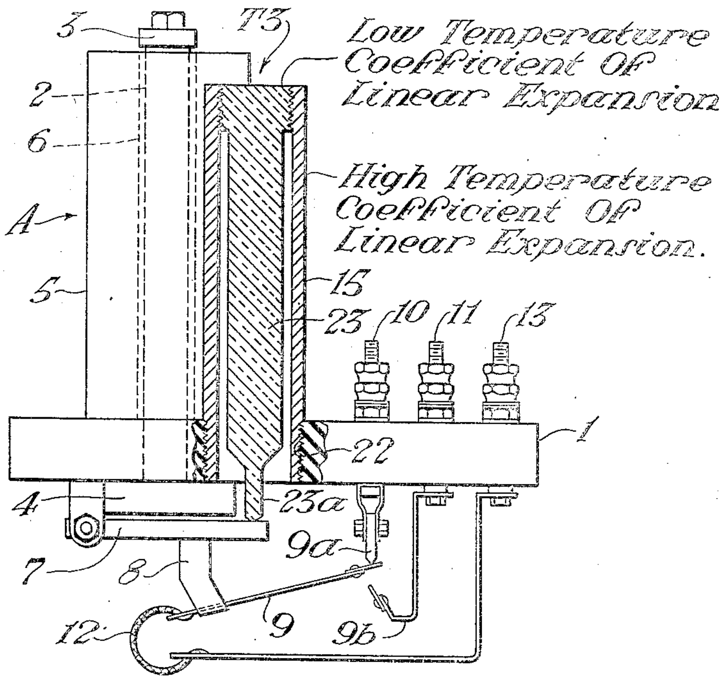


Fig. 3.

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## ELECTRICAL RELAY

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9 Claims. (Cl. 175—342)

My invention relates to electrical relays, and particularly to electrical relays having a low resistance conducting path associated therewith for controlling the time characteristics of the relay.

Relays of the type described exhibit the characteristic that the release time decreases with increases in the ambient temperature. This change in the time characteristics of the relay is undesirable, and one object of my invention is the provision of means for automatically compensating for the effects of changes in the ambient temperature upon the time characteristics of a relay of the type described.

Relays embodying my invention are an improvement upon the relay described and claimed in Letters Patent of the United States No. 1,716,808, granted to Herbert A. Wallace on June 11, 1929, for Electromagnetic device.

I shall describe two forms of electrical relays embodying my invention, and shall then point out the novel features thereof in claims.

In the accompanying drawings, Fig. 1 is a side elevational view with some of the parts in section of a relay provided with one form of temperature compensating means embodying my invention. Fig. 2 is a back view of the relay shown in Fig. 1, with certain of the parts shown in section. Fig. 3 is a side view showing a relay similar to that illustrated in Fig. 1 provided with another form of temperature compensating means embodying my invention.

Similar reference characters refer to similar parts in all three views.

Referring first to Figs. 1 and 2, the relay here shown comprises a top plate 1 of suitable insulating material such as a phenol condensation product, which top plate supports all of the operating parts of the relay. Mounted on the top plate 1 is an electromagnet A comprising, as usual, a pair of parallel cores 2 and 2a connected at their upper ends by a backstrap 3, and provided at their lower ends with enlarged pole pieces 4 and 4a disposed on the underside of the top plate. The cores 2 and 2a are surrounded by energizing windings 5 and 5a wound on sleeves 6 and 6a, respectively, of low resistance conducting material. The sleeves 6 and 6a comprise a means for controlling the time constants of the relay as will be made clear presently. The windings 5 and 5a are intended to be connected in series in the usual manner so as to provide cumulative fluxes in the cores 2 and 2a when these windings are energized, and may be supplied with current from any suitable source not shown in the drawings.

The relay also comprises the usual tractive armature 7 which is pivotally supported for movement toward and away from the pole pieces 4 and 4a according as the windings 5 and 5a are energized or deenergized. The movement of the armature toward the pole pieces is limited by the usual non-magnetic core pins 7a. Attached to the armature by means of insulating supports 8 are a plurality of flexible contact fingers 9. Each contact finger 9 cooperates with a fixed front contact member 9a to close a front contact 9—9a when the armature is swung toward the pole pieces, and with a fixed back contact member 9b to close a back contact 9—9b when the armature is swung away from the pole pieces. Each fixed front contact member 9a is secured to a terminal post 10 mounted on the top plate 1, while each fixed contact member 9b is secured to a terminal post 11 also mounted on the top plate 1. External electrical contact with each movable contact finger 9 is made through the medium of a flexible connector 12 connected to a terminal post 13 mounted on the top plate 1.

With the relay constructed in the manner thus far described it will be obvious that when the electromagnet A becomes energized, the armature 8 will move toward the pole pieces 4 and 4a to its attracted position in which the core pins 7a engage the pole pieces, and will thus close the front contacts 9—9a. When the electromagnet 3 subsequently becomes deenergized, the electromotive forces induced in sleeves 6 and 6a will delay the decay of the flux in the cores 1 and 1a, and as a result, the release of the armature will be delayed. However, as soon as the flux in the cores drops below the critical value, the armature will then drop by gravity to its released position and will thus open the front contacts 9—9a and close the back contacts 9—9b. It will be seen, therefore, that due to the slow acting sleeves 6 and 6a the release of the armature 7 will occur at the expiration of a predetermined time interval after the relay becomes deenergized.

The time required for the armature 7 to release depends in part upon the degree to which the electromagnet was previously energized, and in part upon the resistance of the slow acting sleeves 6 and 6a. If the ambient temperature increases, the resistance of the energizing windings will increase, and assuming that the relay is energized from a source of constant potential, the energization of the electromagnet will then decrease with the result that the release time of the armature will decrease. Furthermore, if the sleeves 6 and 6a are made of a material such as copper which has a positive temperature coefficient of resistance, a rise in the ambient temperature will increase the resistance of these sleeves so that for a given energizing current in the windings 5 and 5a the current induced in the sleeves 6 and 6a will be materially lessened. The smaller the induced current in sleeves 6 and 6a becomes the quicker the flux induced in the cores 2 and 2a will decrease to the level at which the armature releases after the windings 5 and 5a become deenergized, and it follows, therefore, that increases in the ambient temperature will decrease the effectiveness of the sleeves and will thus act to accelerate the release of the relay. The acceleration of the release time of the relay due to the increase in resistance of the sleeves is rather large, and in actual practice the combined effect of the change in resistance of the windings and the sleeves may cause the release time at the highest temperature to which the relays may be subjected to be less than half of the release time at the lowest temperature to which the relays may be subjected.

It is frequently desirable to employ a relay of the type described where a constant rate of release is necessary, and according to my present invention I provide the relay with temperature compensating means which I shall now describe for rendering the time characteristics of the relay independent of changes in the ambient temperature.

As shown in Figs. 1 and 2, the temperature compensating means comprises two temperature compensators T1 and T2 which serve to vary the air gap at the back of the armature in response to temperature changes, and also to vary the position of a magnetic shunt with respect to the pole pieces 4 and 4*a*. These compensators are disposed adjacent the rear edge of the relay on opposite sides of the operating windings, and each comprises a tube 15 of a material having a high temperature coefficient of linear expansion, such as aluminum or brass, and a rod 16 of a material having a relatively low temperature coefficient of linear expansion, such as porcelain or invar. The tubes 15 are screw threaded at their lower ends into through holes 17 provided in the top plate 1, and each tube is internally threaded at its upper end for threaded engagement with an enlarged portion 16*a* provided on the upper end of the associated rod 16. The rods 16 extend downwardly through the tubes 15 with clearance and are provided at their lower ends with brackets 18 carrying trunnion screws 19 which pivotally support the armature 7. The rods 16 also support a shunt bar 20 which extends transversely of the relay above polar extensions 40 and 40*a* provided on the pole pieces 4 and 4*a* respectively. The brackets 18 and shunt bar 20 are secured to the lower ends of the rods 16 by means of screws 21 which pass through clearance holes in the brackets and the shunt bar and are screwed into tapped holes 16*b* provided in the rods.

With the temperature compensating means constructed in this manner a rise in the ambient temperature will cause the metal tubes 15 to elongate an appreciable amount while the rods 16 will elongate only a very slight amount, if any. The resultant relative motion between the tubes and rods causes the air gaps between the pole pieces and the armature to decrease, thereby decreasing the reluctance of the air gaps, and hence increasing the magnitude of the working flux traversing the armature. This relative motion between the tubes and rods also causes the air gaps between the shunt bar and the polar extensions to increase, which decreases the leakage flux through the shunt bar and hence further increases the working flux traversing the armature. In a similar manner, a decrease in the ambient temperature will cause the air gaps between the armature and the pole piece to increase and the air gaps between the shunt bar and the polar extension to decrease which causes a decrease in the working flux traversing the armature. As was pointed out hereinbefore, any increase in the ambient temperature without the temperature compensating means tends to decrease the flux traversing the armature, and it follows therefore that by properly proportioning the parts the temperature compensators can be made to maintain the flux traversing the armature at a value which maintains the release time substantially constant. It also follows that the parts can be so proportioned as to cause the temperature compensating means to overcompensate or undercompensate for changes in the release time of the relay caused by changes in the ambient temperature.

It should be pointed out that while the relay as constructed in Figs. 1 and 2 makes use of both changes in the armature air gaps and a magnetic shunt bar to obtain temperature compensation, each of these means may be used independently, if desired.

Referring now to Fig. 3, in the modified form of my invention here shown, the relay is provided with only one temperature compensator T3. This latter temperature compensator is mounted in a screw threaded hole 22 provided in the top plate 1 directly in front of windings 5 and 5*a* on a line midway between them, and is similar to the previously described temperature compensators T1 and T2 except for the fact that the inner rod, which latter rod is here designated 23, is provided at its lower end with a reduced portion 23*a* which takes the place of the core pins 7*a* shown in Fig. 1, and acts as a variable stop to limit the motion of the armature toward the pole pieces 4 and 4*a*.

With the temperature compensating means shown in Fig. 3 when the ambient temperature rises, the difference in the elongation of the tube 15 and rod 23 causes the lower end of the rod 23 to move upwardly and hence causes the air gap between the pole pieces 4 and 4*a* and armature 7 to decrease. This decrease in air gap causes a greater amount of the magnetic flux induced in the electromagnet by the energization of the windings 5 and 5*a* to traverse the armature, and by properly proportioning the parts the increase in flux traversing the armature caused by the change in air gap can be made sufficient to result in the release time of the relay being maintained substantially constant.

If desired the temperature compensator T3 can be combined with the temperature compensators T1 and T2 shown in Fig. 1.

One advantage of temperature compensating means embodying my invention is that it is rugged and reliable, as well as being relatively inexpensive to manufacture.

Although I have herein shown and described only two forms of electrical relays embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In combination, an electromagnet provided with pole pieces, an armature controlled by said electromagnet, a magnetizable shunting member spaced from each pole piece of said electromagnet by an air gap, and means for varying said air gaps in response to changes in the ambient temperature to compensate for changes in the time constants of said relay caused by

said ambient temperature changes comprising a tube fixed at one end, and a rod secured at one end within the free end of said tube and extending through said tube with clearance and secured at its free end to said shunting member, said tube and said rod having different coefficients of linear expansion.

2. In combination, an electromagnet provided with pole pieces, an armature controlled by said electromagnet, a magnetizable shunting member spaced from each pole piece of said electromagnet by an air gap, and means for varying said air gap in response to changes in the ambient temperature to compensate for changes in the time constants of said relay caused by said ambient temperature changes comprising a tube fixed at one end, and a rod secured at one end within the free end of said tube and extending through said tube with clearance and secured at its free end to said shunting member, said tube having a relatively high coefficient of linear expansion and said rod having a relatively low coefficient of linear expansion.

3. In combination, an electromagnet provided with pole pieces, an armature controlled by said electromagnet, a magnetizable shunting member spaced from each pole piece of said electromagnet by an air gap, and means for varying said air gaps in response to changes in the ambient temperature to control the changes in the time constants of said relay caused by said ambient temperature changes comprising a tube fixed at one end, and a rod secured at one end within the free end of said tube and extending through said tube with clearance and secured at its free end to said shunting member, said tube and said rod having different coefficients of linear expansion.

4. In combination, an electromagnet provided with pole pieces and with a low resistance conducting path for controlling the time constants of said magnet, an armature controlled by said electromagnet, a magnetizable shunting member spaced from each pole piece of said electromagnet by an air gap, and means for varying said air gaps in response to changes in the ambient temperature to compensate for changes in the time constants of said relay caused by said ambient temperature changes comprising a tube fixed at one end, and a rod secured at one end within the free end of said tube and extending through said tube with clearance and secured at its free end to said shunting member, said tube and said rod having different coefficients of linear expansion.

5. An electrical relay comprising an electromagnet provided with a pair of pole pieces, an armature cooperating with said electromagnet, a pair of temperature compensators each comprising a tube fixed at one end and a rod extending into said tube through said one end and secured to the other end of said tube, said tube and said rod having different coefficients of linear expansion, supports for said armature secured to the free ends of said rods, and a shunt bar secured to the free ends of said rods and separated from said pole pieces by air gaps which depend upon the relative lengths of said tubes and said rods, said tubes and said rods having different coefficients of linear expansion.

6. An electrical relay comprising an electromagnet provided with a pair of pole pieces, an armature cooperating with said electromagnet, a pair of temperature compensators each comprising a tube fixed at one end and a rod extending into said tube through said one end and secured to the other end of said tube, said tube and said rod having different coefficients of linear expansion, supports for said armature secured to the free ends of said rods, and a shunt bar secured to the free ends of said rods and separated from said pole pieces by air gaps which depend upon the relative lengths of said tubes and said rods, said tubes and said rods having different coefficients of linear expansion so chosen that the changes in the air gaps between said armature and said pole pieces and between said shunt bar and said pole pieces will compensate for changes in the time constants of said relay caused by changes in the ambient temperature.

7. An electrical relay comprising an electromagnet provided with a pair of pole pieces and with a low resistance conducting path for controlling the time constants of said magnet, an armature cooperating with said electromagnet, a pair of temperature compensators each comprising a tube fixed at one end and a rod extending into said tube through said one end and secured to the other end of said tube, said tube and said rod having different coefficients of linear expansion, supports for said armature secured to the free ends of said rods, and a shunt bar secured to the free ends of said rods and separated from said pole pieces by air gaps which depend upon the relative lengths of said tubes and said rods, said tubes and said rods having different coefficients of linear expansion.

8. In combination, an electromagnet provided with pole pieces, an armature controlled by said electromagnet, extensions on said pole pieces, two temperature compensators each comprising a tube fixed at one end and a rod secured at one end to the other end of said tube and extending through said tube with clearance, and a magnetizable shunt bar secured to the free ends of said rod and spaced from said polar extensions by air gaps, said tubes having different coefficients of linear expansion from said rods whereby variations in the ambient temperature will vary the air gaps between said shunt bar and said polar extensions to control the changes in the time constants of said relay caused by changes in the ambient temperature.

9. In combination, an electromagnet provided with pole pieces and with a slow acting sleeve, an armature controlled by said electromagnet, extensions on said pole pieces, two temperature compensators each comprising a tube fixed at one end and a rod secured at one end to the other end of said tube and extending through said tube with clearance, and a magnetizable shunt bar secured to the free ends of said rod and spaced from said polar extensions by air gaps, said tubes having different coefficients of linear expansion from said rods whereby variations in the ambient temperature will vary the air gaps between said shunt bar and said polar extensions to control the changes in the time constants of said relay caused by changes in the ambient temperature.

ARTHUR E. DODD.