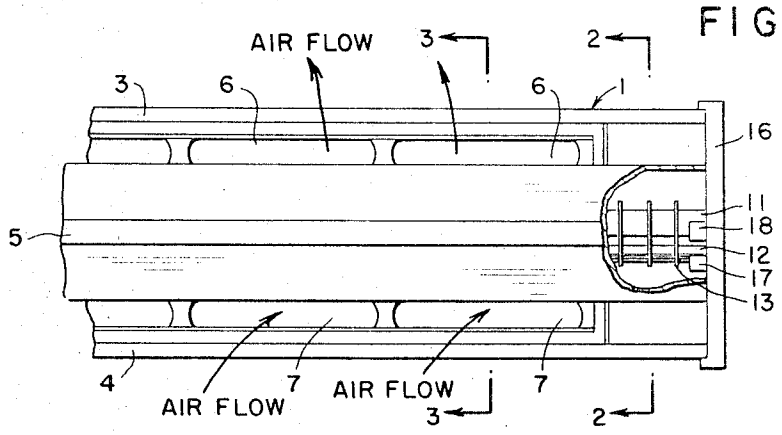
Dec. 20, 1966 C. D. SNELLING 3,293,409

ELECTRIC BASEBOARD HEAT STORAGE UNIT

Original Filed Oct. 21, 1964 3 Sheets-Sheet 1

FIG. 1



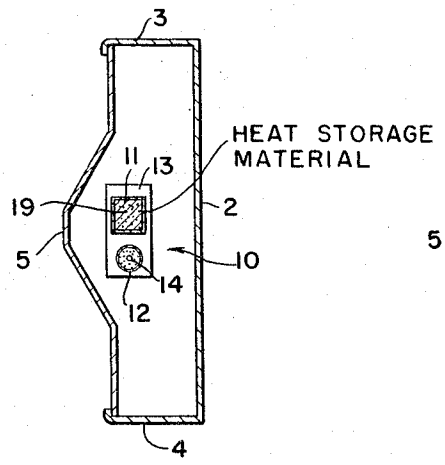


FIG. 2

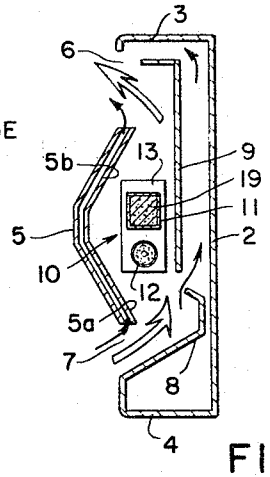


FIG. 3

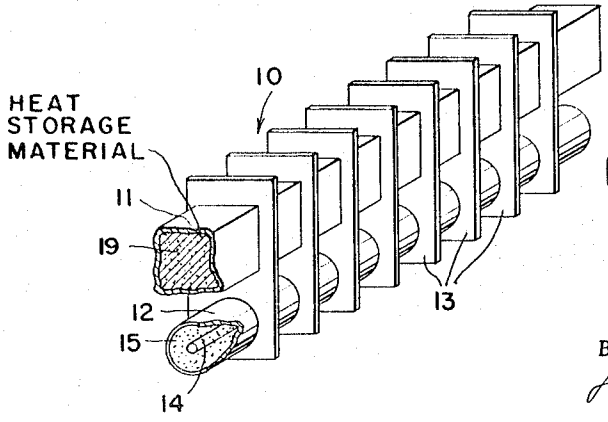


FIG. 4

INVENTOR:
CHARLES D. SNELLING
BY Hofgood & Calvinfolo
ATTORNEYS

ELECTRIC BASEBOARD HEAT STORAGE UNIT

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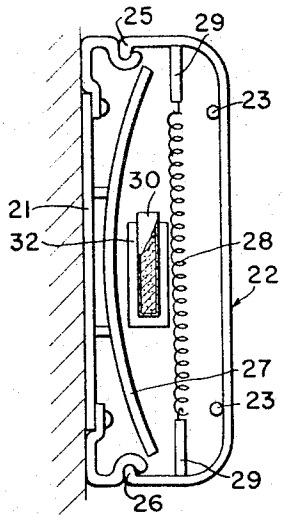


FIG. 5

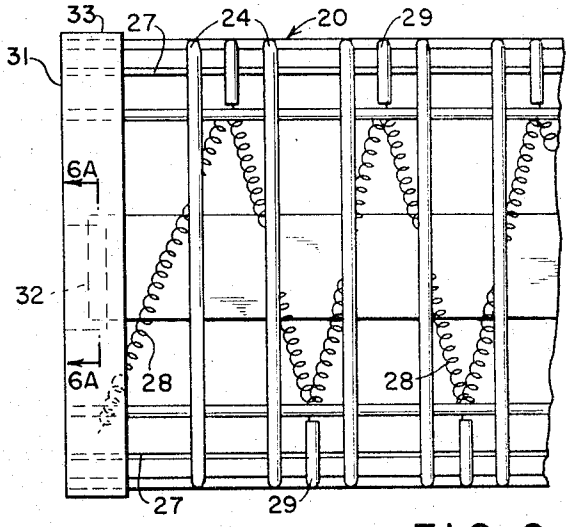


FIG. 6

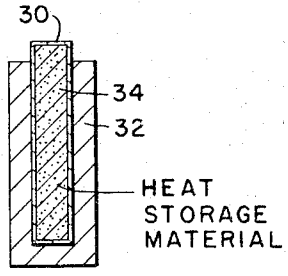


FIG. 6A

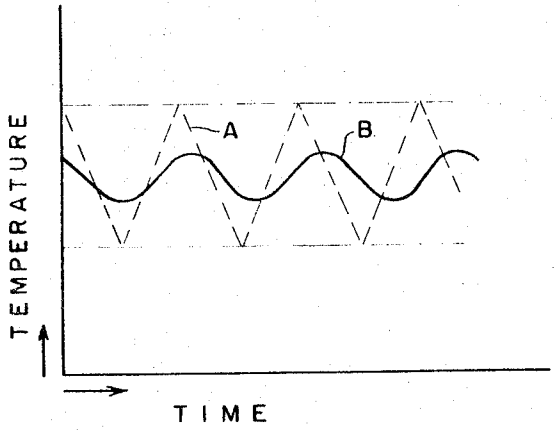


FIG. 7

INVENTOR:
CHARLES D. SNELLING
BY Hopgood & Calimafde
ATTORNEYS

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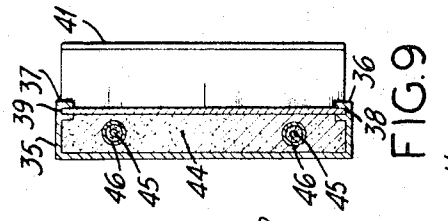


FIG. 9

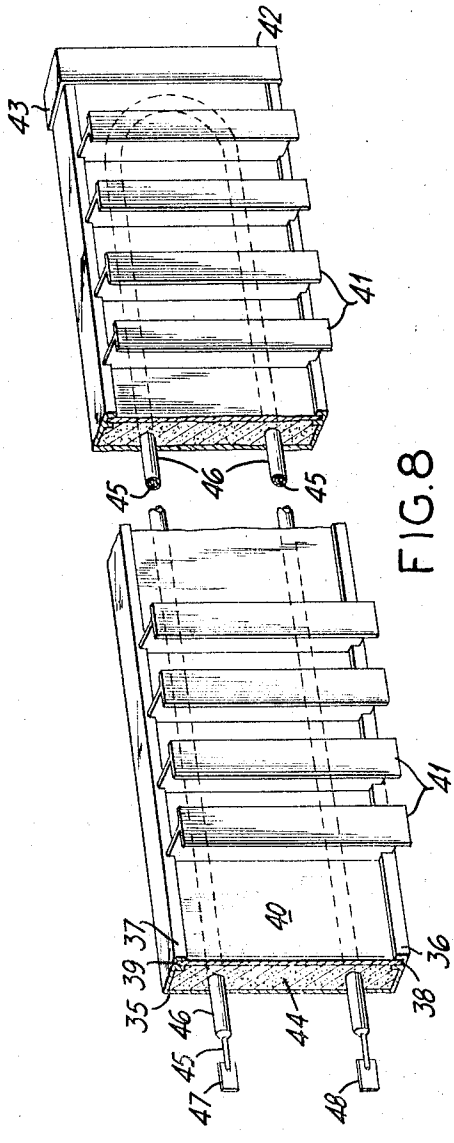


FIG. 8

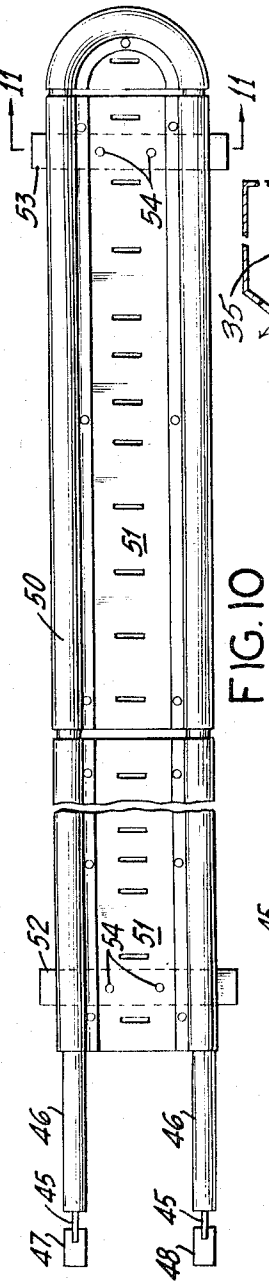


FIG. 10

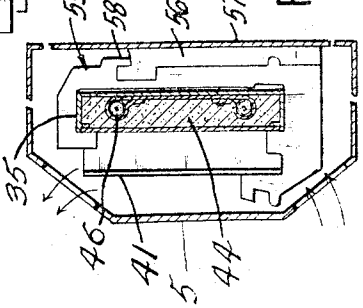


FIG. 12

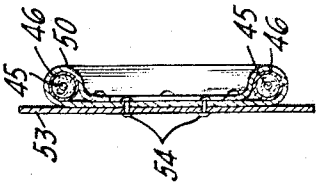


FIG. 11

INVENTOR.
CHARLES D. SNELLING

BY Hopgood & Calimafde

ATTORNEYS.

United States Patent Office 3,293,409 Patented Dec. 20, 1966

3,293,409

ELECTRIC BASEBOARD HEAT STORAGE UNIT

Charles D. Snelling, 2949 Greenleaf St., Allentown, Pa. 18104

Original application Oct. 21, 1964, Ser. No. 405,489. Divided and this application May 12, 1966, Ser. No. 549,528

2 Claims. (Cl. 219—378)

This application is a division of my U.S. application Serial No. 405,489, filed October 21, 1964 which application is a continuation-in-part of my application Serial No. 320,310, filed October 31, 1963, now abandoned.

The present invention relates to a baseboard heating unit and, in particular, to a baseboard electric heating unit capable of maintaining a substantially more uniform flow of heat than prior heaters to an area being heated with minimum temperature fluctuation.

The use of electrical energy as a source of heat in the home has led to the development of small compact baseboard units, so called because they are adapted to be mounted against the baseboard of a wall of a room to be heated. Like the baseboard, the unit is longitudinally configurated except that it is hollow and has enclosed therein a longitudinally arranged electric heating element which is connected into an electric circuit in the usual conventional manner. Baseboard heaters are generally automatic and are operated by a thermostat strategically located in a room or other area being heated. Such heaters may be 6 inches high, about 2¾ inches deep and 2 to 3 feet long, or as long as 8 feet, or even possibly longer. The heating element may comprise the usual 80 nickel–20 chromium electrical heat resistance element completely enclosed within a metal sheath, e.g., a tube, the heating element being buried in an insulating material, such as powdered magnesia or the like, for example similar to a Calrod unit.

Generally, heat exchanger fins surround the heating elements in order to assure optimum heat transfer efficiency, especially in the case where the baseboard heating unit works on the convection principle. The heating is effected by either one of two ways: by the flow of air through the bottom opening of a grill, around the finned heating element and then through the top opening of the grill work out into the room; or by heat reflection off a reflecting unit mounted inside the baseboard unit on the back side thereof behind the heating element. The convection type appears to be the more popular one in use today.

As stated above, the baseboard units are generally automatically controlled by means of a thermostat. Because the elements are not capable of maintaining or storing a high heat content, they are usually designed to throw off a relatively high amount of heat in a short time period. Thus, when the thermostat operates to shut off the electric power, the heating unit immediately cools down and gives off no more heat until the temperature in the room drops to a value corresponding to the setting on the thermostat which actuates the power supply. Because of the time lag which is generally inherent in such a system, a temperature variation is usually noticeable in the room. It would be desirable to have a unit that would not cool down rapidly and that would continually furnish some heat, even when the power is off, so as to smooth out the temperature fluctuation and provides a more uniform heating.

I have now developed a heating unit which will overcome the foregoing difficulties and provide a more uniform type of heating.

It is accordingly the object of my invention to provide a baseboard heating unit which is designed to store heat during a heating cycle and release heat during the off cycle.

Another object is to provide a baseboard heating unit having a heat storage element in cooperable association with an electric heating element adapted to retain heat for release during an off cycle.

These and other objects will more clearly appear when taken in conjunction with the following description and the accompanying drawing, wherein:

FIG. 1 shows in front view a portion of a baseboard heating unit of an air convection type;

FIGS. 2 and 3 are transverse views taken along the lines 2—2 and 3—3, respectively, of FIG. 1;

FIG. 4 is illustrative of one embodiment of a heating element for use with a baseboard of the type shown in FIGS. 1 to 3;

FIGS. 5 and 6 illustrate another embodiment of a baseboard heating unit of the heat-reflective type incorporating the novel features of my invention;

FIG. 6A is a cross section taken along line 6A—6A of FIG. 6;

FIG. 7 depicts temperature curves showing the kind of temperature control obtainable at the air outlet of the baseboard heating units of my invention as compared to the temperature control obtained by the more conventional unit;

FIGS. 8 and 9 show a still further embodiment of a heating unit for use with a baseboard of the type shown in FIGS. 1 to 3;

FIGS. 10 and 11 depict one type of heating element employed in the heating unit of FIG. 8, and

FIG. 12 shows in partial cross section an end view of a baseboard heater illustrating the mounting employed in supporting the heating unit of FIG. 8.

Stating it broadly, my invention comprises a baseboard heat storage and heat releasing unit comprising an elongated housing having a grill on the front side thereof, and an electric resistance heater supportably disposed within and along said housing with an elongated heat storage modular element disposed in heat absorbing relation with the electric heater. The modular element is formed of a hollow longitudinal member having encapsulated therein a chemical heat storage material characterized by a relatively high heat of transition. By "heat of transition" is meant the heat energy exchange which occurs when a chemical heat storage material undergoes a phase change, for example, a crystallographic change in the solid state, or a change of state going from the liquid phase to a solid phase, or vice versa.

Any one of a variety of heat storage materials may be employed in carrying out my invention. A material I may employ is anhydrous sodium sulfate which has a transition temperature of about 450° F. and a heat of transition in the solid state from one crystal form to another of about 128 B.t.u.'s per pound. Another is anhydrous sodium molybdate which has a transition temperature of about 820° F. and a heat of transition in the solid state from one crystal form to another of about 128 B.t.u.'s per pound.

An example of a material having a heat of transition based on a liquid to solid phase change is trisodium phosphate dodecahydrate ($Na_3PO_4.12H_2O$). The foregoing material has a latent heat of fusion or phase change of approximately 100 B.t.u.'s per pound available for heat transfer at a melting temperature between 140° to 180° F., provided there are no variations in its crystallization as it gives up its latent heat. A particularly useful composition is one comprising 31 to 34% trisodiumphosphate, about 4 to 7% sodium hydroxide and the balance water which has a melting point of about 155° F. When the solid material is heated to 155° F., it dissolves in its own

water of crystallization and when it is cooled to just below 155° F. it crystallizes or solidifies and gives off an amount of heat corresponding to about 100 B.t.u.'s per pound. Examples of other heat storage materials are lead acetate [$(PbC_2H_3O_2)_2.3H_2O$] which melts at 167° F., $Na_2S_2O_3.5H_2O$ which melts at 120° F. and exhibits a latent heat of transition of about 86 B.t.u.'s per pound, $NaCH_3COO.3H_2O$ which melts at 137° F. and exhibits a latent heat of transition of about 144 B.t.u.'s per pound, and others.

I desire to use anhydrous sodium sulfate because in the solid state it is capable of storing heat over the range of 300° F. to 600° F. as sensible heat and energy of phase change, that is energy of crystal transition. Moreover, working with materials in the solid state minimizes corrosion and containment problems.

By having a heat storage modular element disposed in heat absorbing relation with the primary heating element, some of the heat is stored as heat of transition, such that when the primary heating element is shut off by the thermostat, the baseboard heater cools slowly rather than rapidly as heretofore. The heat storage element, having a high heat content, gives off its sensible heat until the temperature reaches the point at which the phase change of the contained heat storage material occurs after which it gives up its heat of transition. Instead of obtaining a rapid fluctuation of the temperature during the off cycle, a sort of temperature modulation results as illustrated in FIG. 7 which depicts qualitatively the fluctuation of temperature with time of air leaving the outlet of a thermostatically controlled heater. Two curves are shown, one where the baseboard heater does not contain a heat storage element (curve A) and the other (curve B) where the baseboard heater contains a heat storage element. It will be noted that a broader band of temperature fluctuation is indicated (curve A) with a baseboard heater outside the invention as compared to a more modulated temperature variation (curve B) indicated with the baseboard heater or assembly of the invention.

Referring now to FIGS. 1 to 3, I show a portion of a convection type baseboard heater comprising an elongated housing designated generally by the numeral **1** having a back side **2** for mounting against the base of a wall, top and bottom flanges **3** and **4**, respectively, integral with the back side and a grill **5** on the front side thereof, said grill defining top and bottom openings **6** and **7**, respectively, which cooperate with other elements within the housing to provide a convective flue for air flow into and out of the baseboard heater as shown in FIG. 3.

Referring to FIG. 3, which is a transverse section taken along line **3—3** of FIG. 1, bottom flange **4** is shown integral with back side **2**, the flange terminating into a bent portion **8** which extends inwardly of said housing to provide a convection path rearwardly of a partition **9** which is configurated as an inverted L section extending longitudinally of said housing between the back side thereof and grill **5**.

Grill **5**, forming the front face of the baseboard heater shown in FIG. 3, comprises two spaced apart elements **5***a* and **5***b* whereby to provide a path for the flow of air therebetween to keep the front grill portion from overheating. In this embodiment of the invention, the electrical resistance heating element and the heat storage modular element are formed into the heat assembly shown generally by the numeral **10** (note FIGS. 2, 3 and 4) wherein the modular element **11** is held adjacent to and in heat absorbing relation with heating element **12** by means of heat exchanger fins **13** of aluminum of other heat conductive metal. The heating element comprises a metal sheath which has within it an electrical resistance element **14** which is insulated from the sheath by a powdered refractory **15** such as magnesia and is connected by conventional means (not shown) to a source of power. The heating element and heat storage modular assembly is supported within the housing at the end walls, for example, at end wall **16** via U-shaped saddles **17** and **18**, respectively, which extend inwardly from the end wall as shown in FIG. 1. The modular element embodiment shown in FIGS. 2 to 4 comprises a hollow member having a rectangular cross section and having encapsulated therein a heat storage material **19**, such as anhydrous sodium sulfate. It is desirable that the material of construction be corrosion resistant to the wide variety of the contained heat storage materials which may be employed. Such construction materials may comprise stainless steel, nickel, the nickel alloy known by the trademark Inconel or other suitable material of construction. Preferably the modular element shown in FIGS. 1 to 4 should have a dark surface so as to absorb heat efficiently from the heating element. Where a metal sheath is used for the modular element, the surface should preferably have a black oxide coating to insure efficient heat absorption from the heating element. As stated hereinabove, baseboard heaters are usually controlled by a thermostat which is not shown in the drawing since its use in combination with electric heaters is well known to those skilled in the art.

The convection flow of air into and out of the housing of the heater is illustrated in FIG. 3 which shows the main flow of air as depicted by the broad arrows as going around the fins of the heating element and the heat storage modular element. Minor flow paths of the air are also shown, one between elements **5***a* and **5***b* and the other rearwardly of partition **9**. The minor flow path of air keeps the front and back side of the baseboard from overheating while at the same time conducts some heat from the heater into the room, while the major flow of air about the heat exchanger fins **13** removes a good portion of the heat being generated.

My invention as applied to another baseboard heater of the heat-reflective type is shown in FIGS. 5 and 6 as also comprising an elongated housing designated generally by the numeral **20** comprising back side **21** adapted to be secured to and along the base of a wall and an open or foraminous grill **22**. The grill is formed of slender elements **23** of stainless steel, aluminum or other suitable material running longitudinally of said housing and slender transverse elements **24** running across the face of the grill and abuttingly assured to elements **23** at their points of contact by resistance welding or other suitable means. The grill face is adapted to be spring fitted to the back side of the housing as shown in FIG. 5 at **25** and **26**, respectively.

Attached to the back side within the housing is a longitudinal reflector plate **27** of polished metal, such as sheet aluminum or chromium plated sheet metal. Suspended forwardly of said reflector and behind the grill is an electric resistance heating unit **28** supported by insulated means **29** projecting from the top and bottom of the housing and along thereof, the opposite ends of the electric heating resistant unit being adapted for connection (not shown) to a source of power. As in the first embodiment, a heat storage modular element **30** is provided between the reflector **27** and the heating unit **28**, the modular element being supported by means projecting from an end wall **31** of the housing. The supporting means may comprise a saddle **32** (shown behind the end wall flange **33**, in FIG. 6) formed as a U-shape as shown more clearly in FIG. 6A.

The heat storage material **34** encapsulated in the modular element may be the same as that used in the embodiment shown in FIGS. 1 to 4. As in the first embodiment, the thermostatically controlled electric heat resistance unit throws off heat which, in this case, is reflected into the room being heated. Some of the heat is absorbed by the heat storage modular element and stored as latent heat of transition which it gives off during the off cycle, thereby minimizing temperature

fluctuation in the room between the on and off heating cycle.

In FIGS. 8 to 12, I show as another embodiment a heating unit in which the heating element is encased within the heat storage modular element to insure optimum heat absorption by the heat storage material. The elongated modular element is substantially rectangular in cross section. The outside casing of the modular element is formed of an extruded channel **35** of aluminum having a pair of inwardly projecting shoulders **36**, **37** running longitudinally of the channel. Each of the shoulders is longitudinally grooved (**38**, **39**) and receives therein a plate or sheet **40** of aluminum therealong to complete the enclosure of the modular element. Cooling fins **41** in the shape of a T project outwardly from the surface of fitted plate along the whole length of the element. The modular element is enclosed at its end **42** by a cap **43**, the opposite end being similarly capped but being left exposed for purposes of clarity. The modular element is filled with a heat storage material **44**, such as anhydrous sodium sulfate, and has embedded in it an electrical resistance heating element **45** which is encased in a protective sheath of stainless steel **46** filled with an insulating material, such as magnesia, which completely surrounds the heating element. The whole element, including the sheath, is bent into a U shape as shown (in phantom) in FIG. 8 and as shown in FIG. 10. The ends of the electrical resistant element are connected to terminals **47**, **48** which in turn are connected to power lines, not shown.

The electrical heat resistance elements are preferably assembled as shown in FIG. 10. The loop of the element at **49** is reinforced by means of a bracket **50** using sheet metal which is formed-fitted about the loop. Vanes **51** are provided comprising sheet metal aluminum or other suitable metal of high thermal conductivity with the sides cylindrically formed for slipping over the legs of the heating element as shown in FIG. 10 (note also FIG. 11). A pair of guide members **52**, **53** are riveted to the back of the vanes via rivets **54**. The purpose of the guides is to help position the electrical resistance heating element within the modular heat storage element. In mounting the modular element **35** within the baseboard heater of the type shown in FIGS. 1 to 3, a C-shaped hanger **55** is employed which connects via an over hang **58** to a bracket mount **56** attached to the back of the rear wall **57** of the baseboard heater as shown in FIG. 12. The C-shaped hanger is configurated to receive and support the modular heat storage element and projecting fins **41** in back of grill or front face **5** as depicted in FIG. 12.

It is apparent from the foregoing that I provide a novel baseboard heating element which overcomes the disadvantages of the conventional heaters by providing more uniform heating while minimizing temperature fluctuations between heating cycles in the immediate area being heated.

In effect, my novel baseboard heating element operates as a modulating and temperature averaging device, that is, with my device there is less thermal variation at the heater when the power is off as compared to the conventional baseboard heater, even though the baseboard heater operates at a slower initial warm-up. However, the slower warm-up is advantageous as it inhibits overshoot of temperature (note FIG. 7). For example, in the spring, the air flowing out of the baseboard heater may range in temperature from 105° to 130° F. with the conventional baseboard heater, the device cools rapidly the moment the power is shut off, whereas, with my device, because of its high heat content, heat is continuously being delivered on the off-cycle while the room is losing heat. In the dead of winter when the temperature of the air leaving the baseboard ranges from 165° to 170° F., my device maintains a balance of heat output during the off cycle, while with the conventional baseboard heater the temperature of the air leaving the heater falls markedly the moment the power is shut off thermostatically. This non-continuous type of heating results in marked temperature variations within a room leading in many instances to discomfort.

Although the present invention has been described in conjunction with preferred embodiments, it is to be understood that modifications and variations may be resorted to without departing from the spirit and scope of the invention, as those skilled in the art will readily understand. Such modifications and variations are considered to be within the purview and scope of the invention and appended claims.

What is claimed is:

1. A baseboard heat storage and heat releasing unit comprising an elongated housing having a back side for mounting against the base of a wall and an open front, a foraminous grill covering the front side of said housing, a heat reflector connected to the back side of said housing having a polished surface and being shaped for reflecting substantially all the heat outwardly thereof through said grill, an electric resistance heater supportably disposed within and along said housing in spaced relation to an elongated heat storage modular element supportably disposed in heat absorbing relationship with said electric resistance heater, said heater and said heat storage modular element being positioned between the heat reflector and said grill, said grill, reflector, heater and heat storage modular element extending substantially the length of the housing, said modular element being formed of a hollow longitudinal container having encapsulated therein a chemical heat storage material characterized by a relatively high heat of transition.

2. The baseboard heater of claim **1**, wherein the heater is positioned between the grill and the reflector, and the heat storage modular element is spaced between the reflector and the heater.

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ANTHONY BARTIS, *Primary Examiner.*