July 2, 1963 D. A. HOLLEY 3,096,022

SAFETY THERMOSTATIC CONTROL FOR MARINE ENGINE COOLING SYSTEMS

Filed Dec. 2, 1959

FIG. 1

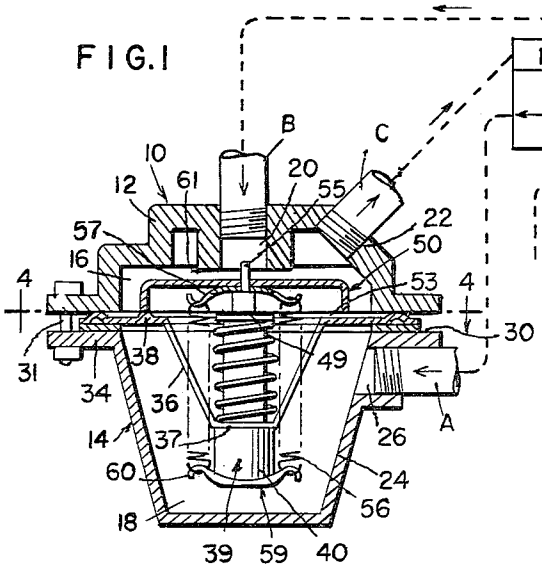


FIG. 2

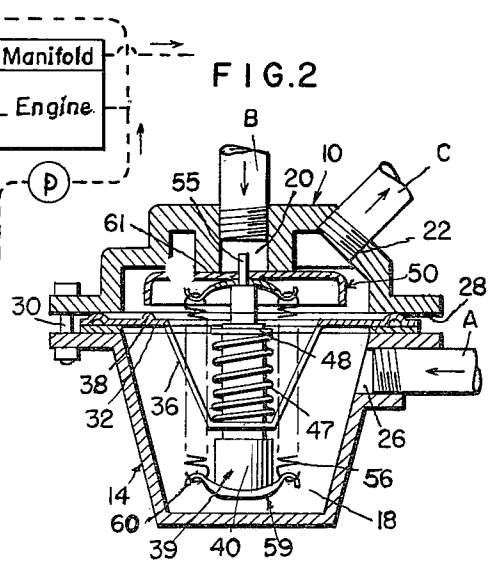


FIG. 4

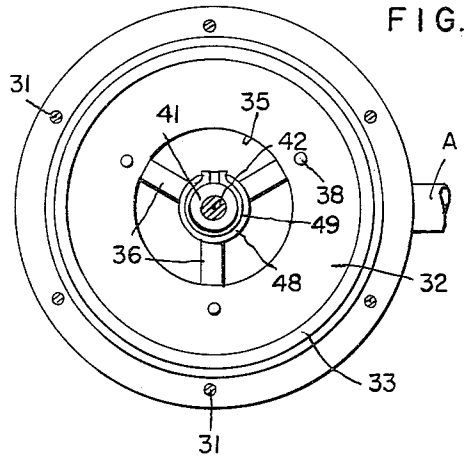


FIG. 3

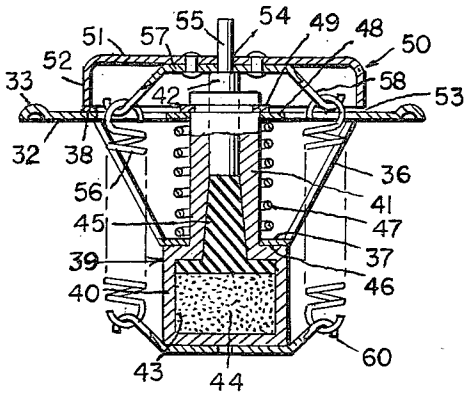


FIG. 6

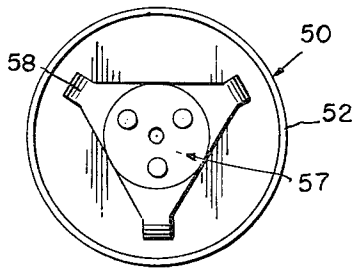
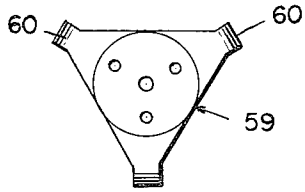


FIG. 5



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SAFETY THERMOSTATIC CONTROL FOR MARINE ENGINE COOLING SYSTEMS

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7 Claims. (Cl. 236—34.5)

This invention relates to improvements in thermostatic controls for marine engine cooling systems and is directed more particularly to a new and novel type of safety valve.

In my prior Patent Nos. 2,536,642 and 2,757,650, I disclose a thermostatic control for marine engine cooling systems, wherein water is taken in from the body supporting the boat in which the marine engine is carried and is directed into the engine water jacket and also through a control valve unit, passing from the unit directly back to the source from which it is taken. This control valve unit embodies a normally seated poppet which in its closed position substantially blocks the passage of water from the engine jacket permitting a major portion of the water from the pump to by-pass the heat sensitive unit housing chamber and permitting only a very small fraction of the water from the engine jacket to enter the chamber having the heat sensitive unit therein. Under normal conditions of operation of the engine the engine block heats up slowly and slowly increases the temperature of the water passing therethrough so that as this gradually heating water from the engine block passes through the heat sensitive unit containing chamber, the unit responds by gradually opening the valve to permit more and more of the heated water to pass around the unit and at the same time gradually shuts off the flow of the water directly from the pump line to the return or discharge passage. Eventually the valve shifts the poppet portion which is actuated by the heat sensitive unit to a position where the full flow of water from the engine jacket passes around the heat sensitive unit and the flow from the pump directly to the outlet is shut off.

In my patents above referred to there is disclosed the use of a bellows type of thermostatic or heat responsive device such as that known as the Sylphon bellows, which employs a highly volatile liquid having the action of expanding rapidly under the influence of a rise in temperature of the water surrounding the unit. Other types of heat sensitive units may be employed in this capacity, but in any case such units respond rather rapidly to a temperature rise.

In systems of the character to which the present thermostatic control device is employed, conditions frequently arise or are created which result in a very rapid reaction of the heat sensitive material in the thermostat, causing the thermostatically actuated poppet to move against a seat which shuts off the flow of water from the discharge side of the pump. As an example, when an engine is started up, if it is rapidly accelerated, the escape means for the engine jacket water to the discharge line cannot carry off the water and the temperature of the latter builds up rapidly so that a more or less violent reaction in the heat sensitive element of the thermostat occurs, forcing the thermostatically actuated poppet onto its seat and if no relief is provided for the continued increase of pressure exerted by the heat sensitive material of the unit, the result is severe damage to the unit.

In the light of the foregoing it is a particular object of the present invention to provide a new and novel thermostatic control for a marine engine cooling system which is designed in a novel manner whereby any overheating of the thermostatic unit or heat sensitive material of the unit will not result in the permanent damage of the unit.

A further object of the invention is to provide in a thermostatic control unit of the character referred to, a

novel supporting means for the active element of the unit whereby the thrust of the unit when opposed by the seating of a poppet valve actuated thereby, will result in a reverse movement of the unit to yield and absorb the thrust action and thereby prevent damage to the unit.

Another object of the invention is to provide a novel yieldable support means for a heat sensitive unit of a type wherein the thermal element is comprised of a powdered copper and wax compound permanently encased in an expansion chamber and exerting when expanded under the application of heat, thrust against a valve actuating piston, whereby such support permits a reverse movement of the thermal element container when the poppet actuating piston is checked in its movement by the result of the poppet seating against an immovable seat.

The invention will be best understood from consideration of the following detail description taken in connection with the accompanying drawing forming part of the specification, with the understanding, however, that the invention is not confined to a strict conformity with the showing of the drawing but may be changed or modified so long as such changes or modifications mark no material departure from the salient features of the invention as expressed in the appended claims.

In the drawings:

FIG. 1 is a sectional view through the thermostatic control unit, in closed position, showing the connections therewith of water conduits leading to diagrammed engine cooling system connections corresponding to those shown in my prior patents referred to and showing the heat sensitive element and spring thereof in elevation;

FIG. 2 is a view corresponding to FIG. 1 but showing the unit in open position and illustrating the relative position of the parts under excessive heating of the heat responsive element;

FIG. 3 is a detail view on an enlarged scale of the element and its supporting means removed from the housing with the thermal element and piston housing in section;

FIG. 4 is a sectional view taken substantially on the plane of section line 4—4 of FIG. 1 and showing the poppet supporting pipes upon which the edge of the poppet rests in valve-closed position;

FIG. 5 is a view in perspective of the element for coupling the lower ends of the poppet return springs with the bottom of the heat responsive element;

FIG. 6 is a view looking at the underside of the poppet and showing the means for connecting the upper ends of the poppet return springs therewith.

Referring now more particularly to the drawing, the numeral **10** generally designates the safety thermostatic control device or unit of the present invention.

This unit comprises a housing having the two parts **12** and **14** which, for convenience of description, will be referred to as the upper and lower or first and second chamber parts although it will be understood that by referring to upper and lower parts it is not the intention to convey that the device must be used in this position since it can function in the inverted position from which it is shown in FIG. 1 or in any other desired position.

The parts **12** and **14** provide a poppet chamber **16** and a heat sensitive element encasing chamber **18**.

The reference characters A, B and C designate pipelines or pipeline connections leading, respectively, from the internal combustion engine cylinder head, the discharge side of the water pump by which water is taken in from a source and circulated into and through the engine water jacket, and the exhaust stack or overboard outlet by way of which the water passes back to its source from the engine.

Only a diagrammatic illustration of the engine water jacket, the pump and the exhaust stack, is here shown in association with these pipes or conduits A, B and C. It

is believed that the operation of the present invention in association therewith will be clearly understood and reference may be had to my hereinbefore referred-to patents for further disclosure of the parts with which these pipes or conduits are connected.

The upper or first part **12** of the housing is provided with the water inlet port **20** with which the pipe or conduit B is connected and, as shown, this port is located in the axial center of the housing and is directed downwardly toward the center of the chamber **18**.

At one side of the port **20** is a second threaded port **22** in which the conduit C leading to the exhaust stack is connected so that it will be apparent that water entering the chamber **16** by way of the conduit B may flow under proper conditions through the chamber to and out through the conduit C.

The wall **24** of the second or lower part **14** of the housing is likewise provided with a threaded port **26** in which is connected a pipe or conduit A leading from the engine jacket or cylinder head.

The upper and lower parts **12** and **14** have opposing coupling faces **28** and **30** respectively which are adapted to be secured together in a suitable manner as by means of bolts **31** and between which a peripheral part of the heat sensitive element and poppet supporting plate is secured.

The numeral **32** designates an annular plate having a ribbed peripheral portion **33** which is secured between the faces **28** and **30** and between at least one of these faces and the secured peripheral portion of the plate is a gasket **34**, the rib **33** projecting upwardly and forming a tight seat or contact with the face **28** of the top part **12**.

The opening in the plate **32** is designated **35** and there is suspended from the plate a spider embodying a number of downwardly converging arms **36** each joining the plate **32** at the edge of the opening **35** and connected at their lower ends with the thrust absorbing spring supporting ring **37**.

The annular plate **32** is formed with several upstanding pips or buttons **38**, here shown as three in number, and these project only a very small distance above the surface of the plate, as, for example, in the neighborhood of 0.006 of an inch.

The numeral **39** generally designates a solid fill pellet type heat responsive member of a standard or known type which embodies a chambered body portion **40** leading into a tubular neck **41**, in the upper end of which is slidably positioned a thrust piston **42**. The chamber **43** in the portion **40** contains a powdered copper-wax compound **44** forming the thermal substance or heat responsive substance and interposed between the top of this substance in the neck **41**, and the piston **42**, is a rubber diaphragm **45**. Upon the application of heat to the body **40** the compound **44** expands and imposes an upward thrust on the piston through the medium of the interposed diaphragm **45**.

As illustrated, the body **40** is of larger outside diameter than the neck **41** so that there is thus provided a shoulder **46** and the neck **41** extends through the ring **37** which normally rests upon this shoulder **46**.

The neck **41** also passes through a thrust absorbing spring **47** which at its lower end rests upon the ring **37** while at its upper end it is pressed against a collar **48** which encircles the top end of the neck and is held in place in a suitable manner as, for example, by means of a snap ring **49**. This spring **47** is under constant compression and, therefore, tends to pull the heat responsive member **39** upwardly and thereby pull the shoulder **46** of the part **40** against the underside of the ring **37** and also functions, upon excessive heating and expansion of the thermal heat responsive material **44** and excessive extension of the piston **42**, to absorb the thrust by permitting the thermal compound and piston carrying element to move back.

The numeral **50** generally designates the poppet which

comprises the disc head **51** and the downturned surrounding flange **52**. This poppet as shown is located in the upper chamber **16** with the flange **52** directed downwardly toward the annular plate **32** and this flange is of the proper diameter to contact or rest upon the pips **38** when the valve is in the closed position, shown in FIG. 1, thereby providing a narrow water passage **53** between the chamber **18** and the chamber **16**.

The center of the poppet head **51** has an opening **54** therethrough. This opening is provided to receive the reduced terminal portion or stem portion **55** of the piston **42**. This stem portion **55** is of sufficient length to extend into the overlying port **20** beyond the poppet seat **61**.

The poppet is thus free to rise on the reduced terminal portion or stem **55** if and when necessary to come into engagement with the seat and without, at the same time, becoming misaligned with the stem. This action or condition might occur when a sudden injection or surge of water takes place into the lower or second chamber. Being free from fixed connection with the stem, the piston thus would not be drawn upwardly in the neck **41** away from the rubber diaphragm.

In starting up the engine cold, if the engine is speeded up so that such a sudden surge of water enters the second chamber, naturally the thermal material or composition **44** would remain unexpanded because such water would be cold. Therefore, if the piston were raised under these conditions and separated from the rubber diaphragm, as stated, a reduced pressure area could be formed between the piston and rubber diaphragm which might result in the drawing of water or foreign matter into such area past the piston with resultant injury to the device. By allowing for the free movement of the poppet on the stem, no such condition will arise from the sudden insurge of cold water into the lower chamber and the application of pressure against the underside of the poppet.

The numeral **56** designates poppet return springs which are connected between the poppet **50** and the lower end of the heat responsive member **39** in the following manner.

There is secured against the underside of the poppet head **51** the small plate **57** which has the outwardly extending hooks **58**, the ends of which are directed to the underside of the head **51**, these hooks corresponding in number to the springs **56**. The upper end of each of the springs is connected with one of these hooks **58**. The numeral **59** designates a saddle plate which is located beneath and in which rests the bottom end of the heat responsive member **39** and this saddle also carries the outwardly extending and downturned hook arms **60** to each of which the lower end of a poppet return spring **56** is coupled.

With an understanding of the conditions under which the present automatic thermostatic control device functions, from a consideration of my prior patents hereinbefore referred to, it will be understood that when the present control device is installed for operation in a marine internal combustion engine, the poppet **50** will be separated from the seat **61** which encircles the inner end of the port **20** and against which the outer side of the body **51** of the poppet is adapted to engage when it is fully shifted away from the annular plate **32**. The poppet will thus be in what will be understood as valve-closed position with the periphery of the flange **52** resting upon the buttons or pips **38**.

Under normal working conditions when the engine is started and warmed up in the proper manner, the water from the circulating pump, not shown, will flow by two paths, one leading to the pipe or conduit A and into the chamber **18** and the other leading to the pipe or conduit B into the chamber **16**. A small amount of this water entering the chamber **18** will pass through the passage **53** into the chamber **16** and pass from this chamber with the water entering by way of the port **20** out through the pipe or conduit C. Thus as the engine gradually warms up, the water gradually increasing in temperature will

enter the chamber **18** and affect the heat responsive compound **44** to extend the piston **42**, thus moving the poppet toward the seat **61**. Thus the flow directly from the port **20** to the port **22** will be gradually shut off and the flow from the port **26** into the chamber **18**, then to the chamber **16** and from there to the outlet port **22** will gradually increase.

During the foregoing operation the poppet return springs **56** will be increased in tension so that when the engine is stopped and the thermal compound contracts the poppet will be drawn back to its closed position.

In the event that a sudden or rapid application of heat to the body **40** of the heat responsive member takes place through the action hereinbefore described, by the intensely heated water entering the chamber **18**, so that the piston **42** is rapidly projected and the poppet seated to close the port **20**, the thrust of the poppet against its seat by the tendency of the piston to continue to move outwardly will be absorbed by the spring **47** which supports the heat responsive member in the manner described, thus permitting the parts **40** and **41** of the heat responsive member to move away from the poppet or reversely with respect to the piston, as illustrated in FIG. 2. Thus the device will be protected against damage which it would otherwise receive if the heat responsive member were secured in its entirety against any such reverse movement so that the piston **42** will continue to be forced outwardly and the poppet **50** would continue to be pressed against its seat by the expanding thermal compound. Consequently with the above action occurring as described, through the provision of the thrust absorbing spring the poppet will be held open to permit free flow of water from the engine jacket to the chamber and out through the conduit C until normal operating conditions are established.

I claim:

1. A thermostatically actuated valve unit comprising a housing, a plate member therein and dividing the housing into a first chamber and a second chamber, said plate member having a central opening therethrough, a fluid inlet port and a fluid outlet port opening directly into the first chamber, a fluid inlet port opening into the second chamber, a spider structure supported by said plate member in said second chamber, a thermal element having a body and a piston carried by the body and movable relative to the body by thermal action, a resilient means connected with said body and supporting the thermal element on the spider, said piston being directed through said plate member opening, a valve poppet positioned within the first chamber over the plate member and supported by the piston and movable thereby between two extreme positions in one of which positions it engages the plate member over the opening therein, and in the other of which positions it closes the fluid inlet port communicating with the first chamber, said valve poppet embodying an annular flange directed toward said plate member and wherein the plate member carries spaced means forming a part thereof with which said flange is adapted to engage, whereby a restricted water passage is provided between the two chambers, and spring means connected with and between the valve poppet and the body portion of the thermal element and normally urging movement of the valve poppet toward said plate member.

2. A thermostatically actuated valve unit comprising a housing formed in at least two parts having confronting peripheral surfaces, a centrally apertured plate member between said housing parts and secured around and adjacent to its periphery between said confronting surfaces whereby the plate member divides the housing into a first chamber and a second chamber, a spider carried by the plate member and extending into the second chamber and including a ring arranged coaxially with the opening of the plate member, a fluid inlet port opening into the first chamber, a valve seat encircling said fluid inlet port, a fluid outlet port opening into the first chamber, a fluid

inlet port opening into the second chamber, said opening of the plate member being coaxial with said valve seat and the first fluid inlet port, a thermal element having an elongate body comprising a thermally responsive medium containing part and an elongate neck part, said neck part extending through the spider ring and being limited in its movement therethrough by engagement of the ring with the said thermal responsive medium containing part, said thermal element further including a piston carried by and movable relative to said neck part and extending axially from the latter through the opening of said plate member, resilient means encircling said neck part of the thermal element body and being secured under compression between said spider ring and an element secured to the neck part whereby to normally urge movement of the thermal body toward the first fluid inlet port, a valve poppet coupled with said piston and located within the first chamber and adapted to be moved by the piston between a first position in which it engages the plate member and covers the opening therein and a second position in which it engages the said valve seat and closes said first inlet port upon the extension of the piston in response to thermal expansion of the medium in the first mentioned part of the thermal element body, resilient means normally urging the traction of the piston to bring the valve poppet to said first position thereof, and said plate member carrying upon its top a number of upstanding elements disposed around the aperture therein and located in a position to be engaged by the valve poppet in the said first position of the latter to provide a flow passage between the poppet and the plate.

3. A thermostatically actuated valve unit comprising a housing formed in at least two parts having confronting peripheral surfaces, a centrally apertured plate member between said housing parts and secured around and adjacent to its periphery between said confronting surfaces whereby the plate member divides the housing into a first chamber and a second chamber, a spider carried by the plate member and extending into the second chamber and including a ring arranged coaxially with the opening of the plate member, a fluid inlet port opening into the first chamber, a valve seat encircling said fluid inlet port, a fluid outlet port opening into the first chamber, a fluid inlet port opening into the second chamber, said opening of the plate member being coaxial with said valve seat and the first fluid inlet port, a thermal element having an elongate body comprising a thermally responsive medium containing part and an elongate neck part, said neck part extending through the spider ring and being limited in its movement therethrough by engagement of the ring with the said thermal responsive medium containing part, said thermal element further including a piston carried by and movable relative to said neck part and extending axially from the latter through the opening of said plate member, resilient means encircling said neck part of the thermal element body and being secured under compression between said spider ring and an element secured to the neck part whereby to normally urge movement of the thermal body toward the first fluid inlet port, a valve poppet coupled with said piston and located within the first chamber and adapted to be moved by the piston between a first position in which it engages the plate member and covers the opening therein and a second position in which it engages said valve seat and closes said first inlet port upon the extension of the piston in response to thermal expansion of the medium in the first mentioned part of the thermal element body, resilient means normally urging the traction of the piston to bring the valve poppet to said first position thereof, and the last named resilient means comprising spring elements connected at one end to the underside of the poppet and extending through the plate member aperture and connected at their other ends to the thermal element at the end of the latter on the side of

the spider ring remote from the first named resilient means.

4. A thermostatically actuated valve unit comprising a housing, a plate member therein and dividing the housing into a first chamber and a second chamber, said plate member having a central opening therethrough, a spider connected with the plate member and supporting a ring disposed within the second chamber and concentric with the opening in the plate member, a fluid inlet port and a fluid outlet port opening directly into the first chamber, a fluid inlet port opening into the second chamber, a valve seat encircling the first inlet port and being coaxial with the spider carried ring, a poppet valve within the first chamber comprising a disc head having a top side adapted to engage said valve seat and having an encircling flange projecting from the opposite side toward said plate member, the poppet valve being movable between the valve seat and the plate member, said flange being designed to engage the plate member in encircling relation with the opening therethrough for substantially closing the opening, a thermal element comprising a body portion a neck portion and a piston carried by the body portion and movable relative thereto by thermal action, said body portion being disposed in the second chamber on the side of the ring remote from the poppet valve and the neck portion extending through the ring toward the poppet valve, there being a connection between the piston and the poppet valve, resilient means encircling the neck portion and connected at one end therewith and engaging at its other end upon said ring, elongate spring elements each connected at one end with the under side of the poppet valve head and extending into the second chamber, and means connecting the other ends of the spring elements with the body of the thermal element.

5. A thermostatically actuated valve unit comprising a housing, a plate member therein and dividing the housing into a first chamber and a second chamber, said plate member having a central opening therethrough, a spider connected with the plate member and supporting a ring disposed within the second chamber and concentric with the opening in the plate member, a fluid inlet port and a fluid outlet port opening directly into the first chamber, a fluid inlet port opening into the second chamber, a valve seat encircling the first inlet port and being coaxial with the spider carried ring, a poppet valve within the first chamber comprising a disc having a top side adapted to engage said valve seat and having an encircling flange projecting from the opposite side toward said plate member, the poppet valve being movable between the valve seat and the plate member, said flange being designed to engage the plate member in encircling engagement with the opening therethrough for substantially closing the opening, a thermal element comprising a body portion, a neck portion and a piston carried by the body portion and movable relative thereto by thermal action, said body portion being disposed in the second chamber on the side of the ring remote from the poppet valve and the neck portion extending through the ring toward the poppet valve, there being a connection between the piston and the poppet valve, resilient means encircling the neck portion and connected at one end therewith and engaging at its other end upon said ring, hook elements secured to the under side of the poppet valve disc head in encircling relation with the thermal element piston, a plurality of elongate spring elements each having an end connected with a hook element and extending therefrom into the second chamber, a saddle plate having said thermal element body resting thereagainst on the side of the body remote from said neck portion, said saddle plate including a plurality of hook elements and each of said spring elements having its other end connected with a hook element of the saddle plate.

6. A valve unit of the character stated in claim 4, wherein said poppet valve disc head has a central opening therethrough and the said connection between the piston and the disc head comprises a stem extending axially of and from the end of the piston adjacent to the head and passing through the said opening in the head and free of fixed connection with the head whereby the poppet valve has limited free movement on the stem.

7. A thermostatically actuated valve unit comprising a housing, a plate member therein and dividing the housing into a first chamber and a second chamber, said plate member having a central opening therethrough, a spider connected with the plate member and supporting a ring disposed within the second chamber and concentric with the opening in the plate member, a fluid inlet port and a fluid outlet port opening directly into the first chamber, a fluid inlet port opening into the second chamber, a poppet valve within the first chamber comprising a disc head having an encircling flange projecting towards said plate member, the poppet valve being movable in the first chamber relative to the plate member, there being means in the first chamber engageable by said disc head for limiting movement of the poppet valve away from the plate member, said flange being positioned to seat upon the plate member in encircling relation with the opening therethrough for substantially closing the opening, a thermal element comprising a body portion, a neck portion and a piston carried by the body portion and movable relative thereto by thermal action, said body portion being disposed in the second chamber on the side of the ring remote from the poppet valve and the neck portion extending through the ring toward the poppet valve, there being a connection between the piston and the poppet valve, resilient means encircling the neck portion and connected at one end therewith and engaging its other end upon said ring, elongate spring elements each connected at one end with the under side of the poppet valve head and extending into the second chamber, and means connecting the other ends of the spring elements with the body of the thermal element.

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