

[54] **ADJUSTABLE THERMOSTATIC DEVICE WITH SNAP SWITCHES**

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[58] Field of Search ..... **200/83 P, 83 Z, 83 WM, 200/83 S, 153 W; 337/115, 117, 311, 312, 320, 323**

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[57]

**ABSTRACT**

A regulator for a cooker hot plate or other heating appliance has a temperature sensing bulb filled with thermally expansible fluid and connected to a pressure bellows. An adjusting screw spindle acts on the bellows which acts in turn through a strut on a pivotally mounted, spring-biased pressure plate. The strut passes between two snap switches which are adapted to be closed by the pressure plate, acting on the switches through adjusting screws, such that the snap switches open at different temperatures. The pressure plate can include a resilient flexible portion by which the pressure plate is pivotally mounted and at the same time spring-biased towards the snap switches. Compensating bimetal means may be inserted between said pressure plate and said snap switches.

**3 Claims, 7 Drawing Figures**

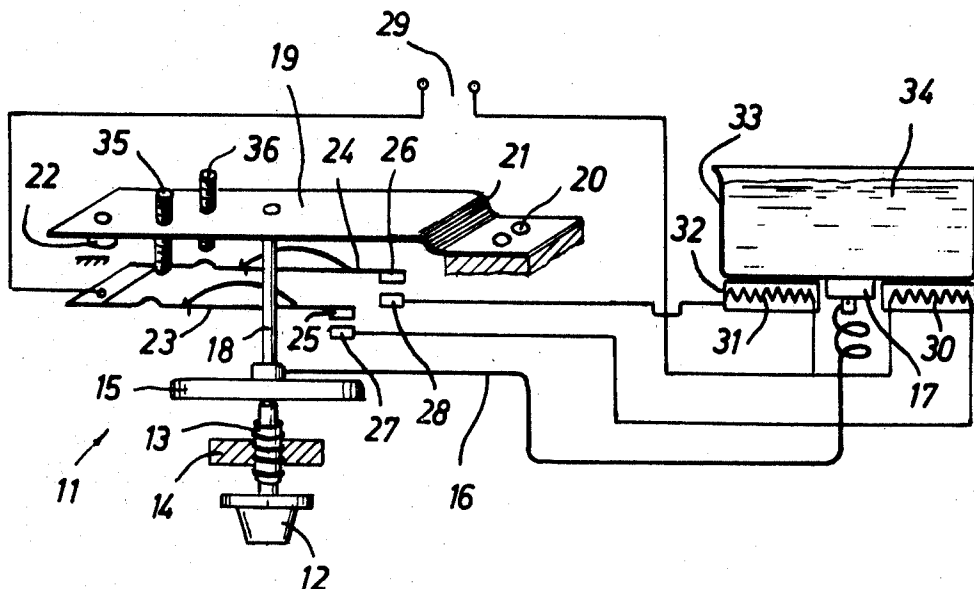
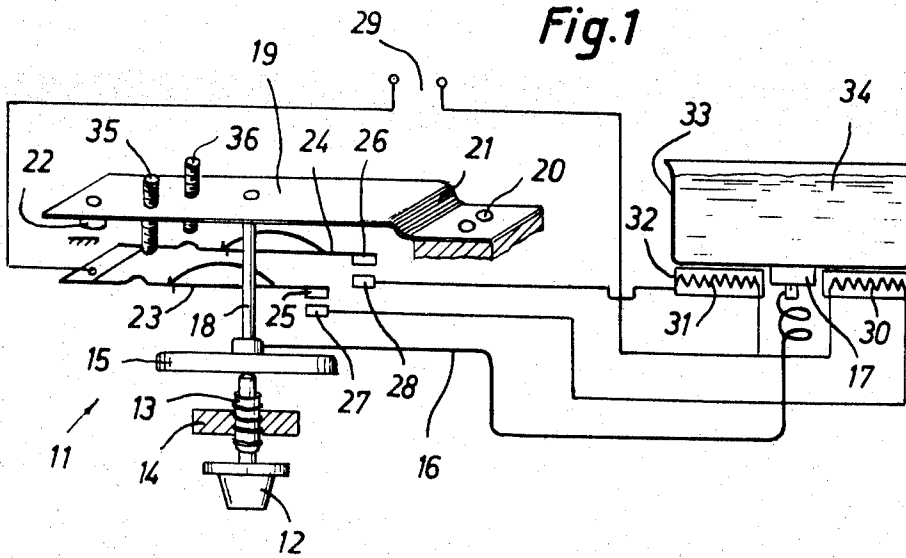
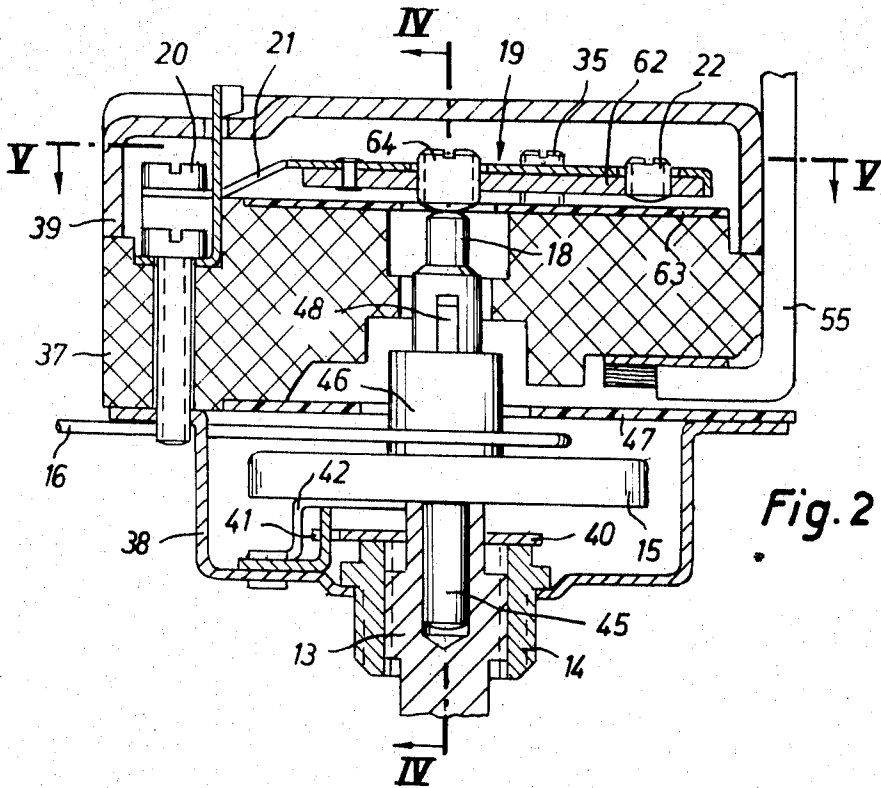
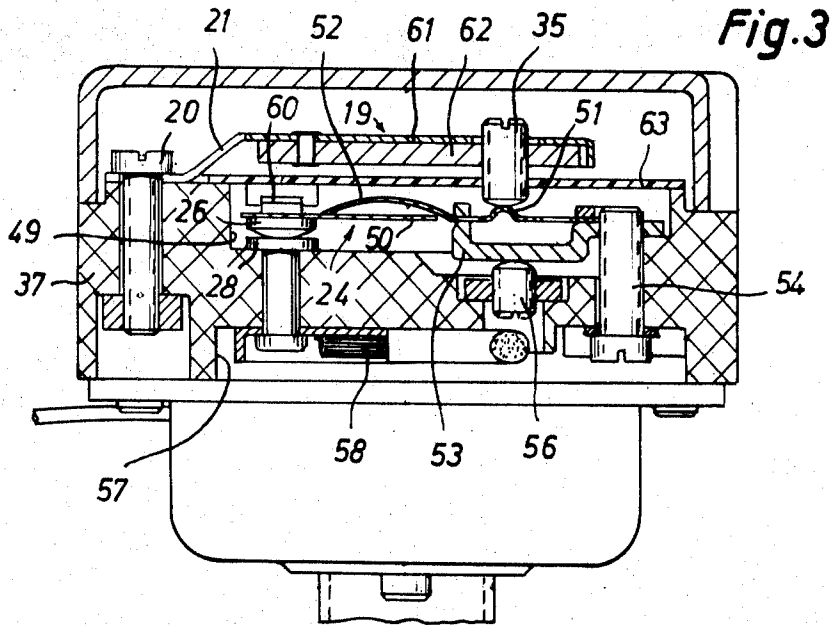
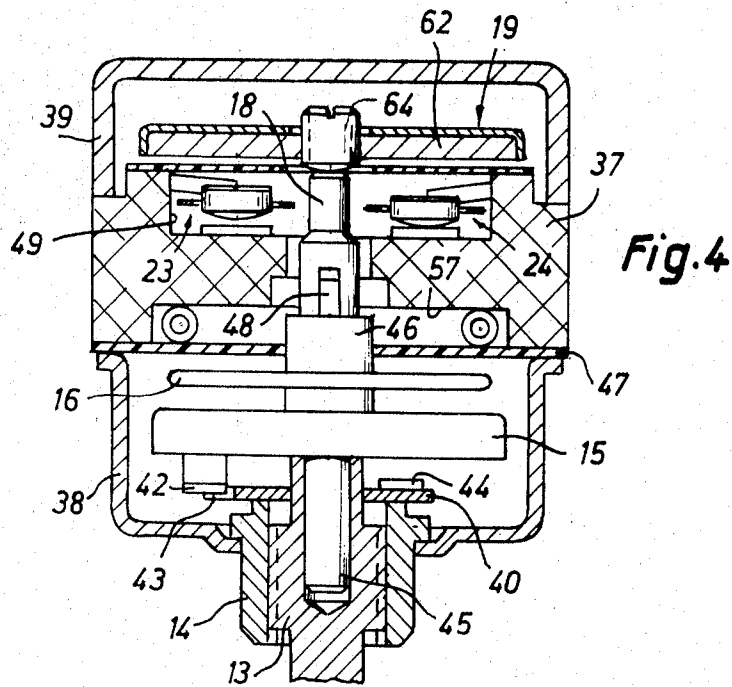
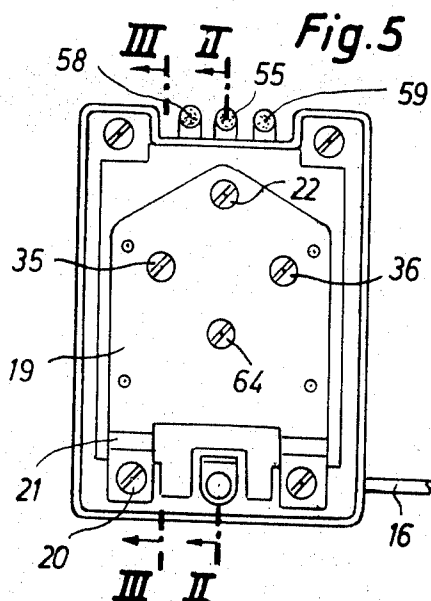
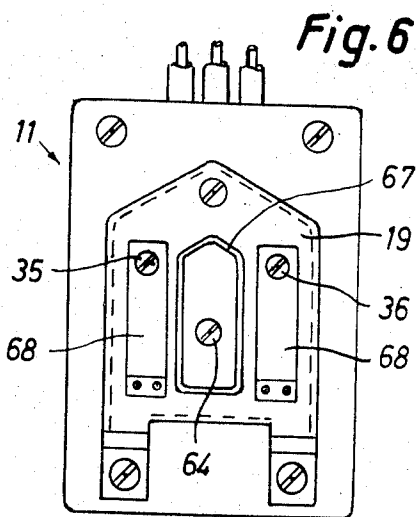
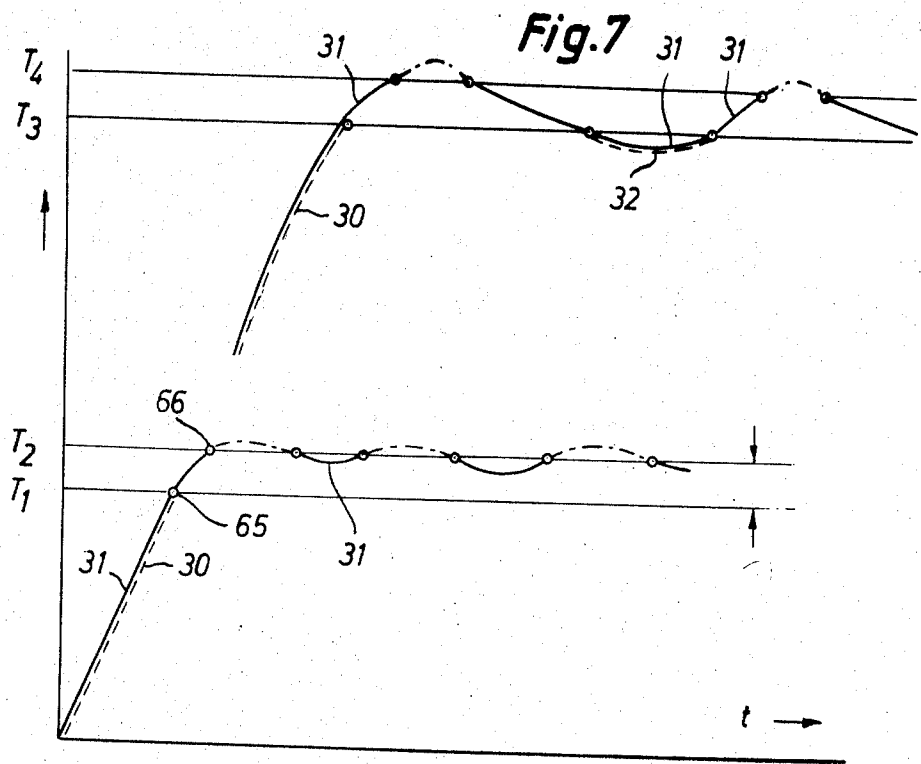


**Fig. 1**







## ADJUSTABLE THERMOSTATIC DEVICE WITH SNAP SWITCHES

This invention relates to a regulator for an electric heating appliance, such as an electric hot plate, comprising a pressure bellows connected to a fluid-filled sensor element exposed to the temperature of the electric heating appliance or of the object to be heated thereby, a screw spindle which can be rotated by a knob and affects the pressure bellows, and at least two snap switches adjustable relative to one another and switching at different temperatures.

Such types of regulator are already known, in which the pressure bellows affects a switch rocker placed between it and the snap switches and pivots the rocker. The switch rocker affects the snap switches, which are switched on in the unloaded state by insertion of an overload spring to press them into an "off" position.

This arrangement makes it necessary to make the regulator rather large and makes great demands on the accurate support of the switch rocker and on the durability of the switch springs of the snap switches. When the regulator is switched off by turning the screw spindle, i.e., always when the electric heating appliance is not in use, pressure is exerted on the switch springs of the snap switches to keep the snap switches in a switched-off position. The overload springs, which must be made relatively stiff to be faultless and accurate so that they can transmit without play all switching operations, do prevent an inadmissible overstressing of the snap springs but, most of the time, they are putting considerable pressure on the snap switches. This pressure becomes particularly strong when the regulator is switched off by turning the screw spindle, when the electric heating appliance or the object heated thereby is still hot. Then, in addition to the regulating process actuated by the spindle, there is also the expansion movement of the pressure bellows.

A feature of the invention is to provide a regulator, which, although of simple construction, prevents the snap springs from being overloaded and can be manufactured in an unusually small size.

According to the present invention, the pressure bellows is connected coaxially and directly to the screw spindle and transmits, by way of a compression strut projecting between the snap switches, the superimposed regulating and expansion movements onto a non-distortable pivotable pressure plate, which is located on the side of the snap switches opposite the pressure bellows and covers the snap switches; the pressure plate, spring-loaded in the direction of the snap switches, influences all snap units by means of adjusting screws so that the snap units, which are no-load condition in the "off" position in their free state, are kept in an "on" position until the compression strut lifts the pressure plate from the snap switches against its spring action, and the pressure plate has a stop which limits its movement towards the snap switches.

It should be mentioned that the snap springs of the snap switches are loaded for only a relatively short time, namely only when power is fed to the electric heating appliance, and that this load can never exceed a high or intolerable value, since the movement of the pressure plate is limited by the stop. But the force of the spring pressing the pressure plate onto the snap switches can be very strong, so that the entire transmission mechanism for the switching movements can be

held in a good backlash free system and the snap switches can be switched with very strong force without risk of overloading.

Desirably, the pressure plate has a flexible section which forms the pivot. This prevents the pivot being susceptible to bearing play at an axle and considerably reduces construction costs. The flexible section can affect the spring load of the pressure plate like a plate spring. This also does away with the need for a separate pressure spring.

Advantageously the pressure plate comprises a part, made of spring material and including the flexible section, the part being connected to a reinforcing plate, which accommodates the adjusting screws and the stop.

As a result of the advantageous force distribution and arrangement of all the regulating parts, it is possible to construct an unusually compact and small regulator. Compared with known regulators in all mounting positions, the size of the mounting can be cut almost by half. This is mainly due to an advantageous feature wherein the regulator housing comprises an insulating block, which carries in recesses the snap switches, their electrical connections and the pressure plate, a housing front accommodating the screw spindle and the pressure bellows, and an insulating cover part over the pressure plate. The electrical connections (also the hydraulic connection) can be in the form of an insulated cable brought out of the regulator through the junction between the insulating block and the housing front. Therefore there is also no need for plug and socket connections directly to the regulator, which increase the size of the mounting especially because of the required accessibility of the plug and socket connections.

The invention is further described, by way of example, with reference to the accompanying drawings, in which:

FIG. 1 is a circuit diagram of a regulator constructed in accordance with the invention;

FIG. 2 is a cross-section on the lines II—II in FIG. 5 of a preferred embodiment of the invention;

FIG. 3 is a section on the lines III—III in FIG. 5;

FIG. 4 is a section on the lines IV—IV in FIG. 2;

FIG. 5 is a top view of the pressure plate (section V—V in FIG. 2);

FIG. 6 is a top view corresponding to FIG. 5 of another embodiment; and

FIG. 7 is a graph in which temperature is plotted as a function of time representing the operation of the regulator in two loaded states.

The regulator 11 shown in FIG. 1 has, as a means of regulating the desired temperature by hand, a knob 12, which turns a screw spindle 13. The screw spindle 13 cooperates with a nut 14 and influences a pressure bellows 15. The pressure bellows is connected by a capillary tube 16 to a temperature sensor 17. The pressure bellows/capillary tube/temperature sensor system is filled with an expansion fluid.

The pressure bellows 15, arranged coaxially on the screw spindle 13, acts by means of a compression strut 18 on a pressure plate 19, which has between its free end and its attachment 20 to the regulator housing a flexible section 21, which allows the pressure plate 19 to pivot. The flexible section acts simultaneously as a plate spring biasing the pressure plate 19 in an anti-clockwise direction. Its pivotal movement in this direc-

tion is however limited by a stop 22. Between the pressure bellows 15 and the pressure plate 19, are located two snap switches 23, 24 whose contacts 25, 26 cooperate with fixed opposite contacts 27, 28 and which are closed in their free state. The compression strut 18 projects between the two snap switches. The pressure plate 19 acts on the switch springs of the snap switches 23, 24 by means of two adjusting screws 35, 36 which are adjusted in such a way that, when the pressure plate pivots, the snap switches do not switch simultaneously but one after another with a preset gap.

The regulator 11 in FIG. 1 is adapted to regulate an electric hot plate. For this purpose, the switch springs of both snap switches 23, 24 are connected to a terminal of a current source 29, while both fixed contacts 27, 28 are connected respectively to two heating resistors 30, 31 of an electric hot plate, which are electrically insulated from each other. The other ends of the heating resistors 30, 31 are connected to the other terminal of the current source 29.

The temperature sensor 17 is resiliently positioned against the underside of a cooking receptacle 33, which is filled with material 34 being cooked.

In FIGS. 2 to 5, a regulator 11 is shown in detail. Its basic construction corresponds to the regulator in FIG. 1. Like parts are indicated by the same reference numerals and are not described further. The regulator has a regulator housing, which comprises an insulating block 37, a housing front 38, and an insulating cover part 39. The housing front 38 is of metal and carries the nut 14 for the screw spindle 13. A disc 40 non-rotatable relative to the screw spindle 13 has a back stop 41 to limit the rotary motion of the screw spindle 13. A plate spring 42 cooperates with a notch 43 in the disc 40 to lock the screw spindle in an off-position. A plate spring 44 acting on the disc 40 checks the motion of the spindle. The pressure bellows 15 is inserted by a pin 45 into a bore of the screw spindle 13. The pressure bellows has a nipple 46, into which the connection of the capillary tube 16 is soldered. The capillary tube is introduced spirally inside the housing front 38 so as not to impede movement of the pressure bellows 15. A small insulating plate 47 is placed between the housing front 38, which fully accommodates the pressure bellows, and the insulating block 37.

The nipple 46 has a pin 48, on which the compression strut 18 is pinned. The compression strut is made of insulating material and projects between the two snap switches 23, 24. In doing so, it reaches through an opening in the insulating block 37. The snap switches 23, 24 are located in recesses 49 in the insulating block 37.

As is usual, the snap switches 23, 24 have a switch spring 50 with a center of pressure 51. The bowed snap spring 52 rests on a part 53, which is attached by screws 54 to the insulating block. The screws 54 for both snap springs (FIGS. 3) are joined to a connecting cable 55 (FIG. 2). The part 53 of each snap switch can be adjusted by a respective screw 56.

The contacts 25, 26 on the switch springs 50 cooperate with the fixed contacts 27, 28 which are fixed at the base of the recess 49 in the insulating block on the side remote from the pressure bellows. The pins bearing the contacts 27 project through the insulating plate 37 and lie in a recess 57. Connection cables are electrically connected to these pins. The connection cables 55, 58 run in the recess 57 of the insulating block 37 and leave the regulator at the joint between the housing front 38

and the insulating block 37. The motion of the switch springs 50 is limited in an upward direction by stops 60.

The pressure plate 19 comprises a part 61 made of insulating material and a stiffening plate 62 riveted to this. The pressure plate 19 covers both snap switches with a small insulating plate 63 lying therebetween. Two fingers on the part 61 form the flexible sections 21 and are attached by fastening screws 20 to the insulating block 37. The flexible sections exert a relatively strong pressure on the pressure plate 19 pushing it towards the snap switches. To further stiffen the part 61, its border regions are bent over.

As shown particularly in FIG. 5, the adjusting screws 35, 36, forming the connection with the centres of pressure 51 of the snap switches, are screwed into the pressure plate 19 or its stiffening plate 62. The compression strut 18 acts by means of an adjusting screw 64 on the pressure plate 19 (FIG. 4) and the stop 22 is a stop-screw, which cooperates with the insulating block (the small insulating plate 63 being inserted between) (FIG. 2). The cover part covers the pressure plate 19.

The regulator of FIGS. 1 to 5 operates as follows: In the switched-off state, the screw spindle 13 is completely turned into the housing by turning the knob, so that the pressure is transmitted by means of the not yet expanded pressure bellows 15 through the compression strut 18 and the adjusting screw 64 to the pressure plate 19. In FIGS. 1 to 5 the latter is pivoted upwards; the adjusting screws 35, 36 are not acting on the center of pressure of the snap switches 23, 24 and the snap switches are in their normal off position. At the same time, the screw spindle acts against the spring pressure of the pressure plate 19. It should be noted that in this position, which is occupied by the regulator for the most time, the snap switches are not at all loaded and so are not exposed to the risk of their adjustment being disarranged owing to continuous stress.

When the regulator is switched on by turning the knob clockwise and set at a certain temperature, the screw spindle 13 moves a certain distance out of the regulator housing (downwards in the drawings).

The compression strut 18 and the pressure bellows 15 are carried down by the spring tension (section 21) acting on the pressure plate 19, but a backlash-free system of these parts is always guaranteed. The adjusting screws 35, 36 affect the snap switches 23, 24 in such a way that the snap switches close or open one shortly after the other. The current from the current source 29 flows through both switch springs, the contacts 25, 26, 27, 28 through the heating resistors 31 and back to the current source 29. The electric hot plate 32 and the material 34 in the receptacle 33 are heated. During this, the sensor bulb 17 assumes a temperature, which is determined by the material 34 as well as, to a lesser extent, by the temperature of the electric hot plate. Its expansible fluid expands and affects the pressure bellows 15 which in turn expands.

It may be assumed here, as in frequent practical examples, that the regulator is used to regulate an electric hot plate of approximately 2,000 watts, that each of the two heating resistors 30, 31 consumes 1,000 watts and the relative adjustment of the two snap switches 23, 24 is effected for the two switches to switch at approximately 10° C. apart. FIG. 7 is also referred to for explanation, wherein temperature is plotted as a function of time. At adjustment of low temperatures, the power pertaining to the adjusted temperature is lower than the

power of one of the heating resistors alone. The regulator knob is set at a temperature approximately corresponding to the temperature T2 in FIG. 7. At this setting, the snap switch 23 switches off at a temperature T1 and the snap switch 24 at a temperature T2. T1 is, as has already been explained, according to the adjustment, approximately 10° below the temperature T2. During the time that the appliance is heating up, while both heating resistors 30, 31 are switched on, (shown in FIG. 7 by a continuous and a dotted line) the heating resistor 30 is switched off when the temperature reaches T1 (point 65) by opening the snap switch 23. Owing to the thermal capacity of the electric hot plate 32, however, the temperature T2 is reached after a relatively short time, so that at point 66 the snap switch 24 also opens and disconnects the heating resistor 31. After a slight further increase in temperature owing to the thermal capacity, the temperature again falls to T2, so that the snap switch 24 closes again, reconnecting the heating resistor 31. Once the temperature T2 is regained, the heating resistor will again be disconnected etc.

The curve shown at the top of FIG. 7 corresponds to a high adjusted temperature, at which (e.g., for roasting) the power required is greater than the power of one heating resistor alone. The heating up takes place in the same manner as already described. At the temperature T3, the heating resistor 30 is disconnected and after the temperature has risen to T4, the heating resistor 31 is also disconnected. After the temperature T4 has been "overshot" (dash-dot line), the heating resistor 31 is reconnected by closing the snap switch 24, but the heating resistor 31 alone cannot hold the temperature T4. After the temperature has fallen to T3, the snap switch 23 switches on again, so that, after a further slight temperature fall, the temperature T3 is regained and owing to the thermal capacity of the hot plate the temperature T4 is also quickly regained with the heating resistor 31 alone.

This regulating system can also cope with the greatest problem in regulating electric hot plates, i.e., cooking with water. This is always difficult because under no circumstances can the material being cooked be heated to a temperature above 100°C. With a purely temperature dependent regulating system that would mean that even a regulator adjusted at 101°C could not regulate the cooking current downwards but would always feed in the full power into the electric hot plate, so that the water would boil too fast. On the other hand, regulation to a temperature 1° below the boiling point of water would have the effect that the material being cooked would never reach boiling temperature. It has now been confirmed that these problems can be removed by providing a heating coupling, normally regarded as undesirable, between the sensor 17 and the electric hot plate 32. The sensor is then so arranged in the hot plate that it is not only heated by the heat of the material being cooked but also, to a certain extent, by the heat of the hot plate. The regulator can now be set higher than the boiling temperature. Because of the thermal resistance to heat transmission to the material being cooked, the electric hot plate will reach a temperature higher than boiling point and will therefore disconnect the energy source.

This coupling is especially advantageous in that it protects the hot plate from overloading. If, while the temperature is set high, the receptacle 33 is removed,

the sensor 17 is still heated and adjusts the power in such a way that the hot plate cannot reach an intolerably high temperature. It is also particularly advantageous to place the sensor in the unheated central region of the electric hot plate with a good thermally conductive coupling with the latter, since heat is easily removed in this area provided there is a receptacle 33 on the electric hot plate. The temperature is consequently relatively low there and only slightly higher than that of the material being cooked. If, however, the receptacle 33 is removed, heat is no longer taken from the unheated central area and the temperature rises comparatively steeply, so that the sensor temperature is increased, creating a safety device against overloading.

FIG. 6 shows a variation of the embodiment of FIGS. 1 to 5. In this embodiment, the pressure plate 19' is provided with beading 67 to increase its rigidity, so that under certain circumstances there is no need for the reinforcing plate 62. However, care must be taken to ensure that the pressure plate's connection is sufficiently rigid, otherwise the amount of adjustment between the two snap switches could be disarranged. The adjusting screws 35, 36 are not screwed directly into the pressure plate 19' but into the ends of compensating bimetals 68, which are attached by their other end to the pressure plate 19'. These compensating bimetals are very strongly constructed and are used to compensate the temperature, to which the regulator is exposed. In the case of a steep rise in the regulator's temperature, the regulator would disconnect even before the set temperature, so the compensating bimetals ensure that the adjusting screws are pressed further through the pressure plate 19' and that the tendency towards premature disconnection is counteracted.

The described regulator has numerous advantages. The strong spring force by which the pressure plate 19' is biased towards the snap switches, ensures a safe and exact connection. A corresponding adjustment of the stop screw 22 prevents the snap switches being pressed down harder than is necessary for them to be accurately controlled. This danger would exist, if, when the electric hot plate was still cold (non-expanded pressure bellows 15), the temperature was set high. In this case, the compression strut 18 simply lifts off from its adjusting screw 64. The complete lack of any bearing play in the pressure plate 19 is an essential advantage for the working reliability and simplifies manufacture. All the adjusting screws (down to the adjusting screws 56 for the basic regulation of the snap switches) are accessible in the fully assembled state of the regulator before the cover part has been put on, so that the adjustment can be easily dealt with. Also the fact, that the pressure plate 19 need not be insulated from the live switch springs of the snap switches, since both switch springs lie at the same potential, is an advantage. As is well known, insulating adjusting screws are very difficult to manufacture and, because of their surfaces being difficult to control, an adjustment is very time-consuming. An important constructional advantage lies in the fact that all mechanical parts of the regulator, including the pressure bellows, can be secured in a ceramic insulating block of relatively low construction. As already mentioned, the special arrangement with the snap switches lying between the pressure plate and the pressure bellows simplifies the manufacture of a regulator of an unusually low height. The arrangement also makes it possible to place the fixed contacts 27, 28 of

the snap switches so that they form simple through pins and the electric mains can all be brought out on a plane between two housing parts.

I claim:

1. A regulator for an electric heating appliance, comprising a housing, a pressure bellows, a sensor element adapted to be exposed to the temperature of the electric heating appliance or of an object being heated thereby, means interconnecting said pressure bellows and said sensor element, a thermally expansible fluid in said pressure bellows, said interconnecting means and said sensor, a rotatable screw spindle, a direct coaxial connection between said screw spindle and said pressure bellows, manually operable adjusting means for rotating said screw spindle, at least two snap switches which are off in their free state, a substantially rigid pressure plate located on the side of the snap switches opposite the pressure bellows and overlying the snap switches, means pivotally mounting said pressure plate in said housing, a compression strut projecting between said snap switches for transmitting the superimposed regulating movement of the screw spindle and the expansion movement of the pressure bellows to said pressure plate, spring means biasing said pressure plate in the direction of the snap switches, adjusting screws operative between said pressure plate and respective ones of said snap switches so that the snap switches are kept in an "on" position until the compression strut lifts the pressure plate from the snap switches against said spring bias, said snap switches being adjusted relative to one another to operate at different temperatures, stop means for limiting movement of the pressure plate toward the snap switches, and compensating bimetal means inserted between said pressure plate and said snap switches.

2. A regulator for an electric heating appliance, comprising a pressure bellows, a sensor element adapted to be exposed to the temperature of the electric heating appliance or of an object being heated thereby, means interconnecting said pressure bellows and said sensor element, a thermally expansible fluid in said pressure bellows, said interconnecting means and said sensor, a rotatable screw spindle, a direct coaxial connection between said screw spindle and said pressure bellows, manually operable adjusting means for rotating said screw spindle, a substantially rigid pressure plate, at least two parallel snap switches which are off in their free state and are located between said pressure bellows and said pressure plate, each snap switch underlying the pressure plate and including a switch spring with an electrical contact at one end thereof and a co-operating bowed snap spring adapted to effect movement of said switch spring and said electrical contact, a housing having an insulating block with recesses thereon for receiving said snap switches, said insulating block being located between said pressure bellows on one hand and said snap switches and said pressure plate on the other hand, means pivotally mounting said pressure plate in said housing, a compression strut projecting between said snap switches for transmitting the su-

perimposed regulating movement of the screw spindle and the expansion movement of the pressure bellows to said pressure plate, spring means biasing said pressure plate in the direction of the snap switches, adjusting screws operative between said pressure plate and respective ones of said snap switches so that the snap switches are kept in an "on" position until the compression strut lifts the pressure plate from the snap switches against said spring bias said snap switches being adjusted relative to one another to operate at different temperatures, stop means for limiting movement of the pressure plate towards the snap switches, and compensating bimetal means inserted between said pressure plate and said snap switches.

3. A regulator for an electric heating appliance, comprising a pressure bellows, a sensor element adapted to be exposed to the temperature of the electric heating appliance or of an object being heated thereby, means interconnecting said pressure bellows and said sensor element, a thermally expansible fluid in said pressure bellows, said interconnecting means and said sensor, a rotatable screw spindle, a direct coaxial connection between said screw spindle and said pressure bellows, manually operable adjusting means for rotating said screw spindle, a substantially rigid pressure plate, at least two parallel snap switches which are off in their free state and are located between said pressure bellows and said pressure plate, each snap switch underlying the pressure plate and including a switch spring with an electrical contact at one end thereof and a co-operating bowed snap spring adapted to effect movement of said switch spring and said electrical contact, a housing comprising a housing front accommodating said screw spindle and said pressure bellows, an insulating cover part covering said pressure plate, and an insulating block with recesses thereon for receiving said snap switches and electrical connections therefor, said insulating block being located between said pressure bellows on one hand and said snap switches and said pressure plate on the other hand, means pivotally mounting said pressure plate in said housing, a compression strut projecting between said snap switches for transmitting the superimposed regulating movement of the screw spindle and the expansion movement of the pressure bellows to said pressure plate, spring means biasing said pressure plate in the direction of the snap switches, adjusting screws operative between said pressure plate and respective ones of said snap switches so that the snap switches are kept in an "on" position until the compression strut lifts the pressure plate from the snap switches against said spring bias said snap switches being adjusted relative to one another to operate at different temperatures, a small insulating plate placed between said pressure plate and said snap switches, said compression strut and said adjusting screws passing through said insulating plate, which substantially closes said recesses in which said snap switches are located, and stop means for limiting movement of the pressure plate towards the snap switches.

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