Dec. 8, 1964 E. J. KIMM 3,160,346

BY-PASS CONTROL VALVE

Filed Dec. 29, 1960 2 Sheets-Sheet 1

Fig-1

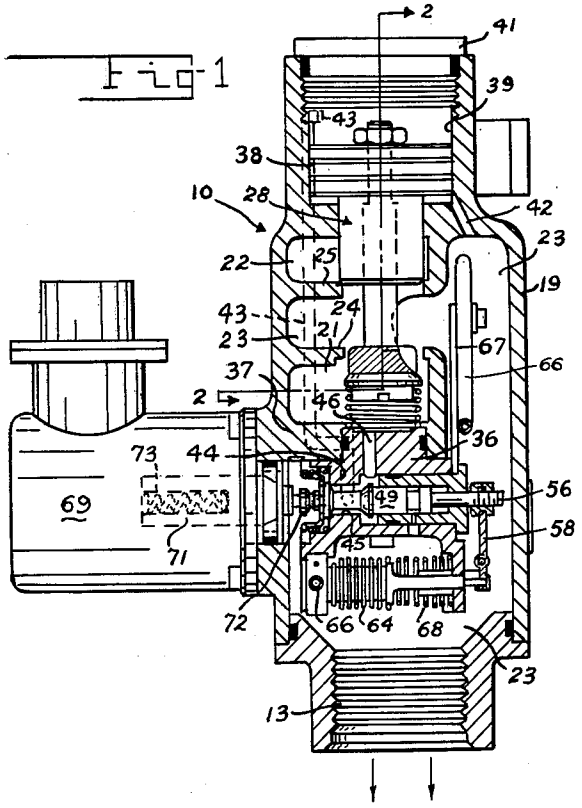


Fig-7

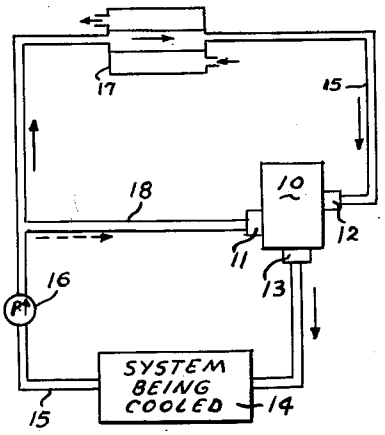


Fig-6

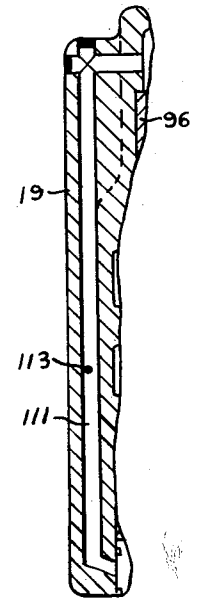
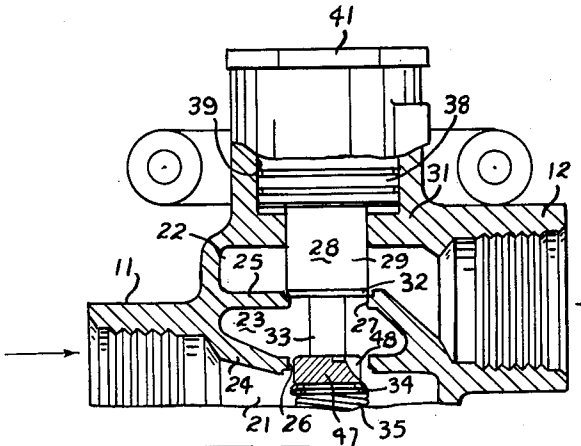


Fig-2



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BY-PASS CONTROL VALVE

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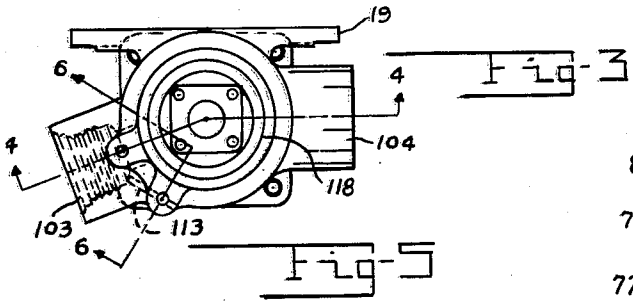


Fig-5

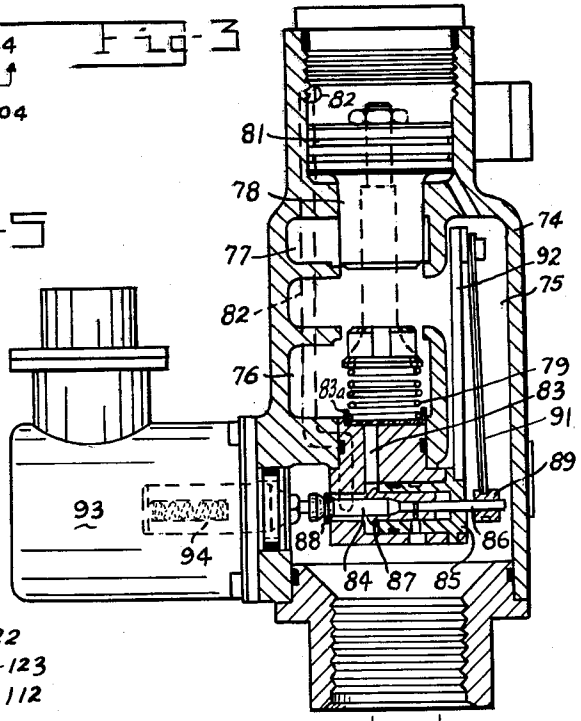


Fig-3

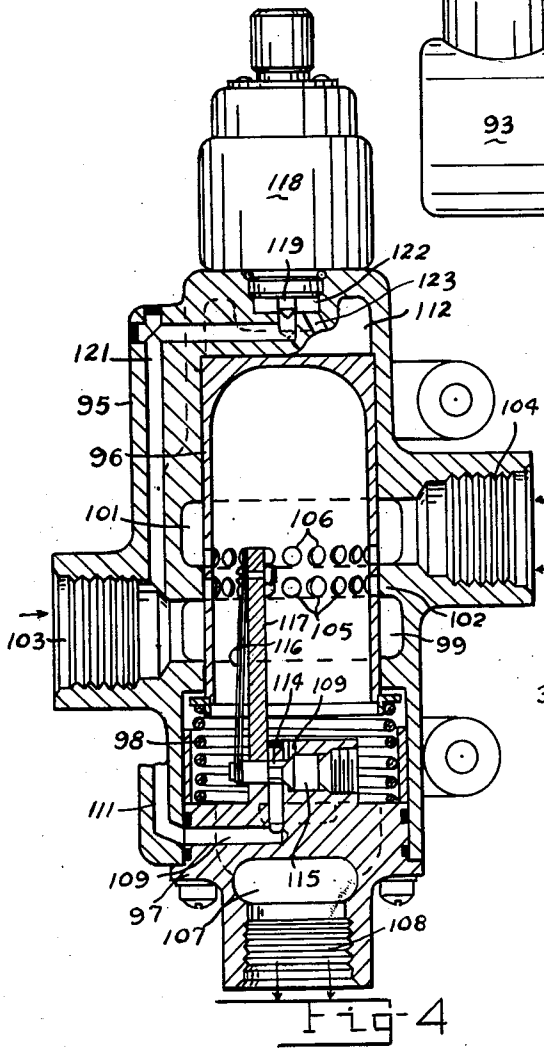


Fig-4

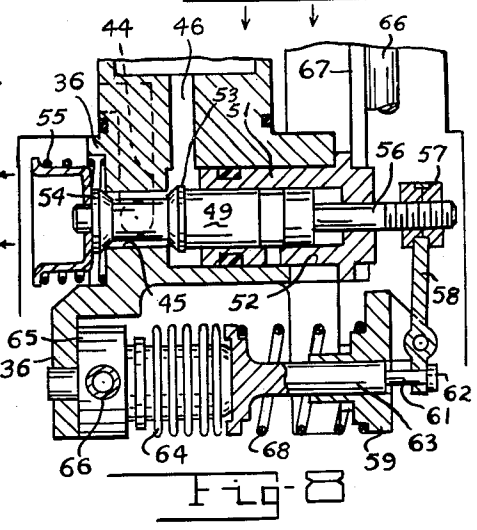


Fig-8

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3,160,346

BY-PASS CONTROL VALVE

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4 Claims. (Cl. 236—12)

This invention relates to fluid flow control valves in fluid circulating systems, and particularly to valves responding to a changing condition of a circulating fluid to direct the fluid in the alternative flow paths, as for example through main and by-pass flow paths.

Although not so limited, the invention has especial application to heat transfer systems utilizing a liquid coolant wherein the liquid is circulated through a heat exchanger when it is in need of cooling and is made to by-pass the heat exchanger when it is not in need of cooling, valve means being provided to sense the temperature of the coolant and to direct and redirect flow in response to temperature change.

The instant invention is concerned with a valve means as described and has for one of its objects the presenting of a compact unitary valve device incorporating temperature sensing means and fluid flow directing means operative as described.

Another object of the invention is to present a by-pass control valve especially characterized by rapid response to signaled temperature change.

Still another object of the invention is to provide a selectively operable override control effective when operated to maintain the valve means in a predetermined position of adjustment irrespective of temperature change.

Other objects and structural details of the invention will appear from the following description when read in connection with the accompanying drawings, wherein:

FIG. 1 is a view, in the main in longitudinal section, of a by-pass control valve in accordance with a first illustrated form of the invention;

FIG. 2 is a fragmentary view in longitudinal section of the valve of FIG. 1, taken substantially along the line 2—2 of FIG. 1;

FIG. 3 is a view like FIG. 1, showing a second illustrated form of the invention;

FIG. 4 is a view like FIGS. 1 and 2 showing a third illustrated form of the invention;

FIG. 5 is a top plan view of the valve of FIG. 4;

FIG. 6 is a detail view in longitudinal section, taken substantially along the line 6—6 of FIG. 5;

FIG. 7 is a diagram showing a system in which a by-pass valve according to the present invention may find a use; and

FIG. 8 is a detail view, enlarged with respect to FIG. 1, of the pilot valve and associated parts comprised in the FIGS. 1–2 embodiment.

Referring to the diagram of FIG. 7, a valve means 10 in accordance with the instant invention is shown therein having external inlet bosses 11 and 12 and a common outlet boss 13. The valve means is a part of an arrangement for cooling a system or space 14 and to this end a liquid coolant is circulated through a flow path 15 of which the system 14 is a part. A pump 16 is interposed in the path 15 to place the liquid under pressure and enforce a positive circulation thereof. Also in the path 15 is a heat exchanger 17 by means of which heat absorbed by the coolant in the system 14 may be removed before the coolant is returned to the system. Beyond heat exchanger 17, path 15 leads to inlet 12 of the valve means 10 and may then be directed from the valve means by way of outlet 13 to the system 14. A by-pass line 18 connects path 15 to the inlet boss 11 and it will be understood that line

18 is termed a by-pass because it is positioned to conduct the circulating coolant directly to valve means 10 and outlet 13 without having to pass through heat exchanger 17.

In accordance with the instant inventive concept, the valve means 10 incorporates temperature sensing means and automatic controls responsive to such means whereby the output of pump 16 is admitted to valve means 10 alternatively by way of inlet 11 or inlet 12 in accordance with the temperature of the flowing coolant. In the event the heat load at the system 14 is not high and the coolant is not in need of cooling then flow to the valve means 10 is by way of by-pass line 18 and inlet 11, the circulated coolant being under these conditions returned directly to the system 14 without being compelled to pass through heat exchanger 17. Under a rising heat load, however, valve means 10 acts to close off flow at inlet 11 and open flow at inlet 12 with the result that by-pass line 18 is closed and the circulated coolant is required to follow path 15 in its entirety, including the route through heat exchanger 17.

Considering now the structure of valve means 10, in the form illustrated in FIGS. 1 and 2, a body 19 has the several bosses 11, 12 and 13 either formed integrally therewith, as in the case of bosses 11 and 12, or installed therein as in the case of boss 13. In either event, the several bosses are formed to define open flow passes communicating with respective interior chambers in the valve body. Thus, boss 11 communicates with a chamber 21, boss 12 with a chamber 22 and boss 13 with a chamber 23. The chambers 21 and 22 are separated by a pair of longitudinally spaced apart internal partition walls 24 and 25. The space between these walls communicates with or forms a part of chamber 23. Further, this space is in controlled communication with the chambers 21 and 22 by reason of respective opposed openings 26 and 27 (FIG. 2) in the partition walls 24 and 25. The openings 26 and 27 are constructed to provide respectively downwardly and upwardly facing valve seats and a dual valve means 28 is arranged in cooperative relation thereto. The valve means 28 includes a cylindrical portion 29 having a sliding bearing in an upper partition wall 31 of the body 19. The portion 29 terminates at its lower end in a downwardly facing tapered formation 32 adapted to seat in and close the opening 27. A reduced diameter extension 33 of the piston element projects through and beyond opening 27 and is formed at its lower end with an upwardly facing tapered portion 34. The latter is disposed beyond or beneath opening 26 and is adapted to seat in and to close such opening. The relationship of the parts is such that the valve portions 32 and 34 are made alternatively effective by lowering and raising motions of the valve means 28. Thus in a lowered position of the valve, portion 32 closes opening 37 and so precludes communication between chamber 22 and chamber 23. At the same time, however, portion 34 of the valve means stands in an open position with respect to port 26 and communication between chamber 21 and chamber 23 is permitted. Raising of the valve means to an opposite position of adjustment is effective to close opening 26 and to open opening 27 with a reversal of the fluid connections to chamber 23.

The valve means 28 accordingly is effective to connect the inlets 11 and 12 alternatively to passage 23 and thereby to outlet 13.

Adjustment of the valve means 28 as described is in part effected by a compression spring 35 which is based on a supplemental body member 36 mounted in a lower partition wall 37 of the body 19. The spring 35 engages valve means 28 on the underside of portion 34 and urges it toward an uppermost position closing opening 26 and

opening port 27. Motion of the valve means downward, in opposition to the spring 35, is effected by a fluid pressure responsive device including a piston 38 connected to the upper end of cylindrical valve portion 29 and slidable in a piston chamber 39 above partition wall 31. The latter wall defines the bottom of the chamber 39 and the upper end thereof is closed by an installed cap 41. The lower end of chamber 39, beneath piston 38, communicates with what may be termed the outlet chamber 23 through body passage 42 (FIG. 1). The upper part of chamber 39, above piston 38, communicates with a downwardly extending body passage 43 which terminates in lower partition wall 37 and registers with a continuation 44 thereof (FIG. 8) is supplemental body 36. The continuation or extension passage 44 terminates in a supplemental body bore 45 also in communication by reason of a passage 46 with inlet body chamber 21. The latter is in continuous communication with by-pass line 18 so that pressure fluid is continuously admitted to the passage 46. Admitted to passage 44 and communicating passage 43, this pressure may enter piston chamber 39 above piston 38, and acting in oppositon to the spring 35, force valve means 28 downward to the position illustrated closing opening 27 and opening port 26. It will be understood, in this connection, that opening 26 imposes a restriction to flow from inlet 11 to chamber 23 with the result that a pressure difference exists as between chambers 21 and 23. Upon admission of pressure fluid to the upper end of the piston chamber 39, therefore, a resultant pressure is available acting in a direction to force piston 38 downwardly as described. To increase the extent of pressure difference the piston element 28 may, as here shown, be formed with a restricting head portion 47 above valve portion 34 adapted to be received in the opening 26. The head portion 47 exerts substantial amount of restriction upon fluid flow from chamber 21 to chamber 23 and is cut by passages 48 providing in effect a circumferential series of flow paths thereby. The pressure in chamber 22 similarly is relatively reduced by reason of the restriction provided by heat exchanger 17 and so is unable to communicate to chamber 23 and passage 42 a pressure resistant to actuating motion of piston 38 as described.

Referring also to FIG. 8, flow through the bore 45 between passages 46 and 44 is controlled by a pilot valve 49 slidable in such bore. A bushing 51 is installed in a counterbore 52 at one end of the bore 45 and the other end of the bore opens through supplemental body member 36 into outlet chamber 23. In longitudinally spaced relation to one another on the valve 49 are opposing valve formations 53 and 54 adapted alternatively to engage and seat in opposing ends of the bore 45. A spring device 55 is mounted on one end of the piston-like pilot valve 49 and urges it leftward or in a direction to seat valve portion 53 at one end of the port 45 and to unseat valve portion 54 from the other end of the bore. According to this arrangement of the parts communication between the passages 44 and 46 is cut off and passage 44 is communicated instead to outlet chamber 23. With this position of the pilot valve 49, therefore, flow of high pressure fluid to the piston chamber 39 is prevented and piston element 28 is enabled to assume an upward position of adjustment as influenced by the spring 35. In a reverse position of the pilot valve, that is in the position illustrated wherein valve portion 54 seats in and closes the outer end of bore 45 and valve portion 53 is unseated within counterbore 52, then the passages 44 and 46 are communicated with one another and high pressure fluid from the chamber 21 is free to flow to the piston chamber 39 for actuation of the valve 28 to its lower position.

The pilot valve 49 has an axial stem 56 projecting through and beyond bushing 51. Adjustably mounted on the stem 56 is a nut 57 engaged by the bifurcated end of a lever 58. The latter is pivotally mounted on a support 59 mounted on to form a part of a downwardly extending portion of the supplemental body 36. The lever 58 projects beyond its pivotal connection to support 59 and has a pin 61 passed transversely therethrough on which is a head 62. The pin 61 is an integrated extension of a stem 63 projecting from the base of a flexible bellows 64. The head of the bellows limits against a downwardly extending portion of the supplemental body 36 and is formed with a hollow container like portion 65. Portion 65 and the bellows proper are filled with a thermally sensitive fluid having the property of expansion under heat. Also forming a part of the bellows assembly, and similarly filled with the expansible fluid, is a tube 66 attached at its one end to the container portion 65 of the bellows and extending upwardly into chamber 23 opposite the space between partition walls 24 and 25 of the body. The tube 66 is closed at its upper end and supported by a bracket 67 mounted on the projecting end of bushing 51. A compression spring 68 is interposed between support 59 and the base of bellows 64. The spring tends to collapse the bellows, and, through pin 61 and head 62, to rock lever 58 in a clockwise direction. So urged, the lever 58 acts to draw the pilot valve 49 to the right whereby to position the parts as illustrated where passages 46 and 44 are intercommunicated with one another. Spring 68 exceeds the spring 55 in strength so that the valve 49 is moved to such position despite the opposition of spring 55.

In the operation of the pilot valve control, with the liquid coolant unheated, starting of the pump 16 finds the by-pass opening 26 closed by valve 34 and finds pilot valve 49 adjusted to interconnect passages 46 and 44. As the incoming pressure in chamber 21 is communicated through passage 46, bore 45 and passage 44 to piston chamber 39 the piston 38 is actuated downwardly to open port 26 and close port 27. Thus the initial flow in the system is by way of by-pass line 18, directly through the valve 10 by way of opening 26 and chamber 23 and back to the system 14. As heat developed in the system 14 is transmitted to the circulating coolant the expansible fluid in tube 66 and bellows 64 responds by effecting an expansion of the bellows resulting in an axial movement of stem 63 and pin 61 to the right. Lever 58 follows such movement, under the urging of spring 55, and, as the temperature of the coolant reaches a predetermined value, valve 53 seats in bore 45 to interrupt flow of high pressure fluid to the piston chamber 39. At the same time passage 44 is communicated through the opposite end of bore 45 to outlet chamber 23. The piston means 28 is in this manner restored to the control of spring 35 which shifts the valve to its alternate position of adjustment wherein portion 34 closes port 26 and valve portion 32 opens port 27. Further flow of coolant in the system then is by way of heat exchanger 17 and back to the valve by way of inlet 12 and chamber 22. Flow from chamber 22 to chamber 23 is by way of the opening 27, and, in passing to the outlet boss 13 the coolant comes in contact with tube 66 and bellows 64. Should the temperature of the circulating coolant fall below a predetermined value the expansive force exerted by the fluid in tube 66 and in the bellows 64 is lessened and spring 68 permitted to recompress the bellows and to exert a corresponding rocking motion of lever 58 in a direction to reconnect passages 44 and 46. The arrangement is one furnishing rapid response to temperature change in the circulating coolant making it possible to hold the temperature of the coolant closely to a predetermined value.

The valve has, for simplicity sake, been described as directing the entire coolant flow alternatively through the heat exchanger or in by-passing relation thereto. The sensing of temperative change is continuous, however, and pilot valve 49 may assume intermediate positions effecting a corresponding positioning of valve means 28. A modulating effect thereby is gained, a part of the total coolant flow circulating by way of heat exchanger 17 and another

part circulating in by-passing relation to the heat exchanger.

Under some circumstances, as for example in the event of a blocked or misoperating heat exchanger, it may be desirable to circulate the coolant by way of the by-pass connection continuously irrespective of coolant temperature. To this end there is mounted on the side of the body **19** an electromagnetic device **69** operable when energized to retract a plunger **71**. The latter is formed with an extension **72** projecting into the body **19** through a lateral opening therein in position to engage one end of the pilot valve **49**. The plunger **71** is urged outwardly by a relatively strong spring **73** with the result that in the absence of energization of electromagnetic device **69** the pilot valve **49** is held positively in the adjusted position illustrated wherein passages **46** and **44** are intercommunicated with one another. In a normal system operation the by-pass control valve is enabled or prepared for use by an initial energizing of device **69** whereby plunger **71** is retracted and the pilot valve released for thermostatic control.

With the pilot valve **49** held by plunger **71**, as described, the action of the bellows **64** in expanding and contracting as a result of temperature change is unaffected due to the sliding connection between pin **61** and lever **58**. Similarly in normal operation, a temperature rise beyond that placing valve **49** in its extreme leftward position is accommodated within bellows **64** by an overtravel thereof relative to lever **58**.

FIG. 3 illustrates a form of the invention which is the same as that of FIG. 1 except for the use of a different form of thermostatic control. In the instance of FIG. 3 a body **74** is formed with an outlet chamber **75**, an inlet chamber **76** and an inlet chamber **77** corresponding respectively to the chamber **23**, **21** and **22** of the FIG. 1 embodiment. A valve element **78** is actuated by a spring **79** and by a piston **81** to perform in the same manner and to the same end and purpose as the valve means **28** of the FIG. 1 embodiment. Pressure fluid for actuation of piston **81** is supplied by a passage **82** alternatively connected to a passage **83** under control of a pilot valve **84** movable in a bushing **85**. A stem **86** on the valve **84** has a sleeve **87** pinned thereto which together with a valve element **88** at the outer end of the pilot valve body form valve formations corresponding to the formations **53** and **54** of FIG. 8. Adjustably mounted on the outer end of the stem **86** is a nut **89** to which is connected one end of a bi-metal strip **91**. The other end of strip **91** is fastened to an upstanding stationary bracket **92**, the arrangement being one placing the bi-metal strip in a position in chamber **75** to be freely contacted by fluid flowing therethrough whether coming from the inlet chamber **76** or the inlet chamber **77**. Under the flexing of strip **91**, occasioned by temperature changes in the circulating coolant, the pilot valve **84** is adjusted axially to connect passage **82** alternately to high pressure supply passage **83** and to outlet chamber **75**, or is adjusted to intermediate positions for modulating flow control. The result, as seen in connection with FIG. 1, is to achieve a selective positioning of valve element **78** in accordance with the temperature of the circulating fluid in order that the temperature of such coolant may be held substantially consant. Flow of high pressure fluid to passage **83** is through a screen **83***a*.

An electromagnetic device **93** and plunger **94** actuated thereby operate in the same manner and to the same end as corresponding elements disclosed in FIG. 1.

FIG. 4 illustrates a further form of the invention utilizing like principles of operation and similar structure. According to this form of the invention, a body **95** provides a vertical bearing for a piston-like sleeve **96**. At the bottom of the body **95** a closure device **97** provides a base for a compression spring **98** which urges the sleeve **96** upward within the body. Longitudinal adjustment of the sleeve serves to connect the interior thereof alternately with inlet chambers **99** and **101** located respectively below and above

an intermediate bearing wall **102** and supplied respectively by inlets **103** and **104**. Communication between such chambers and the interior of sleeve **96** is accomplished through vertically spaced apart circumferential series of openings **105** and **106** adapted to be projected respectively below and above the intermediate wall **102** in response to vertical longitudinal adjustment of the sleeve **96**. The bottom of sleeve **96** is open and is communicated through a passage **107** in closure **97** with outlet opening **108**.

A passageway **109** in closure **97** opens at its one end into outlet passage or chamber **107** and communicates at its opposite end with a vertically extending body passage **111**. The latter extends upward and opens into a chamber **112** above the closed end of sleeve **96**. Simultaneously therewith the passage **111** is in relatively restricted communication with inlet **103** by virtue of a small diameter lateral opening **113** (see FIGS. 5 and 6).

Passageway **109** in closure **97** intersects a bore **114** and a pilot valve **115** is adapted to move in such bore to interrupt communication between portions of the passageway **109** in such manner as alternatively to connect and disconnect it from outlet passage **107**. Occupying an open position with respect to passageway **109**, the valve **115** prevents a build up of pressure in chamber **112** above sleeve **96**. In a closed position the pilot valve in effect interrupts outflow from the passage **111** so that the pressure entering this passage through restricted port **113** is enabled to build up a pressure in chamber **112** greater than the resistance of spring **98**. When this occurs the sleeve **96** is moved downward altering the relationship of inlet chambers **99** and **101** to outlet passage or chamber **107**. The adjustment of pilot valve **115** is under control of a bi-metal strip **116** mounted on a bracket **117** extending upwardly within sleeve **96** from the closure member **97**. The mode of operation of the device of FIG. 4 is essentially the same as those of FIGS. 1 and 3 and the function in a liquid coolant circulating system as described in the same.

In FIG. 4 an electromagnetic device **118** controls, through its reciprocable plunger **119**, fluid flow from inlet **103** to chamber **112** by way of a passage **121**, recess **122** and port **123**. In an extended or seated position as shown the plunger **119** closes passage **121** and so denies direct access of the pressure fluid at inlet **103** to chamber **112**. In this position of the parts, therefore, the valve means is free to operate in its intended manner under the influence of thermostatic strip **116** and pilot valve **115**. Upon energizing of the device **118**, however, valve **119** is retracted and relatively unrestricted fluid under pressure is applied in chamber **112** to effect an immediate movement of the sleeve **96** to its downward position interconnecting inlet **103** to passage **107**. As long as the device **118** remains energized the valve means will continue to be so adjusted and to so direct fluid flow irrespective of temperature change.

What is claimed is:

1. A by-pass fluid control valve, including a body having a pair of fluid inlets supplied with a pressure fluid under differential pressure and a common outlet, valve means occupying alternate extreme positions of adjustment connecting different ones of said inlets to said outlet and positions intermediate said extreme postions, spring means urging said valve means toward a position communicating the inlet of lower pressure to said outlet, said body providing a piston chamber directly communicating at its one end with said outlet, said body further providing a passage to the other end of said chamber in common communication with the inlet of higher pressure and with said outlet, means restricting the communication of said passage with said inlet of higher pressure, an adjustable pilot valve opening and closing communication of said passage with said outlet, means responsive to the temperature of the fluid for adjusting said pilot valve, and a piston in said piston chamber connected to said valve

means and arranged to move said valve means toward the other one of its alternate positions responsive to a rising pressure in the said other end of said piston chamber upon closing of said pilot valve.

2. A by-pass fluid control valve, including a body having a pair of fluid inlets supplied with a pressure fluid under differential pressure and a common outlet, valve means occupying alternate positions of adjustment connecting different ones of said inlet to said outlet and positions intermediate said alternate position, spring means urging said valve means toward a position communicating the inlet of lower pressure to said outlet, a pressure fluid operated device for moving said valve means toward the other one of its alternate positions, said valve means being constructed to impose a pressure drop between the inlet of higher pressure and said outlet in the said other one of its alternate positions, said pressure fluid operated device including a piston exposed on its one side to the pressure at said outlet, a pilot valve settable to positions exposing the other side of said piston to the pressure at said outlet and to the pressure at said inlet of higher pressure, and means responsive to the temperature of the fluid at said outlet for setting said pilot valve.

3. A by-pass control valve according to claim 2, characterized by selectively operable means maintaining a continuous flow of high pressure fluid to said piston irrespective of the fluid temperature.

4. A by-pass fluid control valve, including a body having a pair of fluid inlets supplied with a pressure fluid under differential pressure and a common outlet, valve means occupying alternate extreme positions of adjustment connecting different ones of said inlets to said outlet and positions intermediate said extreme positions, spring means urging said valve means toward a position communicating the inlet of lower pressure to said outlet, said body providing a piston chamber communicating at its one end with the inlet of higher pressure and at its other end with said outlet, a piston in said chamber connected to said valve means and movable in response to a relative elevated pressure at the said one end of said chamber to move said valve means toward the other one of its alternate positions, a pilot valve controlling pressure conditions in said one end of said piston chamber, and means responsive to the temperature of the fluid at said outlet for adjusting said pilot valve, said last named means including a bellows supported by said body and connected to said pilot valve, said bellows being filled with a thermally sensitive fluid and including a tube extension projecting within the body to be contacted by the fluid flowing beyond said valve means toward said outlet.

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