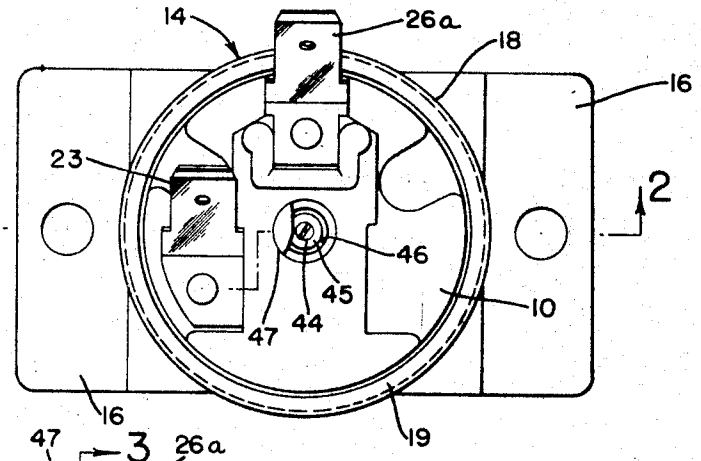
May 19, 1964 E. G. THEM 3,134,003

TAIL-SAFE PROBE-TYPE THERMOSTATIC CONTROL DEVICE

Filed Feb. 17, 1961 2 Sheets-Sheet 1

FIG. 1



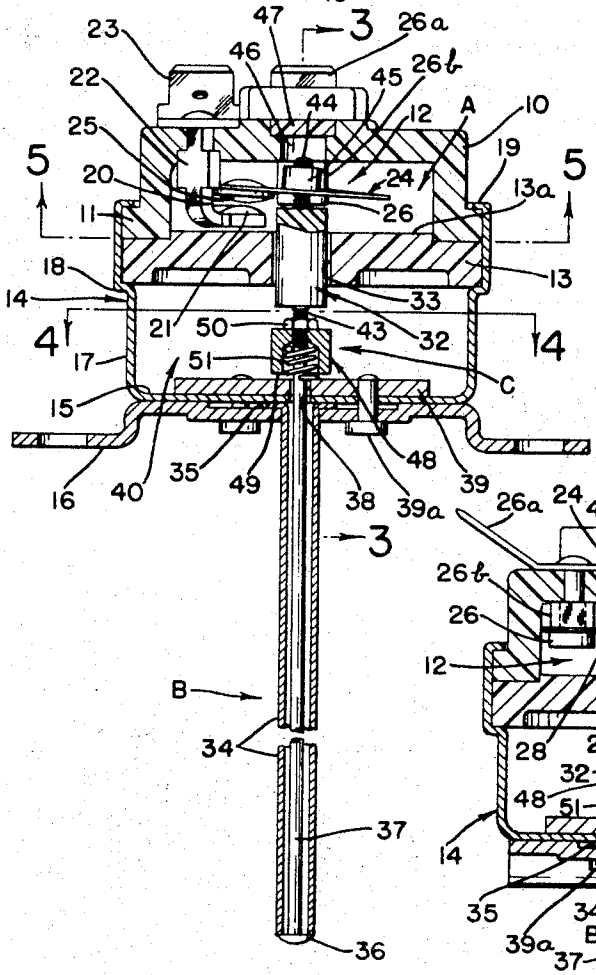
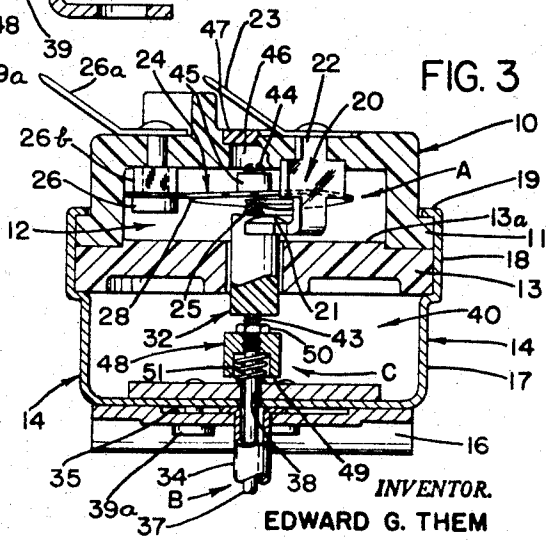


FIG. 2

FIG. 3



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TAIL-SAFE PROBE-TYPE THERMOSTATIC CONTROL DEVICE

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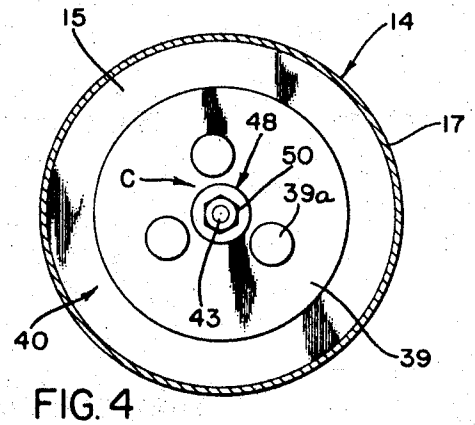

FIG. 4

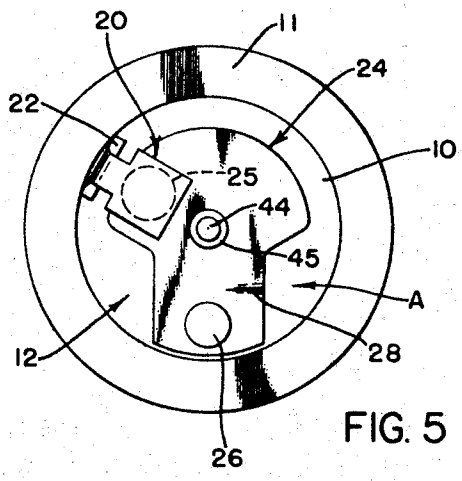

FIG. 5

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FAIL-SAFE PROBE-TYPE THERMOSTATIC CONTROL DEVICE

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4 Claims. (Cl. 200—137)

This invention relates to an improved heat responsive switch, and more particularly to switch actuating means embodying a heat sensing probe member adapted to be positioned in the fuel flame of a heating appliance such as furnaces, ranges, and clothes driers.

Various types of switches have been proposed heretofore which are intended to operate in response to the presence or absence of a gas flame in heating appliances such as furnaces, cooking ranges or ovens, and clothes driers. Such switches have embodied many undesirable features and drawbacks, and through failure have proved to be unsafe for domestic use as a safety device in such appliances. For example, in devices in which a probe has been used as a flame sensing element, after extended periods of exposure to the flame, the probe will deteriorate and disintegrate or break, and thus fail to actuate the switch in the electric circuit to the valve controlling the flow of gas to the appliance. In other cases, the probe will change in physical character to the extent that the switch will fail to operate within a predetermined prescribed period of time or within desired temperature limits. In devices using bimetal as a flame sensing element, over-stress and deterioration of the bimetal is effective to cause failure of the switch actuating elements of the device or to cause the switch to operate within unsafe limits.

It is among the objects of the present invention to provide a new and novel temperature sensing device for actuating a switch controlling the electric circuit to an electrically operated fuel valve which is adapted to interrupt or open said electric circuit on the absence or removal of a flame impinging on the sensing device or a substantial drop in the temperature surrounding the same.

Another object of the present invention is to provide a switch actuating device which will operate within fixed limits of time or temperature regardless of physical changes in the character of the flame sensing element upon extended periods of exposure to a flame.

A still further object of the invention is to provide a switch for controlling the flow of current to an electrically operated fuel valve which is actuated by a flame sensing element, wherein the switch elements are caused to open or close in the event of failure of the flame sensing element.

It is a still further object of the invention to provide a switch for a heating applicance which because of its simplicity, economy of construction, and reliability and efficiency of operation is particularly well adapted as a protective device in controlling the circuit to the fuel valve to such heating appliance.

Another object of the invention is to provide a probe type flame sensing element for a switch wherein relative movement of the members of the sensing element are coordinated with the spacing of the contact elements of the switch so that the former is positive in switch actuating movement within predetermined limits.

These and other objects and advantageous features of the invention, not at this time more particularly pointed out, will become apparent as the nature of the invention is better understood from the following detailed description taken in conjunction with the accompanying drawing, wherein like reference characters denote corresponding parts and wherein:

FIGURE 1 is a top plan view of a device made in accordance with the present invention,

FIGURE 2 is a longitudinal sectional view of the device of FIGURE 1 with the switch contacts shown in normally open position,

FIGURE 3 is a vertical sectional view taken along the line 3—3 of FIGURE 2, centrally through the switch mechanism,

FIGURE 4 is a sectional view taken along the line 4—4 of FIGURE 2,

FIGURE 5 is a sectional view taken along the line 5—5 of FIGURE 2.

With reference to FIGURES 1 and 2 of the drawing, in its over-all assembly the switch device of the present invention embodies a switch proper A, which includes at least one fixed contact and a movable contact which is adapted to either engage or disengage from the fixed contact, a flame sensitive assembly B, and a movement limiting element C which coordinates the movement of the elements of assembly B in response to the presence or absence of a flame projecting on the latter or the influence of substantial temperature changes thereon. In accordance with the present invention the switch proper A and the temperature sensing assembly B in themselves are of conventional construction. The elements of C coordinating the movement of the elements of assembly B to actuate the contact elements of switch A constitute a novel and improved arrangement for translating the movement which takes place in the assembly B in response to the absence of a flame within the chamber surrounding assembly B and for imparting such movement for positive action of the switch proper.

The switch proper A which, as stated, is of conventional construction, is embodied within a housing **10** which may be of suitable insulating material, although under certain applications of the switch device it may be desired to construct the housing of material which would withstand extremely high temperatures, such being the case when the switch would be placed in close proximity to either the pilot flame or main burner of the heating appliance. The housing **10** is generally cup-shaped, having a closed upper end as shown in FIGURES 1, 2 and 3, and at its lower end presenting a laterally outwardly protruding peripheral flange **11**. As shown in FIGURES 2 and 3, the housing **10** presents a generally cylindrical downwardly facing switch chamber **12**. A separate end wall or shield **13** of suitable insulation material, extends across the lower end of the housing **10**, providing a closure for the lower end of the switch chamber **12**. This lower end wall **13** has a reduced diameter central portion **13***a* which projects up into the chamber **12** and has a snug fit therein against the interior side wall of the housing **10**.

The switch housing **10** and the bottom end wall **13**, therefore, are supported by a cup-shaped metal case **14**. As shown in FIGURES 2 and 3 this metal case has its bottom wall **15** secured to a metal mounting bracket **16** which is adapted to be assembled on the appliance with which the device is used and may take any suitable form varying with the application. The metal case **14** presents a generally cylindrical side wall **17** which extends upwardly from the bottom wall **15** and terminates in a laterally inturned flange **19** which snugly overlies the peripherally upwardly facing shoulder of the flange **11** on the switch housing **10**. Between its outurned wall portion **18** and its inturned flange **19**, the metal case **14** snugly engages the respective peripheries of flange **11** of the switch housing **10**, and the bottom wall **13** for the housing.

A stationary switch contact member **20** presents an upwardly facing, rounded contact surface **21** inside the switch chamber **12**. This stationary contact member extends laterally across the upper side of the top of the closure member **13** and has an upwardly extending stem **22**

which projects up through the housing wall for connection to a terminal **23** disposed on the outside of the switch housing.

A movable contact carrying arm **24** carries a downwardly facing mobile contact **25** which engages the stationary contact **20** when the movable contact arm is in the position shown in FIGURE 3. As best seen in FIGURE 5, this movable contact arm **24** is a generally flat, resilient metal leaf which is approximately T-shaped in outline. The contact arm **24** is cantilever mounted at one end by means of a rivet **26** which extends up through the top wall of the switch housing **10** for connection to an externally mounted terminal **26***a*. A rigid metal spacer **26***b* is disposed between the top of the cantilever-mounted end of the contact-carrying arm **24** and the top wall of the housing **10**. The enlarged head on the rivet engages the bottom face of the contact-carrying arm **24** and its cantilever-mounted end and holds it tightly up against the spacer **26***b*. Along the inner edge of its cantilever-mounted end, the contact-carrying arm **24** is formed with a bend as at **28**, so that beyond its cantilever mounting the contact arm is biased downwardly at a slight angle when in its unstressed position, as is best shown in FIGURE 2.

For operating the contact-carrying arm **24**, there is provided a bumper member **32** of suitable insulating material which has a rounded upper end adapted to engage beneath the contact-carrying arm **24** at the center thereof, as will be best seen in FIGURES 2 and 3. This bumper member **32** is slidably received loosely in a central opening **33** extending through the bottom wall **13** of the switch housing. The bumper member **32** has a flat lower end which is disposed below the bottom wall **13** of the switch housing. The lower end of the bumper member **32** is positioned to be engaged and be actuated by the temperature sensing assembly B of the present invention, as described hereinafter.

The temperature sensing assembly in the present invention comprises an elongated tube **34** having a flanged upper end, which seats within a recess **35** formed in the mounting bracket **16**. An elongated rod **37** is welded in the lower end of the tube **34** as at **36**, and extends upwardly therefrom through the tube **34** in concentric relation with the tube. The rod **37** extends up loosely through a central bore **38** formed in the plate **39**. The plate **39** is secured on the inner face of the bottom wall **15** of the casing by means of rivets **39***a* which extend through the casing wall and the mounting bracket **16**. The flanged end of the tube **34** is thus securely clamped between the upper face of the mounting bracket and the outside surface of the bottom wall **15** of the case **14**. The upper end of the rod **37** is disposed in the chamber **40** which is located inside the metal case **14** below the bottom wall **13** of the switch case. Preferably the rod **37** is of a metal having a relatively low coefficient of expansion, while the tube **34** may be of any suitable metal having an appreciably higher coefficient of expansion than the rod **37**. With this arrangement which is a conventional structure of controls of this general design, when the temperature sensing assembly is heated the inner rod **37** will expand less than the outer tube **34**, so that the upper end of the rod **37** will withdraw from within the chamber **39**.

In accordance with the present invention, the relative movement of the rod **37** with respect to the tube **34** is controlled by the assembly C and when such movement exceeds a predetermined amount the assembly C is effective to control the same, or if perchance the elements of assembly B become so deteriorated or separated, that the assembly fails to function normally, the assembly C will come into play to effectively actuate the contact of the switch A.

The assemblage C comprises an elongated threaded shank **43** formed on the upper end of the rod **37** and adapted to abut and engage the lower end surface of the bumper member **32**. The opposite end of the bumper member **32** is engaged by the end of an adjusting member **44** which is threaded through a bearing member **45** secured to the upper face of the contact-carrying member **24**. Adjustment of the member **44** within the bearing block **45** may be effected through an opening **46** formed in the upper surface of the wall of the housing **10**. Any suitable tool may engage the slotted end of the member **44** for rotating the same within the member **45**. A suitable closure member **47** is inserted in the opening **46** to seal the same. Threaded on the shank **43** of the rod **37** is an inverted cup-shaped bushing member **48**, the lower peripheral edge **49** thereof being adapted to engage the upper surface of the plate **39** to effectively restrict the relative movement between the rod **37** and tube **34**. A lock nut **50** is also threaded on the shank **43** to secure the cup-shaped member **48** in adjusted position on the shank **43**. Surrounding the rod **37** as it projects into the chamber **40** and within the cavity of the member **48** is a helical spring **51**. One end of this spring **51** engages the upper surface of the plate **39** and the other end engages and seats within the cavity of the member **48** and normally exerts an upward pressure thereon. The pressure exerted by the spring **51** on the cup-shaped member **48** is sufficient to overcome any bias of the contact-carrying member **24** in the event that there is any breakage between the rod **37** and tube **44** permitting the rod to move independently of the tube **34**. Under such a condition, the assembly C is effective to open the contacts **21** and **25** of the switch mechanism A and thus break the electric circuit to the valve actuating mechanism.

In the operation of the elements of the assembly C, as shown in FIGURE 2, the switch contacts and elements of assembly C are in the position shown under normal room temperature. The spaced gap between the fixed contact **21** and the mobile contact **25** has been predetermined and adjusted by means of the adjusting screw **44**. The inverted cup-shaped bushing member **48** has been threaded on the shank **43** and moved down until the peripheral edge **49** thereof is in contact with the upper surface of the plate **39**. The bushing member is then backed off to provide a predetermined spacing between the peripheral edge **49** and the upper surface of the plate **39** relative to the gap between the mobile contact **25** and the fixed contact **21** of the switch. When this predetermined spacing has been effected, the lock nut **50** is turned up tight and the cup-shaped bushing member **48** is set in fixed position.

The device is then in condition to be mounted on an appliance. For example, the temperature sensing assembling is inserted into the combustion chamber of a furnace so that the pilot flame of the device plays or impinges upon the assembly. When the assembly B is exposed to the flame of the pilot, the tube **34** will expand lengthwise downwardly as shown in FIGURE 2. Such downward movement of the tube **34** will withdraw the rod **37** within the chamber **40** relieving the pressure on the bumper **32** and the bias of the contact-carrying member **24** will bring the mobile contact **25** into engagement with the fixed contact **21** and close the circuit to the control valve. The movement of the rod will continue until the edge surface **49** of the cup-shaped bushing member **48** engages with the plate **39**. Any further expansive movement of the tube **34** will effect a stretching of the rod, but will not be effective upon the assembly C or the elements of the switch member A. In the event that the flame of the pilot, or the burner flame should be extinguished, the tube will contract and the end of the rod will be effective against the bumper **32** to overcome the bias of the contact-carrying member **24** to separate the mobile contact from the fixed contact. In the normal use of heat sensing assemblies of this type, continual impingement on the tube **34** will be effective to change the physical character of the elements of the assembly such that, for example, there is a tendency due to what is known as carbon growth for the tube to be permanently elongated. Such elongation in the tube would be taken up in the stretching of the rod where it is restricted in its outward movement by the bushing member **48**. Thus, there is always a relative

movement upon the flame being removed from the tube or the temperature is substantially decreased in the area surrounding the tube and the contraction would be effective to cause the rod to project into the chamber **40** and separate the contacts.

In other instances, the continual impingement of a gas flame upon the tube causes deterioration of the tube member and eventually brings about a condition where the tube and rod separate. Under such conditions, the spring member housed within the cup-shaped bushing member **48** is brought into play to exert pressure through the rod **37** against the bumper **32** and separate the mobile and fixed contacts of the switch A. Thus, upon the absence of a flame, or upon a breakage of the elements of the temperature sensing assembly B, or the ineffectiveness of the elements thereof to close the switch, the assembly C is always effective to open the contacts of the switch mechanism.

While there has been described herein and illustrated in the accompanying drawing, a presently preferred embodiment of the present invention, it is to be understood that various modifications, omissions, and refinements which depart from the disclosed embodiment may be adopted without departing from the spirit of scope of this invention as defined in the appended claims.

I claim:

1. A heat sensitive control device comprising means defining a hollow housing, a wall member separating said housing into first and second chambers, switch means mounted in said first chamber, a slidable member supported by said wall member for actuating said switch means, a heat responsive probe having a tubular outer member and an actuating member contained therein operatively connected together, said actuating member projecting into said second chamber and engageable with said slidable member and means in said second chamber on the end of said actuating member for adjustably limiting the relative movement between the said actuating and tubular members of said probe when the latter is subjected to high temperature, said last-named means effective upon separation of said members of the probe for actuating said slidable member.

2. A heat sensitive control device comprising means defining a hollow housing, a wall member separating said housing into first and second chambers, switch means mounted in said first chamber, a slidable member supported by said wall member for actuating said switch means, a heat responsive probe having a tubular outer member and an actuating member contained therein operatively connected together, said actuating member projecting into said second chamber and engageable with said slidable member, and means on the end of said actuating member within said second chamber for preventing the withdrawal of the said actuating member from said second chamber beyond a predetermined fixed amount when said probe is subjected to high temperature, said last-named means effective upon separation of said members of the probe for actuating said slidable member.

3. A heat sensitive control device comprising means defining a hollow housing, switch means mounted in said housing, including a stationary contact, a mobile contact for engagement with said stationary contact and a movable contact-carrying arm which carries the mobile contact, a heat responsive probe having an elongated tubular member and a rod within said tubular member operatively connected thereto and projecting into said housing for actuating said movable contact-carrying arm, and means on the free end of said rod for adjustably limiting the movement of said rod away from said contact-carrying arm when the probe is subjected to a temperature beyond a predetermined fixed amount and for moving said rod toward said contact-carrying arm to open the contacts when the members of said probe become separated.

4. A heat sensitive control device comprising means defining a hollow housing, switch means mounted in said housing having a stationary contact, a mobile contact for engagement with said stationary contact, a movable contact-carrying arm supporting said mobile contact biased in one direction, and a heat responsive probe spaced from said contact-carrying arm including an outer tubular member and an inner actuating member connected to said tubular member movable toward and away from said contact-carrying arm in response to heat changes, means mounted on said actuating member for adjustably limiting the movement of the said actuating member when the probe is subjected to a temperature beyond a predetermined fixed amount and after engagement of said mobile contact with said stationary contact, and spring means for moving said actuating member to open said contacts when the said actuating and tubular members of the probe become separated.

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CERTIFICATE OF CORRECTION

Patent No. 3,134,003 May 19, 1964

Edward G. Them

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the heading to the drawings, Sheets 1 and 2, line 2, title of invention, for "TAIL-SAFE" read -- FAIL-SAFE --.

Signed and sealed this 22nd day of September 1964.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents