United States Patent

Bright

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[45] **July 25, 1972**

[54] HYDRAULIC THERMOSTAT

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[73] Assignee: **General Motors Corporation,** Detroit, Mich.

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[52] **U.S. Cl.** .....**337/315,** 73/368.3, 200/153 V, 236/100, 337/394

[51] **Int. Cl.**.....**G01k 5/32,** G05d 23/12, H01h 37/36

[58] **Field of Search** .....73/368.3; 200/153 V; 236/100; 337/314, 315, 317, 393, 394

[56] **References Cited**

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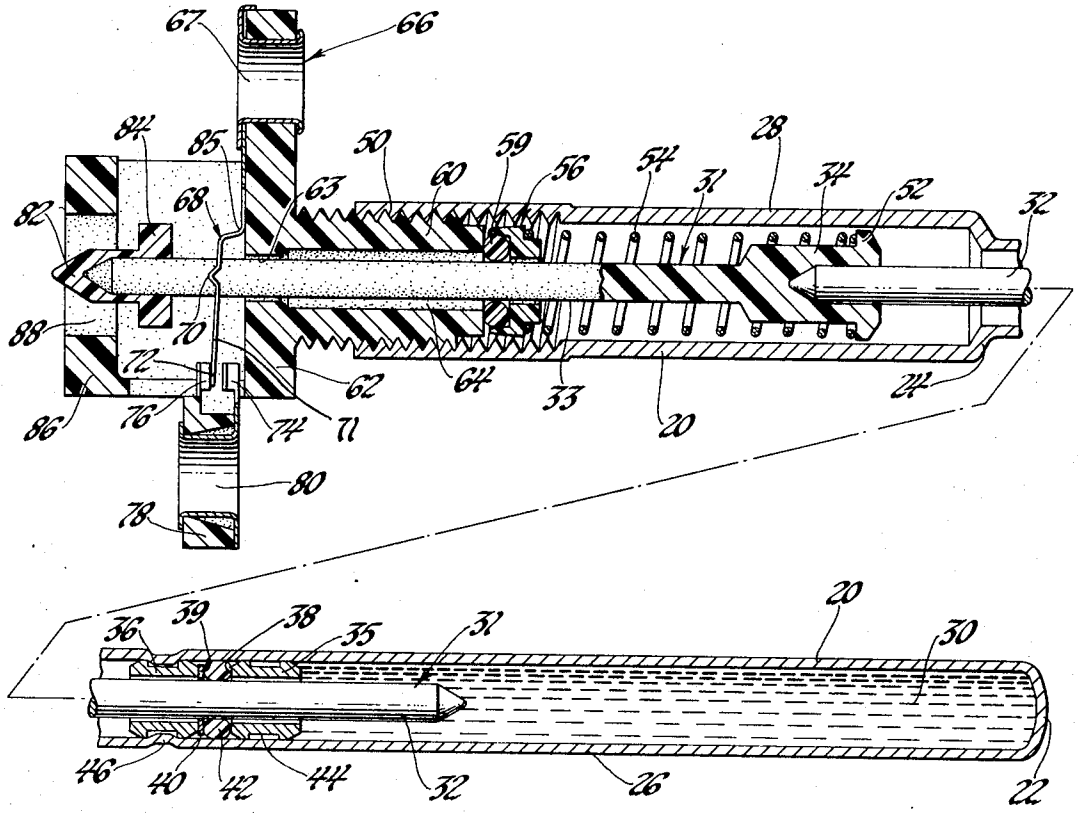
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[57] **ABSTRACT**

In the preferred form, a closed tube is provided with fixed shoulders on the opposite sides of a ring-shaped elastic seal member and a washer surrounding and having close fit with a rod extending into a viscous silicone thermal expansion fluid. At the open end of the tube the rod has a shoulder adapted on the inward movement to engage a double throw switch to move it from engagement with an outer contact into engagement with an inner contact. The rod is urged inwardly by a coil spring having its inner end pressing against a spring retainer fixed to the rod and having its outer end pressing against a second seal ring surrounding the rod for preventing leakage into an outer part of the tube.

3 Claims, 4 Drawing Figures



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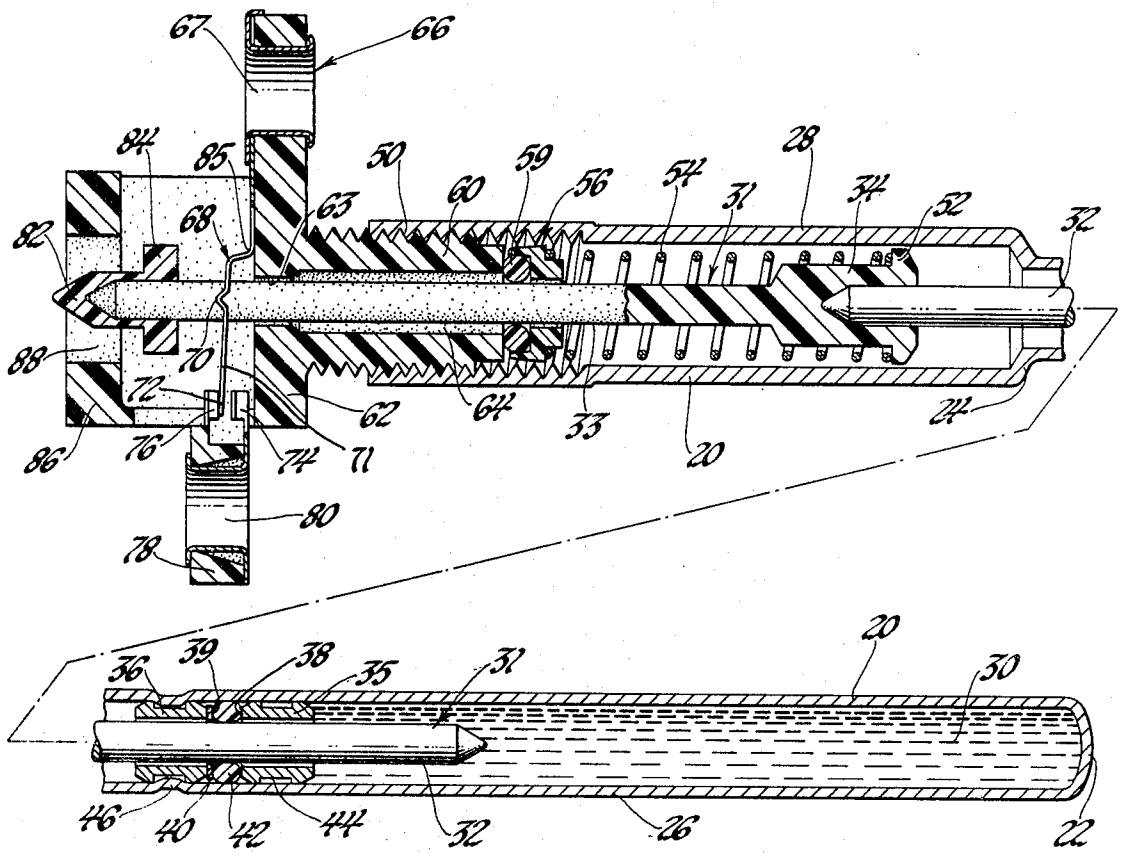


Fig. 1

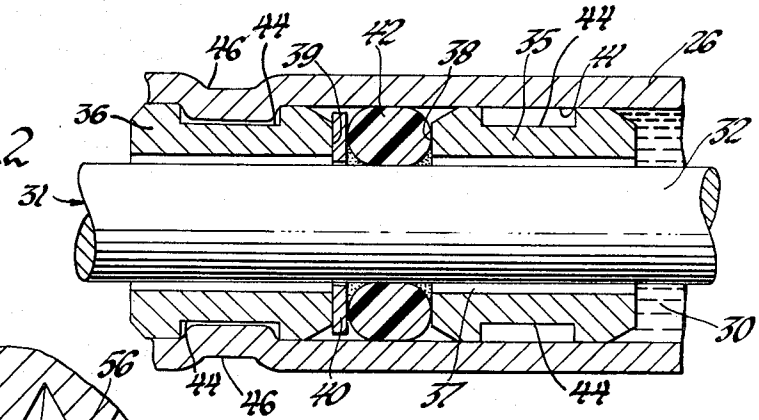


Fig. 2

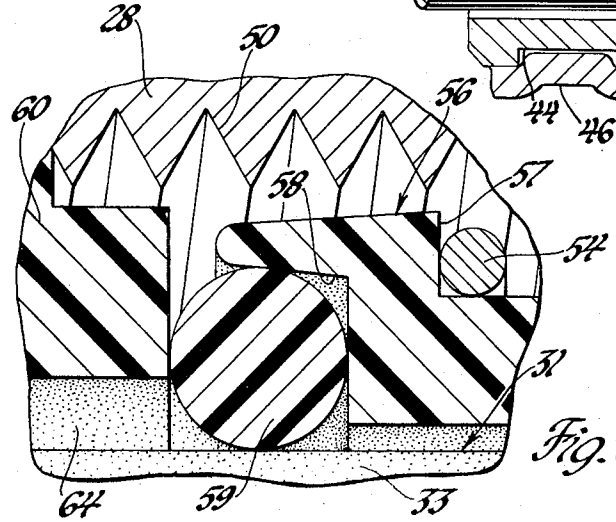


Fig. 3

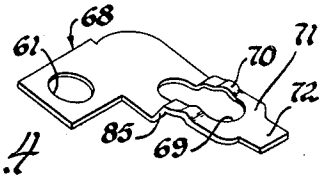


Fig. 4

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HYDRAULIC THERMOSTAT

This invention relates to a simple hydraulic thermostat having a lost motion connection between the control device and the thermally responsive element which is effective to connect when cooled below a predetermined temperature range. An example of a prior art thermostat of this general type is disclosed in U.S. Pat. No. 3,529,770 issued Sept. 22, 1970, and assigned to the same assignee as the instant application.

It is an object of this invention to provide a simple, inexpensive and durable low differential hydraulic thermostat having improved sensitivity which will not leak or lose its accuracy over extended periods at high and/or low temperatures.

Further objects and features of the invention will be readily apparent from the following description, reference being had to the accompanying drawing wherein preferred embodiments of the present invention are clearly shown.

In the drawings:

FIG. 1 is an enlarged transverse sectional view of a hydraulic thermostat embodying one form of my invention;

FIG. 2 is an enlarged fragmentary sectional view of the inner seal ring; and

FIG. 3 is a fragmentary enlarged sectional view of a portion of the outer seal ring;

FIG. 4 is a perspective plan view of the switch plate member.

Referring now to the drawing and more particularly to FIG. 1, there is shown a tube enclosure **20** preferably of brass having closed end **22** and a shoulder **24** separating the smaller diameter portion **26** from a larger diameter portion **28**. Within the smaller diameter portion **26** filling the closed end **22** is a viscous thermal expansion fluid **30** which preferably is a viscous fluoro silicone that may have a viscosity range from about 12,500 to 2,500,000 centipoise (unit measure of viscosity = 1/100 poise). If it is desired, however, other thermal expansion fluids may be used such as a mineral wax. The tube **20** may be made of brass or any other suitable material.

Extending into the fluid **30** within the tube **20** is an actuator rod assembly **31** comprising a stainless steel rod portion **32**, which is conically pointed at its free end, and a suitable electrical insulating plastic rod portion **33** preferably of acetal resin including approximately 20 to 30 percent glass filled polycarbonate. The plastic rod portion has an enlarged coupling socket **34** receiving one end of the steel rod portion **32** which is secured therein by suitable means such as an epoxy cement. Making tight fit within the smaller tube portion **26** are a pair of brass sleeves **35** and **36** which have considerable annular clearance space, indicated at **37** in enlarged FIG. 2, with the steel rod portion **32** to prevent binding between the rod **32** and the sleeves. These sleeves **35** and **36** are spaced to provide opposite shoulders **38** and **39**. Between the shoulders **38** and **39** is a brass washer **40** making a close sliding fit with the outer surface of the steel rod **32** while having considerable clearance with the inside surface or diameter **41** of the wall of the tube portion **26**. In addition to the washer **40**, seal ring **42** of elastic fluorosilicone is located between the shoulders **38** and **39** with seal **42** in juxtaposed relation with the washer **40**. It should be noted that while a single torous shaped or O-ring seal **42** is shown two or more O-ring seals could be employed as may be required without departing from the scope of my invention.

The sleeve **35** is first pressed into place after which the seal ring **42** and the washer **40** are inserted after which the outer sleeve **36** is pressed into place until the seal ring **42** and the washer **40** substantially entirely fill the space between the shoulders **38** and **39** and between the steel rod **32** and the inner surface **41** of the tube portion **26**. The tube portion **26** is provided with an annular crimp or notch **46** bearing against the outer edges of an annular groove **44** in the sleeve **36** to prevent the expansion of the hydraulic fluid **30** from moving the sleeve **36** away from the closed end **22** of the tube **20**. By virtue of this arrangement the seal ring **42** is fixed relative to the inside surface **41** to prevent the seal ring **42** from moving the rod assembly **31** toward the right prematurely during the contraction of the fluid **30** to cause premature opening of contacts to be described.

The coupling socket portion **34** of the actuating rod assembly **31** has molded thereon an annular inner spring retainer **52**, located in the larger tube portion **28**, which supports the inner end of the coil spring **54** which has a force sufficient to overcome the frictional drag of the seal ring **42** on the rod portion **32** and also to provide the desired contact pressure. This spring may have a force of the order of 1 lb. or less. The outer end of the spring **54** bears against a combined spring retainer and seal cup **56** shown in detail in FIG. 3 and preferably molded from acetal resin having an annular shoulder **57** for centering the spring **54**, and on the opposite side a cup-shaped recess **58** receiving the torous shaped seal ring **59** of elastic fluorosilicone which may be identical to the inner seal ring **42**. The inner wall of the tube portion **28** is threaded at **50** to receive a threaded hollow projection **60** which surrounds the rod portion **33** and threads into the open end of the tube **20**. The threaded projection **60** has a snug threaded fit within the outer end of the larger tube portion **28** and extends from a heavy platform **62** which is integral with the threaded projection **60** and has a coaxial passage **64** in it receiving the rod portion **33** of rod assembly **31** while the seal ring **59** is held tightly against the inner end of the protrusion **60** by the spring **54**. The heavy platform **62** contains a passage **63** concentric with the passage **64** having a smaller clearance with the rod portion **33**. The platform **62** is preferably made of a suitable electrical insulating plastic material such as polycarbonate.

This platform **62** supports a terminal **66** in the form of an extruded eyelet **67** extending through an aperture in the platform **62**, having connected to it one end of an L-shaped switch plate member indicated generally at **68**. The switch plate **68**, as seen in FIG. 4, has a circular aperture **61** for reception of eyelet **67** and a slotted aperture **69** in spring blade **71** for reception of the rod portion **33** to allow for the axial movement of the rod **33** through the spring blade **71**. Raised blade portion **71** of the switch plate member **68** has a pair of humps **70** formed on opposite sides of the rod aperture **69**. The movable spring blade **71** provides a double throw contact portion **72** in its free end which is adapted to be moved between the inner and outer stationary contacts **74** and **76** respectively. The contacts **74** and **76** connect to separate terminals provided on a second platform **78** which is integral with the first platform **62**. The inner contact **74** is connected to an eyelet type terminal **80** while the outer contact **76** is connected in a similar manner to a third terminal, now shown.

Thus, the outer end of the insulated plastic rod portion **33** extends through the slotted clearance aperture **69** in the double throw spring blade contact member **71** between the two humps **70** and on its outer end has press fitted thereon a cap **82** of polycarbonate or other electrical insulating material having a wide annular inner shoulder **84** located so as to engage the humps **70** when the temperature of the fluid **30** is lowered sufficiently. The position of the humps **70** relative to the raised spring blade **71** anchorage, indicated at **85**, and the contact **72** assures a multiplying or mechanical amplification of the movement of the rod assembly **31** about 3:1.

The temperature of the fluid at which either contact **74** or **76** is contacted is adjusted by turning the platform **62** and the protrusion **60** relative to the tube **20**. The humps **70** and the shoulder **84** form a lost motion connection which connects on the inward or contact opening movement of the actuator rod assembly **31** upon sufficient lowering of the temperature of the thermal expansion fluid **30** until the movable contact member **68** is prevented from moving further by the engagement of the blade contact **72** with the inner contact **74**. Further contraction of the fluid **30** will merely create a vacuum in the sealed chamber without producing any damage or stress on the parts. Conversely, expansion of the fluid **30** and the outward movement of the rod assembly **31** will not produce any strain or stress on the control since the rod assembly **31** and the cap **82** are free to move outwardly and disconnect the shoulder **84** from the humps **70** to provide the lost motion. The cap **82** can move away from the humps **70** to accommodate any thermal expansion within the highest ex-

pected temperatures such as those incurred during shipping. The outer portion of the rod portion **33** and the cap **84** are protected by a third platform **86** provided with an aperture **88** aligned with the rod assembly **31**, the cap **82** and the slotted aperture **69**.

Since the rod assembly **31** with the exception of coupling socket **34** is of uniform diameter throughout, its movement through the seal rings **42** and **59** will not draw in or expel air or any other fluid from any portion within the tube **20**. In the preferred form the plastic and steel portions **32** and **33** of rod assembly **31** have a diameter of the order of 0.070 in. The high viscosity of the fluid **30** minimizes leakage and makes it possible to keep the force of the spring **54** comparatively low. The spring force need only be sufficient to overcome the friction and provide sufficient contact pressure between the contacts **72** and **74**.

It is important that no air be trapped in the chamber containing the fluid **30**. Any air in this fluid **30** makes the switch slow to respond and causes it to have a large temperature differential between the temperatures at which the spring blade contact **72** breaks contact with the contact **74** and makes contact with the contacts **76** and vice-versa. Preferably the seal ring **42** is compressed sufficiently between the sleeve shoulders **38** and **39** so that it occupies substantially all the space between them surrounding the rod portion **32** within the tube **20**. It will be noted that in applicant's arrangement the sleeve **35** is dimensioned such that it does not require crimping of the tube **26** to secure the sleeve **35** in place while crimping of sleeve **36** is required because of an increase in dimensional tolerances caused by locating sleeve **35**.

The small washer **42** prevents the pressure of the fluid **30** from causing the shearing of the seal ring **42** through the clearance **37** between the rod **32** and the sleeve **36**. The inner diameter clearance **37** of the sleeves **35** and **36** allows for slight axial misalignment of the actuator rod assembly **31** to prevent any interference or binding with the sleeves. The seal **59** prevents the entrance of moisture and other extraneous fluids and solids and also prevents any leakage of the thermal expansion fluid **30** onto the contacts **72**, **74** and **76**.

While the embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is:

1. A thermostatic control including an enclosure containing a thermally expansible fluid, an operating rod within the enclosure extending into contact with the fluid and responsive to the expansion of the fluid, a seal member surrounding said rod and having sealing surfaces in sealing contact with said rod and in sealing contact with said enclosure for preventing the escape of said fluid, spring means for urging said rod into contact with said fluid, wherein the improvement comprises providing said enclosure with shoulders on opposite sides of said seal member having a large clearance with said rod so as to insure against close tolerance binding between said rod and said shoulders, and a washer surrounding and having a close sliding fit with said rod and a large clearance within said enclosure fitted between one of said shoulders and said seal member for preventing said seal member from moving with said rod, a control device mounted upon said enclosure having a bias to a first control position in the direction of the outward movement of said rod upon the expansion of said fluid, said rod having a lost motion connection means connecting with and operating said control device from said first control position to a second control position only upon a predetermined inward movement of said rod upon contraction of said fluid, said lost motion connecting means being arranged to disconnect from said control device upon predetermined expansion of said fluid and predetermined outward movement of said rod to prevent damage to the control when subjected to abnormally high temperatures.

2. A thermostatic control including an enclosure containing a thermally expansible fluid, an operating rod within the enclosure having its free end extending into contact with the fluid and responsive to the expansion of the fluid, a seal member surrounding said rod and having sealing surfaces in sealing contact with said rod and in sealing contact with said enclosure for preventing the escape of said fluid, spring means for urging said rod into contact with said fluid, wherein the improvement comprises providing said enclosure with means rigid with said enclosure supporting opposite sides of said seal member for preventing said seal member from moving with said rod, said enclosure being provided with a platform having a spring blade including contacts thereon supported on said platform, a pair of spaced inner and outer fixed contacts on said platform positioned in double throw fashion with the contacts of said spring blade, said spring blade having an oversize slotted aperture therein aligned with a passage on said platform for reception and axial travel of said rod therethrough, said spring blade having a bias to a first control position in contact with said outer contact in the direction of the outward movement of said rod upon the expansion of said fluid, said rod having engaging means fitted on its outer end for lost motion engagement with said spring blade for connecting with and operating said spring blade to a second control position in contact with said inner fixed contact only upon a predetermined inward movement of said rod upon contraction of said fluid, said engaging means being arranged to disconnect from said spring blade upon predetermined expansion of said fluid and predetermined outward movement of said rod to prevent damage to the control device when subjected to abnormally high temperatures.

3. A thermostatic control including an enclosure containing a thermally expansible fluid, an operating rod within the enclosure having its free end extending into contact with the fluid and responsive to the expansion of the fluid, a seal member surrounding said rod and having sealing surfaces in sealing contact with said rod and in sealing contact with said enclosure for preventing the escape of said fluid, spring means for urging said rod into contact with said fluid, wherein the improvement comprises a pair of spaced sleeves surrounding said rod on opposite sides of said seal member, said sleeves providing said enclosure with shoulders on opposite sides of said seal member, said sleeves having a large clearance with said rod so as to insure against close tolerance binding between said rod and said sleeves, and a washer surrounding and having a close sliding fit with said rod and a large clearance within said enclosure fitted between one of said sleeve shoulders and said seal member for preventing said seal member from moving with said rod, said seal member substantially filling all the confined space between its adjacent sleeve shoulder and said washer and between adjacent portions of said rod and the interior surfaces of said enclosure, said seal member having an original unconfined shape of a torus and being of a resilient elastic material, said enclosure being provided with a platform having a spring blade including contacts thereon supported on said platform, a pair of spaced inner and outer fixed contacts on said platform positioned in double throw fashion with the contacts of said spring blade, said spring blade having an oversize slotted aperture therein aligned with a passage on said platform for reception and axial travel of said rod therethrough, said spring blade having a bias to a first control position in contact with said outer contact in the direction of the outward movement of said rod upon the expansion of said fluid, said rod having a cap fitted on its outer end for lost motion engagement with said spring blade for connecting with and operating said spring blade to a second control position in contact with said inner fixed contact only upon a predetermined inward movement of said rod upon contraction of said fluid, said cap being arranged to disconnect from said spring blade upon predetermined expansion of said fluid and predetermined outward movement of said rod to prevent damage to the control device when subjected to abnormally high temperatures.

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