United States Patent

Jensen et al.

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[54] ELECTRIC RESISTANCE CONVECTION HEATER

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[52] **U.S. Cl.** .....**219/552,** 219/359, 219/539, 219/550, 338/22 R, 338/319

[51] **Int. Cl.** **H05b 3/10**

[58] **Field of Search** .....219/552–553, 359, 219/365, 354, 539, 550; 338/312, 514, 315–320, 522, 22 R

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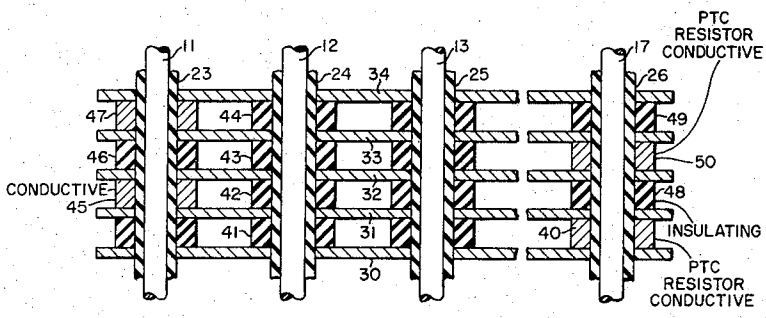
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[57] **ABSTRACT**

An electric resistance convection heater comprising a stack of electrically conductive fin electrodes mounted in spaced relation on a plurality of electrically insulating support elements with spacer washers therebetween, certain of said spacers being formed of insulating material and others being formed of conductive material to cause an electric current applied to different ones of said electrodes to flow serially through the electrodes in a predetermined path, and certain of said conductive spacers being formed of a material having a positive temperature resistance coefficient thus providing self-limiting response for the heater.

4 Claims, 2 Drawing Figures



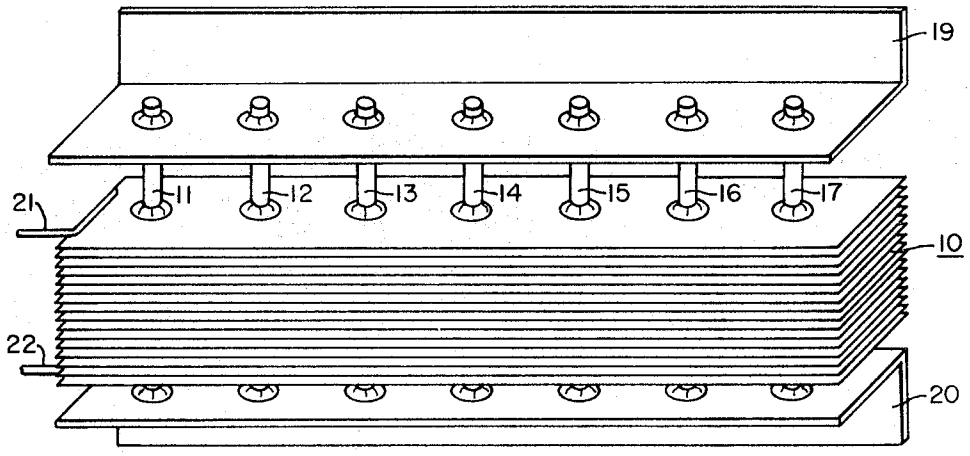


FIG. 1

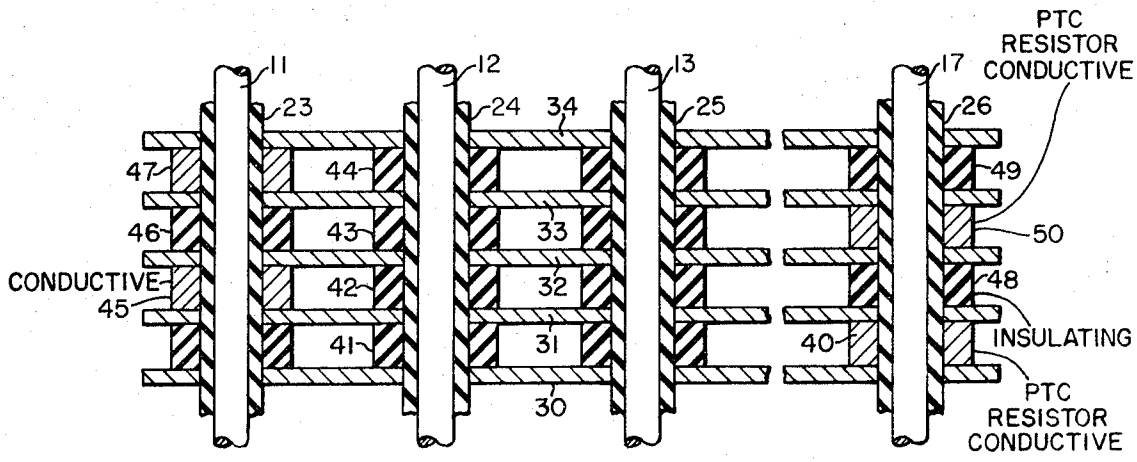


FIG. 2

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ELECTRIC RESISTANCE CONVECTION HEATER

BACKGROUND OF THE INVENTION

Electric resistance convection heaters formed of a stack of spaced electrode fins of sheet material having electrical resistance characteristics are well known. Such heaters may find application for air heating in the furnaces or ducts of ventilation and air conditioning equipment. It is desirable that such heaters be limited in response so that they will not overheat and create a fire hazard in the event of reduced air flow through the heater. Relatively complex protective circuits using various forms of temperature sensing devices have been employed to protect the electric heater in such application. It is therefore desirable to have a simple, reliable and inexpensive form of electric convection heater that is essentially self-limiting in operation to assure that an excess of heat will not be obtained.

PRIOR ART

Reference may be made to the U.S. Pat. No. 424,921 issued to Capek on Apr. 1, 1890 for a description of an electrical heater having a stack of spaced apart sheet resistance electrodes but the arrangement does not provide a self-limiting heater construction in the manner of the present invention.

SUMMARY

In accordance with the invention, the electric resistance convection heater is comprised of a stack of spaced apart sheet electrode heater fins formed of a material having a desired electrical resistivity. The fins are supported in spaced apart relation on a plurality of electrically insulated support elements or rods and the spaced relation is maintained by washer spacers between the fins on the supporting elements. Electric current terminals are connected to spaced ones of the fins and certain of said washers are electrically conductive and others are electrically insulating so that the electric current is caused to flow serially through the fins from one terminal to the other in a predetermined path thus electrically heating the fins and conveying heat to the fluid passing between the spaced apart fins. The feature of the invention is the provision that one or more of the electrically conductive washers is formed of a material having a positive temperature resistance coefficient. Thus, should the temperature of the heater attempt to increase above a design limit for any reason, the resistance of those conductive washers having a positive temperature coefficient would increase to cause the applied voltage across the fins to be reduced thus reducing the effective convected heat from the fins in a self-limiting manner, it being understood that the electrically conductive spacer washers are comparatively small in surface area and are not in themselves convective heating resistance elements.

Other features and advantages will be apparent with reference to the following specification and drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is perspective elevational view of the electric heater of the invention; and

FIG. **2** is a detailed fragmentary sectional view to show the arrangement of the spaced fin electrodes and the spacer washers of insulating material, conductive material, or positive temperature resistance material.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. **1** of the drawing, the heater assembly is comprised of a stack of a plurality of spaced apart fins generally shown at **10**, each fin being an electrode formed of sheet material having a desired electrical resistivity and convective heat capability. The stack of fins are supported on a plurality of insulating support elements **11–17** which elements may be in one form of the invention a plurality of metal rods having insulating sleeves thereon as will be more clearly shown in connection with the description for FIG. **2** of the drawing. The rods **11–17** are supported on supporting frame members **19** and **20**. Electric terminals **21** and **22** are applied to different spaced ones of the fin electrodes and may be as shown to the upper and lower fin electrode, see FIG. **1**.

Referring now to FIG. **2** of the drawing, a portion of the heater stack will be described in detail. The end supporting rods **11** and **17** respectively and intermediate supporting rods **12, 13** are shown to have insulating sleeves **23, 24, 25** and **26** which serve to insulate the fin electrodes from the supporting rods. Should the supporting rods **11–17** be formed of insulating material such as a hard thermoplastic or the like, it would not be necessary to use the insulating sleeves as shown at **23–26**. Several of the sheet electrode fins **30–34** are shown to be supported in spaced apart relation on the support rods **11, 12, 13** and **17** and their associated insulating sleeves **23–26**. In order to maintain the desired spacing between the fins **30–34**, a plurality of spacer washers are positioned on the supporting sleeves **23–26** between adjacent ones of the fins **30–34**. For example, the spacer washer **40** between the fin **30** and the fin **31** on the rod **26** is formed of electrically conductive material while all of the spacer washers **41–44** on the intermediate sleeve **24** are formed of insulating material. On the other hand, the spacer washer **45** adjacent the end support **11** is formed of electrically conductive material while the next above spacer washer **46** is formed of insulating material and the next above spacer washer **47** is formed of electrically conductive material. Similarly the spacer washers **48** and **49** are formed of insulating material while the spacer washer **50** is formed of electrically conductive material. Thus, an electric current applied to the fin electrode **30** will pass through the conductive washer **40** and pass serially from right to left through fin electrode **31** and through the conductive washer **45** to the fin electrode **32** and left to right through that electrode and through the conductive washer **50** to the fin electrode **33** to pass from right to left and through the conductive washer **47** to the fin electrode **34** for passing from left to right. In other words an electric current connected to spaced electrodes **30** and **34** will pass serially through all of the heating electrodes **30, 31, 32** and **33** in a predetermined zig-zag relation.

A principal feature of the invention is the provision that one or more of the electrically conductive washers **40, 45, 47** and **50** are formed of a material having a positive temperature resistance coefficient. For example, conductive washers **40** and **50** are illustrated as having a positive temperature resistance coefficient. Thus should the temperature of the heater stack rise above a design limit, those electrically conductive washers **40** and **50** having a positive temperature resistance coefficient would increase in resistance to increase the voltage drop across such washers and reduce the applied voltage across the heater fin electrodes to thus reduce the total amount of heat converted by the heater stack so that a self-limiting response of the heater assembly will be obtained.

It should be obvious to anyone skilled in the art that the positive temperature coefficient spacer washers may be formed of various materials having the desired characteristics. Therefore, a particular positive temperature coefficient material is not specified. Also the specific dimensions and parameters of the heater fins and spacer washers are not described in detail since they are a matter of design choice believed to be obvious to one skilled in the art.

We claim as our invention:

1. An electric resistance heater comprising, a stack of a plurality of spaced apart heat convecting fin electrodes adapted to be positioned in the path of fluid to be heated, each of said electrodes being formed of thin planar sheet material having a predetermined electrical resistivity, said stack of fins being supported on a plurality of insulated support elements and maintained in closely spaced relation thereon by washer spacers on the elements, means to supply electric current to said stack through a first electric terminal connected to one of said fins and a second electric terminal connected to another of said fins, at least one of said spacer washers being formed of

electrically conductive material and at least another of said washers being formed of electrically insulating material to cause electric current applied to said terminals to flow serially through said fins in a predetermined path; and at least one of said electrically conductive spacer washers being formed of resistive material having a positive temperature coefficient thereby providing a self-limiting electric resistance heater construction with which a predetermined maximum temperature may not be exceeded.

2. The invention of claim 1 in which each of said support elements is formed of metal and an insulating sleeve is positioned on each supporting element to insulate the respective element from each electrode and conductive washer.

3. The invention of claim 1 in which the support elements are rods and include a first rod adjacent one end of the stack of sheet electrodes and a second rod adjacent the other end of the stack of sheet electrodes with a plurality of intermediate

support rods therebetween, said electrically conductive washers being positioned alternately with insulating washers on said first and second rods only to cause said electric current to flow serially through said electrodes from top to bottom, and said electric terminals being secured to the upper and lower electrodes respectively of the stack.

4. The invention of claim 2 in which the support elements are rods and include a first rod adjacent one end of the stack of sheet electrodes and a second rod adjacent the other end of the stack of sheet electrodes with a plurality of intermediate support rods therebetween, said electrically conductive washers being positioned alternately with insulating washers on said first and second rods only to cause said electric current to flow serially through said electrodes from top to bottom, and said electric terminals being secured to the upper and lower electrodes respectively of the stack.

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