

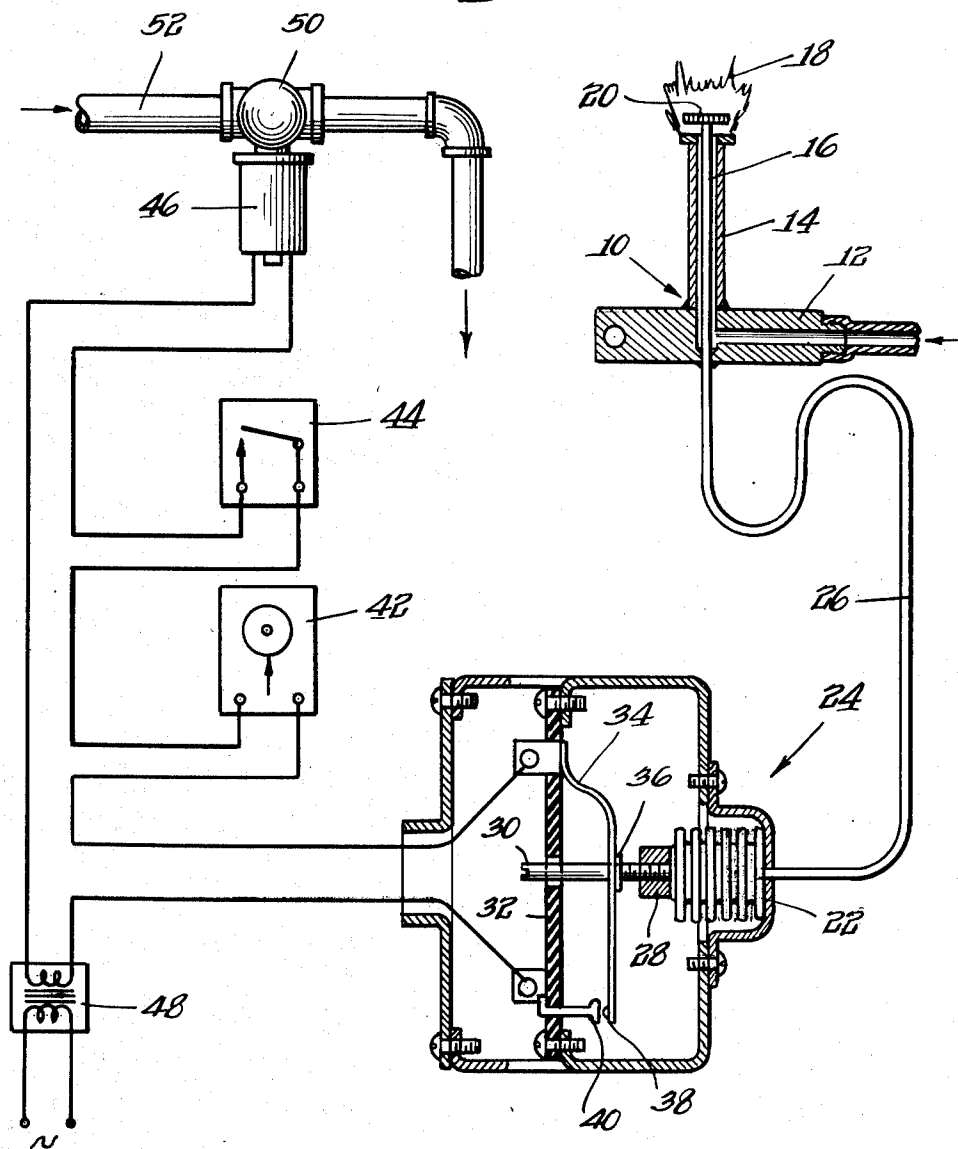
May 12, 1964

C. P. SALMON
ACTUATING COMPOSITION

3,132,518

Filed May 15, 1959

Fig. 1.



INVENTOR.
Clarence P. Salmon
BY
Olson & Trefler
attys.

1

3,132,518

ACTUATING COMPOSITION

Clarence P. Salmon, Elgin, Ill., assignor to Flexonics Corporation, Maywood, Ill., a corporation of Illinois
Filed May 15, 1959, Ser. No. 813,402
3 Claims. (Cl. 73-368.2)

This invention relates generally to thermally responsive devices and especially to an actuating composition which may be used as the charge in a bellows-type thermally responsive device.

In one modern type of control system, a thermoelectric couple is employed to sense and relay information about temperature. In order to use this information for purposes of regulation and control, certain complementary apparatus are required, for example weak magnetic solenoid locking devices are frequently necessary. An important disadvantage of control systems so embodied is the delicate nature of both the thermoelectric couple and the requisite adjunct equipment. This delicate nature predisposes such systems to damage and to becoming maladjusted.

Another modern type of control system has proved particularly useful in applications involving moderate temperatures. This system employs a bellows-type thermally responsive device. Such devices are ordinarily comprised of an expansible, usually metallic, bellows filled with an actuating composition and frequently arranged for remote sensing by means of a bulb communicating with the bellows by means of a capillary tube. Systems incorporating such devices have proved to be comparatively rugged in use.

The actuating compositions confined in bellows-type thermally responsive devices are, for the most part, fluids. One popular scheme involves a single-component liquid charge which completely fills the bellows-type device. A variation of this scheme utilizes a multicomponent eutectic charge as a complete liquid fill. The actuation created by these liquids results from the cubical expansion thereof upon subjection to heat. However, since the cubical expansion of liquids is relatively low, these systems require a sensing bulb which is relatively large in comparison with the bellows in order to obtain sufficiently useful movements from the bellows. As a result of this size disparity, these systems are impractical for many applications.

Another popular scheme calls for a vapor charge achieved by means of partially filling the bellows with a volatile liquid. Actuation, in this case, results from the pressures generated by evaporation of the volatile liquid when it is subjected to temperatures near the boiling point. This type of charge is usually employed for low temperature work, such as in refrigeration controls. A serious disadvantage to this scheme resides in the fact that the bellows must be maintained at a higher temperature than the bulb. If this condition does not exist, vapors produced in the bulb are able to be condensed in the bellows thereby affording no pressure for movement of the bellows. This malfunction may be termed "reflux failure."

Accordingly, an important object of the present invention is to provide an improved actuating composition.

Another object of the present invention is to provide an actuating composition which has the desirable characteristics of a vapor charge but which may be charged as a complete liquid fill.

Yet another object of the invention is to provide an improved temperature responsive control system which may be used to replace delicate thermoelectric systems.

A further object of the invention is to provide a temperature responsive control system which is not disposed to failure if exposed to extraordinary temperatures in use.

A still further object of the invention is to provide

2

a temperature responsive control system which incorporates a bellows-type thermally responsive device, which does not rely on vapor to fill the thermally responsive device and which therefore is not subject to reflux failure.

5 A yet further object of the invention is to provide a bellows-type thermally responsive device which is not restricted to large sensing bulbs.

10 Additional objects and features of the invention pertain to the particular structure and compositions whereby the above objects are attained.

The invention, as to its structure, its mode of operation, and its composition, will be better understood by reference to the following disclosure and drawings forming a part thereof, wherein the figure is a schematic representation of a temperature responsive control system incorporating a thermally responsive device in accordance with the invention, being adapted to a domestic gas heating application.

20 Referring now in detail to the drawing, there will be seen a pilot burner assembly 10 including a fixture 12 and a burner sleeve 14. A sensing bulb 16 extends through sleeve 14 to protrude into a pilot flame 18. Bulb 16 may have a flame dispersible plate 20 affixed to its extremity.

25 The sensing bulb 16 communicates with a bellows 22, which is embodied in a thermostatic switch assembly 24, by means of a capillary tube 26. The free end of bellows 22 carries an internally threaded fitting 28 into which a stud 30 may be screwed to some selected depth.

30 Stud 30 extends freely through an insulating switch plate 32 and a spring arm 34, engaging arm 34 with a centrally disposed shoulder portion 36. Thus, elongations of the bellows 22 are able to urge closing of a movable contact 38 and a fixed contact 40.

35 Closing of the contacts 38 and 40 completes a circuit which includes a room thermostat 42, a limit switch 44, a solenoid 46 and a line transformer 48. Accordingly, solenoid 46 may be directed to operate a main fuel valve 50 in fuel line 52.

40 An important feature of the invention resides in the actuating composition which is charged into the assembly comprised of the sensing bulb 16, the bellows 22 and the capillary tube 26. This composition is intended to be charged as a complete liquid fill and includes a thermally and chemically stable, essentially non-volatile liquid dissolved in a thermally and chemically stable, volatile solvent.

45 Materials which have proved useful as the solute include chlorinated biphenyl, pentaerythritol tetracaprate, tetracresoxysilane and a eutectic mixture of biphenyl and biphenyl oxide. Materials which have proved useful as the solvent include ethers, such as ethyl ether; various alcohols such as methanol; chlorinated hydrocarbons, such as methylene chloride; and aromatic hydrocarbons, such as benzene.

50 The solute is preferably selected to display a boiling point above the temperature range which is to be encountered in use; and while the solute is desirably non-volatile under the conditions of use, some volatilization can be tolerated.

55 In each particular situation, the materials and the concentrations selected are governed by the operating temperature range over which it is desired to have the bellows operate. The materials and their concentrations are generally selected to provide sufficient vapor pressure over the operating temperature range to overcome the spring rate of the bellows and the operating load as to incur actuation of the control mechanism. As is well known, the vapor pressure of a binary solution is calculable from the vapor pressure of the pure components and the mol friction to which each is present. It will become apparent that considerable latitude in operating temperature

range is available from the several materials and from the permissible variation in the concentration of each material.

In one specific embodiment, a composition comprised of approximately 70% chlorinated biphenyl in approximately 30% methanol provided highly desirable movements in a bellows between 200°–250° F. In another embodiment, a composition comprised of approximately 70% chlorinated biphenyl in approximately 30% benzene provided highly desirable movements in the temperature range between 300°–360° F.

For purposes of providing an easy understanding of the invention, it is advantageous to provide at this juncture a description of the mode of operation of the actuating composition as embodied in the domestic gas heating control system illustrated in FIG. 1.

Starting with the pilot burner assembly 10 at room temperature, a newly lighted pilot flame 18 will cause rapid heating of the sensing bulb 16. This heat will cause volatilization of some portion of the solvent used in the actuating composition. Thus, there will be generated a pressure in the closed system comprising the bulb 16, the bellows 22 and the capillary tube 26.

When this volatilization has reached equilibrium with the heat being provided by pilot flame 18, bellows 22 will have been expanded sufficiently to cause closing of the contacts 38 and 40. As will be apparent, the solute portion of the actuating composition acts as a hydraulic fluid pressure transmitter.

Having the contacts 38 and 40 closed, solenoid 46 may be energized in response to the thermal demands established by means of the room thermostat 42.

In the event of failure of the pilot flame 18, sensing bulb 16 cools down whereupon the vaporized portion of the volatile solvent condenses to be reabsorbed with the solute. In response, bellows 22 rapidly contracts withdrawing shoulder 36 from arm 34 whereby the contacts 38 and 40 are opened by the spring action of arm 34. Thus, the main gas burner is prevented from going on in the absence of a pilot flame.

It is important to note that, since the actuating composition of the invention does not rely on vapor to fill the bellows at room temperature, reflux action of the vaporized solvent can be arranged to provide a safety feature. In the event that temperatures outside the ordinary operating range might be encountered, it is possible to arrange bellows 22 with bulb 16 so as to allow any excessive quantities of vapor generated within the bulb 16 to rise through the tube 26 to be absorbed in the cooler bellows 22. Extraordinary pressures which might cause rupture of the bellows are thereby obviated.

While particular embodiments of the invention have been shown, it will be understood of course, that the invention is not to be limited thereto since many modifications may be made. It is, therefore, contemplated to cover by the appended claims any such modifications as fall within the true spirit and scope of the invention.

The invention is claimed as follows:

1. A temperature responsive control system comprising: an assembly including a bellows; and a solvent solution charged into said assembly, said solution being substantially completely in the liquid state and substantially completely filling said assembly and the included bellows at temperatures below the selected operating temperature of said system, said solution including a thermally stable liquid, said liquid being essentially non-volatile at said selected operating temperature, said solution further including a thermally stable solvent for said liquid, said solvent being volatile at said operating temperature whereby to induce expansion of said bellows.

2. A temperature responsive control system comprising: a bellows structure; a bulb structure remotely disposed from said bellows structure; tube means interconnecting said bellows structure and said bulb structure; and a solvent solution charged into said bellows structure, said bulb structure and said tube means, said solution being substantially completely in the liquid state and substantially completely filling said bulb structure, said tube means and said bellows structure at temperatures below the selected operating temperature of said system, said solution including a thermally stable liquid, said liquid being essentially non-volatile at said selected operating temperature, said solution further including a thermally stable solvent for said liquid, said solvent being volatile at said operating temperature whereby to induce expansion of said bellows structure.

3. A temperature responsive control system comprising: a bellows structure susceptible of movement by the vapor pressure of a solvent; a bulb structure remotely disposed from said bellows structure; tube means interconnecting said bellows structure and said bulb structure; a solvent solution charged into said bulb structure, said bellows structure and said tube means, said solution being substantially completely in the liquid state and substantially completely filling said bulb structure, said tube means and said bellows structure at temperatures below the selected operating temperature of said system, said solution including a thermally stable liquid, said liquid being essentially non-volatile at said selected operating temperature, said solution further including a thermally stable solvent for said liquid, said solvent being volatile at said operating temperature whereby to induce movement of said bellows structure; and regulating means operated by said bellows structure.

References Cited in the file of this patent

UNITED STATES PATENTS

610,998	McElroy	Sept. 20, 1898
1,915,265	Bichowsky	June 20, 1933
2,150,203	Bondurant	Mar. 14, 1939
2,846,396	Arnold et al.	Aug. 5, 1958

FOREIGN PATENTS

730,187	Great Britain	May 18, 1955
---------	---------------	--------------