Nov. 18, 1924. 1,515,810

J. V. GIESLER

TEMPERATURE RESPONSIVE DEVICE

Filed June 17 1921 2 Sheets-Sheet 1

Fig. 1.

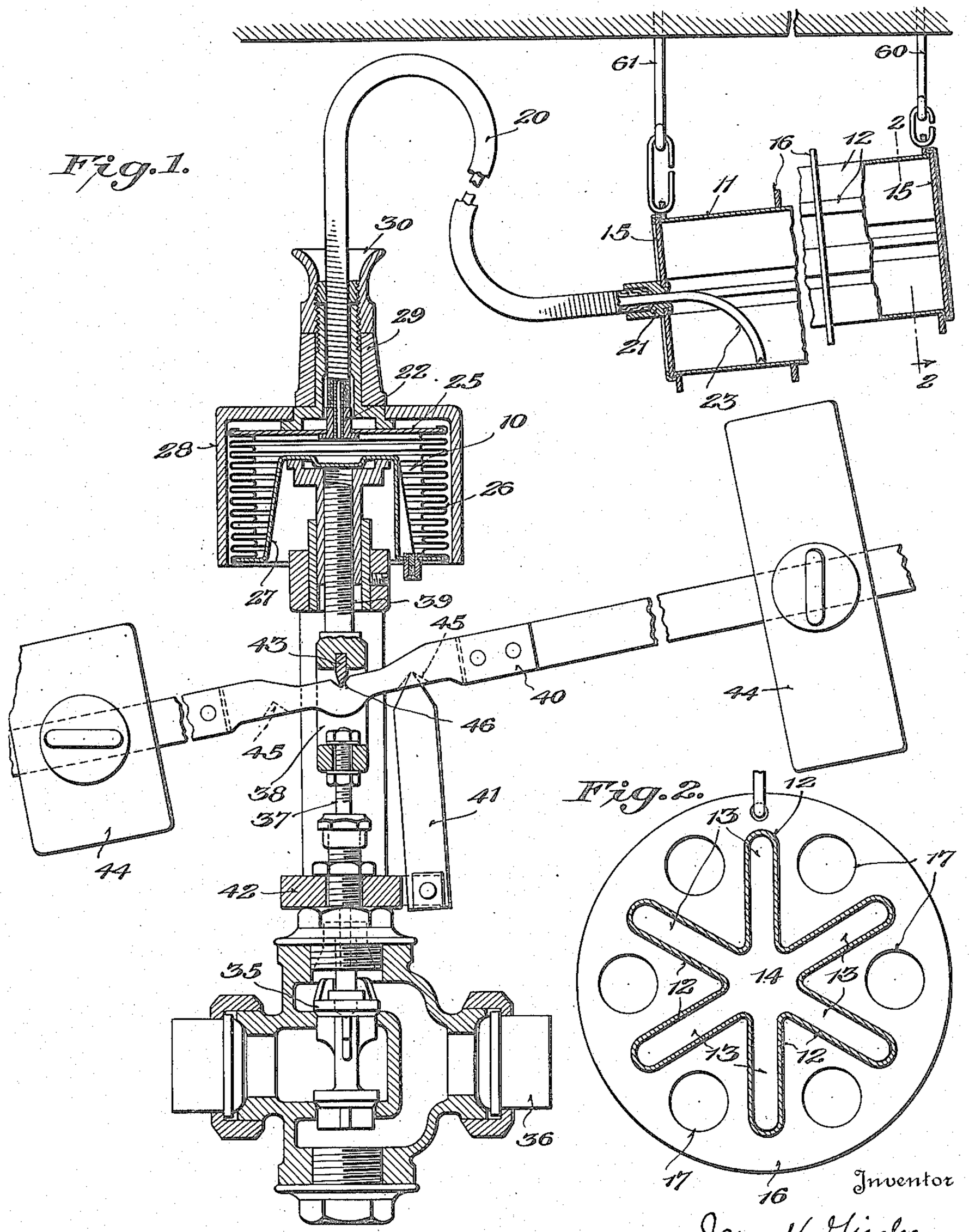

Fig. 2.

Inventor

Jean V. Giesler,

By Mauro, Cameron, Davis & Kerkam

Attorneys

Nov. 18, 1924. 1,515,810

J. V. GIESLER

TEMPERATURE RESPONSIVE DEVICE

Filed June 17 1921 2 Sheets-Sheet 2

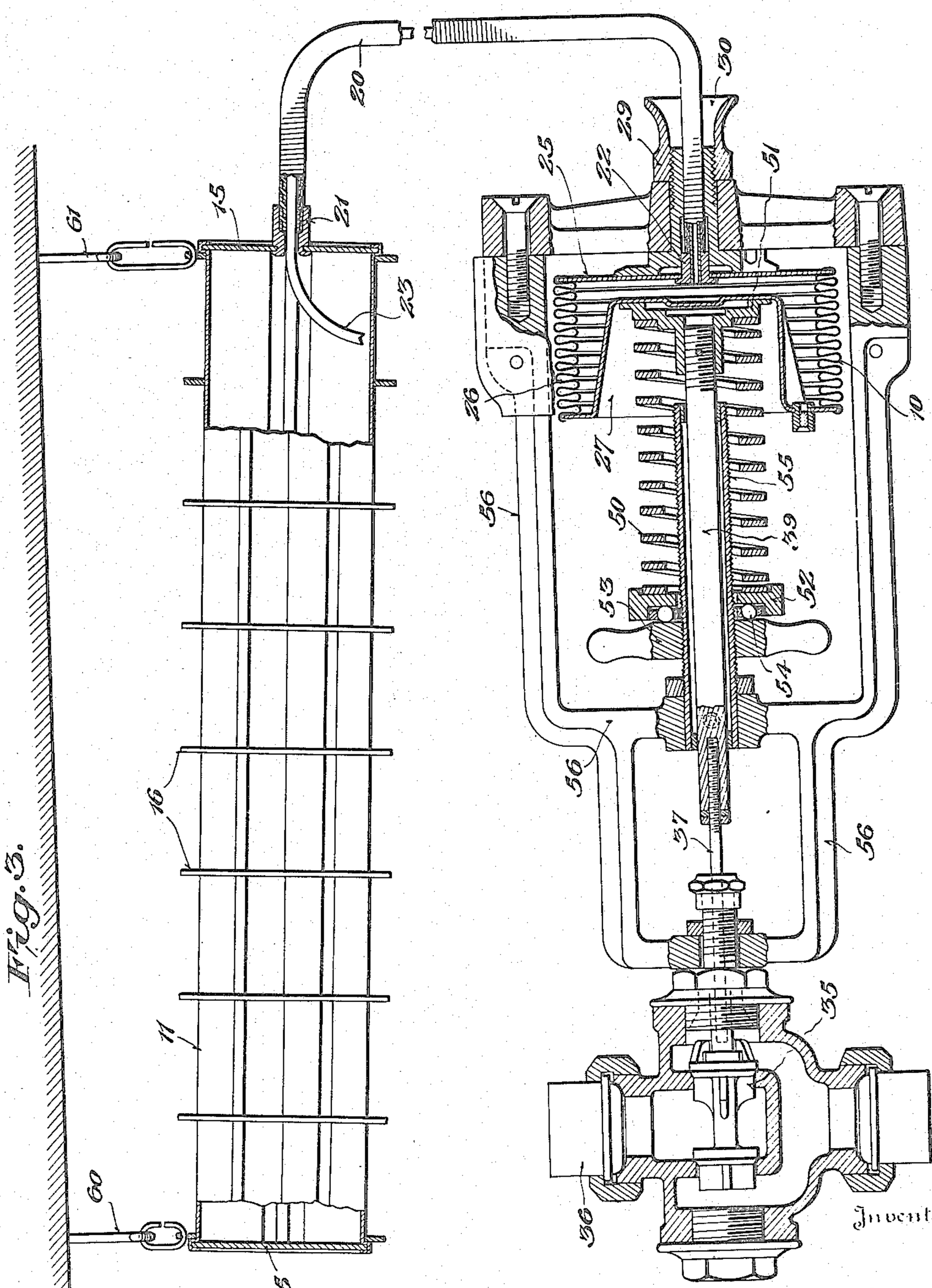

Fig. 3.

Inventor

Jean V. Giesler,

By Mason, Cameron, Lewis & Kirkham

Attorneys

Patented Nov. 18, 1924. 1,515,810

UNITED STATES PATENT OFFICE.

JEAN V. GIESLER, OF KNOXVILLE, TENNESSEE, ASSIGNOR TO THE FULTON COMPANY, OF KNOXVILLE, TENNESSEE, A CORPORATION OF MAINE.

TEMPERATURE-RESPONSIVE DEVICE.

Application filed June 17, 1921. Serial No. 478,352.

To all whom it may concern:

Be it known that I, JEAN V. GIESLER, a citizen of the United States, and a resident of Knoxville, Tennessee, have invented new and useful Improvements in Temperature-Responsive Devices, which invention is fully set forth in the following specification.

This invention relates to temperature-responsive devices, and it has for its object to provide a device of this character which is more sensitive to variations of temperature than those heretofore provided.

In the patent to Weston M. Fulton, No. 1,102,035, granted June 30, 1914, there is disclosed a temperature-responsive device or thermostat which is possessed of high efficiency and many important advantages when its bulb or container of volatile fluid is subjected to materials of relatively high specific heat, such as liquids and solids. A device of this character, however, has a considerable thermal lag when subjected to materials of relatively low specific heat, such as gases, because of the relatively small ratio of the superficial area of its bulb to its volumetric content. This may be illustrated by a comparison of the conditions existing when the bulb of said thermostat is subjected to water and to air. Given a predetermined volume of volatile fluid in said bulb to be raised or lowered through a predetermined number of degrees, a definite number of units of heat must be taken or given up by said volatile fluid irrespective of the character of the material to the varying temperatures of which the bulb is subjected, and this quantity of heat must be transmitted to and through the fixed superficial area of said bulb. But, roughly speaking, it requires three thousand times as many volumes of air as of water to give or take up each unit of heat. It is therefore apparent that a much longer time is necessary to effect this predetermined transfer of heat through the fixed area of the wall of the bulb in the case of air than in the case of water.

It is an object of this invention to provide a temperature-responsive device which is sensitive and efficient in operation, and possessed of a relatively small thermal lag, even when subjected to the temperature variations of a material of relatively low specific heat.

A further object of this invention is to provide a temperature-responsive device which is particularly adapted for use in controlling a source of heat in conformity with changes of temperature in the air, as in drying rooms for example; also one which is available for use with materials of relatively high specific heat when subject to relatively rapid changes in temperature.

To render temperature-responsive devices more sensitive when subjected to materials of low specific heat, such as gases, it has been heretofore proposed to construct the container for the volatile fluid in the form of a plurality of closely-arranged small-bored tubes connected at their opposite ends with suitable headers whereby the volatile fluid is subjected to the varying temperatures in a plurality of columns of relatively small diameter. Devices of this character, however, possess numerous disadvantages, among which may be noted the following:—

While the peripheral walls of said tubes vary in area in proportion to the diameter of the tubes, their volumes vary in proportion to the square of the diameter. Therefore, to obtain a relatively large superficial area for subjection to the varying temperatures, a container of relatively large volume must still be employed and as the number of heat units necessary to change the temperature of the said fluid per degree is in proportion to the mass of volatile fluid, devices of this character still possess an undesirable thermal lag. Moreover, the mass of metal employed in the walls of said tubes varies in proportion to the number of tubes employed so that the division of the volatile fluid into a number of individual columns results in a relatively large increase in the weight and cost of the device. Furthermore, closely-arranged tubes provide constricted air passages therebetween and, as the temperature differences necessary to produce convectional currents varies with the opposition to flow of the medium, the rate of delivery or absorption of heat is retarded owing to the existence of the restricted air

passages between said tubes. Again, each of said tubes has to be brazed or otherwise suitably connected at each end to the header so as to provide a fluid-tight joint therewith and, therefore, the number of such fluid-tight joints required increases directly in proportion to the number of tubes employed—with a consequent increase in the difficulty of securing a fluid-tight device except by the use of extreme care and expensive and time-consuming operations by skilled workers.

It is an object of this invention to provide a temperature-responsive device having a container for volatile fluid which may be provided with a relatively large superficial area without any increase in its volumetric content.

A further object of this invention is to provide a device of this character in which the volumetric content of said container may be reduced to substantiallv the minimum volume of volatile fluid necessary to operate the device and in which the superficial area of said container may be so increased as to greatly augment the sensitiveness of the device in responding to temperature changes.

Another object of this invention is to provide a device of this character in which the ratio of the superficial area to the volumetric content of the container for volatile fluid may be greatly increased without a corresponding increase in the mass of metal employed in the walls of the same.

Another object of this invention is to provide a device of this character which provides for a free circulation of the surrounding medium into contact with all portions of the peripheral wall of the container for volatile fluid.

Another object of this invention is to provide a device of this character in which the number of brazed or other fluid-tight joints are not materially increased over those heretofore employed where the container for the volatile fluid is of generally cylindrical formation.

Another object of this invention is to provide a temperature-responsive device in which the container for the thermosensitive medium may be provided with thinner walls than heretofore employed and which, at the same time, is adequately reinforced against deformation from the interior pressure and which is effectively protected from injury from the outside of the same.

Another object of this invention is to provide a temperature-responsive device of this character in which the container for the thermosensitive medium is supplied with means to facilitate the transmission of heat to and from the same, which means may desirably perform the additional function of reinforcing the walls of said container or of protecting the walls of said container from injury or both.

Other objects relate to the provision of a temperature-responsive device which is simple in construction, inexpensive to manufacture and highly sensitive and efficient in operation.

Stated broadly, the invention comprises a temperature-responsive device including a container for a thermosensitive medium the lateral walls of which are provided with a plurality of longitudinally-extending reentrant recesses so as to have a radiate transverse section.

The invention is capable of receiving a variety of mechanical expressions, two of which are shown on the accompanying drawings, but it is to be expressly understood that the drawings are for purposes of illustration only and are not to be construed as a definition of the limits of the invention, reference being had to the appended claims for that purpose.

Referring in detail to said drawings, wherein the same reference characters are employed to designate corresponding parts in the several figures:—

Fig. 1 is an elevation, partly in section, of a temperature-responsive device embodying the present invention, the container for volatile fluid being shown partly broken away;

Fig. 2 is an enlarged transverse section on the line 2—2 of Fig. 1 and illustrating in elevation one of the plurality of disks mounted at spaced points longitudinally of said container; and

Fig. 3 is an elevation, partly in section, of another embodiment of this invention.

In the form shown, the temperature-responsive device is a thermostat composed of two main elements:—a motor vessel 10 of any suitable form and construction and a container 11 for the thermosensitive medium, such as a volatile fluid, to which the present invention more particularly relates.

In accordance with this invention, said container 11 is provided with a relatively large superficial area in comparison with its volumetric content by so forming the lateral wall of said container that it is provided with a plurality of longitudinally extending reentrant recesses 12 between which the interior of said container is formed into a plurality of longitudinally extending chambers 13 which communicate with the central space 14 that extends axially in said container. These alternating reentrant recesses 12 and internal chambers 13 give said container a radiate transverse section as clearly illustrated in Fig. 2. In the form illustrated, the container 11 is provided with six radiating chambers, but it is to be expressly understood that the invention is not limited to the use of any particular number of such

chambers, as the number of said chambers will depend upon the desired ratio of superficial area to volumetric content.

Said container 11 may be formed in any suitable way, as by deeply corrugating a seamless metal tube the superficial area of which conforms to the desired area to be possessed by the container in its final form. The volumetric content of said container having been determined to conform with the volume of thermosensitive medium which it is desired to subject to the varying temperatures, the number, width and depth of said longitudinally extending reentrant recesses 12 may be selected so as to reduce the volume of the cylinder to the predetermined volume desired in the completed container. The ends of said container may be closed in any suitable way, as by brazing or otherwise suitably attaching to the ends of the lateral wall, so as to provide fluid-tight joints therewith, radiate end walls 15 which conform in their peripheral outline to the corresponding interior cross sections of the lateral wall. Thereby is provided a generally bulb-like container which occupies little or no more space than that occupied by the bulbs of prior devices and which, at the same time, has a greatly increased superficial area and a greatly decreased volumetric content.

In order that the wall of said container 11 may be made relatively thin and at the same time be capable of resisting deformation owing to the internal pressure acting on the same, said container is preferably provided with a plurality of reinforcing members spaced longitudinally of the same. Also, to facilitate the transfer of heat to and from said container, the latter is preferably provided with a plurality of heat-conducting members at spaced points longitudinally thereof. Moreover, to protect the container from external injury, it is preferably provided with a plurality of peripherally projecting members spaced longitudinally of the same. In the preferred construction, all three of these purposes are served by the use of a plurality of co-axial disk-like members 16 mounted on the container at spaced points longitudinally of the same, each of said disks having a central radiate aperture that contacts with the periphery of the container throughout its extent and thereby reinforces and restrains the wall of said container against outward movement or deformation under the action of the internal pressure; said disks 16 also being made relatively thin so that, together with their intimate contact with the wall of the container, they afford highly efficient radiating fins or heat-conducting members for facilitating the transfer of heat to and from said container; said disks also being made of such a diameter that they project a substantial distance beyond the periphery of the container and thereby operate as protectors to afford the wall of the container protection against injury from the outside of the same. As many disks 16 may be employed as are desirable to effectuate any one or all of the functions above described. To facilitate the circulation of air through the longitudinally extending recesses in the container and through the spaces between the disks 16, the latter may be provided with additional apertures 17 of any suitable shape and number, one being shown in each of the inwardly directed projections which enter the longitudinal reentrant recesses between the radiating chambers of the container.

Said container may be connected with the motor vessel in any suitable way. In the form shown, an elongated flexible tube 20 of any suitable construction is brazed or otherwise suitably connected into a block 21 secured to the end wall of the container, the opposite end of said tube 20 being similarly connected to a block 22 secured to the wall of the motor vessel 10. In the preferred embodiment of the invention the motor vessel 10 and elongated flexible tube 20 are maintained full of liquid and the vapor of said liquid exists only in the container 11. To prevent the escape of vapor from the container 11 into the tube 20 the latter is preferably so arranged with respect to the container as to trap the vapor of said liquid in said container. This may be accomplished in a variety of ways, the construction illustrated comprising an extension 23 of the tube 20 which projects into the interior of the container 11 and, to insure the trapping of the vapor when the container is horizontal, it may be bent as illustrated so that its free end is in close proximity to the wall of the container in one of the longitudinally extending radiating chambers 13.

The motor vessel 10 may be of any suitable construction, being illustrated as composed of a stationary end wall 25, a generally tubular, flexible lateral wall 26 having circumferentially-extending corrugations and an axially movable end wall 27, shown as made reentrant so as to diminish the volumetric content of said motor vessel and also, if desired, afford a positive stop for the extent of collapse of said vessel. Said motor vessel 10 may be surrounded, if desired, by a casing 28 and may be mounted on the frame of the device by a nut 29 provided with a flared opening 30 through which the corresponding end of the tube 20 is received.

The movable wall 27 of the motor vessel 10 is operatively connected to the means to be controlled in any suitable way. In the form illustrated the means to be controlled is represented as a valve 35 in a pipe line 36 for conveying a heating medium, and the

stem 37 of said valve is connected through a yoke 38 (in the embodiment of Fig. 1) to an aligned stem 39 suitably associated with the movable wall 27 of the motor vessel 10.

Any suitable means may be provided for opposing expansion of the motor vessel 10 and predetermining the temperature at which the pressure of the volatile fluid effects the movement of said valve to opened or closed position. In the form shown in Fig. 1, expansion of the motor vessel is opposed by a weighted lever 40 fulcrumed on a bar 41 pivoted to the frame 42 of the device, said lever engaging a knife edge 43 mounted in the yoke 38. One or more adjustable weights 44 are slidably mounted on said lever 40 and by their adjustment toward and from the fulcrum of said lever the pressure which must be developed by the volatile fluid to operate the valve 35 can be predetermined. To render said weighted lever available for use when the motor vessel is below the valve mechanism as well as when it is above the valve mechanism, it is preferably provided with two recesses 45, one on each side of the recess 46 which receives the knife edge 43, so that said lever may be reversed and the appropriate recess 45 engaged with the fulcrum bar 41.

The embodiment of the invention illustrated in Fig. 3 corresponds to that illustrated in Fig. 1 except that an adjustable spring 50 is employed to predetermine the temperature at which the valve is operated by the thermostat and the valve stem 37 is directly connected to the aligned stem 39 associated with the movable wall 27 of the motor vessel 10. Said spring 50 at one end engages the movable wall 27 of the motor vessel 10, or a collar 51 in engagement therewith, and at its opposite end engages a collar 52 which in turn engages an adjustable collar 53, through a ball bearing 54 in the embodiment illustrated. Said collar 53 is shown as threaded on a tube 55 which projects from the frame 56 of the device and extends coaxially with the stem 39. If desired, said tube 55 may also provide a guide for the reciprocating movements of the stem 39 as illustrated.

The container 11, when the motor vessel 10 is in fully collapsed condition, must contain a quantity of volatile liquid slightly in excess of that corresponding to the increase in volume of the motor vessel 10 when the latter is in fully expanded condition, the excess amounting to such a volume of liquid as will supply the requisite additional vapor to effect the said expansion of the motor vessel and additionally maintain a seal for the free end of the tube 23. This latter quantity may be reduced by mounting the container in an inclined position as illustrated in Figs. 1 and 3, the support 60 for the free end of the container being shorter than the support 61 for that end of the container which is connected to the tube 20 so that the liquid in said container will flow down and form a seal around the free end of the projecting tube 23. This arrangement of the container also tends to increase the efficiency of the same as it facilitates the circulation of the medium to which the container is subjected and prevents the formation of gas pockets in the reentrant spaces. It is to be expressly understood, however, that such an arrangement is not essential to the present invention, as by slightly increasing the volume of liquid the container may be positioned with its axis horizontal or, by omitting or suitably constructing and arranging the projecting tube 23, the container may be positioned with its axis vertical or at any desired inclination.

In operation, the container 11 is suitably positioned where it is subjected to the variations in temperature to which the device is to respond and the motor vessel 10 is operatively connected to the means to be controlled, the elongated flexible tube 20 permitting these two points to be relatively remote. Assuming that the temperature outside of said container is below that which it is desired to maintain, the vapor in the container 11 is condensed and the reduction in pressure permits the weighted lever 40 or the spring 50 or other suitable means employed to hold the vessel 10 in collapsed condition. This corresponds to the open position of the valve 35 in the embodiments illustrated. As the temperature rises, the liquid in the container 11 volatilizes until the vapor tension is sufficient to overcome the opposition of the weighted lever, spring or other means, whereupon said vapor forces some of the liquid out of the container 11 through the elongated flexible tube 20 into the motor vessel 10 and expands the latter, to close the valve in the embodiments illustrated. The quantity of liquid in the container 11 having been suitably selected, the free end of the tube 23 is still sealed by the liquid remaining in the container when the motor vessel 10 has been fully expanded, so that at no time during the operation of the device does any vapor escape into the tube or vessel to condense therein and interfere with the proper operation of the device. As the volume of liquid necessary to cause expansion of the motor vessel 10 and still leave the free end of the tube 23 in a liquid seal can be readily determined, the volumetric content of the container can be reduced to that suitable for this predetermined volume of volatile fluid and, at the same time, the superficial area of said con-

tainer may be made sufficiently large to insure a rapid transfer of heat between said container and the surrounding medium. Thereby, the temperature-responsive device has particular utility when employed to respond to variations in the temperature of a gaseous medium, such for example as to maintain a predetermined temperature in a drying room. The invention is not limited, however, to such a use as it is apparer that the sensitiveness of the container also renders it particularly useful for subjection to media of higher specific heat, where for example such a medium is subject to rapid temperature changes and, therefore, the thermosensitive device should be highly sensitive and have but a small thermal lag.

It will therefore be perceived that a temperature-responsive device has been provided which is more sensitive than those heretofore suggested and which is especially useful for subjection to media of low specific heat. Moreover, a container for a thermosensitive medium has been provided which may have any desired volumetric content and which, at the same time, may have its superficial area increased to any desired extent, and this has been accomplished without materially increasing the weight or bulk of the device, without resisting circulation of convectional currents by the use of restricted passages, without materially increasing the number of liquid-tight joints that must be formed and without materially increasing the complexity or cost of production of the device. Additionally, a container for a thermosensitive medium has been provided the walls of which may be made relatively thin without danger of deformation from internal pressure and which, at the same time, is efficiently protected from injury exteriorly.

While the embodiments of the invention illustrated on the drawings have been described with considerable particularity, it is to be expressly understood that the invention is not limited thereto, as the same is capable of receiving a variety of mechanical expressions some of which will now readily suggest themselves to those skilled in the art while certain features thereof are capable of use without other features thereof. Changes may also be made in the details of construction, arrangement and proportion of parts without departing from the spirit of this invention. Thus the number, width and depth of the radiating chambers 13 in the container 11 may vary within wide limits in conformity with the ratio which it is desired to maintain between the superficial area of said container and its volumetric content.

Reference is therefore to be had to the claims hereto appended for a definition of the limits of the invention.

What is claimed is:—

1. In a temperature-responsive device, a motor vessel adapted to be operatively connected to means to be controlled, and a volatile-fluid container communicating with said motor vessel, said container being of radiate transverse section.

2. In a temperature-responsive device, a motor vessel adapted to be operatively connected to means to be controlled, and a volatile-fluid container communicating with said motor vessel, the wall of said container being formed to provide a plurality of longitudinally-extending reentrant recesses.

3. In a temperature-responsive device, a motor vessel adapted to be operatively connected to means to be controlled, a volatile-fluid container of radiate transverse section connected to said motor vessel, and a plurality of combined protectors and heat-conductors mounted on said container.

4. In a temperature-responsive device, a motor vessel adapted to be operatively connected to means to be controlled, a volatile-fluid container of radiate transverse section connected to said motor vessel, and a plurality of longitudinally-spaced disks mounted on said container and projecting beyond the periphery thereof.

5. In a temperature-responsive device, a motor vessel adapted to be operatively connected to means to be controlled, a volatile-fluid container of radiate transverse section connected to said motor vessel, and a plurality of longitudinally-spaced disks mounted on said container and having apertures receiving and conforming with the periphery of said container.

6. In a temperature-responsive device, a motor vessel adapted to be operatively connected to means to be controlled, a volatile-fluid container of radiate transverse section connected to said motor vessel, and a plurality of combined heat-conductors and reinforcing members mounted on said container.

7. In a temperature-responsive device, a motor vessel adapted to be operatively connected to means to be controlled, a volatile-fluid container of radiate transverse section connected to said motor vessel, and a plurality of circumferentially-extending fins spaced longitudinally on said container.

8. In a temperature-responsive device, a motor vessel adapted to be operatively connected to means to be controlled, a volatile-fluid container of radiate transverse section connected to said motor vessel, and a plurality of disks on said container each provided with a central aperture conforming to the periphery of said container and having apertures in the inwardly extending projections thereof.

9. A thermostat including a container for

a thermosensitive medium having a radiate transverse section, and a plurality of circumferentially-extending heat-conducting members mounted on said container in longitudinally-spaced relation.

10. A thermostat including a container for a thermosensitive medium having a radiate transverse section, and a plurality of longitudinally-spaced members mounted on said container and projecting peripherally therefrom.

11. A thermostat including a container for a thermosensitive medium having a radiate transverse section, and a plurality of reinforcing members mounted on said container at spaced points longitudinally.

12. A volatile-fluid thermostat including a container for said fluid which is radiate in transverse section.

In testimony whereof I have signed this specification.

JEAN V. GIESLER.