

[54] **RIBBON RESISTOR WITH
SUPPORTING MEANS**

[72] Inventor: **Milton W. Griffes**, Madison, Ohio

[73] Assignee: **Harvey Hubbell Incorporated**,
Madison, Ohio

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[58] Field of Search.....**338/280, 283, 315, 316, 318**

[56] **References Cited**

UNITED STATES PATENTS

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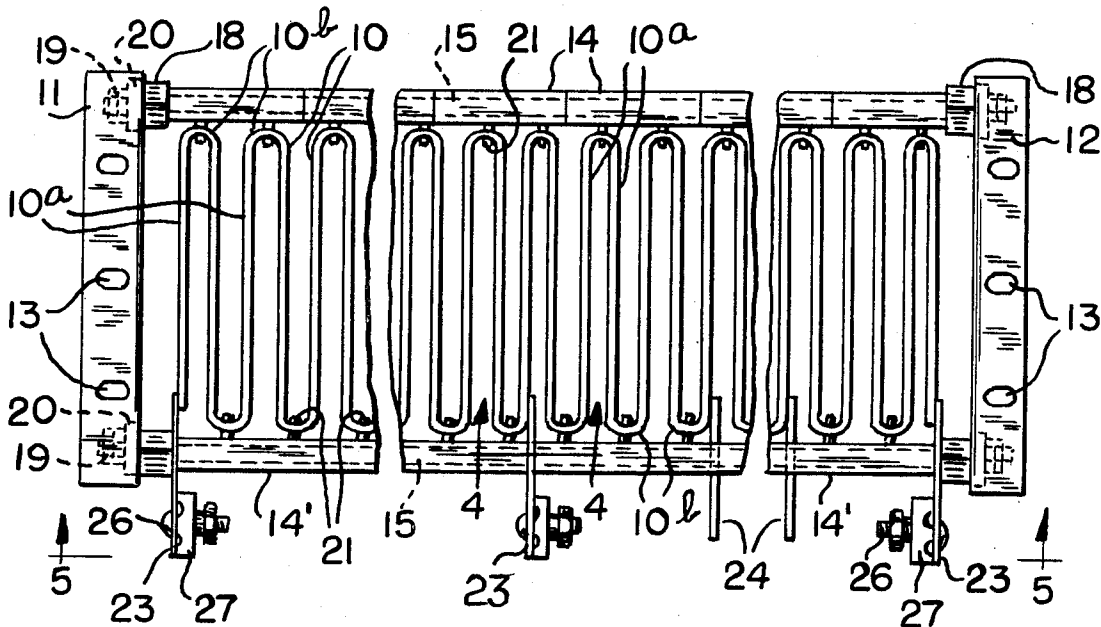
Primary Examiner—E. A. Goldberg

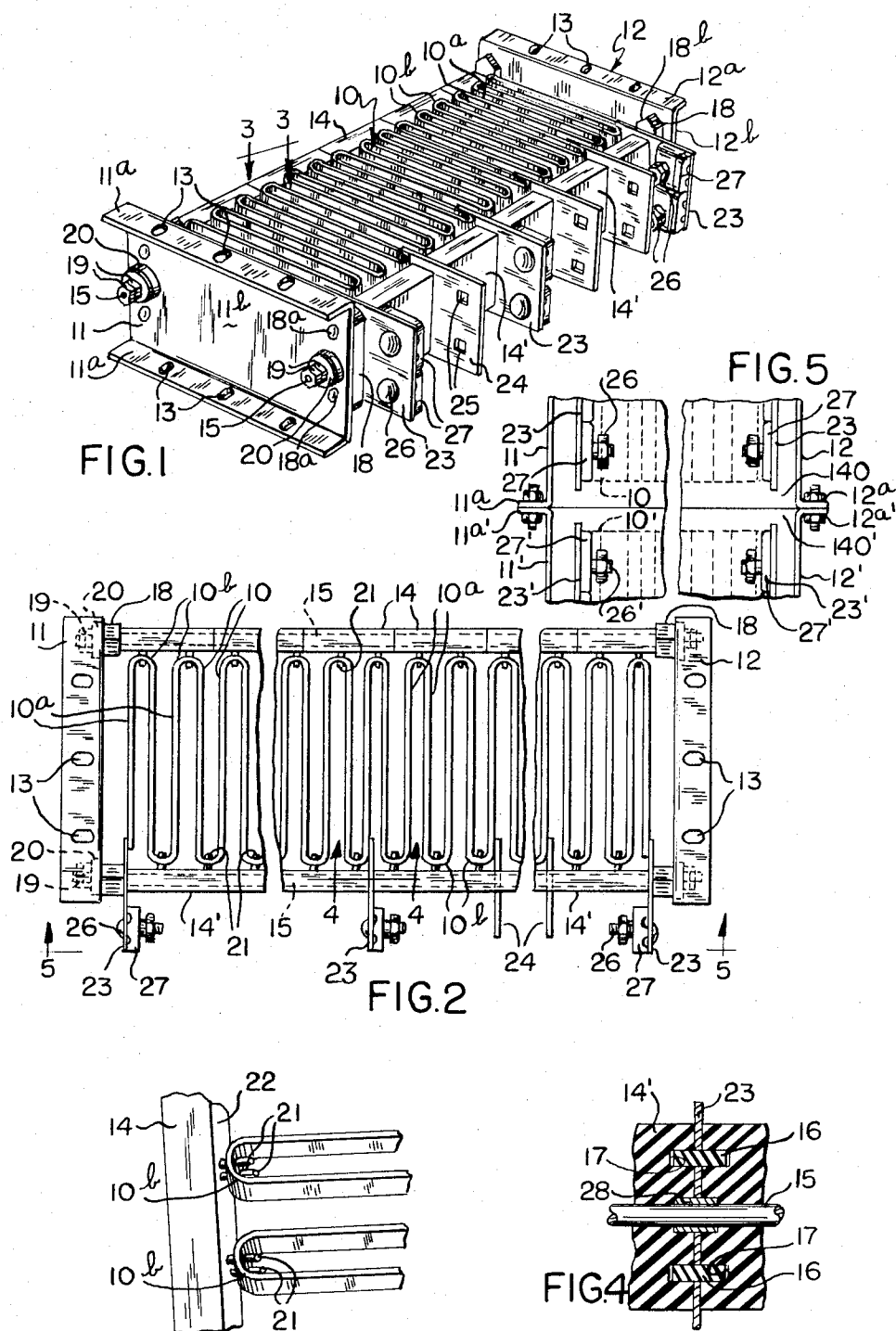
Attorney—Baldwin, Egan, Walling & Fetzer

[57] **ABSTRACT**

A continuous ribbon strip of stainless steel is fan-folded to provide a plurality of equally spaced, parallel uniform linear lengths connected by U-shape folds, and the sole support for the resistor comprises short projections loosely received in openings located along the apices of the U-shape folds with the supporting mechanism including end plates, bolts, supporting insulators and pin projections, providing floating support of the resistor element for free expansion and contraction. Air flow through the folds for effective convective cooling or forced ventilation is substantially unrestricted by the supporting elements.

8 Claims, 9 Drawing Figures





INVENTOR.

MILTON W. GRIFFES

BY

Baldwin, Egan, Walling & Fetzner
ATTORNEYS

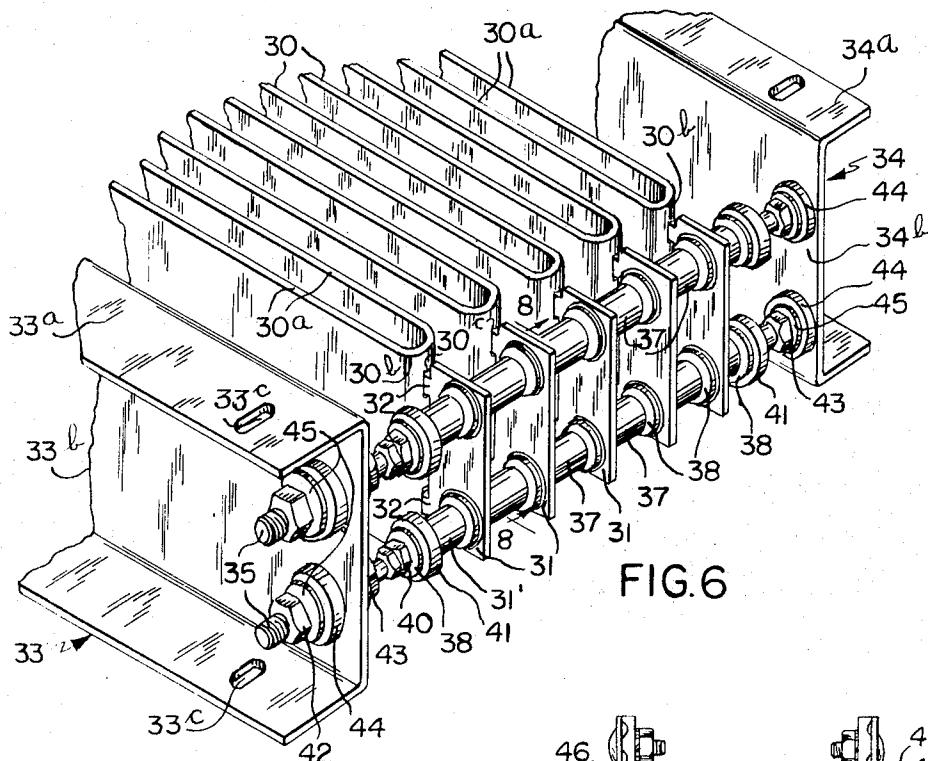


FIG. 6

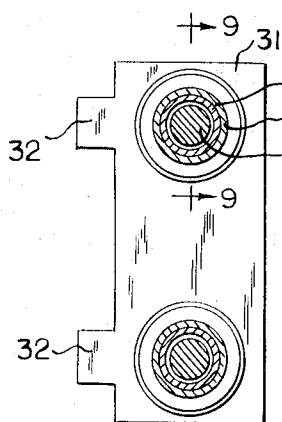


FIG. 8

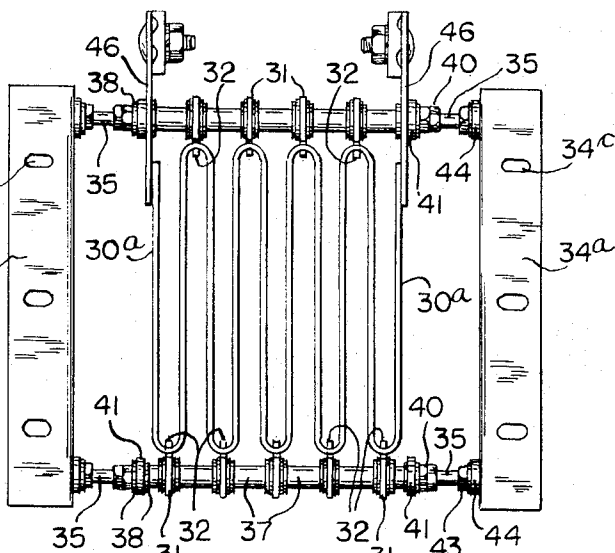


FIG. 7

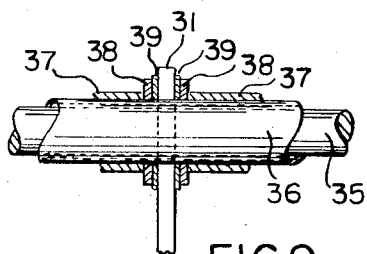


FIG. 9

INVENTOR.

BY MILTON W. GRIFFES

Baldwin, Egan, Walling & Feltzer
ATTORNEYS

RIBBON RESISTOR WITH SUPPORTING MEANS

An object of the present invention is to provide a continuous element high capacity resistor, compact in design and rugged for heavy-duty use such as found in starting, speed regulating and braking of electrical motors found in steel mills, foundries, mines and other industrial areas utilizing cranes, hoists, traction equipment and heavy-duty service equipment.

Other objects and advantages of the invention will be set forth in the accompanying drawings and specification and the essential features thereof will be defined in the attached claims.

In the drawings,

FIG. 1 is a perspective view of a first embodiment of this invention;

FIG. 2 is a top plan view of the same;

FIG. 3 is a fragmental perspective view taken from the position of the line 3—3 in FIG. 1;

FIG. 4 is an enlarged fragmental sectional view taken along the line 4—4 of FIG. 2;

FIG. 5 is a fragmental side elevational view of a modification of the first embodiment taken along the line 5—5 of FIG. 2 and showing one unit mounted on top of another;

FIG. 6 is a fragmental perspective view of a second embodiment of the invention;

FIG. 7 is a top plan view of the same;

FIG. 8 is an enlarged fragmental sectional view taken along the line 8—8 of FIG. 6; while

FIG. 9 is a fragmental sectional view taken along the line 9—9 of FIG. 8.

Referring now to FIGS. 1 and 2, a continuous strip 10 of electrical resistive material is fanfolded to provide a plurality of equally spaced, parallel uniform linear lengths 10a connected by U-shape folds 10b. The preferred material for this embodiment of the invention is a 3 1/2 inch to 4 3/4 inch wide, continuous, A.I.S.I. type, 406 stainless steel element.

The support means for the resistor element comprises two frame end portions 11 and 12 and shown here as portions of steel channels. These channels have flanges 11a and 12a, respectively, perforated at 13 so that a plurality of these units may be bolted together in a vertical structure. Between the frame end portions, a plurality of electrically insulating blocks 14 are assembled on each side of the resistor close to the U-shape folds thereof on rods or bolts 15, each of which extends the full length of the resistor and beyond the webs 11b and 12b of the frame end portions. Each set of insulator blocks, 14 on one side of the resistor and 14' on the other side, is assembled along its associated bolt 15 in end to end relationship, there being suitable openings through the blocks to receive the bolts. Interengaging means is provided on the engaging ends of adjacent blocks for holding the blocks in registration and to provide rigidity in the assembled structure. As shown in FIG. 4, the interengaging means comprises ceramic pins of cylindrical form, one above and one below the bolt 15, these pins being received in suitable recesses 17 in blocks 14 or 14'. The insulator blocks 14 and 14' are of high strength, inorganic and non-tracking in the sense that they will not carbonize under heat. In one embodiment, the blocks are made of a stone-like inorganic plastic, calcium alumino-silicate, made and sold under the trademark Rosite by Rostone Corporation of Lafayette, Ind. The insulator blocks are assembled on

the bolts 15 as shown in FIGS. 1 and 2 and with end insulators 18 between the last linear length 10a at each end of the resistor and the frame end portions 11 and 12. These end insulators are interlocked with the last block 14 or 14' as shown in FIG. 4 at 16 and are also provided with extending nubs 18a which extend through appropriate openings in the frame end portion webs 11b as clearly seen in FIG. 1. Preferably, the upper end 18b of the end insulators is sloped as shown in FIG. 1 so that graphite or other electrically conductive dust will not collect thereon, such as in steel mill use. With the parts thus described assembled on the bolts 15, nuts 19 are threaded on opposite ends of each bolt and pulled up tightly against the outer faces of the frame end webs 11b to hold the parts assembled. Preferably, double jam nuts are used at 19. Insulating collars 20 are provided between the nuts 19 and the frame web 11b as shown.

As best seen in FIGS. 2 and 3, two projections 21 are provided for each U-shape fold 10b of the resistor ribbon. These projections lie on a line parallel to the linear lengths 10a and extend axially of each U-shape fold at its apex. Each of these projections is received loosely in an opening provided through the U-shape fold which is supported. Also, at ambient temperature a small space is provided, as shown at 22, between each U-shape fold 10b and the associated insulator block 14 or 14' which holds the supporting projections 21. Thus, each fold of the resistor ribbon provides a floating support for the resistor element 10 for free expansion and contraction under changing heat conditions. Each of the projections 21 is held in its associated insulator block in any suitable manner. This could be accomplished by molding the pins into the insulator material but in one form of this invention, each of the pins 21 is a spring pin of known construction consisting of a hollow metal cylinder of spring characteristics having a single slot extending longitudinally from end to end of the pin. Such a pin can be compressed radially inwardly and entered into a receiving recess in the insulator block, after which release of the pin causes the spring characteristics to expand the pin to hold it firmly in the insulator block.

The insulator blocks 14 and 14' are alike except for the changes necessary in the blocks 14' to accommodate terminal attachment plates 23 and 24. These plates are welded in line with certain of the parallel linear lengths 10a of the resistor, as desired. Each of these plates, as shown in FIG. 4, has a suitable opening for the passage of a bolt 15 and other openings to accommodate the ceramic pins 16. Also, at their outer ends, there are suitable openings such as that shown at 25 in FIG. 1 to receive bolts 26 which are utilized to secure wire connection terminals 27.

Referring to FIG. 4, an insulator sleeve 28 surrounds bolt 15 wherever it passes through one of the plates 23 or 24 to prevent any shorting of current between folds of the resistor ribbon through the bolt 15. The interlocking structure between blocks 14 comprises ceramic pins 16 like those shown in FIG. 4 but, of course, no insulating sleeve 28 is needed where there are no terminal plates 23 or 24.

A plurality of the units just described can be assembled if necessary, one on top of the other, by securing bolts through openings 13 of the frame end portions of

the two units. This is satisfactory for convection heating because in such cases the air may pass vertically between the folds of the resistor ribbon and may enter or exit in the spaces between the insulator blocks 14 and 14' of a lower unit and similar insulator blocks of the next unit above.

However, in the case of forced ventilation, a modification may be provided as shown in FIG. 5. Here the construction of the upper and lower units is exactly like that heretofore described except with respect to the insulator blocks 14 and 14'. Here the insulator blocks 140 and 140' extend above and below the resistor ribbons 10 and 10'. The blocks 140 and 140' are shown as terminating at the same level as the flanges 11a, 12a, and 11a', 12a'. Thus, when an upper and lower unit are stacked with their flanges 11a and 12a bolted to the flanges 11a' and 12a' below, the insulator blocks 140 and 140' and the uninterrupted frame end portion webs 11b and 12b, at right angles thereto, are secured in registration so as to provide an open vertical tunnel through which air may be forced to provide better cooling for the resistors 10. As is well known, such forced ventilation will permit the resistors to be used at two to three times the current rating for convection cooling.

The second embodiment of this invention, shown in FIGS. 6 through 9, is quite similar in operation except the construction differs. A high capacity resistor ribbon 30 is fanfolded as in the first embodiment to provide a plurality of spaced, parallel uniform linear lengths 30a connected by U-shape folds 30b. The sole support for the resistor comprises a plurality of vertically oriented plates 31, each having stamped integrally therewith spaced vertical projections 32 which enter loosely into suitable openings provided through the U-shape folds of the resistor ribbon lying on a line parallel to the linear lengths 30a and extending axially of each U-shape fold 30b at its apex. At each end of the resistor element are frame end portions 33 and 34 and between them, on each side of the resistor, extend vertically spaced parallel support bars 35. The construction along each support bar is the same so one only need be described. Referring to FIGS. 8 and 9, each bar 35 has an electrically insulating tube or sleeve 36 surrounding it between the frame end portions. Mica is suitable for this sleeve. Between each pair of plates 31, a hollow steel tubular spacer 37 is provided and between the spacer and the plate 31 on each side of the latter is provided first a steel washer 38 next to the spacer and a mica washer 39 between the washer 38 and plate 31. A similar structure is shown between each end plate 31 and a limiting spacer nut 40 threaded on the rod 35. This includes a spacer 31' which abuts against an insulating collar of mica 41 and between 31' and 41 and between 40 and 41 there is a steel washer 38. Each of the bolts 35 passes through the web 33b or the web 34b of the frame end portions and is there secured firmly by nuts 42 and 43 on opposite sides of the frame web. Between each of the nuts 42 and 43 and the associated end web is a suitable insulator 44 and a steel washer 45.

It will be noted that each of the plates 31, being rigidly supported by two of the bolts 35, allows no rocking of the plates 31 and the projections 32 allow the resistor ribbon to float thereon with room for the U-shape folds 30b to move back and forth on the projections 32 under various changes of temperature.

As best seen in FIG. 7, suitable terminal plates 46 are welded in line with certain of the linear resistor lengths 30a and the plates 46 are supported on the bolts 35 in the same manner as indicated at 36, 37, 38 and 39, with respect to the plates 31.

Suitable bolt holes are provided at 33c and 34c so that flanges 33a and 34a of one unit may be bolted to another similar unit vertically lined thereabove.

It should be noted that in both of the embodiments of this invention the projections 21 of the first embodiment and projections 32 in the case of the second embodiment extend very slightly inwardly beyond the thickness of the resistor ribbon, not more than a fraction of an inch, so that ventilation between the folds of the resistor ribbon is substantially unrestricted.

In one form of this invention, the stainless steel resistor ribbon is from 3 1/2 to 4 3/4 inches wide and the linear lengths 10a or 30a are between about 8 and 10 inches long. The thickness of the ribbon per current to be handled runs from about one thirty-seconds inch to three-sixteenths of an inch when the current rating is between about 150 amps. to 700 amps., respectively.

In the case of the second embodiment, one device utilized rods 35 of 7/8 inch diameter surrounded by a mica tube 36 which was about one-sixteenth inch thick. In this embodiment, the support plates 31 were one-eighth inch thick.

Thus, this invention provides a fanfolded resistor which is uniquely supported by metal pins or projections leaving the resistor element free to expand and contract. It does not distort even under severe duty cycles. The construction is rugged throughout, the insulation system is superior and the heavy welded terminals for circuit connections render this equipment suitable for heavy mill duty. The construction leaves the space between the folds of the resistor substantially unobstructed for convection or forced air cooling. There are no strip welds to cause mechanical or electrical failures. The use of inorganic, non-tracking insulating blocks insures insulation integrity even in conductive dust and moisture laden atmospheres.

What is claimed is:

1. A support means for a continuous ribbon-type resistor fanfolded into a plurality of equally spaced parallel uniform linear lengths connected by U-shape folds, comprising a frame having portions at opposite ends of said resistor opposite said linear lengths, supports connected between said frame portions, one support extending crosswise of said fanfolds on each side of said resistor, there being an opening through said ribbon resistor at the apex of each U-shape fold, projections carried by said supports, one projection opposite each of said openings, each of said projections being loosely received in its associated opening, means electrically insulating said resistor from said supports and from said frame, and terminals attached to said resistor.

2. A support means as defined in claim 1, including two of said openings being provided at the apex of each U-shape fold, two of said projections, one entering each of said openings, and said openings and said projections lying on a line parallel to said linear lengths and extending axially of each U-shape fold at its apex.

3. A support means as defined in claim 2, including insulator blocks firmly mounted on said supports, and said projections being mounted in said blocks.

4. A support means as defined in claim 3, wherein said frame comprises uninterrupted end plates at each end of said resistor at right angles to said insulator blocks and extending to predetermined levels above and below the ribbon of said resistor, said insulator blocks extending from end plate to end plate to provide substantially uninterrupted walls on side adjacent and just outside said U-shape folds, and said blocks terminating at said predetermined levels, whereby a plurality of said support means may be stacked vertically with said blocks and end plates in registration whereby to provide an open vertical tunnel for forced ventilation.

5. A support means as defined in claim 2, wherein plates are firmly mounted on said supports, and projections are rigid with said plates.

6. A support means as defined in claim 2, wherein plates are firmly mounted on said supports, and projections are integral with said plates.

7. A support means as defined in claim 1, including two of said openings being provided at the apex of each U-shape fold, two of said projections, one entering each of said openings, and said openings and said projections lying on a line parallel to said linear lengths and extending axially of each U-shape fold at its apex, each of said supports comprising a bolt running the full length of said resistor and beyond said frame end portions, said insulating means including insulator blocks positioned end to end along said bolts, there being suitable openings through said blocks to receive said bolts, interengaging means on the engaging ends of adjacent blocks holding said blocks in registration, interengaging means between the end block on each bolt and the adjacent frame end portion to provide rigidity,

said projections mounted in said blocks, and nuts threaded on the ends of said bolts and pulled up tight against the outer surfaces of said frame end portions and holding said blocks and said frame end portions assembled with said resistor held on said projections, there being insulating means between said nuts and said end portions.

8. A support means as defined in claim 1, including two of said openings being provided at the apex of each U-shape fold, two of said projections, one entering each of said openings, and said openings and said projections lying on a line parallel to said linear lengths and extending axially of each U-shape fold at its apex, a vertically extending plate opposite each of said U-shape folds, each pair of said projections being vertically spaced on one of said plates, there being two of said supports on each side of said resistor, each of said supports comprising a bolt running the full length of said resistor and beyond said frame end portions, there being two openings through each of said plates through which the associated bolts pass, an electrically insulating tube surrounding each of said bolts between said frame end portions, said tubes extending through said openings in said plates, hollow spacers surrounding said tubes between said plates and between the last plate on each bolt and the adjacent frame end portion, electrically insulating means between spacers and said plates and between said spacers and said frame end portions, and nuts threaded on the ends of said bolts and pulled up tight against the outer surfaces of said frame end portions and holding said plates and said spacers and said frame end portions assembled with said resistor held on said projections, there being insulating means between said nuts and said end portions.

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