United States Patent

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[54] **SUPPORTING AND INSULATING ARRANGEMENT FOR ELECTRICAL RESISTOR OR THE LIKE**
5 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **338/57,** 219/532, 219/537, 338/58, 338/203, 338/232, 338/260, 338/295, 338/299, 338/305, 338/317, 338/319
[51] **Int. Cl.** **H01c 1/08**
[50] **Field of Search** 338/53, 57, 58, 203, 232, 260, 261, 295, 299, 305, 315, 317, 318, 319; 219/532, 536, 537

[56] **References Cited**
UNITED STATES PATENTS

3,213,401	10/1965	Owen	338/299 X
3,016,441	1/1962	Hackman et al.	338/317 X
2,921,172	1/1960	Hackman	338/317 X
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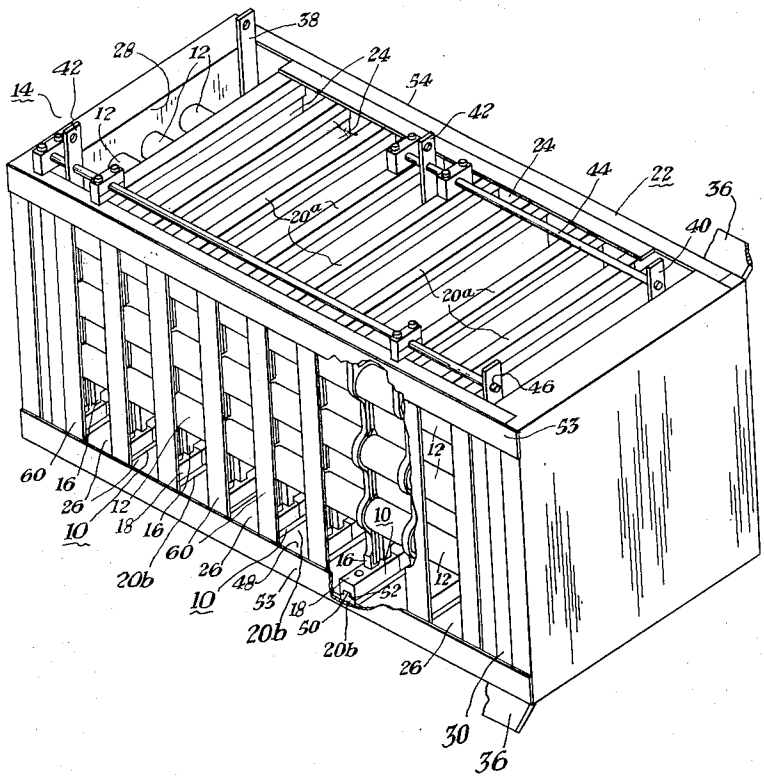
ABSTRACT: I disclose an electrical resistor having a plurality of elongated resistor elements arranged in a closely spaced generally parallel array and connected electrically for electrical loading purposes. A supporting and insulating arrangement for the elements is disposed intermediate the ends of the elements. The arrangement has a plurality of metallic supporting straps and insulating members detachably joined.



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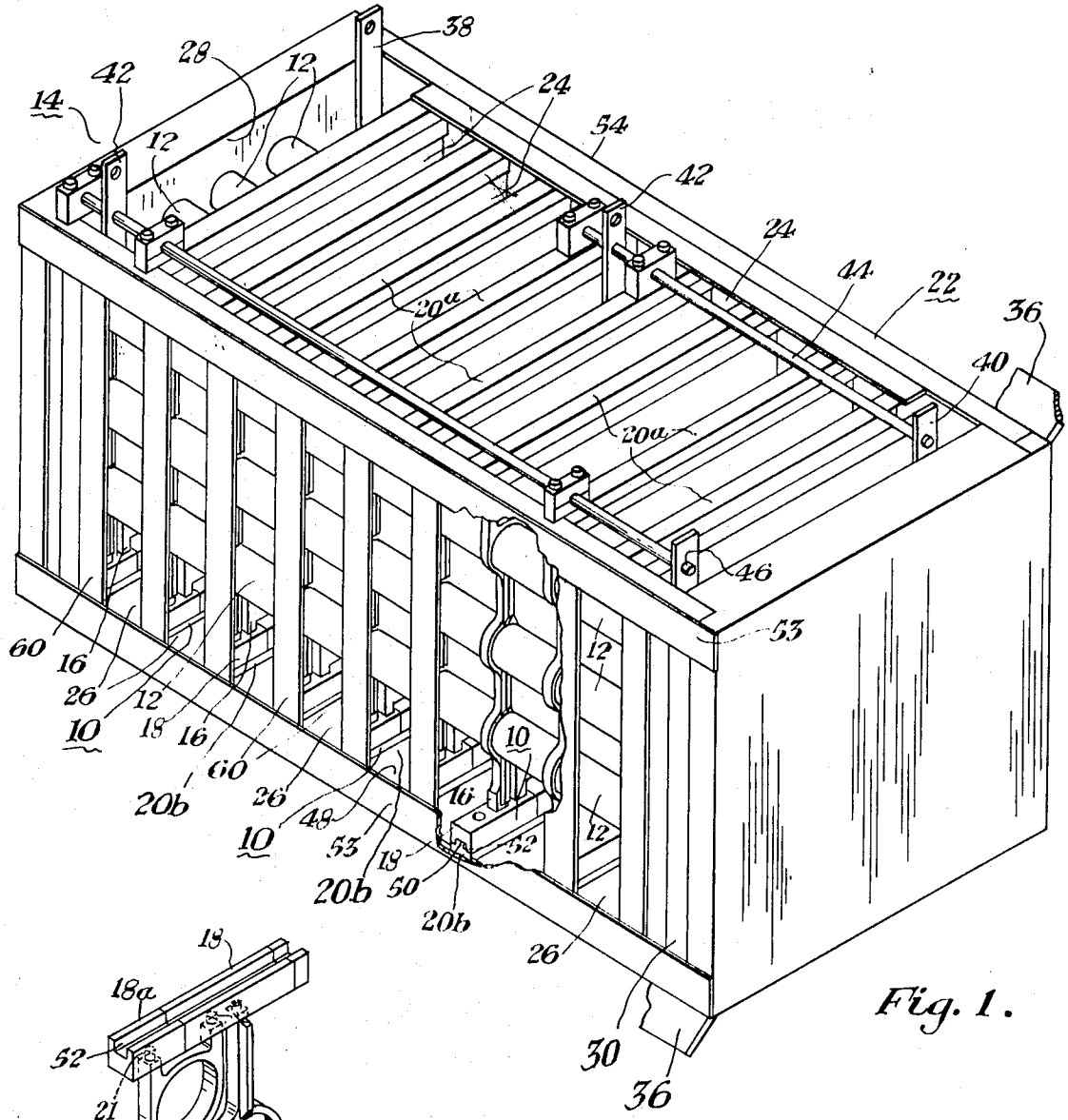

Fig. 1.

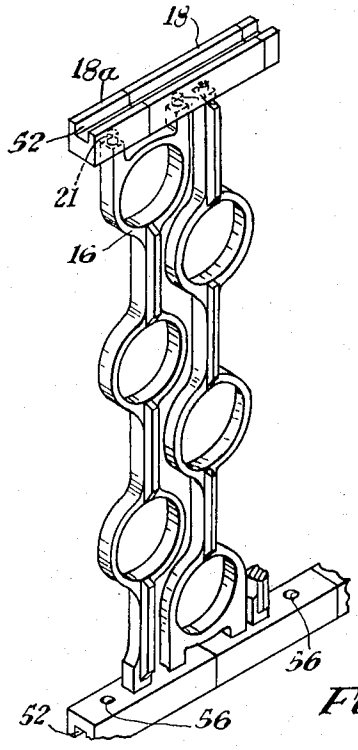

Fig. 4.

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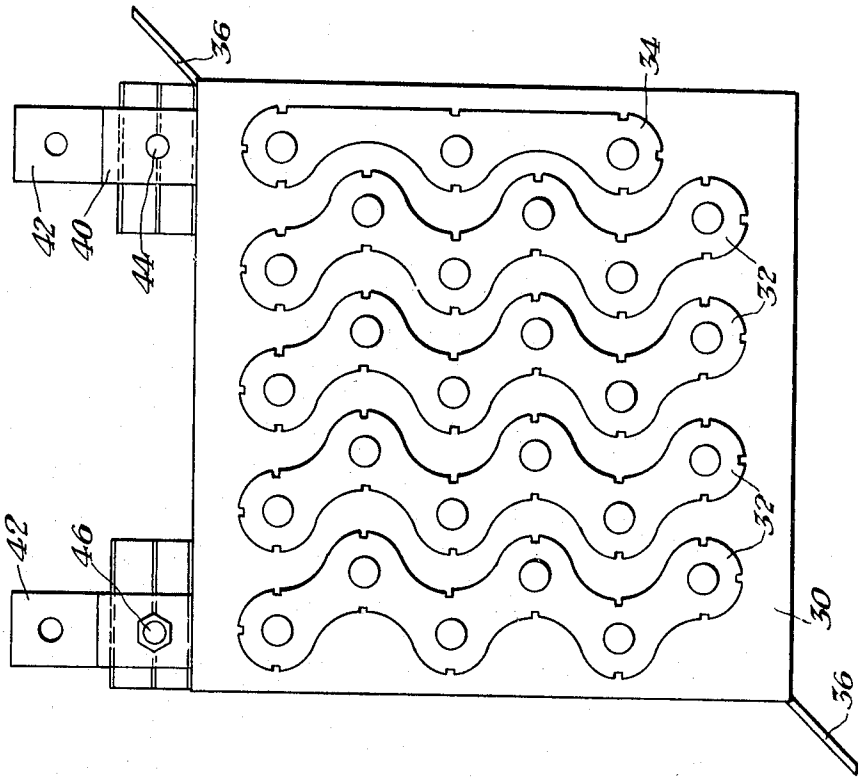

Fig. 3.

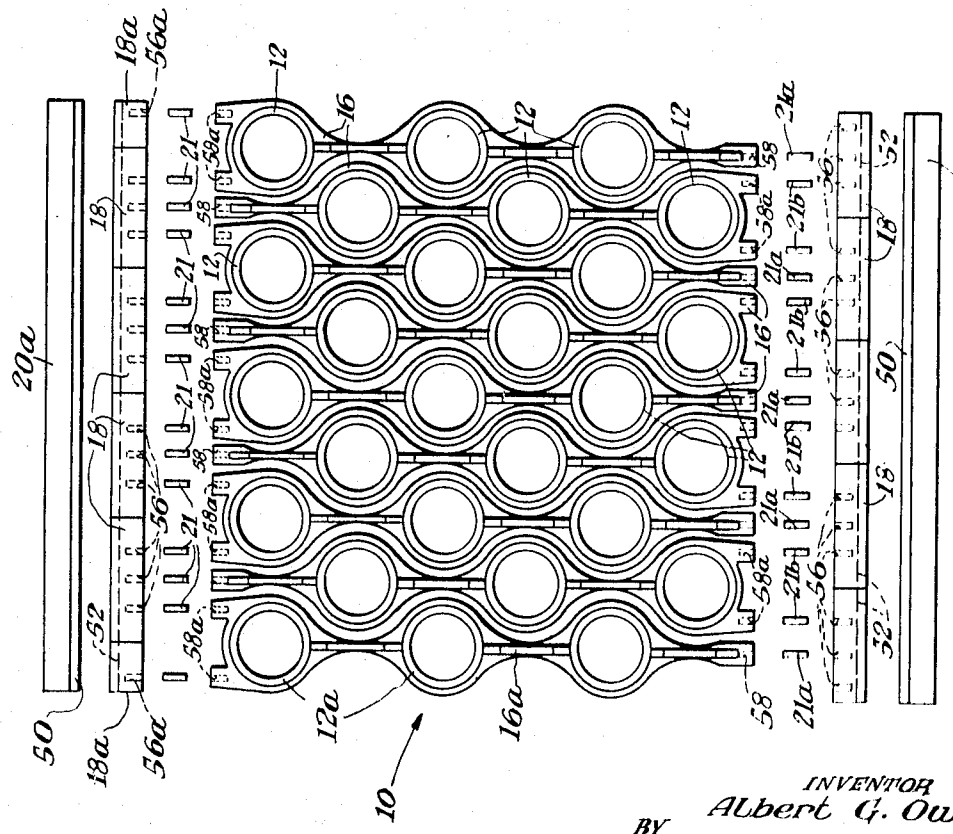

Fig. 2.

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SUPPORTING AND INSULATING ARRANGEMENT FOR ELECTRICAL RESISTOR OR THE LIKE

This application is an improvement upon my U.S. Pat. No. 3,213,401 entitled "Electrical Resistor" issued Oct. 19, 1965.

My present invention relates to an electrical resistor and more particularly to an electrical resistor having means for dissipating extremely large quantities of heat. More particularly, I disclose a novel, insulating and supporting arrangement for the resistor elements which arrangement is capable of withstanding elevated temperatures without evidencing a more rapid deterioration than that of the resistor elements themselves.

Electrical resistors of the character described are usually provided in the form of a bank of resistor elements and are capable of a wide variety of uses. A prominent use for this type of electrical resistor is in various types of dynamic braking systems, such as used in railway locomotives. Dynamic brakes are used on downgrade runs to relieve the loading and resultant wear and tear on the air-operated shoe-type brakes. In one form of dynamic braking system, the drive motor of the locomotive is operated as a generator. For maximum braking action the drive motor, when run as a generator, must be loaded electrically as much as possible, within the limits established by the electrical characteristics of the motor. The load imposed on the drive motor generator, therefore may be of the same order as the power consumption of the drive motor in its driving mode. As the power rating of a typical locomotive drive motor may be of the order of 4,000 hp., obviously a considerable quantity of heat must be dissipated from the resistor when the drive motor is operated in a generating or braking mode.

Electrical resistors employed for this purpose usually employ a low employ resistance metal such as iron or one of the resistance metal alloys. In the case of iron resistor elements it is desirable to prevent the maximum temperature of the resistor from reaching 1,800° F., as metallic iron undergoes certain granular changes at this temperature which embrittles the metal and changes its resistance characteristic. Accordingly, it is essential to support and insulate the elements of the resistor without interferring with or disrupting the cooling draft circulated through the resistor.

Resistor constructions vary but usually include a bank of elongated resistor elements, which preferably are supported at a number of points along their lengths to prevent sagging and breakage or interelement contact. For example, the resistor elements can be fabricated in the form of elongated relatively closely spaced wire coils. Arrangements for forming elongated coils from wires of differing diameters and with varying pitches, such that progressively higher intensity coils are disposed within the resistor in the direction of the source of the cooling draft, are set forth in my aforementioned Letters Patent. The group of elongated resistor elements, assembled either by this technique or by conventional techniques, are then supported at multiple points along their length by a suitable support structure.

Previously it has usually been the practice to utilize transite coil separators, each having a number of holes therein, one for each coil or element in the resistor. In typical resistor ten such separators may be used, i.e., two end separators and eight intermediate separators. The resistor elements, therefore, rest directly on the transite separators for the most part, which are thereby exposed to the intense heat of the resistor elements. At the elevated temperatures at which the resistor element is operated, the intermediate transite separators deteriorated at a rapid rate, owing to vaporization and removal of the silicon impregnant compound and the cement binder. In consequence, the remaining asbestos fiber, which forms the bulk of transite and similar insulating materials, is left in an embrittled condition. The deteriorated separators break easily under mechanical shock and vibration and permit those ones of the resistor elements at different potentials to short out. Moreover, where the resistor is exposed to the moisture, the remaining asbestos fiber is capable of considerable moisture, the remaining asbestos fiber is capable of considerable moisture absorption with resultant electrical breakdown between the resistor elements.

Those transite or similar separators which are usually employed at the ends of the resistor bank are exposed to considerably less resistor heat, and therefore do not deteriorate in this fashion.

Accordingly, I have now developed a supporting ,spacing and insulating arrangement for resistor elements which evidences prolonged resistance to shock forces and vibration, even after continued exposure to excessive temperatures. The insulating arrangement is impervious to moisture under all operating conditions irrespective of the operating temperature of the resistor. I have found that my novel supporting and insulating arrangement will not deteriorate even when the resistor elements are operated at destructive temperatures. Thus, the load dissipating capacity of may resistor is not limited by the insulating that may be employed. Therefore, a resistor, when provided with my novel supporting arrangement, requires considerably less maintaining and obviates downtime, in the locomotive or in other associated equipment.

In general, my novel supporting and insulating arrangement includes metallic coil supports which engage unipotential points on selected ones of the elongated resistor elements and are spaced and electrically isolated from similar supports by insulators fabricated from ceramic or other material capable of withstanding resistor operating temperatures. The coil supports and insulators are assembled in such manner as to be resistant to mechanical shock forces and vibration. My novel supporting and insulating arrangement is not subject to moisture absorption.

I am aware of course of various types of resistance element support structures, for example those typified by the U.S. Pat. to Hackman et al. No. 3,016,441; Hackman No. 2,921,172; Dibble No. 1,751,797; Mackintosh No. 715,827; and Larson No. 678,887. In each of these patents there is disclosed a resistance element supporting arrangement including various types of metallic straps, brackets, or convectors with various types of insulating materials disposed between the metallic members and the resistor elements. There is no teaching of utilizing metallic supports or straps for engaging unipotential points of adjacent resistor elements. Nor do any of these references teach spacedly supporting a number of metallic supports maintained at differing potentials for electrical isolation. Likewise there is no teaching of means for electrically isolating the metallic straps not only from one another but also from a metallic cage or housing for the resistor bank. Finally, there is no disclosure of a supporting and insulating structure which can be readily assembled and disassembled relative to a closely spaced array of resistor elements.

I overcome the disadvantages of the prior art and attain the foregoing advantages of the invention by providing an electrical resistor comprising a plurality of elongated resistor elements arranged in a closely spaced generally parallel array, means for electrically connecting said elements for electrical loading purposes, means for directing a cooling draft through the spaces between said elements, and at least one supporting and insulating arrangement for said elements disposed intermediate the ends thereof, said arrangement including a plurality of supporting straps and a number of insulating members detachably adjoined thereto, each of said supporting straps bridging an adjacent pair of said insulating members to at least aid in maintaining said arrangement in assembled relation.

I also desirably provide an electrical resistor comprising a plurality of elongated resistor elements arranged in a closely spaced generally parallel array, means for electrically connecting said elements for electrical loading purposes, means for directing a cooling draft through the spaces between said elements, and at least one supporting and insulating arrangement for said elements disposed intermediate the ends thereof, said arrangement including a plurality of metallic supporting straps and insulating means detachably joined thereto, said resistor elements being electrically connected in series-parallel, and each of said metallic supporting straps engaging each of a subgrouping of said elements at unipotential points.

I also desirably provide a similar resistor wherein said supporting and insulating arrangement engages a group of relatively closely spaced electrical impedance members, said arrangement comprising a plurality of metallic connecting straps and a number of insulating members, means for detachably joining said straps to said insulating members, and each of said straps engaging at least some of said impedance elements at unipotential points.

I also desirably provide a similar resistor wherein said insulating means are discrete members detachably mounted on a casing for said resistor and shaped to space said metallic straps from one another.

During the foregoing discussion, various objects, features and advantages of the invention have been set forth. These and other objects, features and advantages of the invention together with structural details thereof will be elaborated upon during the forthcoming description of certain presently preferred embodiments of the invention and presently preferred methods of practicing the same.

In the accompanying drawings I have shown certain presently preferred embodiments of the invention and have illustrated certain presently preferred methods of practicing the same, wherein:

FIG. 1 is an isometric view partially broken away of one form of resistor arranged in accordance with my invention;

FIG. 2 is a cross sectional, partially exploded view of the apparatus as shown in FIG. l;

FIG. 3 is a right end view of the apparatus as shown in FIG. 1, with the end cover removed; and

FIG. 4 is a partial isometric view of one of the metallic supporting straps and a number of the insulating supporting blocks used in the apparatus of FIG. 1.

Referring now more particularly to the drawings, the exemplary supporting and insulating arrangement 10 of FIG. 2 is used in this example for supporting a group of resistor elements 12 used in the resistor 14 shown in FIG. 1. The supporting and insulating arrangement 10 includes a plurality of supporting straps 16, a number of insulating blocks 18, and several connecting pins 21. When the resistor 14 is used as a dynamic brake resistor, the supporting and insulating arrangement 10 is fabricated from materials capable of withstanding the elevated temperatures involved. Thus, the straps 16 can be fabricated from cast iron or other suitable material capable of withstanding such temperatures. In the illustrated arrangement of the resistor 14, the resistor elements such as the subgrouping of elements 12*a* contacted by a given strap, such as the strap 16*a*, are electrically connected in series-parallel such that the points of their contact with the strap 16*a* are at unipotential. Thus, the straps 16 can be fabricated in this application from either a conductive or nonconductive material, as there are no potential drops along the length of each strap. On the other hand the insulating blocks 18 desirably are fabricated from an insulating material such as porcelain or other suitable ceramic. As described more fully below the ceramic blocks 18 electrically isolate the metallic straps 16 (and the subgroupings of resistor elements) from one another and from the supporting framework including bars or supports 20*a* and 20*b* of the resistor 14.

The insulating members 18, 18*a* also afford thermal insulation relative to the adjacent portions of the casing 22. Thus, the resistor elements 12 are both electrically and thermally insulated from the casing structure 22 by means of the aforementioned end panels 28, 30 and the several supporting and insulating arrangements 10 spaced along the length of the resistor elements 12.

In a typical construction of the resistor 14, a cage or housing 22 is provided having two or more open sides 24, 26. The ends of the casing 22 are enclosed by a pair of end panels 28, 30 fabricated from a transite or other suitable insulating material. A number of zigzag electrical connecting straps 32, 34 can be secured at each end of the casing 22 to the protruding ends of the resistor elements 12. An inspection of FIGS. 1 and 3 indicates the series-parallel connections of the resistor elements 12 in accordance with conventional practice. A pair of diagonally extending mounting plates 36 extend along diametrically opposed corners of the casing 22 for mounting purposes. The bank of resistor elements 12 are electrically connected at its end to terminals 38, 40 which in turn are connected to the endmost connecting straps 34. A third terminal 42 may be connected near the midpoint or otherwise intermediate the ends of the resistor bank for the purpose of delivering an electric potential for auxiliary use, such as a motor-driven fan for forced cooling of the resistor bank through the open sides 24, 26. As better shown in FIG. 1 some or all of the terminals 38–42 can be positioned where desired on the casing 22 and connected to the resistor bank by means of copper bus bars 44, 46.

For most efficient cooling of the resistor elements 12, the latter can be provided in coil form of varying pitch and wire diameter, in accordance with the teachings of my aforementioned patent.

In the arrangement shown, the top and bottom 24, 24*a* of the casing 22 are each provided with an array of the supporting bars 20, as mentioned previously in connection with FIG. 2. The top supporting bars 20*a* desirably are equally spaced along the otherwise open side or top 24 of the casing 22. The bottom supporting bars 20*b* are similarly spaced and desirably are aligned respectively with the upper bars 20*a*. The bottom 24*a* of the casing 22 may otherwise be closed by panel 48.

Each of the supporting bars 20*a*, 20*b* is provided with an inwardly projecting ridge 50 sized for insertion into groove 52 of each of the insulating blocks 18. An array or group of insulating blocks 18 is mounted on each of the supporting bars 20*a* or 20*b* with half blocks 18*a* being provided where required, owing to the staggered array of the upper blocks as compared to the lower blocks. Each group of insulating blocks are maintained in alignment by their engagement with the associated one of the supports 20. Each row of insulating blocks 18 (and 18*a* where used) moreover, are held together by reason of their connections to the supporting straps 16 as described below. The assembled arrangement 10 is maintained against lateral displacement as a unit by the longitudinally extending flange members 53 forming part of the casing 22 and by rear panel 54.

When the supporting and insulating arrangement 10 is assembled in the manner indicated by FIG. 2, the arrangement 10 assumes a unitary configuration in which the supporting straps 16 are more or less rigidly spaced from one another for electrical isolation and are electrically and thermally insulated, through their engagement with the supporting blocks 18 and 18*a*, from the resistor casing 22. In furtherance of this purpose each of the supporting blocks 18 are provided with three pinholes 56 (FIGS. 2 and 4) while the half-blocks 18*a* are provided with a single similar hole 56*a*. Each of the elongated supporting straps 16 is provided with a similar single pinhole 58 at the end of the single joining member and with a pair of such holes 58*a* in a pair of spaced fork members for joining the insulating blocks 18 through connecting pins 21. The aforementioned pins 21 can be fabricated from steel or other suitable structural material and are driven into the closely fitting strap pinholes 58, 58*a* respectively.

When assembling the resistor 14 a plurality of mounting and supporting arrangements 10, corresponding to the number of pairs of supporting bars 20*a*, 20*b* are each assembled as indicated in FIG. 2 together with the associated pair 20*a*, 20*b* of the supporting bars 20. This assembly can then be mounted and secured as a unit into the casing 22 and spaced along the length thereof as shown in FIG. 1. In assembling the supporting and insulating arrangement 10, the large end of each of the straps 16 bridges an adjacent pair of insulating blocks 18 or 18, 18*a* by loose insertion of the pins 21*b* into the respective pinholes thereof. The smaller end of each strap 16 is joined by the associated pin 21*a* to the central pinhole 56 of the blocks 18. This assembly arrangement not only maintains the adjacent insulative blocks in a closely spaced array but also physically spaces adjacent ones of the metallic supporting strap 16 which are, of course, at differing potentials, as they

respectively engage differing subgroupings of the series-parallel resistor elements.

The adjacent open side 26 (FIG. 1) is provided with a number of spaced columnar supports 60 for circulation of cooling draft through the resistor 14. Desirably the supports 60 are assembled in a staggered array relative to the supporting bars 20a, 20b so as not to shield the supporting straps 16 and adjacent surfaces of the resistor elements.

Although other structural materials can be employed for fabricating the supporting and insulating arrangement 10, the use of cast iron straps 16 is admirably suited to the exemplary application of the invention, where the resistor elements 12 are fabricated from iron wire. The straps 16, then, are capable of withstanding temperatures considerably in excess of 1,800° F. and hence are abundantly capable of withstanding the maximum operating temperatures of the resistor elements 12. Moreover, the heat transfer characteristic of the strap 16 when made of cast iron or the like, is sufficiently low to avoid transferring deleterious quantities of heat to the insulating blocks 18. Neither the supporting strap 16 nor the insulating blocks 18 are susceptible to thermal or mechanical shock. At the same time all components of the resistor 14, including the supporting straps 16 and the insulators 18, remain completely moistureproof and hence retain their supporting and insulating characteristics under all environmental conditions. Finally, the resistor 14 can be readily disassembled for maintenance or replacement of parts.

From the foregoing it will be apparent that novel and efficient forms of electrical resistors have been disclosed herein. While I have shown and described certain presently preferred embodiments of the invention and have illustrated presently preferred methods of practicing the same it is to be distinctly understood that the invention is not limited thereto but may be otherwise variously embodied and practiced within the spirit and scope of the invention.

I claim:

1. An electrical resistor comprising:

a. a plurality of elongated resistor elements arranged in a plurality of spaced parallel planes, all the resistor elements parallel to each other and all the elements elongated in a single direction end to end in all planes formed by the resistor elements forming the plurality of planes;

b. means electrically connecting the elements;

c. at least one supporting and insulating arrangement for the elements, the arrangement having:

1. a plurality of metallic supporting straps in a plane traversing the plurality of parallel planes formed by the resistor elements, the straps supporting the elements; and

2. a plurality of electrically insulating members detachably adjoined to each end of the supporting straps, each of the supporting straps at one end bridging an adjacent pair of insulating members to aid in maintaining the assembled relation.

2. An electrical resistor as recited in claim 12 wherein each of the straps is elongated and has a pair of spaced fork members at one end engaging the insulating members and the strap having a single joining member at the other end of the strap, the straps arranged in an alternating array with a strap with spaced fork members at one end being adjacent a strap with a single joining member at a corresponding adjacent end, the pair of spaced fork members joined to an adjacent pair of insulating members and the single joining member at the other end of the strap joined to the midpoint of an insulating member.

3. An electrical resistor as recited in claim 13 wherein a pair of elongated supports are engaged respectively with the insulating members, the elongated supports are positioned at opposite ends of the plurality of straps, engaging means formed in the supports and insulating members for aligning the insulating members with its associated support.

4. An electrical resistor as recited in claim 13 wherein the fork members and single joining members are so spaced that the insulating members are assembled in substantially end-to-end contact with one another and the straps are assembled thereby in mutually spaced relation.

5. An electrical resistor as recited in claim 15 wherein the insulating members are discrete members detachably mounted on a casing for the resistor and shaped to space the metallic straps from one another.

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