

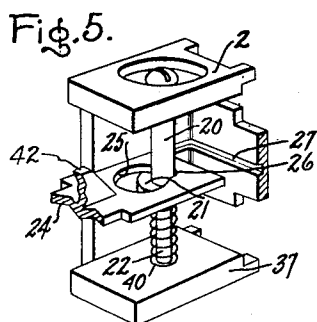
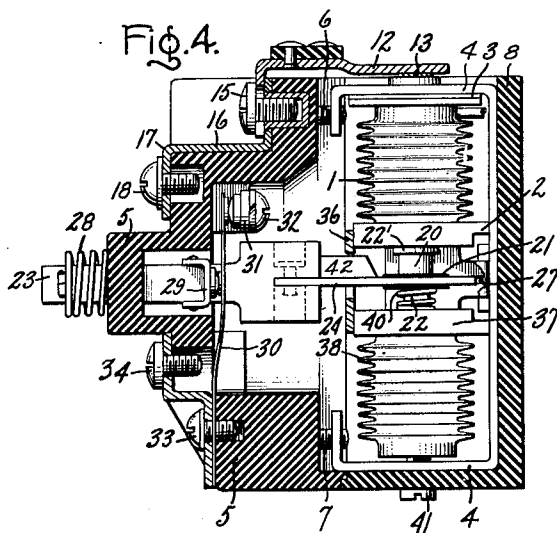
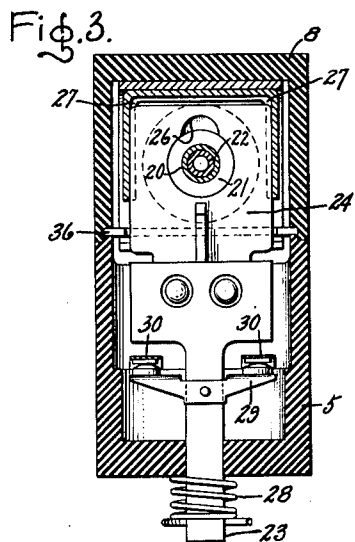
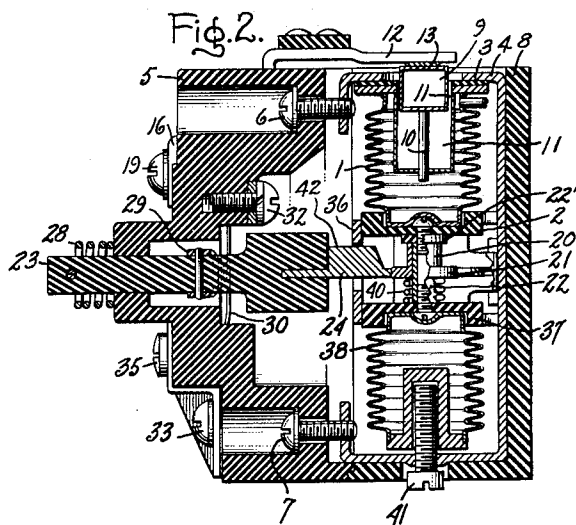
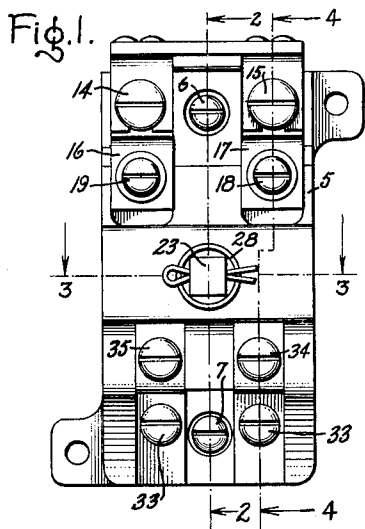
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2,595,846

OVERLOAD PROTECTIVE SWITCH

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OVERLOAD PROTECTIVE SWITCH

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Our invention relates to control devices, and more particularly to current responsive thermal overload protective relays for electric apparatus, such as electric motors, and has for its object a reliable relay that is shock-resisting, is compensated for changes in ambient temperature, is readily adaptable to a variety of A.-C. and D.-C. current ratings, is quick acting in response to current changes, can be quickly and easily reset, and inherently safeguards the circuit in case of a failure of its operating or compensating members.

In carrying out our invention we provide an expansible container provided with a movable wall, free to move in response to changes in fluid pressure, filled with a vaporizable liquid, and directly connected through a small opening to a small container constituting a boiler, which is also filled with the vaporizable liquid. We provide a control member operated by the movement of the movable wall and a means of heating the container constituting a boiler. In order to compensate for changes in ambient temperature we provide a second container with a movable wall, free to move in response to changes in fluid pressure, filled with a liquid-vapor mixture, and positioned so that its expansion opposes the expansion of aforesaid container.

For a more complete understanding of our invention, reference should be had to the accompanying drawing in which Fig. 1 is an elevational view of a thermal relay embodying our invention; Fig. 2 is a sectional view taken along the line 2—2 of Fig. 1 looking in the direction of the arrows; Fig. 3 is a sectional view taken along the line 3—3 of Fig. 1 looking in the direction of the arrows; Fig. 4 is a sectional view taken along the line 4—4 of Fig. 1 looking in the direction of the arrows; and Fig. 5 is an enlarged perspective view of a latch disk and rod, guides for the bellows, and a part of a latch plunger member.

Referring to the drawing, our invention in one form comprises as an operating member a suitable expansible container provided with a movable wall, such as a low spring rate expansible bellows 1, guided at its lower end by a plastic guide 2, and at its upper end connected to a plastic insulation plate 3. The plate 3 bears against a metal holding strip 4 which is connected to a plastic case 5 by screws 6 and 7 and to a plastic back or cover 8 by other screws (not shown). The bellows 1 is directly connected to a small boiler 9 by a tube 10 of small diameter. The assembly is completely filled with a suitable vaporizable liquid, such as trichlorotrifluoroethane (F113) or acetone, and sealed, thereby maintaining equal fluid pressure in the bellows 1 and the boiler 9. As seen in Fig. 2 the bellows 1 is thermally insulated from the boiler 9 by the air gap formed by the cylindrical space 11, except for the conduction through the small tube 10.

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Consequently the tube 10 is made just large enough to allow ready equalization of fluid pressure, but small enough to minimize conduction of heat, between the boiler 9 and the bellows 1.

5 Preferably the tube 10 is formed of a metal having favorable high temperature characteristics, such as that known commercially as "Nichrome." The boiler 9 is just large enough relative to the bellows 1 so that vaporization of part of the contained liquid, such as acetone, will force sufficient liquid from the boiler 9 into the bellows 1 to operate a latch tripping mechanism hereinafter described, but small enough to prevent overstraining the bellows 1 in case the boiler 9 is sufficiently heated that all of the liquid contained within it is vaporized.

After the acetone in the boiler 9 reaches its vaporization temperature the expansion of the vapor is rapid, and sufficient liquid acetone is quickly forced into the bellows 1 to actuate suitable electric circuit control means described below. Until the acetone in the boiler 9 reaches its vaporization temperature, however, its expansion is so slight that it has substantially no effect upon the volume of acetone in the bellows 1 and consequently does not cause appreciable movement of the operating member. This sudden action feature constitutes one of the inherent shock-resisting characteristics of our invention as the operating member remains in its closed position until a predetermined heat rise is effected in the boiler 9. Moreover without a transfer of heat to the boiler the acetone will not vaporize. Thus for the short time duration of a physical shock substantially no liquid acetone will vaporize as it will receive no appreciable transfer of heat. Any tendency of the free end of the bellows 1 to move toward its trip actuating position as a result of a shock will be counteracted by the reduction in fluid pressure within the bellows 1 and the boiler 9. Then the pressure of the atmosphere upon the bellows 1 will force the free end to return to its previous position. The small orifice connection, consisting of the tube 10, between the boiler 9 and the bellows 1 further serves to dampen any movement of the free end of the bellows 1 by preventing a sudden transfer of liquid from the boiler 9 to the bellows 1. Thus the effect of a shock would be to move the free end of the bellows 1 less toward the trip position than if the nichrome tube 10 were larger. These shock resisting features are also inherent characteristics of our invention.

Means for heating the boiler 9 is provided in the form of an electrical resistance type removable heater 12. A heating element 13, preferably formed of Nichrome or the like, is spring loaded against the top of the boiler 9, as shown in Fig. 2. The heater 12 is attached to the plastic case 5 by screws 14 and 15 as shown in Fig. 1, and connected to the power circuit by connector

lugs 16 and 17 and contact screws 18 and 19. The removable heater 12, while of simple design, makes this application of our invention adaptable to motors and circuits of both A.-C. and D.-C. power of current ratings varying from 1/4 to 100 amperes. The design of the heater element 13 making the transfer surface as large as the top of the boiler 9 makes for quick response of our relay to changes in the current density in the heater 12.

A latch tripping mechanism is provided including a cylindrical latch member 20 with a projecting flange or disk 21 on its lower end and a guide rod 22 on which the latch member 20 is slidably mounted. The tripping mechanism further includes a spring biased plunger 23 with a plate 24 and an aperture 25. It can best be understood with reference made to Figs. 3 and 5. The rod 22 is secured at its upper end by a screw to the guide 2 of the bellows 1, a washer 22' being interposed between them. The aperture 25 of the plate 24 is slightly larger than the projecting disk 21 and may have, as shown in Figs. 3 and 5 a small slot 26 just large enough to accommodate the shank portion of the latch member 20. The plunger plate 24 is guided on three sides by the guide slot 27, and is normally held in the right hand position shown in Figs. 2 and 4 by the latch disk 21. The maximum travel of the plunger is indicated by the position in Fig. 5, which shows the latch member 20 in the lower or trip position and the plunger plate 24 in its left hand circuit breaking position.

The operation of the latch tripping mechanism can be explained with reference to Figs. 3, 4 and 5. Upon expansion of the bellows 1 the latch member 20 is forced downward, and when the latch disk 21 disengages the plate 24, the plunger moves quickly with a snap action to the left as shown on the drawing under the bias of the spring 28 until it reaches the position shown in Fig. 5. Means are provided by which the lateral movement of the plunger 23 in its biased direction opens the control circuit by releasing the pressure exerted by a switch or contact bar 29 on two strips 30, made of a conducting spring metal such as spring bronze. The two contact buttons on the switch bar 29 thereupon are released from contact with the corresponding buttons on the spring bronze strips 30, which in turn move to the left, as seen in Fig. 4 in accordance with their bias. The two contact buttons on a contact bar 31, as shown in Fig. 4, are normally in contact with two corresponding contact points on the bronze strips 30, and the contacts are opened upon movement of the bronze strips 30 following release of the restraining force of the switch bar 29. By the positioning of the two contact bars 29 and 31 we provide an additional shock resisting feature, since a physical shock tending to jar either one of the strips 30 away from one of its contact bars will cause it to bear upon the other contact bar with a correspondingly greater force. Thus an open circuit resulting from a shock is very unlikely. The contact bar 31 is fixed to the plastic case 5 by screws 32. The spring bronze strips 30 are fixed to the case 5 by screws 33 as shown in Fig. 1 and Fig. 4. We provide external connector screws 34 and 35 as shown in Fig. 1 and Fig. 4. With no contact between bronze strips 30 and either contact bar 29 or 31, the external connector screws 34 and 35 of the control circuit are deenergized and the power circuit thereupon opened by the usual relay means. We further

provide a metal guide plate 36 held against the bellows guide 2 and a lower bellows guide 37 by the outside edges of the frame 5. The guide 36 serves to keep the latch rod 22 perpendicular to the plunger plate 24.

To compensate for changes in ambient we provide a suitable container with a movable wall, such as a low spring rate expansible bellows 38, filled with a liquid and vapor mixture of a vaporizable liquid such as methyl bromide or ethyl chloride. One end of the bellows 38 is free to move in response to changes in fluid pressure and the other end bears against the flat metal holding strip 4. The compensating bellows 38 is guided by the guide 37, and its movable end upon expansion exerts an upward pressure on the latch member guide rod 22 to the lower end of which the guide 37 is secured whereby this pressure is transmitted to the bellows guide 2 and through it on the bellows 1. A spring 40 located between the bellows guide 37 and the latch disk 21 exerts a pressure which biases the latch member 20 upward into engagement with the washer 22', and limits the upward force exerted by the projecting disk 21 on the plunger plate 24 when the plate 24 is in the position shown in Fig. 5.

An increase in ambient causes the pressure of the ethyl chloride to rise and thereby causes the bellows 38 to expand. Said expansion exerts pressure through latch rod 22 on the bellows 1, thus raising the vaporization temperature of the acetone in the boiler 9. If the spring rates of the bellows 1 and the bellows 38 are set so as to be equal when the latch member 20 is in the release position, then the acetone in the boiler 9 will vaporize in sufficient quantity to cause the latch member 20 to move to the release position when the vapor pressure in the boiler 9 just exceeds the vapor pressure in the bellows 38. For thus balancing the spring rates of the bellows 1 and 38 we provide a factory adjustment screw 41 as shown in Fig. 2 and Fig. 4. Since the boiling point of acetone for any given pressure, ranging from zero to seventy pounds per square inch gage, is approximately 45° C. above that of ethyl chloride at the equivalent pressure, the temperature at which the relay will trip will be approximately 45° C. above ambient. Thus the compensating bellows 38 has as its object to cause the plunger 23 to be released at a predetermined temperature rise, i. e., a predetermined current density in the heater element 13, regardless of ambient changes. Moreover a further shock resisting feature is added by the effect of the bellows 38. If the bellows 1 moves toward its latch releasing position because of shock this movement will be opposed by the bellows 38. The vapor pressure within the bellows 38 will be increased with such movement of the bellows 1 and thus will add to the force of the atmosphere in returning the bellows 1 to its normal position. The latch mechanism 20, 21, 23, and 24 is arranged to safeguard the power circuit in case of a failure of, or leak in, either bellows 1 or 38. Upon failure of the bellows 1 the vapor pressure of ethyl chloride in bellows 38 will force up the latch disk 21 of latch member 20 until it clears the top of the plate 24 of plunger 23, the spring 28 thereupon forcing open the plunger 23 and opening the control circuit contacts. Upon failure of bellows 38, the force which it normally exerts will be reduced, which in turn will reduce the rated current of the relay by reducing the vaporization temperature of the acetone in the boiler 9.

An inherent feature of our invention is its quick reset characteristic. After the heat of vaporization of the acetone in the boiler 9 is reached, some acetone vaporizes and forces liquid acetone into the bellows as described before. Consequently, after release of the plunger 23, the bellows 1 is completely filled with cool, liquid acetone, while the boiler 9 contains hot acetone vapor. Upon condensation of a slight amount of the hot acetone vapor, a drop in pressure in the boiler 9 results, and cool liquid acetone enters the boiler 9 to equalize the pressure in the bellows 1 and the boiler 9. This action causes immediate additional condensation in the boiler by chilling the acetone vapor therein, thus causing more liquid acetone to enter the boiler 9 from the bellows 1. The condensation of the acetone vapor is rapid because the liquid acetone from the bellows 1 continues to chill it until the boiler 9 is again completely filled with liquid acetone. Then resetting is possible by pressing in the plunger 23 to allow the aperture 25 of the plunger plate 24 to become aligned with the disk 21 of the latch member 20.

Resetting time is further shortened by the addition of a wedge-like projection 42 on the top of the plunger plate 24, making it just high enough to push the bellows guide 2 up several mills when the guide 2 is in the tripped position as shown in Fig. 5. This forces a small quantity of liquid acetone into the boiler 9 to chill the hot vapor more quickly than it normally would cool and condense, and will be helpful in case our invention is applied to a relay use requiring exceptionally quick resetting.

While we have shown a particular embodiment of our invention, it will be understood, of course, that we do not wish to be limited thereto, since many modifications may be made, and we therefore contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of our invention.

What we claim and desire to secure by Letters Patent of the United States is:

1. A thermal overload protective device for an electric circuit comprising, a first sealed expansible container containing a vaporizable liquid and having a first rectilinearly movable wall, a second sealed expansible container containing a thermally expansible vapor under pressure and having a second rectilinearly movable wall disposed in opposing relation with respect to said first wall, means rigidly connecting said walls together, electric heating means disposed to vaporize said liquid in response to excessive flow of current in said circuit, switching means adapted to interrupt said circuit, a member biased for movement transversely of the direction of movement of said connected walls to actuate said switching means to circuit interrupting position, and latching means connected to said movable walls and engaging said member when said walls are in a normal intermediate position to restrain circuit interrupting movement of said member, said latching means disengaging said member upon movement of said walls in either direction, whereby said circuit is interrupted upon failure of either of said containers.

2. A thermal overload protective device for an electric circuit comprising, a first expansible bellows containing a vaporizable liquid and having a first rectilinearly movable end wall, a second expansible bellows containing a thermally expansible vapor under pressure and having a second rectilinearly movable end wall, means con-

necting said end walls together in fixed spaced apart opposing relation, electric heating means for vaporizing said liquid to expand said first bellows in response to excessive flow of current in said circuit, switching means adapted to interrupt said circuit, means including a flat plate biased for movement transversely of the direction of movement of said movable walls, to actuate said switching means to circuit opening position, and latching means carried by said connecting means and disposed in edgewise latching engagement with said flat plate when said movable walls are in a normal position with said liquid unvaporized, whereby said plate is released to interrupt said circuit, upon vaporization of said liquid or upon failure of either of said bellows.

3. A thermal overload protective device for an electric circuit comprising a pair of expansible bellows disposed in end-to-end relation with their adjacent end walls connected together for rectilinear movement in opposing relation, a vaporizable liquid in one of said bellows, a thermally expansible vapor in the other of said bellows, electric heating means for vaporizing said liquid in response to flow of excessive current in said circuit, switching means adapted to interrupt said circuit, and latching means for retaining said switching means in a circuit closing position comprising a flat plate biased for edgewise movement transversely of the direction of movement of said end walls and a detent normally engaging said plate in edgewise relation and connected to be disengaged from said plate in response to movement of said end walls in either direction.

4. A thermal overload protective device for an electric circuit comprising a base, a pair of expansible bellows disposed in end-to-end opposing relation with their remote end walls fixed to said base, a rod connecting the movable adjacent end walls of said bellows for rectilinear movement in fixed spaced apart relation, a vaporizable liquid in one of said bellows, a thermally expansible vapor in the other of said bellows, electric heating means for vaporizing said liquid in response to the flow of a predetermined excessive current in said circuit, switching means adapted to interrupt said circuit, means for actuating said switching means to circuit opening position including an apertured plate loosely embracing said rod and biased for edgewise movement perpendicular to said rod, and a flat latching plate mounted upon said rod and disposed for edgewise latching engagement in said aperture when said liquid is in an unvaporized state.

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