Aug. 23, 1932. H. N. SHAW 1,873,053

ELECTRICAL HEATING APPARATUS

Original Filed Sept. 3, 1925

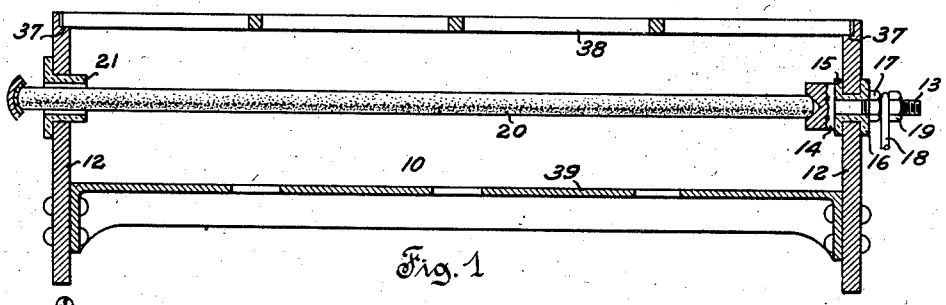



Fig. 1

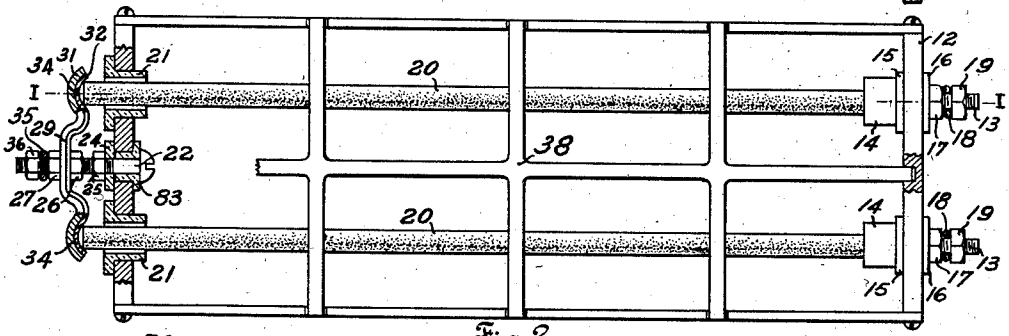



Fig. 2

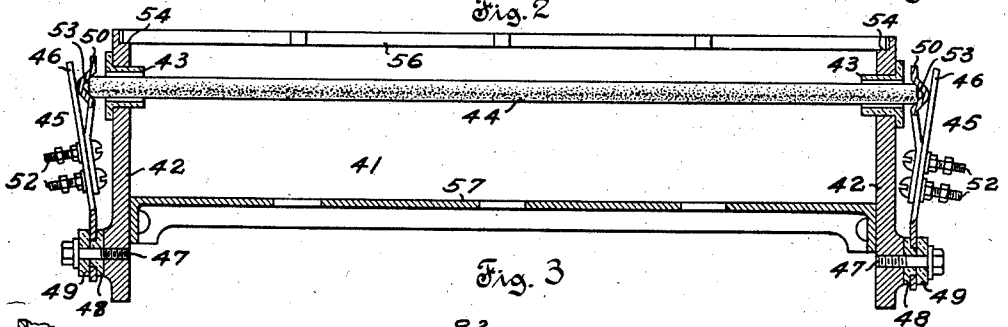



Fig. 3

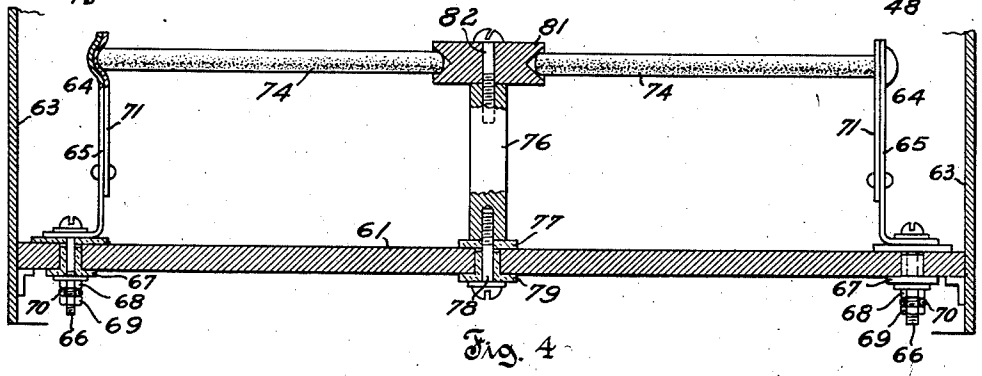



Fig. 4

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# UNITED STATES PATENT OFFICE

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## ELECTRICAL HEATING APPARATUS

Original application filed September 3, 1925, Serial No. 54,193. Divided and this application filed March 7, 1928. Serial No. 259,674. Renewed January 7, 1932.

This invention relates in general to electrical heating apparatus, and it has more particular relation to certain classes of such heating apparatus embodying or utilizing improved means or devices for electrically and mechanically mounting or maintaining self-sustaining electrical resistance heating elements or units in electrically and mechanically operative position and condition in such apparatus.

The present application constitutes a division of my copending application Serial No. 54,193, filed September 3, 1925.

In accordance with the present invention, electrical heating apparatus of improved design and construction and particularly adapted for use as hot-plates, cookers and the like and wherein the production of relatively high operating temperatures may be desirable, is provided, such apparatus embodying or utilizing self-sustaining resistance heating elements, and being especially adapted for use of such elements as are in the form of molded and heat-hardened bodies produced from a composition containing carbon or a carbide, particularly silicon carbide, as an essential constituent, and the apparatus also embodying improved mounting devices for the heating elements which insure efficient mechanical support for the latter and electrical connection thereof to a supply circuit.

As a particular feature of the present invention, electrical heating apparatus in accordance therewith embodies or utilizes a combined electrical connection and mechanical support for the resistance heating element, the combined support and terminal being yieldingly urged to abut against the extreme end or ends of the resistance heating element with sufficient pressure to satisfactorily insure the desired mechanical support of and electrical engagement with the heating element. An additional feature is that the terminal mounting permits ready insertion of the heating element to and its removal from operative position. Again, beneficial use is made of the fact that certain materials are particularly well adapted to afford desired mechanical strength and resiliency and to maintain satisfactory electrical contact with a heating element of this general character even when the latter and the associated portion of the contact or terminal are maintained at relatively high temperatures. Again, additional advantages, particularly in the matter of sustained efficient life of the heating elements and terminal mountings therefor, are secured by utilizing a resistance heating element wherein the terminal portions are rendered of appreciably greater conductivity than the body portions, because of a different character or composition of such terminal portions.

The above and other objects and advantages are attained by the present invention, various novel features of which will be apparent from the description and drawing herein disclosing several embodiments of the invention, and will be more particularly pointed out in the claims.

In the accompanying drawing showing heating apparatus embodying features of this invention:

Fig. 1 is a sectional elevation, in the plane of the line I—I of Fig. 2, of one form of electrical heating apparatus embodying the present invention.

Fig. 2 is a partly sectional plan view of the apparatus shown in Fig. 1.

Fig. 3 is a view similar to Fig. 1 showing an electrical heating device embodying a modified form of terminal mounting for the heating element.

Fig. 4 is a sectional elevation of another modified form of electrical heating device.

In accordance with the disclosure of Figs. 1 and 2, the invention is applied to an electrical heating device, which may readily be utilized as a hot-plate, broiler, or the like, comprising a substantially box-shaped frame 10 having side walls 12 which serve as a general support for the heating elements. At points adjacent the upper edge of one of the side walls 12 of the frame, one or more conductive terminal bolts 13 are disposed, each of these bolts having its head 14 at the inner side of the wall. A flanged insulating bushing 15 passes through the aperture in and effectively separates the bolts 13 from the wall 12, also serving to insulate the head 14

of the bolt from the wall. An insulating washer 16 surrounds the bolt and bears against the outer side of the wall 12, a nut 17 being threaded on the outer end of the bolt 13 and serving to draw the bolt into and secure the same rigidly in operative position. A line connection 18 is secured in position between the nut 17 and a clamping nut 19 on the bolt 13. The inner end of the head 14 of each bolt is formed as a recessed or cup-shaped contact, or has a recessed contact piece secured thereto, by welding or otherwise, for the reception of the terminal end of a self-sustaining unitary heating element 20, here shown of bar or rod shape, and it may have its ends of somewhat rounded or convex shape, thus facilitating any necessary adjustment of the terminal end in the recessed contact while insuring required contact surface between the parts. The bolt 13, or at least the contact piece at the head thereof, is preferably of a good heat-resistant, conductive material, such as an iron-chromium alloy or Monel metal; and the cup-shaped recess in the contact piece may be, as indicated in the drawing, of approximately conical outline, at least in part.

The opposite side wall 12 of the frame is provided with apertures in substantial alinement with the recess contact face of terminal head 14, these apertures having insulating bushings 21 mounted therein and being preferably sufficiently large to permit the heating element to be wholly free of the bushing to a slight extent. This wall 12 is shown as provided with an additional aperture at a point intermediate a pair of the apertures carrying insulating bushings 21. A bolt 22 passes through this intermediate aperture, with the head of the bolt at the inner side of and insulated from the wall by a flange on an insulating bushing 83 which passes through the wall and serves to insulate the bolt 22 from the wall. An insulating washer 24 spaces a nut 25, threaded on the bolt, from the wall, and the nut serves to draw the bolt into and maintain the same in fixed position upon the side wall 12.

The outwardly extending portion of the bolt 22 is provided with a nut 26, serving as an adjustable abutment or seat, along with a second adjustable nut 27; and between the two nuts 26 and 27, a resilient contact element or terminal 29 is mounted in position, the point of mounting on the bolt 22 being adjustable by adjustment of the nuts 26, 27. As indicated the contact element or mounting 29 extends in opposite directions from the supporting bolt 22 and comprises a relatively stiff and resilient, and heat-resistant conductive supporting element 31 of material such as Monel metal or an iron-chromium alloy, and an inner leaf or strip 32 of more highly conductive metal, such as aluminum, or an aluminum-nickel alloy, and preferably welded, riveted, or otherwise secured to the strip 31. The body portion of the mounting or terminal 29, at each side of the supporting screw 22, may be bent or otherwise suitably formed so as to bring the ends thereof in desired operative position and preferably relatively close to the side wall 12 of the supporting frame at points in line with the apertured bushings 21 through which the ends of the resistance elements 20 project. The inner side of the mounting or terminal element 29 at the terminals thereof, at least the contact strip 32, is formed with sockets or recesses, as indicated at 34, which may be of more or less generally conical shape and of such size as to easily and adjustably receive the terminal ends of the resistance heating elements 20, the other end of each of which is in engagement with the recessed contact associated with the head 14 of the corresponding bolt 13.

A line terminal 35 is maintained in electrical connection with the terminal mounting 29 through the holding nut 27 and a clamping nut 36 adjustable on the bolt 22. By carrying the terminals 18' and 35 out to a suitable switch or contact-maker, any desired combination of series or parallel connections, and consequent varying heating effects, of the resistance heating elements 20 may be secured.

The leaf strip 32 may extend throughout the full length of the resilient supporting strip 31, as indicated, or it may extend only part way, after the fashion of the contacts of the apparatus shown in Figs. 3 and 4, described hereinafter. The terminal element 29 is preferably reversely bent to some extent for the purpose of increasing its spring effect or ability to exert pressure on the terminal end of the heating element in the general direction of its axis; and the position of this terminal element on the supporting bolt 22 and the strength and resilience of this element, especially the resilient supporting strip 31 thereof, are so selected that the recessed contact portions of the mounting are caused to engage the extreme ends of the heating elements with the required pressure exerted in the direction of the longitudinal axes of the heating elements, to yieldingly maintain the desired electrical contact between the ends of the heating elements and the recessed contacts 34 and 14 and also to mechanically support and maintain the heating elements in operative position through the butt-end engagement thereof with the recessed contact portions 14 and 34, and preferably free of any support except that of the terminal contact elements 29 and 14. The heating element 20 may readily be removed from operative position, preferably after loosening the nut 27 to a slight extent, by flexing the resilient mounting element against its normal bias until it clears the end

of the heating element. The mounting may then be swung about the bolt 22 to a position wherein the heating element may be drawn out through the bushing 21, and a replacement inserted to position, after which the mounting may again be swung to and secured in its operative position, as shown.

Suitable supporting means are associated with the upper edges of the side walls 12 of the supporting frame for mounting a plate, perforated cover, grate or grille 38, a convenient method being to form recesses providing seats 37 upon which the cover, grate or grille may rest or be supported, as indicated, or in any desired manner. A rear or lower wall 39 may serve as a part of a protective enclosure, and in some cases, with suitable curvature, it may have the function of a reflector, of more especial utility when the device is set on edge. It may be desirable to provide apertures in this wall 39 for ventilation purposes.

The construction shown herein may be modified to a considerable degree, as desired, as by placing the contact mounting 29 and the shank of its supporting bolt 22, with the contact retaining nuts thereon, on the inside of the wall 72; but the arrangement illustrated may be considered more desirable where the maintenance of a low temperature at the contact terminals 34 is particularly desired. Likewise, individual spring contact terminals or mountings of the same type as the element 29, but with a single contact portion 34, may be substituted for the bolts 13 with their contact heads 14. And the rigid butt terminal contact or mounting 14 may be replaced by a spring butt terminal similar to the terminal contact or mounting 29.

In accordance with Fig. 3, features of the invention are shown as applied to a heating device of the general class heretofore described and shown in Figs. 1 and 2, but wherein the contact terminals may be wholly at the outer side of the supporting frame 41. Opposed side walls 42 of the frame are provided with alined apertures in which are mounted insulating bushings 43 of such size that resistance heating elements 44 passing therethrough are readily maintained spaced from the walls thereof. The contact terminal used is indicated generally at 45, and consists of a relatively straight, stiff and resilient supporting leaf or strip 46, in the form of a single lamination or multiple laminations, of heat-resistant conductive material, of the character described hereinabove. This leaf spring is supported adjacent its lower end by a holding screw 47 having a threaded end and passing through an aperture in the leaf and insulated therefrom and threaded into an aperture in the wall 42, the leaf being insulated from the wall 42 by a flanged insulating bushing 48, and an insulating washer 49 separating the spring leaf and the head of the screw 47.

On the inner side of the resilient leaf 46 is a conductive contact strip or leaf 50, either single or laminated and preferably of a material suitable for a conductive contact exposed to heating, and preferably riveted or welded, or bolted, as indicated, at its lower end to the supporting leaf spring 46, by means of connection screws 52 and securing nuts thereon. One or both of these connection screws 52 may serve as the terminal for a line connection. At its upper end, the contact strip 50 is recessed at 53, in generally conical form, to produce an engagement or contact portion for adjustably receiving and mechanically and electrically engaging the end, preferably somewhat rounded or convex, of the heating element 44 through butt-end engagement therewith. By suitable design of the contact element 45 as to strength and resilience of the supporting leaf spring 46 and the mounting of the same and its contact strip 50, and selection of the length of the heating element 44, these contact elements are caused to effectively fully support and yieldingly maintain the heating element, through butt-end engagement therewith, in normal operative position with the desired electrical engagement between the parts. The resistance heating elements 44 are preferably of the type described hereinabove, and protrude to a slight extent beyond the side walls 42 of the supporting frame. To replace a heating element 44, one or both of the terminal mounts 45, after any necessary loosening of the screw 47, are distorted against the normal bias sufficiently to withdraw the recessed contact portion 53 from one end of the heating element, the mounting being then swung about its supporting screw 47 so as to permit the heating element being drawn out through the adjacent aperture in the wall 42. With a replacement element in position, the mounting 45 can be readily swung back to and mounted in operative position.

Supporting flanges or shoulders 54 may be provided at the upper edge of the side walls 42, to serve as a support for a removable grille or grate 56; and a bottom plate 57, apertured if desired, may be secured in position through flanges on the plate secured to the side walls 42. This plate 57 may be plane or suitably shaped to act as a reflector of heat rays from the heating element 44.

In the modification disclosed in Fig. 4, a base 61, of metal or insulating material, is carried by an enclosing box-like frame 63. Contact terminals 64 are mounted on the support 61 adjacent the sides thereof, and include a relatively stiff and resilient leaf spring element 65 of heat-resistant conductive material, such as Monel metal or an iron-chromium alloy, having its lower end bent

at right angles and mechanically secured to and insulated from the frame 61. The mounting means includes a bolt 66 passing through an aperture in the base and having its head in electrical and mechanical engagement, directly or through a washer, with the upper side of the bent-over portion of the leaf spring 65. The bolt 66 is insulated from the base 61 by a bushing 67 having a flange at its lower side bearing against the lower face of the base. A clamping nut 68 secures the bolt 66 and thus the terminal mounting 65 in operative position on the base. A line connection 70 may be secured in position on the bolt 66 between the nut 68 and a clamping nut 69.

A contact strip 71 of suitable conductive material, as described hereinabove, is secured, by riveting, welding or otherwise, to the supporting leaf or strap spring 65. The inner side of the contact strips 71 at the upper ends thereof, and, if desired, the corresponding portion of the supporting leaf spring 65, are provided with concavities or recesses, as indicated, for the adjustable reception of the ends of the resistance heating elements 74 which have but-end engagement with the walls of the recesses.

At a point intermediate the contact terminals 64, an upright support 76 is secured upon the base 61, this support being shown as of conductive material suitably insulated by a separator 77 from the base 61. The upright support 76 may be secured in position by a screw 78 passing through the base or frame 61 and threaded into the lower end of the support, the head and shank of the screw being insulated from the base 61 as by means of a flanged insulating bushing 79. There is mounted on the upper end of the support 76 a conductive block 81 of suitably heat-resistant material, the same being provided with a suitable number of recesses intended for the reception of terminal portions of heating element 74 which have butt-end engagement with the walls of the recesses, the opposite ends of the heating elements being supported by and in yielding and releasable engagement with the terminal mountings 64.

The terminal mountings 64 are so designed, especially the resilient pressure springs 65 thereof, as to cause the heating elements 74 to be effectively supported in position between the conductive strips 71 of the mountings and the contact block 81, with the required pressure to insure secure and efficient yielding mechanical support of the heating elements and efficient yielding electrical engagement between the terminal mountings and the ends of the heating elements through butt-end engagement therewith. Any heating element may be readily removed and replaced by distorting the terminal mounting 64 against its normal bias sufficiently to permit the end of the heating element to be moved past the end of the mounting. With the two terminal elements 64 shown herein used as line terminals, the heating elements 74 are connected in series through the contact piece 81; however, by using the bolt or screw 78 as one line terminal, the heating elements may be connected in parallel to the supply line. With such a line connection and suitable switching arrangements, the heating elements may be connected at will either in series or in multiple between the supply line terminals, and corresponding desired heating effects may be thus secured. If desired, the terminal mountings 64 may be mounted on the side walls 63 of the frame. Also, these terminal elements may be mounted on the outer side of the side walls 63, with the contact recesses disposed opposite apertures in such walls, in a manner apparent from the disclosure of Figs. 1, 2 and 3. When the desired electrical heating effects permit or require it, the intermediate contact piece 81 and its support may be removed, and a single heating element may be supported in operative position between the two contact terminals 64.

As indicated, the conductive terminal mountings described hereinabove include means for resiliently or yieldingly supporting the heating element and maintaining the desired electrical connection from a line circuit to the ends of the heating element, wholly through butt-end engagement between the heating element and the terminal mountings; and this resilient effect may be present in one or both of the terminal mountings. Satisfactory resilient and heat-resistant materials for producing the desired resilient engaging and supporting effects in the terminal mountings are tempered steel, or an iron-chromium alloy, such as ascoloy, Monel metal or suitable bronze; and likewise, with these resilient parts of suitable cross-section, they serve efficiently as a portion of the electrical path through the terminal mounting.

The resistance heating elements 20, 44, 74, are preferably unitary, self-sustaining, molded and heat-hardened composition products wherein a carbonaceous material, such as silicon carbide, is the principal constituent. Certain heating elements of the preferred character are known in the art, the same being composed of silicon carbide as an essential constituent, with or without one or more modifying substances for altering mechanical or electrical characteristics of the final product. The preferred heating element comprises a heat-producing body portion and integral terminal portions of the same cross-sectional area as the body portion but of such different composition as to have greater conductivity and less heat-producing effect than the body portion. This condition of more highly conductive terminals insures that portions of the metallic terminal mountings in

electrical and mechanical engagement with the ends of the heating element are maintained in satisfactory operating condition during a long life.

Where the operating temperatures of the heating appliance are relatively low, the recessed contact portion of the terminal mounting may be of aluminum, or an alloy thereof, such as aluminum-nickel, which does not oxidize or scale to a distinctive extent under the circumstances, it probably forming a relatively thin oxide film which does not build up or increase appreciably after being once established. However, where temperatures produced are higher or approach or exceed the melting point of aluminum, Monel metal, a nickel-copper alloy, and iron-chromium or iron-chromium-nickel alloys, give desirable operating results. Aluminum alloy contacts for electrical resistors are described in an application by John A. Boyer, U. S. Serial No. 386,998, filed August 19, 1929.

The desired yielding but-end contact relation between the contact portion of the terminal mounting and the end of the heating element is secured through the resiliency and normal bias of the terminal mounting element, the contact portion of which is movable about its point of support due to the spring effect of a portion of the mounting. Certain desirable results as to movement of the contact portion of the mounting may be secured in other manners, such as pivoting the mounting element at its point of support, or otherwise guiding the contact portion for substantially straight line movement along the axis of the heating element; and the normal biasing of the contact portion to secure the desired movement thereof may be secured in varying degrees through other forms of springs, gravity, and the like.

Desirable results may be secured by spraying under high pressure a coating of finely divided conductive particles on the contact portion of the metallic supporting element, after thoroughly cleaning, as by sand-blasting, the latter. Likewise, desirable results may be secured by depositing a similar thin sprayed metal coating on the extreme end of the resistance element, for the purpose of establishing a satisfactory initial electrical engagement between the parts, thus assisting in quickly establishing the desired normal operating condition of the contacting part.

The present invention is especially concerned with the provision of apparatus capable of commercially satisfactory and efficient operation at temperatures corresponding to a glowing condition of the resistance heating element; and electrical heating appliances embodying features of the present invention relating to the electrical and mechanical mounting of the resistance heating element as described hereinabove are capable of giving extremely satisfactory results and efficient operation at temperatures up to as high as and even beyond 2,500° F.

It should be understood that the invention set forth herein is not limited to the exact details of construction and operation described, for obvious modifications may occur to persons skilled in the art; and it is desired that the claims cover such various modifications within their scope as may occur to those skilled in the art.

It is claimed and desired to secure by Letters Patent:

1. In an electrically heated appliance, a support having apertured side wall portions, a recessed contact in alinement with an aperture in a side wall portion and having a yielding and resilient support, a second contact on the opposite side of the last mentioned side wall portion, and a rod-shaped electrical resistance heating element passing through the aperture in the last mentioned side wall portion and yieldingly mounted for direct heat transmission in electrically and mechanically operative position between said contacts through the yielding direct butt-end engagement of said first contact upon an end of said heating element.

2. In an electrically heated appliance, a support having apertured side wall portions, a pair of recessed contacts in alinement with apertures in said side wall portions, each of said contacts having a yielding and resilient support therefor, and a rod-shaped electrical resistance heating element passing through two of said apertures and yieldingly mounted for direct heat transmission in electrically and mechanically operative position between said contacts through the yielding direct butt-end engagement of said contacts on the ends of said heating element.

3. In an electrically heated appliance, a support having apertured side wall portions, a recessed contact in alinement with an aperture in a side wall portion and having a yielding and resilient support mounted on the outer side of said side wall portion, a second contact, and a rod-shaped electrical resistance heating element passing through said last mentioned aperture and yieldingly mounted for direct heat transmission in electrically and mechanically operative position between said contacts through the yielding direct butt-end engagement of said first contact upon an end of said heating element.

4. In an electrically heated appliance, a support having apertured side wall portions, a pair of recessed contacts in alinement with apertures in said side wall portions, each of said contacts having a yielding and resilient support therefor mounted on the outer sides of said side wall portions, and a rod-shaped electrical resistance heating element yieldingly mounted in electrically and mechanically operative position between said contacts through the yielding direct butt-end engage-

ment of said contacts on the ends of said heating element.

5. In an electrically heated appliance, a support having side wall portions, opposed recessed contacts caried by said side wall portions, certain of said contacts including a resilient supporting portion, and rod-shaped electrical resistance heating elements each passing through at least one of said apertures and yieldingly mounted for direct heat transmission in mechanically and electrically operative position between and in direct butt-end engagement with pairs of said contacts, one of each pair including a resilient support, and the contacts in engagement with the corresponding ends of adjacent heating elements being connected in series.

6. In an electrically heated appliance, a support having opposed side wall portions, one of said wall portions being apertured, terminal contacts carried by said support, one of said contacts being disposed on the outer side of said apertured wall portion and including a recessed portion in alinement with the aperture in said wall portion, and a resilient conductive portion integrally connected at one end to said recessed portion and mounted in position at its opposite end on said wall portion, and a rod-shaped electrical resistance heating element with its body portion disposed between said wall portions and having one end projecting through the aperture in said wall portion, said heating element being yieldingly mounted in mechanically and electrically operative position at least in part through the forcible but yielding butt-end engagement of said recessed contact upon the end of said heating element.

7. In an electrically heated appliance, a support having opposed side walls one of which is apertured, terminal contacts carried by said support, one of said contacts being disposed at the outer side of said apertured wall and including a recessed portion in alinement with the aperture in said wall, and a resilient portion upon which said recessed portion is mounted, said resilient portion being mounted at one end on said wall, and a self-sustaining, non-metallic resistance heating element having terminal portions more highly conductive than the body portion of the element and having a terminal portion of increased conductivity extending through the aperture in said wall and into engagement with the recessed contact on the outer side of said wall, said heating element being yieldingly maintained in position through direct butt-end engagement thereof with said contacts, with said resilient mounting of said outer contact urging the latter into forcible but yielding engagement with the extreme end of said heating element.

8. In an electrical heating appliance, a supporting frame having an apertured plate at its upper side, an integral self-supporting non-metallic resistor rod mounted below said plate, a bolt whose head abuts the inner surface of an end wall of the frame and whose threaded portion extends outside the frame, a resilient contact arm rotatable about said bolt outside of said frame and having a contact recess adjacent an end thereof for supporting said resistor rod in electrical and mechanical engagement by butt-end pressure of the resilient member, an aperture in said end wall through which the resistor rod extends, a second recessed contact for the other end of the resistor rod mounted on the opposite end of the frame from the first-mentioned end wall, and means for adjustably supporting said resilient contact arm whereby the resistor rod may be removed through the aperture in the end wall immediately after distortion and rotation of said resilient arm.

9. The electrical heating appliance described in claim 8 in which the rotatable resilient arm carries a plurality of contacts and the adjacent end of the frame has a corresponding number of similarly spaced apertures, while the opposite end of the frame supports a corresponding number of similarly spaced contacts, the rotatable resilient member being so mounted that by distortion and rotation it may hold a plurality of resistor rods in mechanical and electrical engagement by butt-end pressure on the ends of the resistor rods.

In witness whereof I affix my signature hereto.

HAROLD N. SHAW.