May 28, 1957 A. K. VELAN 2,793,814

TEMPERATURE CONTROLLED STEAM TRAP

Filed Feb. 16, 1955 2 Sheets-Sheet 1

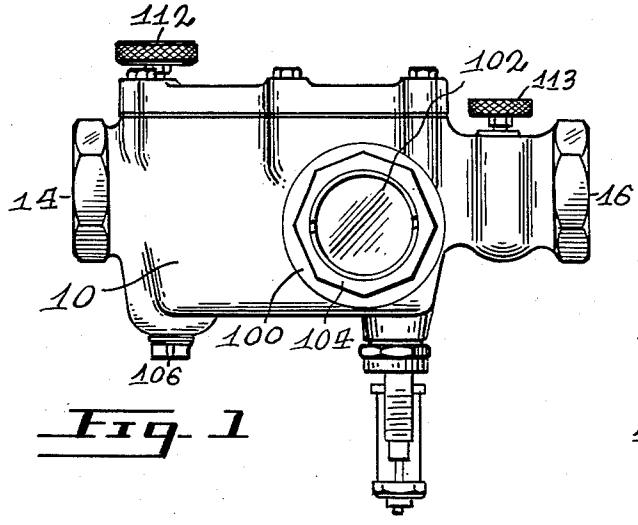


Fig. 1

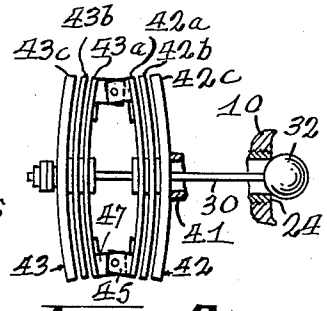


Fig. 4

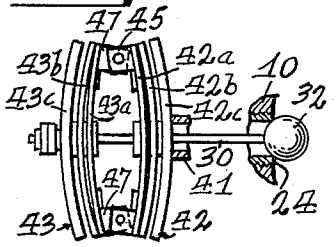


Fig. 5

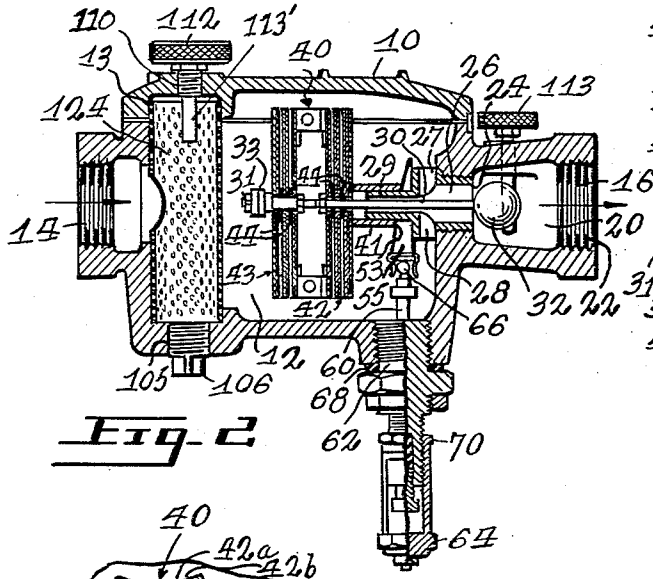


Fig. 2

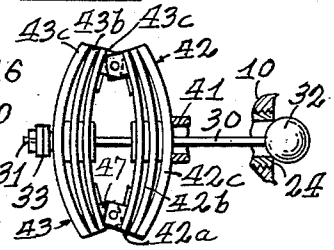


Fig. 6

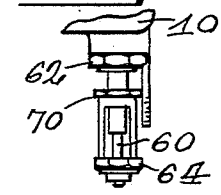


Fig. 7

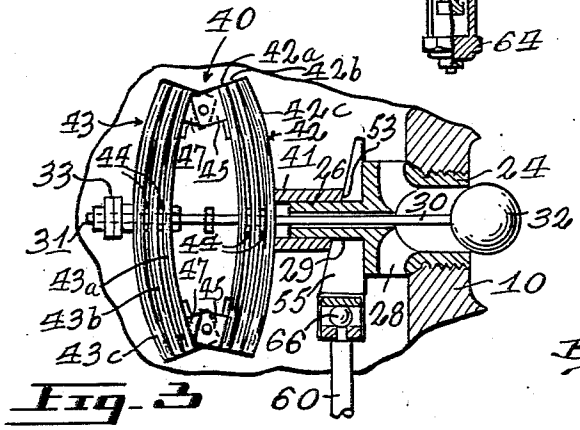


Fig. 3

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May 28, 1957 A. K. VELAN 2,793,814

TEMPERATURE CONTROLLED STEAM TRAP

Filed Feb. 16, 1955 2 Sheets-Sheet 2

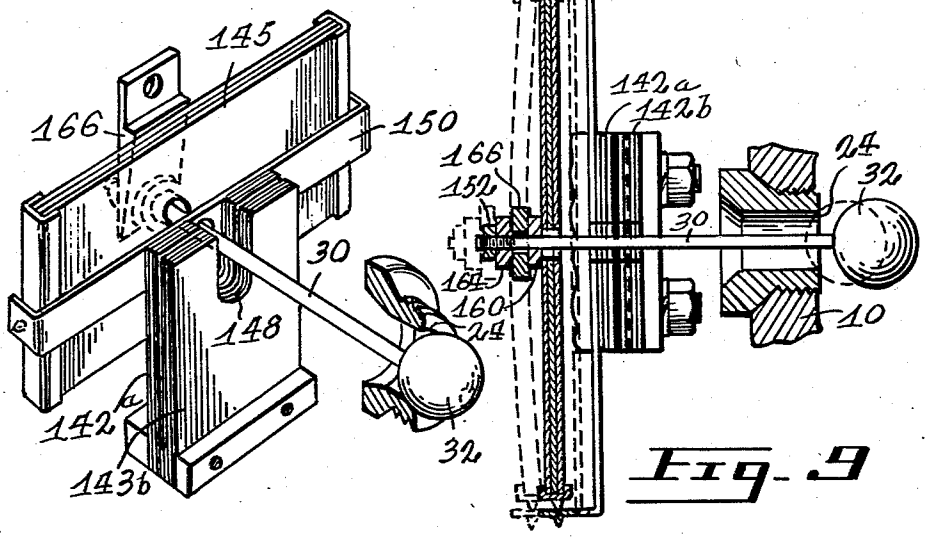


Fig. 8

Fig. 9

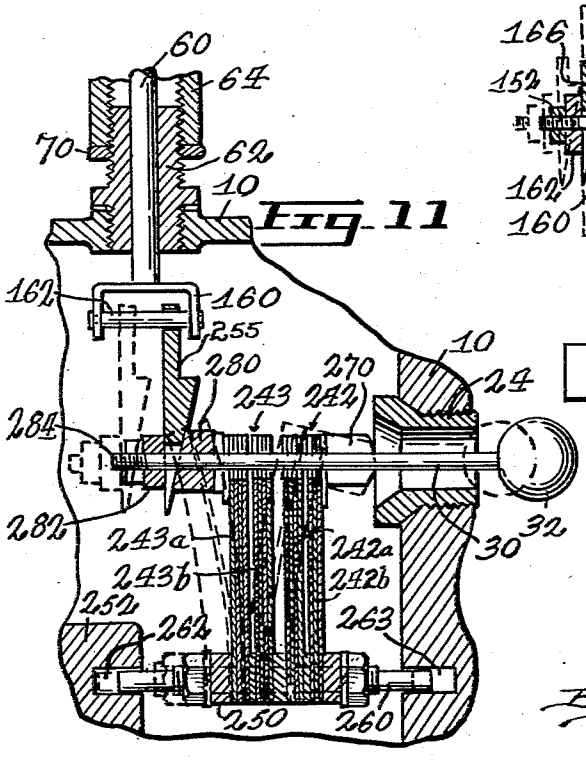


Fig. 11

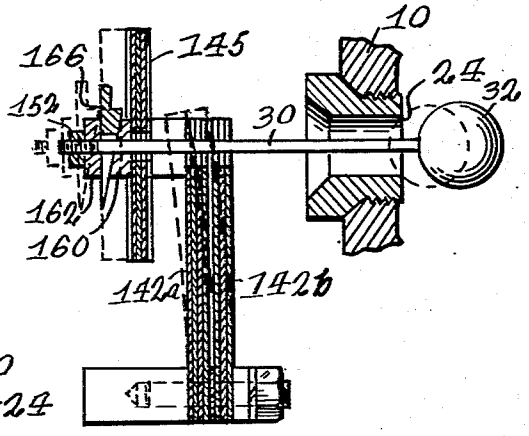


Fig. 10

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TEMPERATURE CONTROLLED STEAM TRAP

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Application February 16, 1955, Serial No. 488,671

25 Claims. (Cl. 236—59)

Introduction

The present invention relates to an improvement of devices for controlling the air-venting and condensating of steam using equipment working on bi-metallic or bellows thermostatic principle.

In heating installations, for example those used in processing industries, heating plants, and the like, where saturated steam or super-heated steam is employed as a heating medium, it is necessary to provide various automatic devices so that the air will be discharged from the systems during the initial heating up from cold condition, and then steam must be discharged from the system without the loss of live steam, and the back flow of condensate prevented. Normally, separate devices are used for each operation, for example, steam traps are provided for the automatic discharge of condensed steam, air-vents of various types and designs are used for the automatic discharge of air from the systems during the heating up period, and check valves of various types and descriptions are installed in front of the discharging side of the steam traps to prevent possible back flow of condensate from the turn lines of the adjoining equipment. In some installations, temperature control valves are installed on the discharging side of the steam traps in order to hold up hot condensate under pressure in the system, and to allow the discharge of condensate having a predetermined lower temperature.

These devices are all necessary to meet the requirements of an efficient steam installation as well as separate valves and valve seats to control the steam traps, air vents and check valves. Further, most steam traps at present available can be installed only in one position so that it is necessary to employ various types and sizes to accommodate varying pressures and lowered conditions.

These disadvantages have in the main been overcome by the applicant's steam trap structure shown and described in United States Patent 2,629,553, which issued February 24, 1953. This steam trap construction provides a single controlling device that combines the function of all the previously required elements, namely, steam trap, air vent, check valve, control glass, strainer and temperature control valve. Through the use of a single pressure and temperature responsive free floating valve arrangement this steam trap is adapted to control the venting of air, the discharge of condensate and a back flow of condensate. This trap construction is so designed that relative position has no effect in operation enabling it to be installed in any position.

The present invention aims to provide a further improvement in the type of steam trap described above wherein the capacity of the trap is more than doubled through the use of a specially designed temperature and pressure responsive controlling element in combination with the free floating valve.

Accordingly, the invention is embodied in a steam trap having a fluid chamber, inlet and outlet passages for the chamber, the outer end of the outlet passage having a

valve seat, a valve member having an elongated stem extending from a tail end within the chamber to an outstanding closure head disposed outside of the fluid chamber, and adapted to seat on the valve seat, and comprises a temperature responsive controlling element which includes a first bi-metallic member supported within the chamber in the path of the valve stem and a second bi-metallic member connected to the first bi-metallic member. The second bi-metallic member is provided with valve stem engaging means and the connection between the bi-metallic members is such that movement of the first member is transmitted to the second member and the movement of the second member is added to the movement of the first member. As the second member is engaged with the valve stem any movement of either or both of the bi-metallic members causes a corresponding movement of the valve head relative to the valve seat.

As will be appreciated, this cooperating arrangement of the controlling bi-metallic members greatly increases the thermal responsive strength of the controlling element and the extent of the possible movement of the valve head relative to the valve seat permitting the use of larger orifices and accordingly increases the capacity of the trap with respect to condensate discharge.

More specifically, the preferred bi-metallic members utilized each comprises of a plurality of spaced apart bi-metallic segments, each segment being of graduated strength relative to an adjacent segment and being mounted in the fluid chamber so that each segment will act in coordinated sequence under conditions induced by steam temperature and pressure. This construction gives each bi-metallic member greater sensitivity.

In one preferred construction, the bi-metallic members are mounted so as to extend transversely to and above and below the elongated stem of the controlling valve in the steam trap. Each member comprises of a plurality of spaced apart segments which are held together centrally with the terminal ends of the first segment of each member pivotally connected to the corresponding terminal ends of the second bi-metallic member. The bi-metallic segments in the connected members are so disposed that under steam pressure and temperature, the members in sequence, depending on their thermal responsive strength, deflect or bow towards each other. The interconnected segments of both of the members include central openings to accommodate the valve stem with the outer segment of the first of the members connected centrally to a cylindrical sleeve which slidably fits over a corresponding cylindrical projection provided on the inner face of the valve seat. The inner end of the valve stem, which extends through and beyond the second bi-metallic member is provided with an outstanding stop member against which the outer segment of the second bi-metallic member bears so that any deflection of any of the segments of the first and/or second bi-metallic members acts on the valve stem bringing the valve head into seated position.

Means are provided for adjustment of the clearance of the valve head relative to the valve seat in the form of a wedge-shaped cam member which is interposed between the first bi-metallic member supporting sleeve and the valve seat projection.

In an alternative arrangement, the bi-metallic members are supported and connected at one end only by a common support which is slidably mounted beneath the valve stem. In this construction, the upper ends of the segments of the first and second members are slotted to accommodate the valve stem with the outer segment of the first member having a pivotally mounted contact member bearing against the inner face of the valve seat. The outer segment of the second bi-metallic member is pro-

vided with a divided valve stem engaging member into which the inner terminal end of the valve stem slidably fits and which is adapted to act against the terminal end of the valve stem upon deflection of any of the segments of the first and/or the second member. The segments of the first and second bi-metallic members are arranged so that the upper unsupported ends of each member deflect away from the corresponding segments of the other member when subjected to increased temperature conditions.

The engagement of the projection of the first bi-metallic member under this deflection into contact with the valve seat, moves the common support which is mounted for sliding movement within the fluid chamber, and consequently, the second member. As the second bi-metallic member acts on the valve stem as described above, the movement of the first member and the deflection of the second member combines to act on the valve stem to bring the valve head into seated position.

In a further alternative arrangement, the features of both of the previously described constructions are combined to produce the equivalent result. In this construction, the first bi-metallic member is secured at one end to the interior of the fluid chamber beneath the valve. The second bi-metallic member is mounted on the upper end of the first member on a supporting yoke with the valve stem passing through the centre of the second member. The segments of the first member are disposed so as to deflect away from the valve seat as are also the segments of the second member. Since the first member supports the second member, through the supporting yoke, the deflection of both members are combined and by the engagement of the second bi-metallic member with the inner end of the valve stem, the valve head is drawn into seating contact with the valve seat as previously described.

Means are provided in both of the alternative arrangements to provide for adjustment of the clearance between the valve head and the valve seat in the form of adjustable wedge shaped members which are interposed between the terminal ends of the valve stems and the valve stem engaging segments of the bi-metallic members.

Having thus generally described the nature of the invention, particular reference will be made to the accompanying drawings wherein there is shown by way of illustration preferred embodiments thereof and in which:

Figure 1 is a side view of a preferred construction of a steam trap embodying a controlling element in accordance with the invention.

Figure 2 is a transverse cross section of the steam trap construction shown in Figure 1 to illustrate the relative position and arrangement of a preferred form of bi-metallic control element in accordance with the invention.

Figure 3 is a diagrammatic view partly in section of a portion of the steam trap construction shown in Figure 2 with the segments of both coupled bi-metallic members shown in complete deflected condition with the valve head seated on the valve seat under maximum temperature conditions.

Figures 4, 5 and 6 are diagrammatic views showing the action of a preferred form of bi-metallic controlling element in accordance with the invention as it would appear with, one segment of each member pulling, Figure 4; two segments of each member pulling, Figure 5; and all three segments of each member pulling, Figure 6.

Figure 7 is a detailed view of a temperature control arrangement which can be utilized with the valve head clearance adjusting members of the steam trap constructions illustrated.

Figure 8 is a diagrammatic view in perspective elevation of an alternative form of a bi-metallic element controlling arrangement in accordance with the invention.

Figure 9 is a view in plan partially in section of the construction shown in Figure 8.

Figure 10 is a cross sectional view in side elevation of the controlling element arrangement shown in Figure 8.

Figure 11 is a side view partially in section of a still further alternative arrangement of a bi-metallic controlling element construction in accordance with the invention.

With particular reference to Figures 1 and 2 of the drawings, a universal steam trap embodying controlling elements in accordance with the invention is shown as comprising a main outer body **10** having an internal recess constituting a fluid chamber **12** and opposed borings constituting inlet **14** and outlet passages **16**. The outlet passage **16** leads into an intermediate enlargement **20** and is continued by a tapped opening **22** providing a means of connection to the piping of a heating system. The inlet passage **14** is also tapped to allow further connection. The outlet passage **16** is tapped and a fitted valve seat **24** is mounted in the passage so that the end of the seat extends slightly into the enlargement **20**. The valve seat **24** is shaped so as to have a central valve stem accommodating passage **26** and transverse outlet passages **27**, **28** to permit the fluid to pass from the fluid chamber **12**. A cylindrical extension **29** is provided on the inner end of the valve seat **24**, the passage **26** continuing through this extension.

A valve member having an elongated shank **30** and a bulbous valve head **32** is mounted for free floating movement within the fluid chamber **12** in the following manner. The preferred dual member bi-metallic temperature and pressure responsive controlling element in accordance with the present invention is mounted on the extension **29** of the valve seat **24** by a cylindrical element supporting member **41** which slidably fits over the valve seat extension **29**.

The bi-metallic element **40** comprises a first bi-metallic member **42** and a second bi-metallic member **43** which are pivotally connected to each other. Each of the members **42, 43** is made up of a plurality of thermal responsive bi-metallic segments of graduated strength **42***a*, **42***b*, **42***c* and **43***a*, **43***b*, **43***c*, respectively.

The segments **42***a*, **42***b* and so on, in each of the members **42, 43** are connected to each other centrally of their length by spacing plates **44** so that the terminal ends are free for deflection. The inner segments **42***a*, **43***a*, of the respective members are pivotally connected to each other at their terminal ends by connecting brackets **45**, **47** so that the deflection of the segment **42***a* of the first member **42** is transmitted to segment **43***a* of the second member **43**, and the deflection of the segment **43***a* of the second member **43** is added to the deflection of the first member. The progressive deflection of the other segments **42***b*, **42***c* and **43***b*, **43***c* brings their terminal ends into contact with the ends of the first segments so that as the temperature and pressure increase, the temperature responsive strength of the controlling element accordingly increases.

Each of the bi-metallic segments and their spacing plates **44** are provided with a central opening through which the elongated shank or stem **30** of the valve freely fits. The terminal end **31** of the valve stem **30** is provided with a retaining nut **33** which bears against the outer plate **43***c* of the second member **43**.

As previously mentioned, the combined members **42, 43** are supported relative to the valve stem **30** by the cylindrical supporting member **41** which is fixed to the outer segment **42***c* of the first member **42**. The face **53** of the member **41** adjacent the valve seat **24** is tapered and a pivotally mounted adjusting wedge **55** is provided which fits between the rear face **25** of the valve seat **24** and the face **53** of the member **41**. The adjusting wedge **55** is bifurcate so as to extend on each side of the valve seat extension **29** and is pivotally mounted on the end of an elongated rod **60** which extends through a threaded plug **62** to the exterior of the body **10** where it is connected to an adjustable threaded cap **64** fitting over the end of the plug **62**. The pivotal connection

between the end of the rod **60** and the wedge **55** comprises of a ball and socket joint **66** which is mounted on the end of the rod **60**.

A sealing ring **68** is preferably provided in the plug **62** to prevent possible escape of fluid between the rod **60** and the interior of the plug, and a locking nut **70** is provided so as to enable the adjusting cap to be locked in any desired position. With this arrangement, rotation of the adjusting cap **64** on the exterior of the body **10** causes a corresponding raising or lowering of the wedge **55** so as to act against the element supporting member **41**, thus varying the clearance between the valve head **32** and the valve seat **24**.

The bi-metallic members **42, 43** are constructed so that the deflection of the combined segments follows a curve substantially equal to the saturated steam curve. As it would be extremely difficult, if not impossible, to obtain a single bi-metallic element having the exact characteristics of the saturated steam curve pressures and temperatures, the present multi-segment construction was developed so that the temperature responsive controlling element would respond, as nearly as possible, to the saturated steam curve.

While the main controlling element of the applicant's earlier steam trap construction, as shown in United States Patent 2,629,553, also embodies these general characteristics, this earlier structure was not capable of handling large quantities of condensate in the manner of the present improvement.

As will be appreciated, by the particular connection of the bi-metallic segments to the valve stem and the preferred means of combining the bi-metallic members, the actual distance of deflection of the members is greatly increased as is their effective thermal responsive strength. This gives the present controlling element the advantage of providing a steam trap with more than double the normal capacity of the earlier type of steam trap of this nature.

The various segments **42***a*, **42***b* and **42***c* and **43***a*, **43***b*, and **43***c* are mounted in spaced apart relationship relative to each other by the spacing plates **44** so that only the first segments **42***a*, **43***a* will be in effective operation from, for example, zero to about 22 p. s. i., that is, from about 212° F. to about 250° F.

The second segments **42***b*, **43***b* come into operation at about 250° F. and add ability to add force to the segments **42***a*, **43***a* over the range of about 250° F. to about 325° F. for about 69 p. s. i. At this point, the segments **42***c*, **43***c* come into operation to add force to the segments **42***a*, **42***b* and **43***a*, **43***b* for pressures from about 69 p. s. i. up to about 250 p. s. i.

It will be appreciated that the adding of additional segments or variation of the thermal responsive strength of the individual segments will permit making a controlling element adapted to handle higher temperatures and greater pressure if desired. It will also be understood that while the segments **42***a*, **42***b*, **42***c* and **43***a*, **43***b*, **43***c*, are shown as each comprising one single bi-metallic segment comprising two plates of varying metal having largely different coefficients of thermal expansion that in actual practice each segment comprises of a plurality of similar bi-metallic plates. The number of bi-metallic plates in each segment is increased proportionally upwards from the segments **42***a*, **43***a* to the segments **42***c*, **43***c*, the exact number of plates in each segment depending on the strength and size of the individual plates and the thermal pull required to keep the valve closed against the steam pressure. This factor, of course, is determined by the area of the orifice of the valve seat **24** and the surface acted on of the valve closure head **32**.

In the construction illustrated the casing body also includes a side opening **100** leading into a chamber **12** and a chemically resistant gas disc **102** is mounted in this opening between suitable asbestos gaskets. The disc **100** is retained in position by the means of an annular

cover **104** threadably engaged in the body opening **100**. This provides a control glass whereby a visual check may be made of the fluid within the chamber **12**.

The end of the chamber **12** adjacent the inlet passage **14** is reduced to a substantial cylindrical portion **13** wherein the strainer **124** is mounted by known means. As indicated in the drawing, the clearance between the strainer and the adjacent walls of the valve chamber is at least as small as the strainer openings. A tapped opening **105** is provided in the body **10** beneath the portion **13** and a strainer plug **106** is threadably secured in this opening. A tapped opening **110** is provided in the body **10** over the portion **13** and a rapid reaction bi-metallic thermometer **112** is threadably engaged in this opening so that the temperature sensitive portion **113'** is in the path of the fluid passing into the chamber **12**. A similar type thermometer **113** is disposed in the enlargement **20** of the outlet passage **16**.

Function and operation

As will be understood from the foregoing description, the valve member **32** can move freely forward and backward relative to the valve seat **24** and the valve seat extension **26** and the combined controlling thermal responsive elements provide a means of aligning the valve stem **30** rather than a fixed rigid support. The movement of the valve head **32** away from the valve seat **24** is limited by the adjusting nut provided on the inner terminal end of the valve stem **30**. As the combined bi-metallic elements **42, 43** are supported within the fluid chamber **12** by the cylindrical member **41**, they are adapted, on being subjected to the influence of steam, to deflect pulling the closure head **32** into contact with the valve seat **24** and thus closing the valve. When cooler condensate enters the chamber **12** the drop in temperature causes the combined elements **42, 43** to deflect in a reverse direction allowing the valve head **32** to be forced from the valve seat **24** by the fluid pressure.

The clearance of the valve head **32**, in a cold state when no steam is in the trap, is determined by the position of the adjusting wedge member **55**. By turning the adjusting cap **64** in one direction, the member **55** moves upwards diminishing the clearance between the valve head **32** and the valve seat **24**. By turning the adjusting cap **64** in the opposite direction the wedge member **55** moves downward increasing the clearance between the valve head **32** and the valve seat **24**.

In operation, and with reference to Figure 2, the trap is shown in a position where the equipment is started up from a cold inoperative condition. There is no steam in the lines so that only air and cold water is being pressed out from the lines by the boiler steam pressure. This pressure acting on the surface of the valve closure head **32** pushes the closure head away from the valve seat **24**. The valve head moves in this direction until the adjusting nut on the end of the valve stem **30** contacts the outer segment **43***c* of the combined members. Accordingly, the trap is open and the pressure line connected with the return line. In this condition, the valve member acts as an air vent allowing an initial blast discharge of air and cold water.

As the steam enters the trap, the valve is closed by steam temperature. This is shown diagrammatically in Figures 4, 5 and 6. The condensate is discharged and steam is in the equipment in all lines leading to the trap. The incoming steam hits the first of the bi-metallic segments **42***a*, **43***a*, which causes a combined deflection of these segments of the controlling members which pulls the valve head **32** into seating condition on the valve seat **24**. As previously described, due to the present construction of the heat-sensitive combined elements **42, 43** the additional segments will continue to operate in like manner as the pressure and temperature of the steam increase so that a large pressure and temperature range can be accommodated.

When the steam condenses the valve is opened by pressure; in this condition condensate enters and closes the chamber **12**. The opening of the valve member is performed in two steps. The first step is performed by temperature impulse in the following manner. As the temperature of the condensate entering the trap is lower than the steam temperature, the bi-metallic element makes a slight movement towards the opening position of the valve head **32** as the valve closure head **32** is free floating and always under pressure. Then released by this reverse movement, the valve head **32** is pressed out from the seat **24** and opens the trap connecting the high pressure side with the return line. Thus the flow of condensate is released. When this step occurs, we have the following powers acting in the trap. The thermal pull developed by the deflection of the combined element members acts in the direction to keep the valve head seated against the valve seat **24**. The pressure acts on the seated surface of the spherical valve head **32** which has substantially the same surface as the opening of the valve seat **24**. This pressure acting on the valve head surface develops a pressure power acting against the thermal pull in the opening direction when the condensate enters the trap.

The combined bi-metallic members are slightly deflected from the closing direction when the thermal pull of the bi-metal drops sufficiently so that the above mentioned pressure power overcomes the thermal pull and opens the valve. When the flow of condensate is released and the head partially unseated, the pressure acts on the complete inner surface of the valve head **32**. This surface has a greater area than that of the valve seat **24** so that more pressure power is applied to the valve head **32** overcoming the gradually weakening thermal pull of the bi-metallic element. This increased pressure pushes the bi-metallic element into its original supporting position so that the valve member is allowed to make its complete movement in the opening direction, which due to the particular arrangement of the bi-metallic segments opens the valve to complete and full capacity which is substantially double that of similar traps of this nature.

A similar result is obtained by the alternative construction of the combined bi-metallic thermal responsive members shown in Figure 8. In this construction, a first series of bi-metal segments **142***a*, **142***b* are mounted within the fluid chamber **12** in a fixed position relative to the valve stem **30** and the valve head **32**. Each of the members **142***a*, **142***b* are of graduated thermal strength as described before and are adapted upon being subjected to increased temperature conditions to deflect in a direction away from the valve seat **24**.

A second bi-metallic member **145** is supported and connected to the member **142***a* by a supporting yoke **150** in a direction transverse to the deflecting direction of the members **142***a*, **142***b*. This second bi-metallic member **145** is supported on the yoke **150** so as to be capable of deflection away from the combined members **142***a*, **142***b* so that its deflection is added to the deflection of these members giving additional travel to the movement of the valve closure head **32**. The members **142***a*, **142***b* are slotted as indicated at **148** and the support **150** includes a central opening as does the bi-metallic member **145** to accommodate the inner terminal end of the valve stem **30**. A locking nut **152** is provided on the end of the valve stem **30** and an adjusting arrangement similar to that previously described for the preferred construction is provided to allow for adjustment of the clearance between the valve head **32** and the valve seat **24**. This arrangement comprises a first member **160** secured to the outer face of the bi-metallic member **145** and a second member **164** mounted on the terminal end of the valve stem **30**. The outer face **162** is tapered and a cooperating adjusting wedge **166** is provided which through an adjustable screw arrangement similar to that described for the preferred construction is utilized to move this wedge. The only difference required is that the wedge must be supported for sliding movement relative to the adjusting stem, shown in Figure 11. This is accomplished by having the end of the rod **60** provided with a yoke supporting a shaft and having the member **166** mounted for sliding movement on the shaft.

In operation, this alternative construction functions in a similar manner to that described previously for the preferred construction. The bi-metallic segments of the members **142***a*, **142***b* deflect in sequence with the first segment **142***a* of the member **142** first deflecting and consequently moving the second member **145** away from the valve seat **24**. The deflection of the member **145** is added to the deflection of the first member **142***a* so as to seat the valve closure head **32** on the valve seat **24**. The second segment **142***b* of the first group of bi-metallic members **142** cooperates as described before to give the necessary additional thermal responsive resistance against the pressure in the fluid chamber **12** when the pressure and temperature increase.

A still further alternative arrangement is shown in Figure 11 wherein a pair of bi-metallic members **242**, **243** are utilized to achieve the same result as described for the preferred and first alternative constructions.

In this arrangement, the members **242**, **243** each comprise of two segments of bi-metal which are gain of graduated strength relative to each other with the lower ends of the members **242**, **243** being held together and supported by a support **250** within the fluid chamber **12**. The fluid chamber **12** is slightly modified in the interior to provide an outstanding projection **252** and the support **250** is mounted for sliding movement between this portion of the body **10** and the external wall. A shaft **260** which extends through this support **250** to protrude beyond the support at each end is journalled for sliding movement in openings **262**, **263** provided in the casing portions referred to.

The segments **243***a*, **243***b* of the member **243** are adapted to deflect in a direction away from the valve seat **24** while the segments **242***a*, **242***b* of the member **242** are adapted to deflect towards the valve seat **24**. The first segment **242***a* of the member **242** is provided with a valve seat engaging member **270** so that upon deflection of the member **242***a* the entire support **250** is moved away from the inner wall of casing **10** relative to the valve seat **24**. Since the bi-metallic member **243** is also connected to the support **250**, it is initially moved in this direction and by the deflection of the member **243***a*, the end of the valve stem **30** is acted on so as to bring the valve closure head **32** into closing position against the valve seat **24**.

The bi-metallic segment **243***a* is connected to and is adapted to bear against an adjusting member **280** which slidably fits over the inner terminal end of the valve stem **30** and which acts in cooperation with a further adjusting portion **282** fixed to the end of the valve stem **30** and retained by an adjusting nut **284** with an adjusting wedge **255** to provide a means of adjusting the clearance between the valve closure head **32** and the valve seat **24**. As in the previous arrangements described, the rear face of the adjusting portion **280** is tapered and the wedge **255** which is bifurcate so as to be adapted to fit over the shaft or stem **30** of the valve, is adapted to cooperate with this wedge face and the member **282** so that adjustment of the shaft **60** is adapted to raise and lower the wedge member **255**.

The wedge member **255** is mounted in a similar manner to that described for the wedge member **150** in the first alternative construction, that is, the end of the shaft **60** is provided with a supporting yoke **160**, a shaft **162** is mounted on this yoke and the member **255** is mounted on the shaft **162** whereby it is capable of sliding movement when the end of the valve stem **30** is urged outwards due to the deflecting action of the controlling bi-

metallic elements. Due to the mounting of the supporting member **250** this is also free to slide towards and away relative to the valve seat **24** under the controlling deflecting movements of the bi-metallic members.

It will be appreciated by reference to the accompanying drawings and the preceding description that the preferred construction and the alternative constructions of a bi-metallic controlling element in accordance with the present invention, when embodied in the type of steam trap described, makes it possible for a more complete and sensitive control of a steam trap than was previously possible. Moreover, due to the coupling of two or more bi-metallic members in the manner described the capacity of the trap is more than doubled when compared with that of previous steam traps of this type.

As will be appreciated, when referring specifically to the preferred construction, the central positioning of the valve stem relative to the deflecting portions of the controlling element doubles the effective thermal responsive strength permitting the use of larger valve orifices and the coupling of the two elements with their deflection opposed or combined doubles the effective distance travel of the deflection.

I claim:

1. A temperature and pressure responsive controlling element adapted for use in a steam trap of the type having a fluid chamber, inlet and outlet passages to said chamber with the outer end of said outlet passage provided with a valve seat and a closure valve having a valve stem, and an outstanding closure head adapted to seat on said valve seat; comprising a first thermal responsive member supported within said trap fluid chamber adjacent said valve seat, a second thermal responsive member connected to said first thermal responsive member and having valve stem engaging means, at least one of said thermal responsive members comprising a plurality of spaced apart thermal responsive bi-metallic segments, each of said segments being connected to adjacent segments by a minor portion only and having a major portion free to respond individually under predetermined temperature conditions and including at least one free end spaced from an adjacent segment, the first segment of said one member being in opposed relationship with said other thermal responsive member and being inter-connected therewith whereby movement by deflection of said one member is transmitted to said first segment of said other member, and movement of said first segment by deflection is added to the movement of said other member and transmitted to said valve stem to move said valve closure head into engagement with said valve seat, and movement of the remainder of said segments of said one member by deflection is progressively added to the combined closing pull of said first segment and said other member.

2. A temperature and pressure responsive controlling element as claimed in claim 1 wherein said first thermal responsive member is mounted within said fluid chamber relative to said valve seat so as to be adapted to deflect in a direction away from said valve seat and said second thermal responsive member is mounted relative to said first member so as to be adapted to deflect in a direction opposed to said first member deflection.

3. A temperature and pressure responsive controlling element as claimed in claim 1 wherein said second thermal responsive element is supported within said fluid chamber by its connection with said first member.

4. A temperature and pressure responsive controlling element as claimed in claim 1 wherein said first and second thermal responsive elements are mounted on a common support and said support is mounted for sliding movement within said fluid chamber.

5. A temperature and pressure responsive controlling element adapted for use in a steam trap of the type having a fluid chamber, inlet and outlet passages to said fluid chamber with the outer end of said outlet passage provided with a valve seat, and a closure valve having a valve stem and an outstanding closure head adapted to seat on said valve seat; comprising a first thermal responsive member supported within said trap fluid chamber adjacent said valve seat, a second thermal responsive member connected to said first thermal responsive member and having valve stem engaging means, said first and second thermal responsive members each comprising a plurality of spaced apart thermally responsive bi-metallic segments, each of said segments being of graduated thermally responsive strength relative to an adjacent segment and being connected to each adjacent segment by a minor portion only with the major portion including at least one end spaced from adjacent segments free to respond individually under predetermined temperature conditions, the weakest of said segments of said first member being disposed in opposed relationship with the corresponding segment of the other of said members and being interconnected one with the other whereby movement by deflection of said first member is transmitted to said second member and movement by deflection of said second member is combined with the movement of said first member and transmitted to said valve stem to move said first valve closure head towards said valve seat.

6. A temperature and pressure responsive controlling element as claimed in claim 5 wherein said first thermal responsive member is mounted within said fluid chamber relative to said valve seat so as to be adapted to deflect in a direction away from said valve seat and said second thermal responsive member is mounted relative to said first member so as to be adapted to deflect in a direction opposed to said first member deflection.

7. A temperature and pressure responsive controlling element as claimed in claim 5 wherein said second thermal responsive element is supported within said fluid chamber by its connection with said first member.

8. A temperature and pressure responsive controlling element as claimed in claim 5 wherein said first and second thermal responsive elements are mounted on a common support and said support is mounted for sliding movement within said fluid chamber.

9. A temperature and pressure responsive controlling element adapted for use in a steam trap of the type having a fluid chamber, inlet and outlet passages to said fluid chamber with the outer end of said outlet passage provided with a valve seat, and a closure valve having a valve stem and an outstanding closure head adapted to seat on said valve seat; comprising a first thermal responsive member supported within said trap fluid chamber adjacent said valve seat, a second thermally responsive member connected to said first thermal responsive member and having valve stem engaging means, said first and second thermal responsive members each comprising a plurality of spaced apart thermal responsive bi-metallic segments, each of said segments being connected to each adjacent segment by a minor portion only with the major portion including one end spaced from adjacent segments free to respond individually under predetermined temperature conditions, the first of said segments of said first member being disposed in opposed relationship with the corresponding segment of the other of said members and being interconnected between with the other whereby movement by deflection of said first member is transmitted to said second member and movement by deflection of said second member is combined with the movement of said second member and transmitted to said valve stem to move said first valve closure head towards said valve seat.

10. A temperature and pressure responsive controlling element as claimed in claim 9 wherein said first thermal responsive member is mounted within said fluid chamber relative to said valve seat so as to be adapted to deflect in a direction away from said valve seat and said second thermal responsive member is mounted relative to said

first member so as to be adapted to deflect in a direction opposed to said first member deflection.

11. A temperature and pressure responsive controlling element as claimed in claim 9 wherein said second thermal responsive element is supported within said fluid chamber by its connection with said first member.

12. A temperature and pressure responsive controlling element as claimed in claim 9 wherein said first and second thermal responsive elements are mounted on a common support and said support is mounted for sliding movement within said fluid chamber.

13. A temperature responsive controlling unit adapted for use in steam traps of the type embodying a fluid chamber having fluid inlet and outlet passages, a valve seat in said fluid outlet passage, and a valve including an outstanding valve head adapted to seat on said valve seat and a valve stem extending from said valve head; comprising a first thermally responsive bi-metallic element connected to an element supporting member mounted for sliding movement on an extension of said valve seat, said first element consisting of a plurality of interconnected spaced apart bi-metallic segments disposed relative to said supporting member so as to be adapted to deflect in a direction away from said valve seat, a second thermally responsive element consisting of a plurality of interconnected spaced apart bi-metallic segments pivotally connected to said first thermally responsive element with the segments of said second element disposed so as to deflect in a direction towards said first element, each of the segments of said first and second members being connected to an adjacent segment by a minor portion only with the major portion including two free ends spaced apart from the corresponding ends of adjacent segments and adapted to respond individually under predetermined temperature conditions, said second thermally responsive element including valve stem engaging means, whereby deflection of said first element is transmitted to said second element and deflection of said second element is added to said first element deflection and transmitted to said valve stem moving said valve head relative to said valve seat.

14. A temperature responsive controlling unit as claimed in claim 13 wherein the segments of each of said first and second bi-metallic elements are of graduated thermally responsive strength relative an adjacent segment, the weakest of said segments of said first member being disposed in opposed relationship with the corresponding segments of said second member with said pivotal connection being between said opposed weakest segments.

15. A temperature responsive controlling unit as claimed in claim 13 wherein the segments of each of said elements are interconnected centrally of their length and each element includes a central opening adapted to accommodate said valve stem, said supporting member having a corresponding central opening and being mounted concentrically of said element openings.

16. A temperature responsive controlling unit as claimed in claim 13 wherein a tapered wedge is mounted for sliding movement between said element supporting member and said valve seat, said wedge being supported on an adjustable shaft extending exteriorly of said fluid chamber.

17. A temperature responsive controlling unit adapted for use in steam traps of the type embodying a fluid chamber having fluid inlet and outlet passages, a valve seat in said fluid outlet passage, and a valve including an outstanding valve head adapted to seat on said valve seat and a valve stem extending from said valve head; comprising a first thermally responsive member mounted within said fluid chamber in alignment with said valve seat and valve stem, a supporting yoke mounted on said first thermally responsive member and a second thermally responsive member mounted on said supporting yoke and including valve stem engaging means, said first and second thermally responsive members being disposed so as to deflect in a direction away from said valve seat under predetermined temperature conditions, whereby the deflection of said first member is transmitted to said second member and the deflection of said second member is added to the deflection of said first member and the combined deflectional movement of both members is transmitted to said valve stem moving said valve head relative to said valve seat.

18. A temperature responsive controlling unit as claimed in claim 17 wherein said first thermally responsive member comprises a plurality of spaced apart thermally responsive bi-metallic segments, each of said segments being of graduated thermally responsive strength relative to an adjacent segment and being connected to each adjacent segment by a minor portion only with the major portion free to respond individually under predetermined temperature conditions, said supporting yoke being connected to the weakest of said segments.

19. A temperature responsive controlling unit as claimed in claim 17 wherein said thermally responsive member comprises at least one bi-metallic segment with the outer ends engaged with said supporting yoke and the center portion free for deflection.

20. A temperature responsive controlling unit as claimed in claim 17 wherein a tapered wedge is mounted for sliding movement between said second thermally responsive member valve stem engaging means and said valve stem inner terminal end, said wedge being supported on an adjustable shaft extending exteriorly of said fluid chamber.

21. A temperature responsive controlling unit as claimed in claim 17 wherein said first thermally responsive member comprises a plurality of spaced apart thermally responsive bimetallic segments, each of said segments being connected to each adjacent segment by a minor portion only with the major portion including one free end spaced from the adjacent segments free to respond individually under predetermined temperature conditions, said supporting yoke being connected to a first one of said segments.

22. A temperature responsive controlling unit as claimed in claim 21, wherein said second thermally responsive member comprises at least one bi-metallic segment with the outer ends engaged with said supporting yoke and the centre portion free for deflection.

23. A temperature responsive controlling unit as claimed in claim 21 wherein a tapered wedge is mounted for sliding movement between said second thermally responsive member valve stem engaging means and said valve stem inner terminal end, said wedge being supported on an adjustable shaft extending exteriorly of said fluid chamber.

24. A temperature responsive controlling unit adapted for use in steam traps of the type embodying a fluid chamber having fluid inlet and outlet passages, a valve seat in said fluid outlet passage, and a valve having an outstanding valve head adapted to seat on said valve seat and a valve stem extending from said head; comprising first and second thermal responsive members mounted on a common supporting member, said supporting member being mounted for sliding movement within said fluid chamber in alignment wih said valve stem and valve seat, said second thermal responsive member including valve stem engaging means, said first and second thermal responsive members each comprising a plurality of spaced apart thermally responsive bi-metallic segments, each of said segments being of graduated thermally responsive strength relative to an adjacent segment and being connected to said adjacent segment and to said common support by a minor portion only with the major portion including one end spaced from an adjacent segment free to respond individually under predetermined temperature conditions, the weakest of said segments of said first member including means for engaging the inner end of

said valve seat and the weakest of said segments of said second member including said valve stem engaging means, the segments of said first and second members being mounted in said common support in opposed relationship whereby the deflection of the segments of said first member is transmitted through said common support to said second member and the deflection of the segments of said second member is added to the deflection of said first member and transmitted to said valve stem moving said valve head towards said valve seat.

25. A temperature responsive controlling unit adapted for use in a steam trap of the type embodying a fluid chamber having fluid inlet and outlet passages, a valve seat in said fluid outlet passage, and a valve having an outstanding valve head adapted to seat on said valve seat, and a valve stem extending from said valve head; comprising, first and second thermal responsive members mounted on a main supporting member, said supporting member being mounted for sliding movement within said fluid chamber in alignment with said valve stem and valve seat, said second thermal responsive member including valve stem engaging means, said first and second thermal responsive members each comprising a plurality of spaced apart thermally responsive bi-metallic segments, each of said segments being connected to said adjacent segment

and to said common support by a minor portion only with the major portion including one end spaced from the adjacent segment free to respond individually under predetermined temperature conditions, the first of said segments of said first member including means for engaging the inner end of said valve seat and the first of said segments of said second member including said valve stem engaging means, the said segments of said first and second member being mounted in said common support in opposed relationship whereby the deflection of the segments of said first member is transmitted through said common support to said second member and the deflection of the segments of said second member is added to the deflection of said first member and transmitted to said valve stem moving said valve head towards said valve seat.

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