Dec. 19, 1939. E. KLAFSTAD ET AL 2,183,650

RELIEF VALVE

Filed Nov. 16, 1937 2 Sheets-Sheet 1

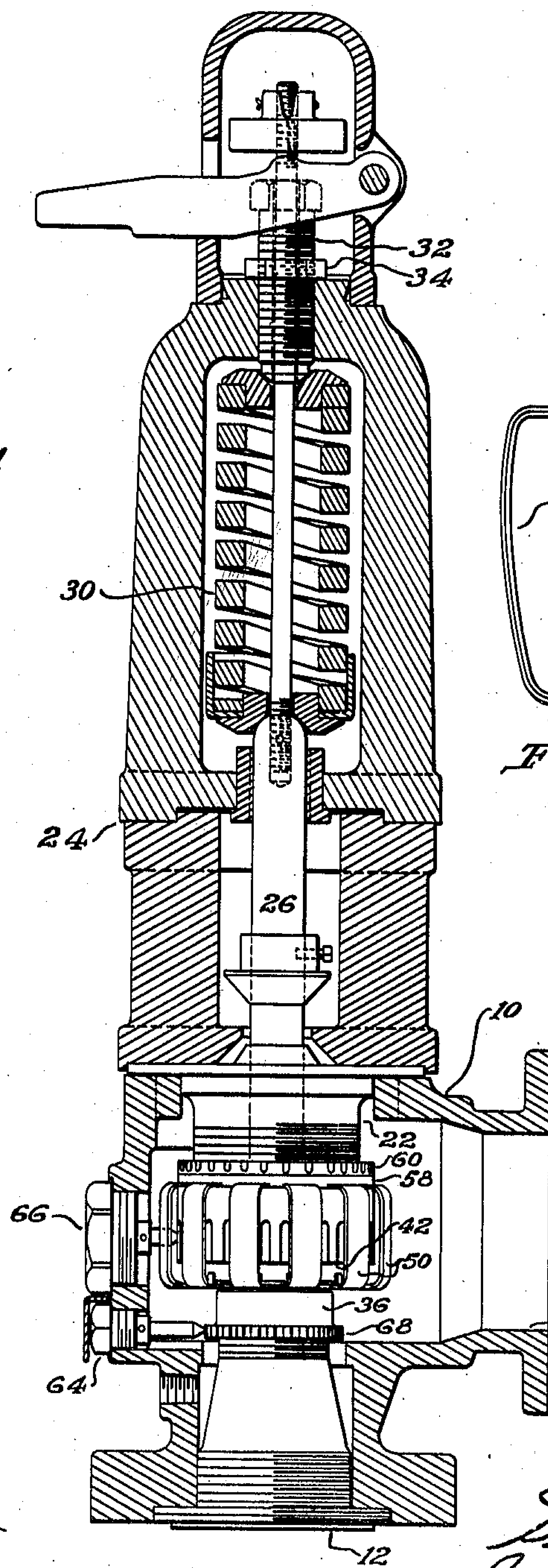

Fig. 1

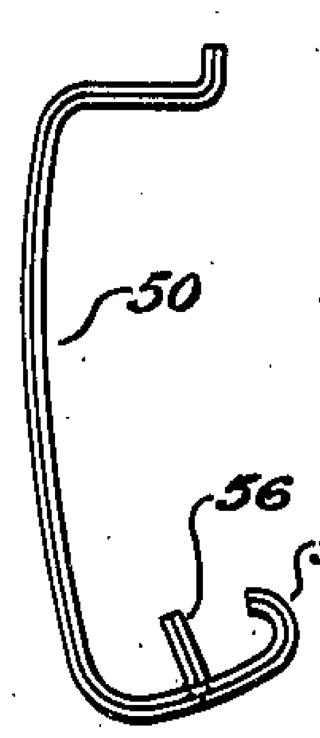

Fig. 3

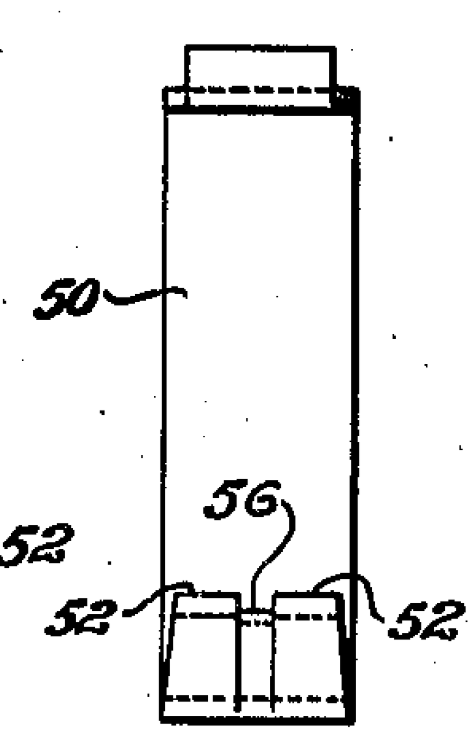

Fig. 4

Witness

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RELIEF VALVE

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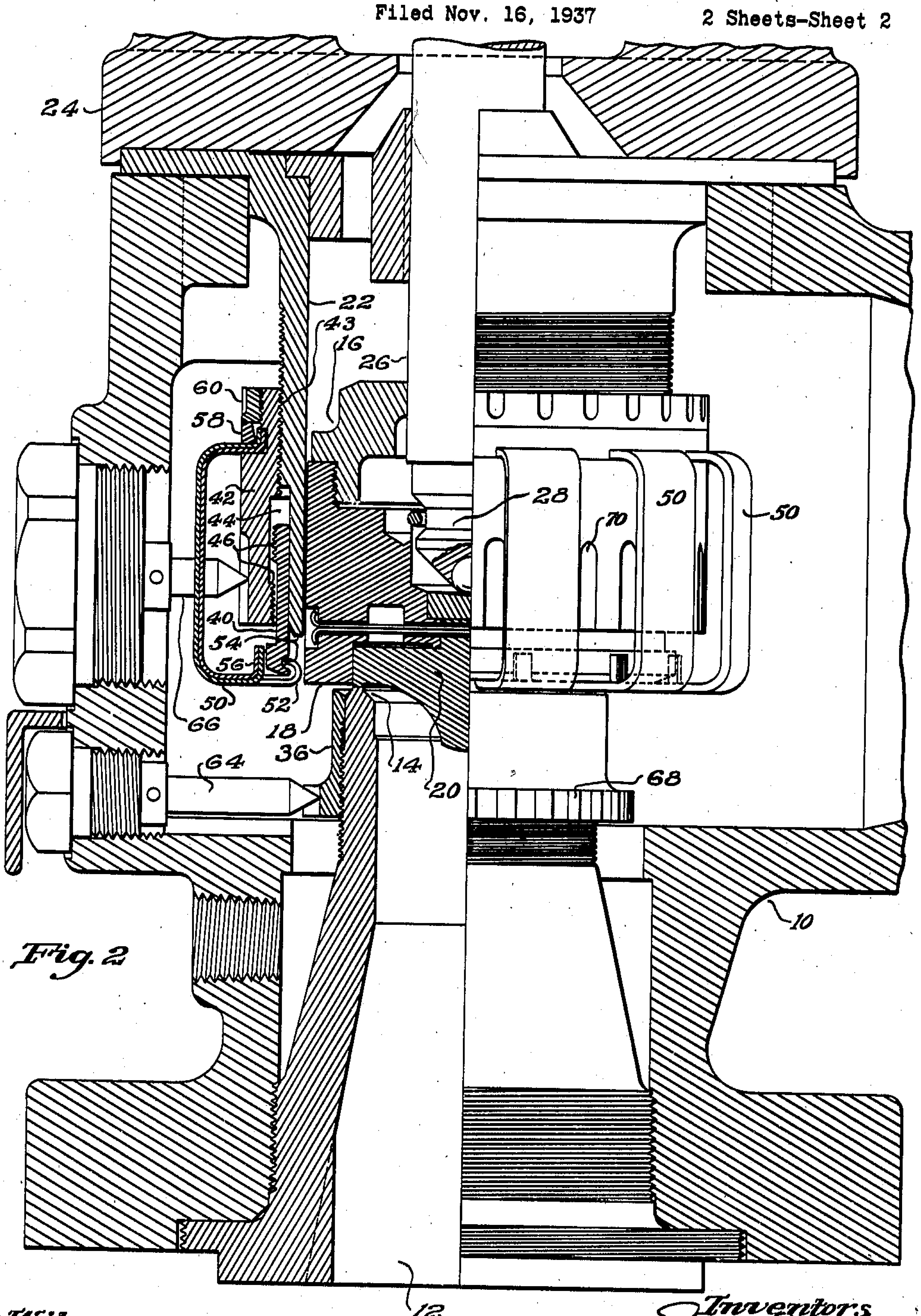

Fig. 2

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UNITED STATES PATENT OFFICE

2,183,650

RELIEF VALVE

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13 Claims. (Cl. 137—53)

The present invention is concerned with safety and relief valves, and relates more particularly to such valves employed for the relief of high pressure boilers and fluid conduits such as steam lines.

The type of relief valve with which the present invention is concerned is described generally in United States Letters Patent to Coffin, No. 1,743,430, dated January 14, 1930. This valve employs a spring-loaded closure member designed to recede from its seat when the pressure of fluid in the discharge orifice exceeds a predetermined amount. Cooperating with the closure member is an annular ring-like fluid deflector or shroud contacting with and deflecting escaping fluid as the valve opens. This deflection of escaping fluid controlled through adjustment of the shroud converts kinetic energy of the escaping fluid into effective lifting energy which complements the lifting effect due to static pressure in a manner to force the spring-loaded closure member to a full open position with little or no increase in pressure beyond that necessary to initially move the member from its seat. Not only does this method of construction permit full opening of the closure member with relatively slight increases in pressure, but it permits closing of the member upon a relatively slight drop in pressure below the predetermined range, and causes the valve to operate with what is commonly termed a low "blow-down."

It is the purpose and object of the present invention to design a valve of this general type which will operate with equal efficiency on both saturated and superheated steam.

With this and other objects in view, the invention accordingly consists in a spring-loaded closure member designed to open upon exceeding a predetermined pressure, and provided with means for the conversion of the available energy of the escaping fluid into useful lifting force, this means having provision for automatic adjustment to compensate for the effective difference in the available reactionary (or lifting) forces between the two types of fluid, namely, saturated steam and superheated steam, at approximately the same pressures.

In a simple and efficient form of the invention, the annular fluid deflector shroud ring with which the valve is provided is supported by temperature responsive members which upon increase in temperature tend to automatically vary the position of the shroud ring in a manner to modify the discharge path and increase deflection of escaping fluid as the temperature rises. With this form of construction a shroud ring properly designed to deflect, for example, saturated steam at 600 lbs. pressure, will be automatically altered in its position to cause greater deflection when superheated steam is employed at the same pressure, due to the greater temperature of the superheated steam at the corresponding pressure, this difference aggregating, for example, about 200° F. The movement of the shroud ring into a position where greater fluid deflection is secured compensates for the loss in the available forces in the superheated steam at the same pressure, and imparts the requisite complementary lifting force to the closure member, the movement of the shroud ring being proportional to the applied temperature and the lifting force required at any point.

By virtue of such a construction, a valve properly adjusted will operate equally well on saturated or superheated steam at approximately the same pressure, whereas without these improved compensating features, a valve set for operation upon either superheated or saturated steam will not function equally satisfactorily when used with the other type of fluid.

In the accompanying drawings illustrating the preferred form of the invention, Fig. 1 represents a section in elevation of a safety valve embodying the features of the invention; Fig. 2 is a detail, partly in section, illustrating the thermostatically controlled deflector ring with associated parts; and Figs. 3 and 4 are details illustrating elevations in different planes of a thermostatic member for supporting the deflector ring.

The valve shown in the illustrated embodiment of the invention comprises a body portion 10 in which is threadedly supported a throat tube 12 forming a fluid discharge orifice terminating in a seat 14 normally closed by a disk assembly 16, comprising an outer portion or recessed disk 18 within which is mounted the disk proper 20 through connections which provide for a slight swiveling movement. The disk assembly as a whole is slidingly received within a cylindrical guide 22 which is fixedly clamped to the body 10 through a spring housing 24. The disk assembly is connected with a spindle 26 through the connection assembly indicated at 28, and the spindle extends outwardly through the spring housing to a point remote from the seat. The disk assembly and spindle are loaded through a coiled compression spring 30 surrounding the spindle and capable of adjustment to vary the loading effect through the threaded adjusting member 32 mounted in the spring housing and locked in position by a nut 34, all as will be evident to those skilled in the art.

This type of valve is completely guided outside of the throat tube, leaving the latter completely unobstructed for the discharge of escaping fluid. Upon recession of the disk assembly from its seat, escaping fluid is controlled and deflected, first by a throat ring 36 threadedly mounted upon the outside of the throat tube, and again by an outer fluid deflector or shroud ring 40 which normally projects below the disk assembly as it recedes from its seat. This abrupt deflection of escaping fluid converts the available energy of the fluid into effective lifting force which augments the lifting force due to static pressure and causes the valve to go to full lift opening upon recession from its seat and escape of fluid thereby.

The shroud ring 40 is supported from an outer adjusting ring 42 which in turn is threadedly connected to the guide sleeve 22 at 43. Both the guide sleeve 22 and the adjusting ring 42 are recessed, as indicated in Fig. 2, to provide an annular slot 44 within which the shroud ring is received and moves. For convenience of assembly the shroud ring and adjusting ring are provided with complementary threaded portions 46 which serve to permit assembly of the parts into the positions indicated, and provide cooperating shoulders to limit the play of the shroud ring within the annular slot. Actually the shroud ring is connected to the adjusting ring through a series of thermo-responsive coupling members 50, each having a generally U-shaped form and fixed at one end to the adjusting ring and connected at its opposite or free end to the shroud ring. These members or clips, as shown more particularly in Figs. 3 and 4, are provided with inturned lower ends 52 which engage in an annular recess 54 formed in the shroud ring and are provided with tongues 56 engaging behind the shroud ring to prevent disengagement. The upper or fixed ends of the clips are fixedly connected with the adjusting ring through a spacer ring 58 and a clip locking ring 60, as indicated in Fig. 2. It will be evident that the U-clips are so designed that as temperature increases they tend to deflect from the position shown in Fig. 3 to the approximate position shown in Fig. 2, moving the shroud ring downwardly and thereby causing a greater deflection of escaping fluid.

Actually it has been found that when the valve is employed in connection with the relief of high pressure steam at 600 lbs. approximately, the movement of the shroud ring from a position satisfactory for saturated steam to a position satisfactory for superheated steam at this pressure may approximate seventy thousandths of an inch in order to compensate for the difference in steam characteristics with a temperature difference of 200° between the two fluids. The clips are preferably made of high temperature bimetal of a type commercially available employing a high expansion chrome nickel-steel as the inner element and Invar or its equivalent as the low expansion outer element.

As indicated more particularly in the drawings, a series of these U-shaped clips are symmetrically grouped about the disk assembly for supporting the shroud ring, and due to the fact that the lower ends of the clips are directly in the path of escaping steam the temperature of the clips responds instantly to any change in temperature of the escaping fluid for proper actuation of the shroud ring. In other words, in actual practice it has been found that there is no substantial time lag in the operation of the shroud ring when the valve opens and fluid is discharged thereby. Obviously other arrangements than that shown for producing temperature control compensation of the shroud ring might be produced without departing from the scope of the present invention, which is merely intended to illustrate one feasible and practical method of so doing.

In initially assembling the valve the main adjusting ring, together with the throat ring, are adjusted to secure proper operation under given conditions, the temperature compensation thereafter suitably altering the operation of the valve for modified conditions. Both the main adjusting ring and throat ring are retained in adjusted position by limiting screws 64 and 66, which are threaded inside the valve casing and engage at their inner ends with one of a series of slots 68 and 70 formed in the peripheral portions of the rings. The valve casing is provided with a flange connection 72 for discharging into a fluid conduit.

It will be evident that with the foregoing construction we have provided a relief valve which opens upon exceeding predetermined pressures, and which thereafter is further opened by augmenting the static lifting energy through conversion of a variable amount of available energy present in the escaping fluid, this variation in the amount of energy converted depending specifically upon the temperature of the escaping fluid in the relief range.

It will be understood that wherever the term "relief valve" is employed throughout the specification and claims it is intended to define a valve of this general type, irrespective of whether it may be designated in trade parlance as a safety or relief valve.

What is claimed is:

1. A relief valve comprising a casing having a fluid discharge opening terminating in a seat, a closure member contacting the seat to close the orifice, means for loading the member to oppose the fluid pressure within the orifice, means for augmenting the lifting effect due to fluid pressure by conversion of a portion of the available energy of escaping fluid, and thermostatically controlled means cooperating with said energy conversion means for regulating the additional energy procured through said conversion.

2. A relief valve comprising a casing having a fluid discharge orifice terminating in a seat, a closure member closing the seat, means for loading the member, an adjustable shroud ring surrounding the member to engage and deflect escaping fluid, thermostatically controlled means for regulating the position of the shroud ring, and an adjustable throat ring surrounding the seat and complementing the action of the shroud ring.

3. A relief valve comprising a casing having a throat tube forming a fluid discharge orifice, a seat at the terminus of the tube, a disk valve contacting the seat, a valve stem connected with the disk valve, a loading spring surrounding the stem, a guide in which the disk valve is slidingly received, a shroud ring projecting beyond the guide serving to engage and deflect escaping fluid, and thermostatically responsive means for supporting the shroud ring in a manner to vary the projection of the shroud ring in accordance with variations in temperature.

4. A relief valve comprising a casing having a throat tube forming a fluid discharge orifice, a seat at the terminus of the tube, a disk valve

contacting the seat, a valve stem connected with the disk valve, a loading spring surrounding the stem, a guide in which the disk valve is slidingly received, an annular ring surrounding the seat and serving to engage and deflect escaping fluid, and a series of bimetallic loops fixedly supported at one end and engaging and supporting the ring at the opposite end designed through deflection to vary the position of the ring.

5. A relief valve comprising a casing having a fluid discharge orifice terminating in a seat, a closure member cooperating with the seat to control flow through the orifice, means for loading the member, a ring adjacent to and coaxial with said discharge orifice for deflecting the escaping fluid, and a thermostatic member designed to support and adjust the relative position of the ring in accordance with the temperature of the escaping fluid.

6. A relief valve, comprising a casing having a fluid discharge orifice terminating in a seat, a closure member cooperating with the seat to control flow through the orifice, means for loading the member, an annular member surrounding the discharge orifice and defining a discharge path for escaping steam, and thermally responsive means for modifying the discharge path in a manner to vary the reactive effect of the escaping steam upon the closure member.

7. A relief valve, comprising a casing having a fluid discharge orifice terminating in a seat, a closure member cooperating with the seat to control flow through the orifice, means for spring loading the member, an annular ring-like member surrounding the seat and generally co-axial therewith, the annular member defining the discharge path of the steam beyond the seat in a manner to produce a reactive lifting load upon the closure, and thermally responsive means modifying the discharge path defined by the annular member with the temperature of escaping fluid.

8. A relief valve, comprising a casing having a fluid discharge orifice terminating in a seat, a closure member cooperating with the seat to control flow through the orifice, means for loading the member, an annular member surrounding the discharge orifice and defining a discharge path for escaping steam, and bi-metallic members responsive to the temperature of escaping steam for modifying the discharge path.

9. A relief valve, comprising a casing having a fluid discharge orifice terminating in a seat, a closure member cooperating with the seat to control flow through the orifice, means for loading the member, and thermally responsive means for variably defining the discharge path of escaping steam annularly about the seat in accordance with variations in temperature of the escaping fluid.

10. A relief valve, comprising a casing having a fluid discharge orifice terminating in a seat, a closure member cooperating with the seat to control flow through the orifice, an annular member surrounding the seat and separated therefrom to define a discharge path beyond the seat, and means governed by the temperature of escaping fluid to vary the position of the annular member and in consequence the discharge path defined thereby.

11. A relief valve, comprising a casing having a fluid discharge orifice terminating in a seat, a closure member cooperating with the seat to control flow through the orifice, means for loading the member, an annular ring-like member surrounding the seat for engaging and deflecting fluid escaping through the orifice, and a thermostatic support designed to maintain the ring-like member in a position determined by the temperature of the escaping fluid.

12. A relief valve, comprising a casing having a fluid discharge orifice terminating in a seat, a closure member cooperating with the seat to control flow through the orifice, means for loading the member, an annular ring-like member surrounding the seat and spaced therefrom to define a discharge path for steam, and a plurality of bimetallic members supporting the annular member and designed through deflection to vary the position of the annular member in accordance with temperature changes of the escaping steam.

13. A relief valve, comprising a casing having a fluid discharge orifice terminating in a seat, a closure member contacting the seat to close the orifice, means for loading the member to offset the pressure of fluid in the orifice, means for defining the discharge path of steam annularly about the orifice in a manner to convert the energy of escaping steam and complement the fluid pressure normally lifting the member, and thermally responsive means for modifying the lifting effect thus created by conversion of available energy of the escaping steam.

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