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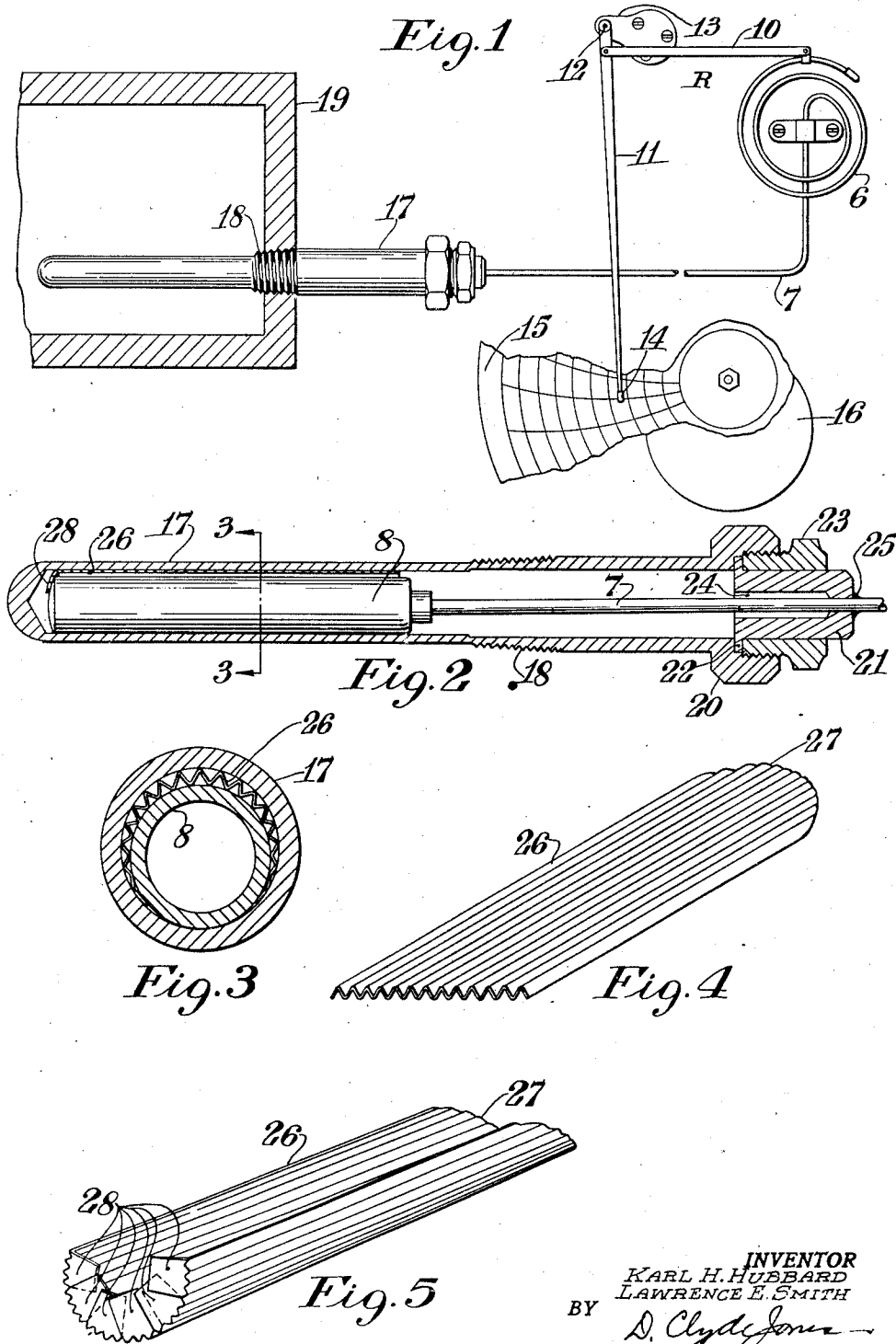
K. H. HUBBARD ET AL

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COMBINATION WELL AND BULB CONSTRUCTION FOR THERMOSENSITIVE DEVICES

Filed June 13, 1935

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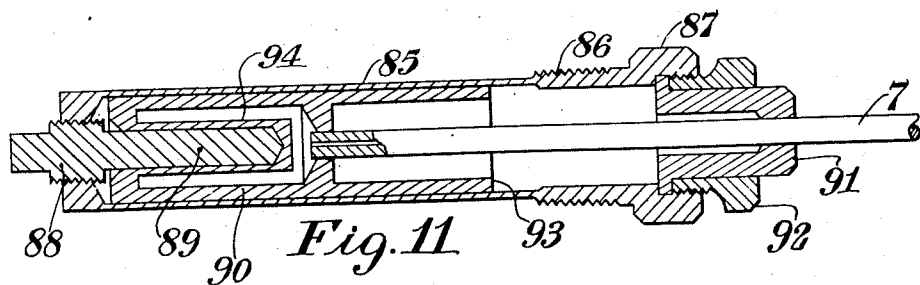
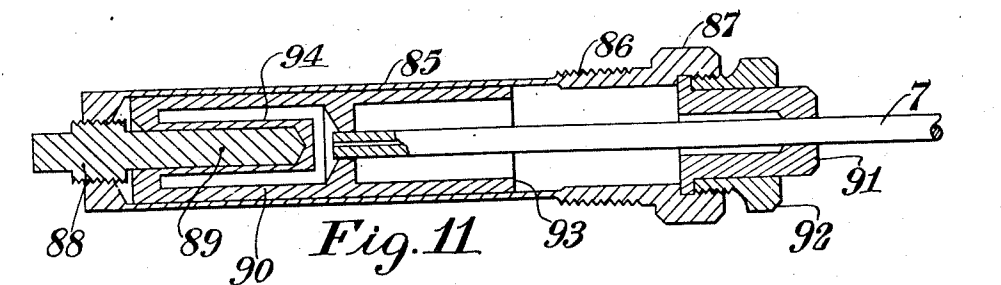
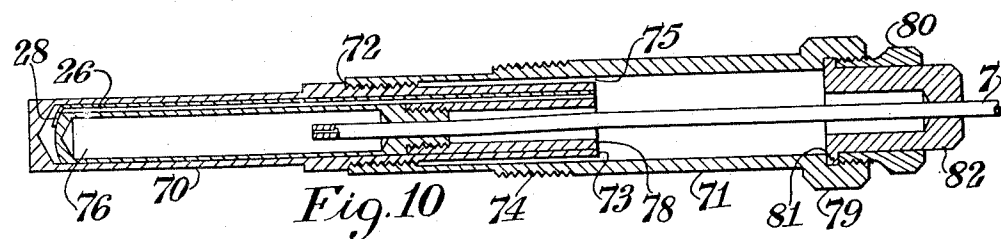
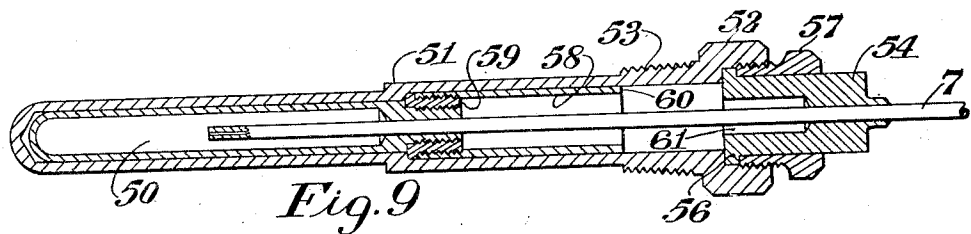
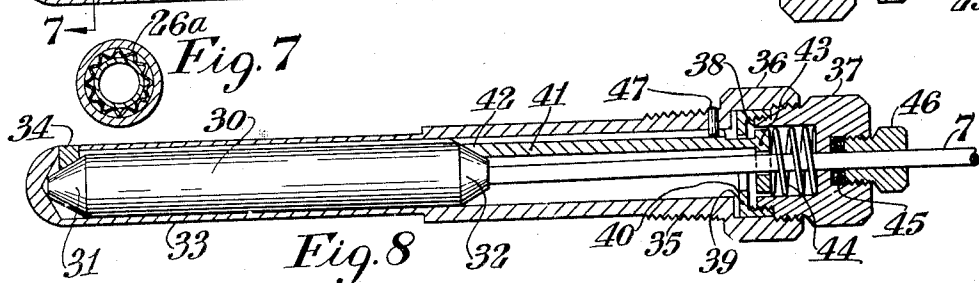
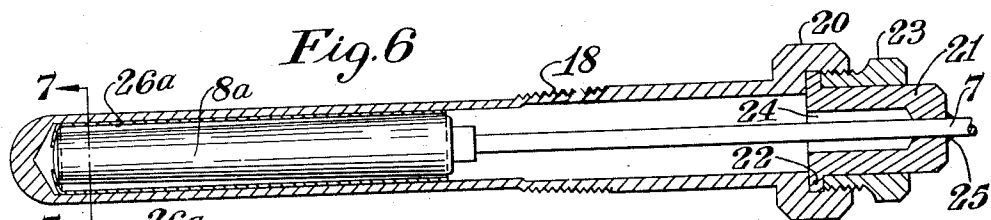
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2 Sheets-Sheet 2



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COMBINATION WELL AND BULB CONSTRUCTION FOR THERMOSENSITIVE DEVICES

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11 Claims. (Cl. 297—3)

In many installations of thermosensitive systems it is customary to mount the bulb thereof in a protective well, but since the bulb must be easily removed from the well it has been the practice to provide a small clearance between the inner surface thereof and the outer surface of the bulb. Such space, however, constitutes a poor heat conducting region so that heat transfer therethrough is greatly retarded, causing the thermo-responsive system including the bulb to be sluggish in its response.

In order to overcome this sluggishness of such a system it has been proposed to taper the inner surface of the well and to taper the outer surface of the bulb correspondingly, so that when the bulb is forced into the well these surfaces will be in approximately contacting relation, but such a construction has been expensive to manufacture and it has been found that a film of dust or particles of dirt accumulate between the related surfaces tending to reduce the transfer of heat from the well to the bulb. Furthermore, such a tapered well and bulb construction results in the sticking of the bulb in the well at high temperatures so that these parts cannot be readily separated as is required in use.

In order to improve the heat transfer between the well and the bulb, it has also been proposed to fill the space between these parts with grease, graphite, mercury and like materials but these materials are inconvenient and in many cases impractical to use.

Present constructions of bulbs, bulb mountings and wells tend to dissipate heat away from the bulb and are notably ill-adapted for the most rapid, efficient heat transfer to the bulb in cases where there is only short immersion thereof.

In accordance with the main feature of the present invention, a novel arrangement is provided whereby heat is readily transferred from a well to a bulb of a thermosensitive system and yet these parts are inexpensive to manufacture and are readily separable as occasion demands. Another feature of the invention relates to metallic means for bringing the outer surface of the bulb into more efficient heat conducting relation with the inner surface of the well. A further feature of the invention relates to a corrugated conducting sleeve interposed between the bulb and the well. Still another feature of the invention relates to a straight sided well and a tapered bulb with a tapered, corrugated conducting sleeve interposed between the well and the bulb. An additional feature of the invention relates to a heat transfer sleeve mounted as

an extension on the bulb and positioned in heat transfer relation to a portion of the well so that there is a maximum amount of heat transmitted thereto and a minimum amount of heat dissipated therefrom.

Other features of the invention will appear from the detailed description and claims when taken with the drawings in which Fig. 1 is a conventional showing of a temperature recording instrument with the bulb and its tube system enclosed in a socket or well which is mounted in the wall of a tank or receptacle; Fig. 2 is a longitudinal section through the well of Fig. 1 illustrating the manner in which the bulb of the tube system of the instrument is mounted thereon; Fig. 3 is a cross-sectional view of the well, bulb and conducting sleeve interposed therebetween, taken substantially on the line 3—3 of Fig. 1 looking in the direction of the arrows; Fig. 4 is a perspective view of a corrugated transfer sleeve of Fig. 2 partially manufactured; Fig. 5 is a perspective view of this corrugated transfer sleeve ready for use; Fig. 6 is a longitudinal section through a well illustrating a tapered bulb with a special heat transfer sleeve mounted in the space between the well and the bulb; Fig. 7 is a cross-sectional view thereof taken substantially on the line 7—7 of Fig. 6; Fig. 8 is a longitudinal section of a modified type of well and a modified type of bulb together with means for forcing the bulb into intimate engagement with the inner surface of the well; Figs. 9 and 10 are longitudinal sections taken through modified types of well and bulb constructions; and Fig. 11 shows still a different arrangement for effecting heat transfer between a well and a bulb.

Referring especially to Fig. 1, R generally designates a temperature recording instrument including a tube system comprising a Bourdon spring 6, a capillary tube 7 and a bulb 8 (Fig. 2) which system may be filled with a thermosensitive medium. The free end of the Bourdon spring is connected by a link 10 to the upper end of a pen arm 11 which is pivotally mounted at 12 in a bracket 13. The lower end of the pen arm is provided with a stylus 14 which is adapted to make a temperature record on a chart 15, mounted on the arbor of a suitable clock mechanism 16.

The bulb 8 is mounted in a socket or well 17 50 which projects into a tank 19 or the like to contain a medium, the temperature of which is to be determined, this well being provided externally at its intermediate portion with screw threads 18 engaging a threaded aperture in the wall of the 55

tank. As best illustrated in Fig. 2, the well is closed at its left-hand end and its right-hand end terminates in a wrench head 20 by which the threaded portion 18 on the well can be screwed into or removed from the wall of the tank. The capillary tube 7, leading from the bulb 8, is preferably of low heat-conducting material such as steel, and has soldered or otherwise fastened thereto a connecting piece 21 provided with a flange 22. A swivel nut 23 having one face engaging this flange makes threaded engagement with the internally threaded wrench head 20 to clamp the connecting piece to the well. It should be mentioned that the connecting piece, as indicated at 24, is provided with an annular recess about the capillary tube 7, the connecting piece being connected to the capillary tube at the restricted region 25 which is located as remotely as possible from the bulb consistent with the required assembly of the parts. The inner surface of the well 17 and the outer surface of the bulb 8 are cylindrical in shape and of such diameters that the bulb 8 has sufficient clearance to move freely within the well, but the resulting air space between the bulb and the well results in high resistance to the transfer of heat therethrough to the bulb.

In accordance with the present invention, a corrugated resilient heat transfer sleeve 26 preferably of aluminum is inserted between the bulb 8 and the inner surface of the well 17 to engage substantially 220° of the circumference of the bulb, so that one side of the bulb is forced into intimate relation with a portion of the inner surface of the well. For a given clearance between the well and the bulb, the thickness of the material used in the sleeve determines whether the sleeve can enclose more or less than 220° of the circumference of the bulb. This sleeve which should have high heat conductivity and which should be highly resistant to oxidation with its resultant flaking, is preferably made of aluminum for high temperatures and of copper for relatively low temperatures. The transfer sleeve as shown in Fig. 4 is formed of a corrugated strip having a rounded end 27 which strip is then bent into arcuate shape as shown in Fig. 5 with a portion of its straight end folded at right angles, as indicated at 28, to engage the free end of the bulb 8. The rounded end 27 facilitates the insertion of the bulb into the well, this shape being desirable since when the bulb is inserted into the well for the first time, it is necessary to flatten the corrugations at each margin of the strip and the rounded end of the strip tends to reduce the resistance to starting the bulb into the well. It should be noted that the threaded part 18 of the well, as herein illustrated, is so positioned thereon that the portion of the well containing the bulb is entirely immersed in the medium, the temperature of which is to be sensed.

By the use of the transfer sleeve, heat is conducted from the well to the bulb in three ways. First, since a portion of the bulb is forced against the inner surface of the well, excellent heat transfer between these parts is effected. Second, the flattened margins of the sleeve substructure fill additional sections of the space between the bulb and the well so that there is a good transfer of heat from the well to the sleeve and thence to the bulb, the air gap between the several parts being reduced to a minimum. Third, the high points of the corrugations respectively engage the inner surface of the well and the outer surface of

the bulb so that there is an additional transfer of heat through the sleeve to these parts.

In the modified form of the invention shown in Fig. 6, the parts thereof are identical with those just described, except that the bulb 8a is tapered and the transfer sleeve 26a substantially encircles the bulb, the raised areas of the sleeve contacting both the bulb and the inner surface of the well (see Fig. 7). In this construction the smaller end of the bulb is adjacent to the closed end of the well and therefore the corrugations in the strip or sleeve 26a vary in depth from one end thereof to the other, being deeper at the smaller or free end of the bulb. In this arrangement the heat transfer from the well to the bulb is effected mainly through the sleeve 26a, giving approximately the results obtained in a tapered bulb and tapered well construction without the likelihood of these parts sticking together as in that construction.

In the further modified form of the invention illustrated in Fig. 8, the bulb 30 is provided with tapered ends 31 and 32 while the well 33 which contains the bulb has a wedge-shaped internal projection 34 adjacent the closed end thereof to cooperate with the tapered end 31 of the bulb. This well is likewise provided with a threaded portion 35 by which it can be mounted in a threaded opening in a tank or receptacle (not shown), the well being provided with a wrench head 36 to facilitate the mounting of the well in the mentioned opening. In this instance also an externally threaded connecting piece 37 makes threaded engagement with the internally threaded wrench head 36. The connecting piece also has its left end reduced and threaded as indicated at 38, to make threaded engagement with a collar 39. This collar is provided with a flange 40 by which a bar 41 is supported in the connecting piece. The free end 42 of this bar is tapered to engage the tapered end 32 of the bulb, while the other end of the bar is provided with an apertured head 43 through which the capillary tube 7 passes. This head is contained in the collar 39 and is engaged by a coil spring 44 mounted within the swivel nut which spring tends to force the tapered end 42 of the bar along the tapered portion 32 of the bulb as the swivel nut is screwed into the threaded end of the well. Thus as the bulb is forced into the well, the wedge-shaped part 34 engages the tapered end 31 of the bulb while the tapered end 42 of the bar engages the tapered end 32 of the bulb thereby forcing one side of the bulb against the wall of the well. A pin 47 projecting through the wall of the well 33 engages a longitudinal groove in the bar 41 to limit this bar to longitudinal movement with respect to the well. As herein illustrated, the connecting piece 37 may be freed from the capillary tube 7, being locked thereto by a washer 45 of packing material which is compressed against the capillary tube by a nut 46 screwed into the end of the connecting piece. In this modification the eccentricity of the long axis of the bulb with respect to the long axis of the well, is relied upon to improve the heat transfer from the well to the bulb. It can be proved mathematically that if the bulb is off center 0.9 of the average clearance between the bulb and the well, the rate of heat transfer between the two surfaces due to air gap conduction alone is 2.3 times that with the bulb concentric with the well, whereas if the bulb off-center value is increased to 0.95 the rate of heat transfer is increased 3.2 times with respect to rate prevailing

in the concentric arrangement of the bulb and well. Experiments thus far conducted confirm these results.

In the modified form of the invention shown in Fig. 9, a relatively short bulb 50 is encased in a relatively long well or socket 51. This well, as in the other forms thereof, is provided with a wrench head 52 by which its externally threaded portion 53 can be screw-threaded into the wall of a tank or other receptacle. Here also the connecting piece 54 which is soldered to the capillary tube 7 of the bulb, is provided with a flange 56. This flange is engaged by the externally threaded swivel nut 57 which is screwed into the internally threaded wrench head to force the flange against this head. In order to conduct heat from the portion of the well between its threaded part 53 and the part thereof engaging the bulb, a heat conducting sleeve 58 is fastened to the capillary tube end of the bulb, the spacing between this sleeve and the inner surface of a large portion of the well being as small as is consistent with the easy removal of the conducting sleeve through this portion of the well. The conducting sleeve 58 may be mounted in heat-conducting relation to the bulb 50 in any suitable manner, but as herein illustrated a collar 59 which is internally threaded to engage the threaded end portion of the bulb and externally threaded to engage one end portion of the sleeve 58, is provided. It will be noted that, as indicated at 60, the free end of the transfer sleeve is spaced from the adjacent end of the connecting piece 54 and this connecting piece, with the exception of its point of connection to the capillary tube, is provided with an annular recess 61 surrounding the capillary tube 7 in order to lengthen the heat conducting path from the bulb to the connecting piece and thereby reduce the possible heat dissipation.

In many bulb and well installations it is desirable to have a small immersion of the well and the bulb contained therein, and yet it is essential that there should be the maximum possible transfer of heat from the immersed portion of the well to the bulb. In the modified form of the invention shown in Fig. 10, there is disclosed an efficient construction for accomplishing this result, wherein the well is composed of two sections 70 and 71 which are of two different diameters and which are joined together as indicated at 72 by a threaded connection. The section 70 is preferably made of material of good heat conductivity, while section 71 is made of material of low heat conductivity. The section 71 of the well is provided with a threaded portion 74 by which the well may be mounted in a pipe or other receptacle. It will be noted that the section 70 of the well has an extension 73 in telescopic relation with the part 71, there being a pronounced annular air space 75 between these parts. The tube end of the bulb 76 has connected thereto by a screw-threaded connection, an extension 78 spaced somewhat from the part 73 of the well and extending substantially the same distance as this part. As in the foregoing arrangement the well section 71 is provided with a wrench head 79 adapted to make threaded engagement with the swivel nut 80. This nut is adapted to force the flange 81 of the connecting piece 82 into the wrench head. A corrugated heat-conducting sleeve of the type illustrated in Figs. 3 and 5 is interposed between the parts 70, 73 of the well and the bulb 76 with its extension 78. By this construction there is not only

a direct transfer of heat between the section 70 of the well and the bulb 76, as set forth in connection with the arrangement of Figs. 2 and 3, but there is also a similar transfer of heat from the section 71 of the well and thence through the extension 73 and, in turn, through sleeve 26 to the bulb extension 78 from whence it is conducted to the bulb 76. The annular space 75 between the well section 71 and the extension 73, as well as between the end of this extension and the connecting piece 82, tend to reduce greatly the heat dissipation away from the bulb.

In the form of the invention illustrated in Fig. 11, the well 85 is provided with an externally threaded portion 86 and a wrench head 87 at one end. The other end of the well is provided with a threaded opening to receive the threaded plug 88 which has an integral extension 89. The bulb 90 has a reentrant portion 94 in its free end to receive the plug extension with a relative close fit as shown. The capillary tube end of the bulb has an integral conducting extension 93 extending along the wall of the well. The capillary tube 7 has soldered thereto a connecting piece 91 of the construction already described which connecting piece is clamped to the head 87 by swivel nut 92 in the manner previously set forth. In this last-mentioned form of the invention, in addition to the heat transfer from the side wall of the well 85 both to the bulb 90 and to the bulb extension 93 through the air space existing between these parts, heat transfer is effected from the plug 88 and the plug extension 89 to the reentrant wall of the bulb 90.

While the invention has been disclosed in connection with the thermosensitive element or bulb of a tube system, it will be understood that other thermosensitive elements, such as an expansion stem, a resistance unit of a resistance thermometer or a thermocouple can be substituted therefor.

The present disclosure is given merely by way of example and the invention is not to be limited thereby, except as specifically defined in the following claims.

We claim:

1. In combination, a thermosensitive tube system including a bulb containing a thermosensitive medium and a capillary tube of low heat-conducting material communicating with the interior of said bulb, said bulb having an extension sleeve encircling a section of said tube in spaced relation thereto, a connecting piece of substantial length encircling another section of said tube, said connecting piece being separated from said tube by a substantial annular recess except at a point remote from said bulb where said connecting piece is joined to said tube, and a well in which said bulb and extension sleeve are enclosed, said well being attached to said connecting piece.
2. In combination, a thermosensitive tube system including a bulb containing a thermosensitive medium and a capillary tube of low heat-conducting material communicating with the interior of said bulb, said bulb having an extension sleeve encircling a section of said tube in spaced relation thereto, a connecting piece encircling another section of said tube but separated therefrom by a substantial annular recess except at a point remote from said bulb where said connecting piece is joined to said tube, a well in which said bulb and extension sleeve are encased, said well being attached to said connecting piece, and a resilient heat-conducting strip engaging

the inner wall of said well and the side wall of said bulb.

3. In combination, a bulb of a thermosensitive system, an extension sleeve attached to one end of said bulb, said sleeve having a diameter approximately equal to the diameter of said bulb, and a well in which said bulb and extension sleeve is encased.

4. In combination, a bulb of a thermosensitive system, an extension sleeve attached to one end of said bulb, a well in which said bulb and extension sleeve are encased, and a resilient heat conducting strip engaging the inner surface of said well and also the outer surface of said bulb and said sleeve.

5. In combination, a bulb of a thermosensitive system, a well enclosing said bulb, and means for holding said bulb eccentrically in said well with a portion of the side wall of the bulb in close heat-conducting relation to a portion of the inner surface of the well.

6. In combination, a bulb of a thermosensitive system, a well enclosing said bulb and means within said well for holding said bulb eccentrically in said well with a side portion of the bulb in close heat-conducting relation to a portion of the inner surface of the well.

7. In combination, a well, a bulb of a thermosensitive system enclosed in said well, and means including a resilient strip for forcing a part of said bulb against the side wall of said well.

8. In combination, a well, a bulb of a thermosensitive system mounted in said well, and means including a corrugated heat-conducting strip interposed between the side wall of said well and the side wall of said bulb whereby said bulb is held eccentrically with respect to said well in

contact with a portion of the wall thereof, the depth of said corrugations being maximum at an intermediate portion of the strip and being gradually reduced in depth to substantially a flat surface at the side margins of the strip.

9. In combination, a hollow elongated well having an open end and a closed end, an elongated bulb of a thermosensitive system enclosed in said well, and a corrugated heat-conducting strip interposed between and in contact with at least a portion of the side wall of the well and the side wall of the bulb, said corrugations progressively varying in depth from an intermediate portion of said strip to a margin thereof.

10. In combination, a cylindrical well having an open end and a closed end, a cylindrical bulb of a thermosensitive system enclosed in said well with an end of said bulb adjacent the closed end of said well, and a corrugated heat-conducting sleeve interposed between and in contact with a portion of the side wall of the well and the side wall of the bulb, said sleeve having a portion thereof projecting into the space between one end of said bulb and the closed end of said well.

11. In combination, a hollow cylindrical well having an open end and a closed end, a cylindrical bulb of a thermosensitive system enclosed in said well with an end of said bulb adjacent the closed end of said well, and a corrugated heat-conducting sleeve interposed between and in contact with a portion of the side wall of the well and the side wall of the bulb, said sleeve having a portion adapted to engage the mentioned end of said bulb.

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