July 27, 1948. V. N. TRAMONTINI 2,446,029

THERMAL TIME DELAY SWITCH

Filed Sept. 14, 1946

Fig. 1

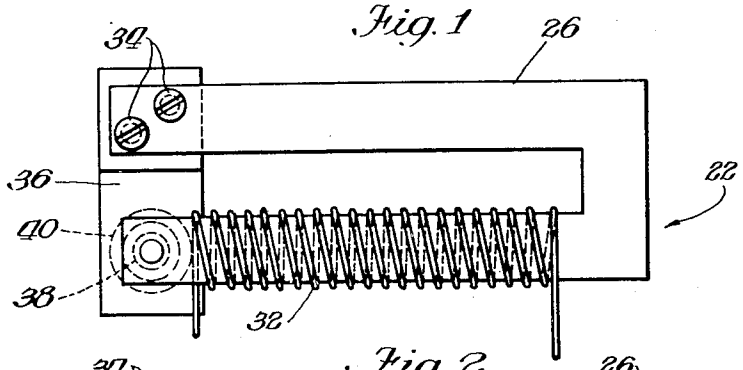


Fig. 2

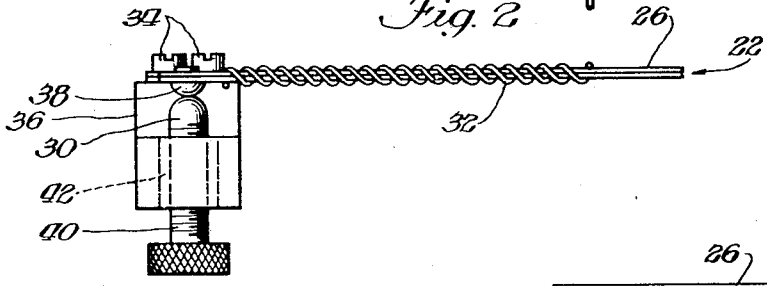
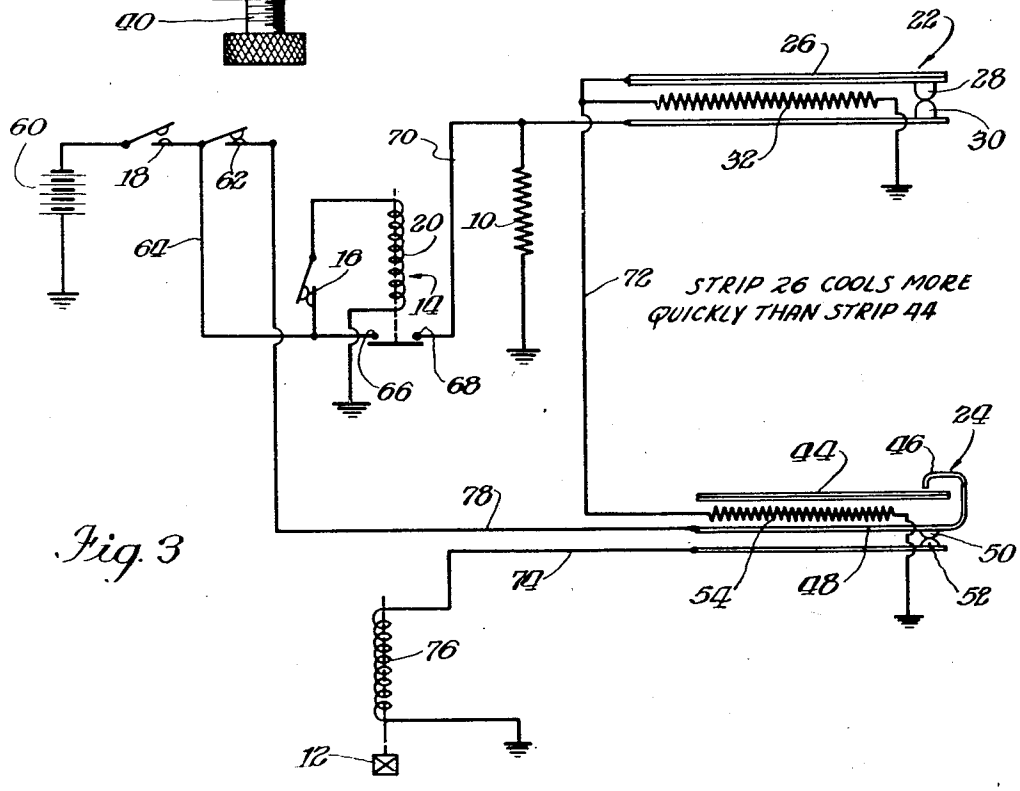


Fig. 3



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THERMAL TIME-DELAY SWITCH

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1 Claim. (Cl. 175—320)

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The present invention relates to time delay switches and more particularly is concerned with a time delay switch of the type adapted to be used in an electric safety circuit such that after a given time interval the switch operates to perform some useful function. Although the switch of the present invention has other uses, primarily it is intended as a safety device to shut off the flow of fuel to a vehicle heater of the combustion type in the event that the heater fails to function properly within a predetermined time interval after being turned on.

It is common practice to provide vehicles with liquid fuel consuming heaters, the fuel usually being gasoline, of a type such that the fuel to the heater is turned on or off remotely through the agency of a magnetic valve. Such a heater is shown in the copending application of George W. Allen and Vernon N. Tramontini for "Heaters" filed June 14, 1946, Serial No. 676,776. The particular heater shown in this copending application is provided with a magnetic valve which permits fuel to flow through the heater when the magnetic valve is energized and interrupts the flow of fuel whenever the valve is de-energized. Under some conditions the flow of fuel to the heater even if the heater is not operating properly is not particularly objectionable inasmuch as the quantity of fuel which may collect in the heater and thereafter flow from the exhaust pipe is not very great. Under other conditions, however, it is quite desirable to provide an automatic device which will shut off the flow of fuel to the heater in the event that the heater does not start within a matter of two or three minutes after the heater has been turned on.

In the past, time delay switches have been proposed for heater control purposes. Such switches usually depend upon the rate of heating of a bimetal strip by an electric resistance element to determine the interval from the time the heater is turned on until the fuel supply is automatically turned off in the event that the heater does not start meanwhile. The difficulty with such schemes when applied to automobile or other vehicle heaters is that the voltage at the heater may vary all the way from approximately four volts to over eight volts and therefore the rate of heating of the thermosensitive element of such time delay switches will not be even approximately constant under different voltage conditions. For instance, a high voltage source will cause the thermosensitive element to heat up quickly and to turn off the heater within a comparatively short time interval whereas low voltages will require a longer time for operation and under some conditions the switch may never operate at all because the heat loss from the thermosensitive element may balance the heat gain from the electric resistance heater before the thermosensitive element has deflected enough to operate the switch. It is, therefore, one of the objects of the present invention to provide a novel time delay switch of the electrically heated bimetal type which will have a substantially constant time of operation even though the voltage supplied thereto may vary throughout a wide range.

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Another object is to provide an improved voltage compensated electrically operated time delay switch which can be manufactured at low cost.

Still another object is to provide an improved vehicle heater electrical circuit which will interrupt the flow of fuel to the heater in the event that the heater does not start within a short period, even though the voltage at the heater may fluctuate considerably.

Yet another object is to provide a device as called for above which may be manufactured as two separate elements which may be located remotely with respect to each other, the two elements simply being connected by electrical wiring.

Other objects and advantages will become apparent from the following description of a preferred embodiment of my invention which is illustrated in the accompanying drawings.

In the drawings:

Fig. 1 is a somewhat diagrammatic top view of a portion of my device;

Fig. 2 is a side view thereof; and

Fig. 3 is an electrical circuit diagram showing the complete device including an electric circuit suitable for the use of the device in a vehicle heater installation.

A heater suitable for use with the device of the present invention is described in the previously referred to copending application. For the purpose of understanding the present invention it is sufficient to consider that such a heater is provided with an electrical igniter of the hot wire type, indicated in Fig. 3 by the numeral 10, which is energized at the time of starting of the heater. This igniter quickly heats to ignition temperature and normally starts combustion within the heater in a matter of ten to twenty seconds, although under some conditions ignition may be delayed for a period of an additional half minute or so, particularly if the ambient temperature is low or the voltage is low so that con-

siderable time is required to bring the igniter to operating temperature.

A magnetic valve, indicated by the numeral 12, is located in the fuel line to the heater and is normally in closed position. When this valve is energized electrically, it opens and permits fuel to flow until de-energized.

Thus, the flow of fuel to the heater can be controlled by energizing or de-energizing the magnetic valve 12. The igniter 10 is energized by way of a relay 14 under the control of an igniter switch 16. The switch 16 is normally closed whenever the heater is cold so that as soon as the master switch 18 is closed the coil 20 of the relay 14 will be energized, thereby closing relay 14 and energizing the igniter 10. If the heater starts promptly as it should, the increase in temperature of the igniter switch 16 which is normally located so as to be sensitive either to the temperature of the air flow from the heater or to the temperature of some portion of the heater, will cause this switch to interrupt the circuit to the coil 20 of the relay, thereby permitting the relay to drop open and deenergize the igniter 10.

The switch of the present invention operates in conjunction with the igniter circuit and functions to interrupt the supply of fuel to the heater in the event that the igniter circuit remains energized after a period of, say, three minutes. Referring to Fig. 3 of the drawings, it will be seen that the switch of the present invention is comprised of two main elements. That indicated generally by the numeral 22 may be considered as an impulse sending device while the portion indicated generally by the numeral 24 may properly be considered as the unit having direct control over the magnetic valve 12. The first of these elements, that is, the unit 22, is comprised of a bimetal blade 26 anchored at one end while the opposite end is provided with a contact 28 which operats in conjunction with a second contact 30 which may be considered as rigidly or adjustably mounted with respect to the contact 28. In other words, under normal conditions, the contact 30 does not move excepting for the purpose of adjusting the device. An electric resistance heating element 32 is associated with the bimetal blade 26 so that whenever the element 32 is energized the temperature of the blade 26 will be elevated above ambient.

As shown in Figs. 1 and 2, the bimetal strip 26 is preferably of the ambient temperature compensated type. That is, it is formed of a U-shaped piece of bimetal strip anchored at one end by screws 34 which extend into an insulating block 36. The opposite end of the bimetal strip is equipped with a contact 28 which moves upwardly and downwardly whenever one leg of the U-shaped bimetal element is curved more than the other. Ambient temperatures have little or no effect upon the position of the contact 28, since an increase in temperature in the device caused by an increase in ambient temperature causes the bimetal strip to curve so that its upper face is concave. Inasmuch as one end of the U-shaped strip is anchored, the contact will remain in a fixed position, since any curvature of one leg of the U will be offset by an equal amount of curvature in the other. The electric resistance heating element 32 previously referred to is formed by wrapping a single layer of resistance wire around the leg of the U-shaped bimetal strip which carries the contact 28. Whenever this resistance element is energized, it will raise the temperature of its leg of the bimetal strip carrying the contact 38, thereby causing the contact 28 to be raised. When both legs of the thermosensitive element are at substantially the same temperature, the contact 28 rests against and makes contact with the previously referred to contact 30 which, in Fig. 2, is shown as mounted upon the end of a manually adjustable thumb screw 40 threaded through a bushing 42 molded in the insulating block 36.

The second portion of the device, indicated at 24, may be considered as essentially the same as the portion 22 just described excepting that instead of the bimetal strip 26 carrying the contact 28 directly, the similar strip 44 in the control unit 24 is enabled to move an appreciable distance before taking up sufficient lost motion to catch beneath a hook 46 formed at the end of a flexible strip 48 which in turn is provided with a contact 50. As in the case of bimetal strip 26, the similar strip 44 is equipped with an electric heating element 54 of the resistance type. If desired, the bimetal element 44 of the controller 24 may also be of the temperature compensated type, although this is not so necessary in order to obtain close regulation as it is in the case of the impulse sending unit 22. Also, the strip 44 and heater 54 should be insulated or otherwise arranged so that the cooling rate thereof will be slower than for the strip 26.

The device is connected and operates in the following manner. The automobile or similar battery 60 is grounded at one side while the other side is connected through the previously referred to master switch to one side of an overheat switch 62. This overheat switch is of the thermostatic type and is sensitive to the temperature of the heater or the temperature of the air leaving the heater in such manner that any malfunctioning of the heater which causes an abnormally high temperature will result in the switch 62 opening, thereby turning off the heater. The lead which extends from the overheat switch 62 is connected by a wire 64 to one of the contacts 66 of the relay 14. Also, this same lead 64 is connected through the previously referred to igniter switch 16 to one end of the relay coil 20, the other end being grounded. The other relay contact 68 is connected by a lead 70 to one terminal of the igniter 10, the other terminal being grounded. This lead 70 is also connected to the stationary contact 30 of the impulse sending unit 22, the movable contact 28 associated therewith being connected to one end of each of the two electric resistance heaters 32 and 54, this connection being made by a lead 72. In each instance, the opposite ends of the electric heating elements 32 and 54 are grounded. The stationary contact 52 of the controller 24 is directly connected by a lead 74 to coil 76 of the magnetic fuel control valve 12, the other end of the coil being grounded while the movable contact 50 is connected by way of the flexible strip 48 and lead 78 to the dead contact of the overheat switch 62.

Before the heater is placed in operation, the master switch 18 will be open, the overheat switch will be closed as will the igniter switch 16, while the relay contacts 66 and 68 will be open. Also, contacts 28 and 30 will be together as will contacts 50 and 52. If, under such conditions, the master switch 18 is closed, the battery energizes the relay coil 20 by way of lead 64 and the contact of the igniter switch 16. The relay 14 is therefore closed so as to energize the igniter 10 by way of the contacts 66 and 68 and lead 70. The temperature of the igniter there-

fore begins to rise. Meanwhile, current also flows from the lead 70 by way of contacts 30 and 28 and bimetal strip 26 to the lead 72 and thence through the two electric heating elements 32 and 54 to ground. The temperature of these two resistance elements therefore begins to rise and they in turn begin to raise the temperature of the bimetal strips 26 and 44. During this period current also flows through the overheat switch 62 and lead 78 to contact 50 and thence by way of contact 52 and lead 74 to the coil 76 of the fuel valve 12. The valve therefore opens, permitting fuel to flow to the heater.

If the heater starts in a normal length of time the temperature of the heater or of the air passing therethrough will rise sufficiently to open the switch 16, thereby de-energizing the relay coil 20 and permitting the contacts 66 and 68 to separate. The lead 70 is therefore de-energized with the result that the igniter 10 begins to cool as do the resistance heaters 32 and 54. The result therefore is that contacts 52 and 50 never separate, since movement of the bimetal strip 44 under the influence of heater 54 has never been sufficient to close the lost motion gap which exists between the free end of the strip 44 and the hook 46. The coil 76 of the fuel valve 12 therefore remains energized and the heater continues to receive fuel.

If, on the other hand, the heater does not start within a reasonable time, the relay 14 remains closed, since the switch 16 has not been heated to operating temperature. The result is that heating elements 32 and 54 continue to be energized until the temperature of the strip 26 rises sufficiently so that upward flexure of the free end of this strip separates the contact 28 from the contact 30. As soon as this occurs the heating element 32 and the heating element 54 will both be de-energized, since both these heating elements are energized by way of the contacts 28 and 30. Both heating elements 32 and 54 therefore begin to cool until the contacts 28 and 30 re-engage so as to repeat the cycle. The heater 54 for the bimetal element 44 therefore receives current in impulses. Eventually, these impulses heat the bimetal element 44 sufficiently so that the free end is deflected upwardly enough to lift the hook 46 and separate the contacts 50 and 52, thereby de-energizing the coil 76 of the fuel valve 12.

If the voltage at the battery 60 is high, then upon closing of the contacts 28 and 30 the resistance element 32 will quickly supply enough heat to the bimetal element 26 to separate the contacts 28 and 30. On the other hand, it will require approximately the same cooling time before the contacts 28 and 30 reclose regardless of how rapidly they have been heated to the separating point. Conversely, if the voltage at the battery 60 is low, the contacts 28 and 30 will remain closed a longer time interval before the heating element 32 has dissipated enough energy to heat the strip 26 to the point where the contact 28 is separated from the contact 30. In general, the amount of energy dissipated by the heating element 32 in separating the contacts 28 and 30 will remain approximately the same regardless of whether it accomplishes this quickly at high voltage or slowly at low voltage.

Inasmuch as the heating element 54 is in parallel with the heating element 32, it will be seen that the energy dissipated by the heating element 54 will remain constant over any time interval long enough to average the electrical impulses from the contacts 28 and 30. Thus, the amount of energy supplied to the bimetal strip 44 over a period of, say, three minutes will remain substantially constant at all voltages within the range of operation of the device even though under some conditions power may be supplied to the heating element 54 by short duration impulses at high voltage or at other times by long duration impulses at low voltage. Thus, even though the voltage at the battery 60 may fluctuate widely, the time required for the separation of contact 50 from the contact 52 will remain substantially constant.

As has been pointed out previously, the bimetal strip 44 and heater 54 should be insulated or otherwise arranged so that the cooling rate will be slower than for the strip 26. This is because the strip 26 must cool down to its starting temperature at the end of each off cycle in order to reclose the contacts 28 and 30, whereas the heating effect upon the bimetal strip 44 is accumulative. In other words, successive on cycles raise the temperature of strip 44 more than its temperature decreases during the succeeding off cycles. This effect can be accomplished by providing less ventilation for the bimetal strip 44 or by covering the strip and heating element with an insulating wrapping, or by providing a heating element of lower resistance so that more energy is dissipated during each on cycle in the heating element 54 than in the similar element 32.

Having described my invention, what I claim as new and useful and desire to secure by Letters Patent of the United States is:

A voltage compensated time delay switch comprising a pair of contacts, a bimetal element arranged to separate said contacts when heated to a predetermined temperature, an electric heating element in heat transfer relation to said bimetal element, a second set of contacts, a second bimetal element arranged to separate the last said contacts when heated to a predetermined temperature, a second electric heating element in heat transfer relation to the last said bimetal element, and circuit means connecting both of said heating elements in parallel and for energizing both of said heating elements by way of the said second set of contacts, the characteristics of the heating elements and the bimetal elements being such that simultaneous energization of both heating elements will cause separation of the second set of contacts before the first set of contacts has separated while simultaneous de-energization of both heating elements will cause closing of the second set of contacts before the relationship of the first set of contacts has been substantially disturbed.

VERNON N. TRAMONTINI.

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