

This invention relates to a temperature sensor assembly according to the prior-art portion of patent claim 1.

From DE-33 29 653 A1 a heating device for a flow-through heater of a beverage-brewing apparatus is known. In addition to producing hot water and supplying it to the brewing unit, the second function performed by the known flow-through heaters which includes the controlled keeping warm of the produced brew by means of a warming plate following completion of the brewing cycle, is the subject-matter of several patent applications. The basic problem of keeping the brew warm by a control action is that the amount of heat supplied to compensate for the heat losses experienced by the brew in the collection container, which may be as low as some 10 watts, is required to be likewise produced by the flow-through heater. However, this heater has a relatively high heating power as desired for the brewing mode, which may be of the order of 1,000 watts or greater.

In order to produce such a comparatively low heating power on a time average using a flow-through heater of this type, the principle of the controlled keep-warm mode consists in that the flow-through heater is set in operation for a relatively short period of time, following which it is deactivated again for a relatively long period of time. To this effect, the flow-through heater is activated and deactivated in a known manner by a thermostat device in thermal contact therewith, the thermostat interrupting the supply of power to the flow-through heater on reaching its opening temperature, re-establishing it after cooling down to its closing temperature.

As a result, a relatively large quantity of heat is supplied to the brewed beverage from the warming plate through the bottom of the collection container in a relatively short period of time, which in turn causes the lower layers of the brew resting at the bottom of the collection container to be heated an appreciable amount, therefore rising in the collection container while cooled down layers sink towards the bottom of the collection container. This produces a circuit fed by convection within the collection container, as a result of which the complete brew can be kept warm at approximately the desired average temperature. However, this continually occurring cycle of heating and subsequent cooling impairs the aroma of the brewed beverage particularly if coffee is involved.

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To diminish the adverse effect which the controlled keep-warm mode has on the aroma of coffee, a variety of proposals have been made in the art.

Thus, for keeping warm small batches of coffee, it has been proposed to provide, in addition to the already existing thermostat, a second thermostat with a lower opening temperature which is insertable in the circuit for the heating element of the flow-through heater by means of a switch referred to as a "mini-brew" switch, whereby the heating power delivered by the flow-through heater on a time average is reduced (see DE, 87 01 916 U1). In this arrangement, however, the heating power of the flow-through heater is reduced also in the brewing mode, which prolongs the duration of the brewing cycle without any noticeable beneficial effects on the aroma of the brew being accomplished.

Another approach to solve this problem which is aimed at the keeping warm of small batches of coffee consists in that operation of the mini-brew switch activates a supplemental heater. This supplemental heater then heats the sole thermostat provided when it is in its open position, as a result of which the period of time after which the thermostat returns to its closed position is extended, so that here too, the amount of heat supplied to the warming plate on a time average is reduced (see EP 0 186 097 A1).

In the flow-through heaters described in DE 87 01 916 U1 as well as in EP 0 186 097 A1, activation of the appropriate switching means for keeping warm smaller batches of brewed beverage also requires operation of the mini-brew switch in addition to the main switch, because otherwise the brewed beverage would be subjected to relatively high temperature variations in the keep-warm mode. Where applicable, therefore, it is necessary for the user to operate two switching means which, for one thing, tends to be forgotten and, on the other hand, adversely affects the operating comfort.

DE 35 35 687 A1 discloses a device which is not only provided for the controlled keeping warm of minor quantities of a brewed beverage. In the flow-through heater described in this specification, its thermal contact with the warming plate is acted upon by mechanical means, such that a bimetallic element controls the distance between the flow-through heater and the warming plate in such a manner that the distance is greater when the flow-through heater is very hot than it is when the flow-through heater is less hot. As a result, the quantity of heat

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issued by the flow-through heater to the warming plate is stabilized, that is, the maximum levels of the heating power delivered are reduced while the minimum levels are increased.

All approaches identified in the foregoing and aimed at diminishing the detrimental effect on the aroma of the brewed beverage have the common shortcoming that they utilize the temperature of the thermostat in thermal contact with the flow-through heater as the control criterion of the flow-through heater, which temperature is assumed to reflect to some degree of accuracy, the actual temperature relationships prevailing in the brewed beverage held in the collection container. Moreover, all thermostats described have a relatively large hysteresis, that is, their opening temperature at which they interrupt the power supply to the electric heating element of the flow-through heater may well be about 10° C or more above their closing temperature at which they reconnect the electric heating element to the power supply. Also this property of the thermostats used contributes substantially to the described instability of the amounts of heat issued in the keep-warm mode by the flow-through heater to the warming plate per unit of time.

Further, from U.S. Pat. No. 4,812,624 a temperature sensor assembly of the type described in the foregoing is known which is suitable for measuring the temperature of a brewed beverage held in a collection container of a beverage-brewing apparatus, the sensor being equally in abutting engagement with the outside of the collection container. In this specification, the temperature sensor is held between several insulating disks and an additional coil spring in such a manner that the sensor is at all times biased into engagement with the outer surface of the collection container, being thus in a position to determine the temperature of the collection container - and thus the temperature of the liquid contained therein - relatively accurately.

Finally, from EP-A-348 298 a temperature sensor for a heating unit is known which has its sensor tip likewise biased into abutting engagement with the outer surface of a vessel, the bias being produced by a spring acting on the temperature sensor. In this arrangement, the temperature sensor is directly guided in the housing of the unit, thus establishing thermal contact with the housing which ultimately may result in faulty measurements. No provisions exist to seal the temperature sensor relative to the housing.

It is therefore an object of the present invention to devise a temperature sensor assembly according to the prior-art portion of patent claim 1 which is suitable for integration in a warming plate in a simple and economical manner, which is at all times in abutting engagement with the surface of the collection container, which responds promptly to temperature variations of the brewed beverage, and which is at the same time sealed relative to the warming plate using simple means.

For a temperature sensor assembly according to the prior-art portion of patent claim 1, these requirements are satisfied by the features identified in the characterizing portion of this patent claim.

By virtue of the temperature sensor slidably arranged in the housing of an apparatus for brewing beverages, which sensor, with the collection container sitting on the warming plate, is at all times urged into abutting engagement with the outer surface of the collection container by a biasing force acting in the direction of the collection container, good thermal contact of the sensor with the collection container is ensured at all times. Considering that in the manufacture of glass collection containers relatively large dimensional variations may occur, which applies equally to the components used in a beverage-brewing apparatus, such dimensional variations are compensated for by this invention. The temperature sensor is thus at all times in physical contact with the collection container as a result of the force urging it into abutting engagement with the collection container. Particularly in the keep-warm mode, this enables the beverage held in the collection container to be thermally sensed particularly well, enabling the heating device heating the collection container to be controlled with corresponding accuracy. Further, the brew held in the collection container can be heated in small heating steps to preserve the aroma particularly well.

The advantage accomplished with the temperature sensor of the present invention is that the weight of the collection container, whether empty or filled, causes the temperature sensor to be axially displaced into the interior of the warming plate, the sensor being thus at all times in abutting engagement with the support surface of the collection container. This embodiment of the temperature sensor of the present invention has the advantage that the temperature sensor, rather than being mounted in the housing of the beverage-brewing apparatus, is slidably mounted in the warming plate directly by means of the holding member. This enables the dimensional

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tolerance occurring between the contact surface of the temperature sensor and the upper side of the warming plate following assembly of the temperature sensor, to be maintained at a particularly low level which is beneficial for a larger travel of displacement of the temperature sensor.

In the temperature sensor assembly, a rubber or elastic plastic member provides for the remainder of the requisite thermal contact between the warming plate and the temperature-detecting element, in addition to ensuring a secure holding function in a simple and economical manner. Moreover, the low-cost elastic holding member is at the same suitable for use as a seal for sealing the base member of the beverage-brewing apparatus arranged beneath the warming plate.

Configuring the temperature-detecting element as an NTC resistor as disclosed in claim 3 results in the advantage that the resistor allows the current in the heating device to rise when the beverage cools down. Resistors of this type are particularly inexpensive obviating the necessity of elaborate temperature control devices.

By means of the heat-conducting paste, a large surface area for establishing thermal contact is obtained on the metal sleeve, causing the temperature sensor to respond to low temperature variations.

The temperature sensor assembly of the present invention affords the advantage that the holding member performs at the same time the function of a spring. The provision of an additional component is thereby obviated. This advantage is enhanced still further in that the holding member is a bellows providing the additional function of sealing the opening relative to the temperature sensor and the warming plate, thus preventing contaminant and water ingress through the opening into the interior of the base member in which electrical conductors and circuitry may be received. Further, such a bellows affords ease of manufacture and can be fitted in the opening and to the temperature sensor under radial bias without requiring additional fastening means (claim 2).

The features of claim 3 enable the NTC resistor to be mounted in the sleeve particularly readily without the need for additional fastening means. In addition to ensuring good heat transference, the heat-conducting paste also provides for fastening of the retaining arms to the NTC resistor in an easy and uncomplicated manner.

An embodiment of the present invention will now be described in more detail in the following with reference to the accompanying drawings. In the drawings,

FIG. 1 is a sectional view of a flow-through heater with a collection container seated thereon, together with its mounting structure in the base member of a beverage-brewing apparatus, showing the temperature sensor assembly of the present invention only in a side view; and

FIG. 2 is a longitudinal sectional view of the temperature sensor assembly of FIG. 1, showing the fastening means of the temperature sensor to the left of the center line in the form of retaining arms, and to the right of the center line in the form of a half shell.

In FIG. 1, the warming plate 10 has its periphery connected to the base member 13 of the apparatus for brewing beverages, for which purpose detent means 13a may be employed. Because the warming plate 10 is connected to the electric heating device 3 which is in turn connected to the water conduit 2 through the land 14 and the sheet-metal member 15, the connecting means 13a also serve as means for mounting the complete flow-through heater 1 in the base member 13. Seated on the warming plate 10 is the cylindrical collection container 9 made of glass which has a recess 22 at its bottom providing, in combination with its shape on the periphery of the bottom, a circular-ring-shaped support surface 23 of the collection container 9 on the warming plate 10. In this arrangement, the position of the support surface 23 is selected such as to follow the contour of the electric heating device 3 over large areas. It is only in the open area between the electrical leads 20a and 20b (situated therebehind) of the electric heating device 3 resulting from the horseshoe-shaped configuration of the flow-through heater 1, in which area the temperature sensor assembly 21 is located, that the spatial extents of the support surface 23 and of the electric heating device 3 do not match. Rather, at this particular location, the temperature sensor assembly 21 extending through the warming plate 10 from below (see FIG. 2) and held therein in a holding member 24 shown only schematically in FIG. 1 contacts the support surface 23.

In this manner it is ensured that, for one thing, heat produced by the electric heating device 3 is directed through the warming plate 10 to the collection container 9 holding a brewed beverage, and that, for another thing, the temperature sensor assembly 21 is

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equally in good thermal contact with the brewed beverage through the support surface 23. As will be set forth in more detail in the following with reference to the description of FIG. 2, thermal contact between the temperature sensor assembly 21 and the warming plate 10 is substantially smaller than between the temperature sensor assembly 21 and the support surface 23.

FIG. 2 is a longitudinal sectional view of the temperature sensor assembly 21 in its mounting area on the warming plate 10, showing the sensor in a position depressed downwardly, when viewing the drawing, by the support surface 23 of the collection container 9. The warming plate 10 punched from steel sheet and preferably produced by a deep-drawing process includes a frusto-conical section 40 extending downwardly when viewing the drawing, forming a depression tapering downwardly and terminating in an annular collar 41. The annular collar 41 defines an opening 42 for engagement with a holding member 24 provided with an annular groove 43, such that annular end surfaces 44, 45 engage the annular collar 41, thereby securely locating the holding member 24 in the opening 42.

The holding member 24 is formed of a rubber element or a heat-resisting plastics material as, for example, silicone or Teflon. In FIG. 2, the holding member 24 extends upwardly along the inner wall 46 of the frusto-conical section 40 and is bent over at the elevation of the warming plate 10 towards the center line 47 such that its upper edge 77 does not protrude from the upper side 54 of the warming plate 10. The end portion 48 of the holding member 24 serves the function of a bellows. The bent end of the bellows 48 forms an annular bead 49 radially biased into engagement with an annular groove 50 provided in the cup-shaped portion of the sleeve 51. For good heat conduction, aluminum is the preferred material selected for the sleeve 51.

As becomes clearly apparent from FIG. 2, the temperature sensor assembly 21 with the sleeve 51 is carried by the holding member 24 and, in the position shown in FIG. 2, is urged into engagement with the support surface 23 of the collection container 9 with a biasing force in order to accomplish good heat transference from the support surface 23 of the collection container 9 to the temperature sensor assembly 21. In order to ensure that the sleeve 51 is urged into engagement with the support surface 23 with a predetermined biasing force, the bellows 48 exerts a biasing force on the sleeve 51 in an upward direction when viewing FIG. 2. This biasing force

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results from the bending deformation occurring in the bellows 48 as the temperature sensor assembly 21 is pressed down. On removal of the collection container 9 from the warming plate 10, the temperature sensor assembly 21, as a result of the bending stress stored in the bellows 48, moves upwardly when viewing the drawing until the bending stress in the bellows 48 is nearly canceled.

In the initial condition of the holding member 24, the annular bead 49 and the adjoining bellows area are directed upwardly when viewing the drawing, the shape of the holding member 24 then corresponding approximately to the original shape as molded. Accordingly, when pressure is not exerted on the bottom area 52 of the sleeve 51 in a downward direction when viewing the drawing, the contact surface 53 adapted to be make contact with the support surface 23 of the collection container 9 will protrude from the upper side 54 of the warming plate 10, which however cannot be seen in FIG. 2 because the support surface is shown as urging the temperature sensor assembly 21 downwards in opposition to the bending force produced in the bellows 48.

At the location where the annular groove 50 is formed on the sleeve 51 of FIG. 2, the sleeve tapers conically in downward direction in its outer circumferential area 76, continuing in a tubular section 55. The annular section 56 formed by the annular groove 43 includes a through bore 57 extending concentrically with the outer circumferential surface 58 of the tubular section 55 of the sleeve 51 at a small relative distance to enable the sleeve 51 to be axially slidable in the holding member 24 free from friction. This is necessary because the bending forces which occur in the bellows 48 as it is deformed and which allow an axial displacement along the center line 47 are comparatively low. At all events, this biasing force must not be greater than the weight of the collection container 9 when not storing liquid; on the other hand, it must always be sufficiently large to ensure that the temperature sensor assembly 21 moves upwardly when viewing FIG. 2 on removal of the collection container 9 from the warming plate 10, its contact surface 53 then protruding from the upper side 54 of the warming plate 10.

In FIG. 2, the sleeve 51 has a blind-end bore 59 whose horizontally extending bottom 60 is formed in the bottom area 52, that is, close to the contact surface 53. A temperature-responsive element 62 configured as an NTC resistor is inserted into the open end 61 of the blind-

end bore 59 arranged below the annular section 56 of the holding member 24, such that its pin 63 protruding at the tip abuts the bottom 60, as a result of which good heat transference is accomplished from the bottom area 52 to the NTC resistor 62.

In FIG. 2, a heat-conducting paste 64 is applied to the surface of the NTC resistor 62 in the temperature-responsive area, that is, the area surrounding the pin 63, which paste is in good thermal contact with the bottom 60 and the NTC resistor, the resulting large area of surface contact thus causing the temperature-responsive element 62 to respond to temperature variations particularly rapidly. Provided on the heat-conducting paste 64 in diametrically opposite arrangement are retaining arms 65 of which only the arm to the left of the center line 47 can be seen. To illustrate two fastening possibilities in a single Figure, one retaining arm 65 is shown to the left, and one half shell 81 is shown to the right, of the center line 47. In the one embodiment, therefore, two diametrically opposite retaining arms 65, and in the other embodiment, two diametrically opposite half shells 81 are provided as fastening means for the temperature-responsive element 62. The retaining arms 65 extend along the length of the blind-end bore 59, embracing the tubular section 55 of the sleeve 51 at their open ends 61. Detent means 66 are formed at these ends which snap resiliently into recesses 67 provided on the outer circumferential surface 58 of the tubular section 55, as a result of which the temperature-responsive element 62 is securely held in engagement with the bottom 60 inside the blind-end bore 59, as is clearly shown in FIG. 2. The NTC resistor 62 is connected to a circuit (not shown) by two leads 70, 71.

In the fastening structure of the temperature sensor 62 in the metal sleeve 51 shown to the right of the center line 47, the sensor is enclosed by two half shells 81 (of which only the right-hand half shell is shown), thus providing a sleeve 80. To hold the sleeve 80 thus formed together, a very thin tube 82 made of plastics or Teflon is used in order not to impair the conduction of heat from the metal sleeve 51 to the temperature sensor 62. Projecting from the lower open end 61 of the metal sleeve 51 shown to the right of the center line 47 when viewing FIG. 2 are two retaining arms 83 formed on the half shells 81 and fixedly connected with the metal sleeve 51 at the end thereof by detent means 84 engaging a groove 85 provided in the metal sleeve 51. With this embodiment, fastening and assembly of the temperature sensor 62 in the metal sleeve 51 is particularly simple.

As shown in FIG. 2 to the right of the center line 47 at the upper end of the temperature sensor 62, the pin 63 does not extend into abutment with the bottom 60, being rather surrounded by the heat-conducting paste 64 applied to the opening 86 of the sleeve 80 formed by the half shells 81 prior to assembly. The advantage of the embodiment shown to the right when viewing FIG. 2 over the embodiment shown to the left is that it provides for improved central location of the temperature sensor 62 by means of the half shells 81.

In FIG. 2, at the location where the leads 70, 71 exit the assembly, these are provided with an insulating means 68, 69 sealingly enclosed by an annular collar 87 connecting the retaining arms 65 or the half shells 81 to prevent contaminants and humidity from entering the chamber 72 formed by the blind-end bore 59. Further, the tubular section 55 of the sleeve 51 is connected to ground 73 to prevent an operator from being exposed to voltage in the event of his or her contacting the contact surface 53 of the temperature sensor assembly 21.

The switching device 74 in FIG. 2 serves to ensure that the flow-through heater 1 is not set in operation by activation of the main switch of the beverage-brewing apparatus when the collection container 9 is removed from the warming plate 10, that is, when the temperature sensor assembly 21 is in its initial, extended position from the housing of the beverage-brewing apparatus and when the beverage-brewing apparatus is not turned on as yet. This is accomplished by the open position of the switch 74 and the resultant Off-signal in the microcontroller (not shown), so that the microcontroller does not allow an activation of the beverage-brewing apparatus.

When, in the other event, the collection container 9 is removed from the warming plate 10 during the brewing cycle, the switching device 74 will be likewise opened by displacement of the temperature sensor assembly 21, and a signal will be delivered to the microcontroller which processes this signal such as to cause deactivation of the flow-through heater 1 although the main switch is still on. As soon as the collection container 9 is replaced on the warming plate 10 (FIG. 2), the switching device 74 will be short-circuited, supplying a signal to the microcontroller which then re-activates the flow-through heater 1 and causes the brewing cycle to be resumed.

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By contrast, when the beverage-brewing apparatus is in the keep-warm mode, the switching device 74 will be equally opened on removal of the collection container 9 from the warming plate 10 as a result of the axial displacement of the temperature sensor assembly 21, a suitable signal being then delivered to the microcontroller which, via a circuit arrangement provided in the microcontroller, will then continue to supply electric energy to the flow-through heater 1 for a period of, for example, ten minutes. If the collection container 9 is not replaced on the warming plate 10 during this period, the microcontroller will cause deactivation of the beverage-brewing apparatus.

If the collection container 9 is placed down on the warming plate 10 prior to the expiration of this keep-warm period, the flow-through heater 1 will continue to be on, its temperature being then controlled by a further thermostat (not shown). This last-mentioned control action which is activated in the keep-warm mode operates independently of the residual thermal contact so that the temperature sensor assembly 21 will cause de-energization of the flow-through heater 1 when it responds, due to the residual thermal contact, within a shorter period of time, that is, before the waiting period of ten minutes has elapsed.



Patent Claims:

1. A temperature sensor assembly (21) for measuring the temperature of a brewed beverage contained in a collection container (9) of an apparatus for brewing beverages, with the bottom (23) of the collection container (9) being in thermal contact with a warming plate (10) heated electrically by a heating device (3), said temperature sensor (21) detecting the temperature on the outside of the collection container (9), thus controlling the heating device (3) by means of an electrical signal delivered by the temperature sensor (21) in dependence on the temperature, said thermal contact between the collection container (9) and the temperature sensor (21) clearly prevailing over the thermal contact between the temperature sensor (21) and the warming plate (10), and the temperature sensor (21) being axially slidably guided in a recessed portion (40) of the warming plate (10), such that the temperature sensor (21), with the collection container (9) placed down on the warming plate (10), is urged into abutting engagement with the collection container by a biasing force acting in the direction of the collection container (9), causing the temperature sensor (21) to be in good thermal contact with the collection container (9),
c h a r a c t e r i z e d i n t h a t the remainder of the thermal contact between the temperature sensor (21) and the warming plate (10) caused by heat conduction is provided by a holding member (24) made of a rubber or plastics material which, on the one hand, is sealingly mounted in the warming plate (10) and, on the other hand, guides and sealingly encompasses the movable temperature sensor (21), and that the holding member (24) includes a portion (48) in which the biasing force acting on the temperature sensor (21) is produced as the holding member is elastically deformed by displacement of the temperature sensor (21).

2. The temperature sensor assembly as claimed in claim 1,
c h a r a c t e r i z e d i n t h a t the temperature sensor assembly (21) is comprised of an electric temperature-detecting element (62) and a metal body (51) which receives said temperature-detecting element (62) and with which it is in good thermal contact, that the one end portion (48) of the holding member (24) includes an annular bead (49) radially biased into engagement with an annular groove (50) provided on the metal body (51), and that the other end portion includes an annular

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section (56) engaged within the opening (42) of the warming plate (10).

3. The temperature sensor assembly as claimed in claim 2, characterized in that the metal body (51) is comprised of a sleeve (51) closed relative to the bottom of the collection container (9), that the temperature-detecting element (62) is an NTC resistor, and that the good thermal contact between the sleeve (51) and the NTC resistor (62) is established by filling the space therebetween with a heat-conducting paste (64).

4. The temperature sensor assembly as claimed in claim 3, characterized in that retaining arms (65) are provided on the heat-conducting paste (64), said arms extending to the outside through the metal sleeve section (55) and having detent means (66) for resiliently engaging within recesses (67) provided on the outer circumferential surface (58) of the metal sleeve section (55).

5. The temperature sensor assembly as claimed in claim 3, characterized in that the temperature-detecting element (62) is surrounded by two half shells (81) providing a sleeve (80), that the half shells (81) are enclosed by a tube (82), that the sleeve (80) has its open end (83) sealed by the heat-conducting paste (64), and that the NTC resistor (62) is embedded in the heat-conducting paste (64).

6. The temperature sensor assembly as claimed in claim 5, characterized in that diametrically opposite retaining arms (83) are arranged on the half shells (81) at the open end (61) of the sleeve (51), that said retaining arms (83) embrace the sleeve (51) from outside, and that said retaining arms (83) are provided with detent means (84) for resilient engagement with recesses (67) provided on the outer circumferential surface (58) of the metal sleeve section (55).