

Oct. 15, 1940.

J. MARSTEN

2,218,204

RESISTOR CONSTRUCTION

Filed July 19, 1935

3 Sheets-Sheet 1

Fig. 1.

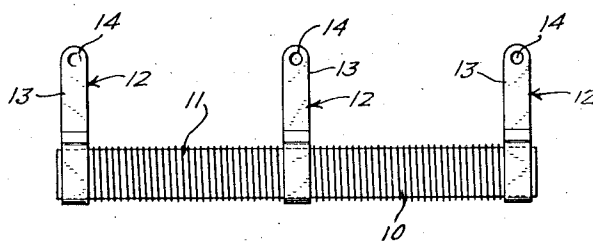


Fig. 2.

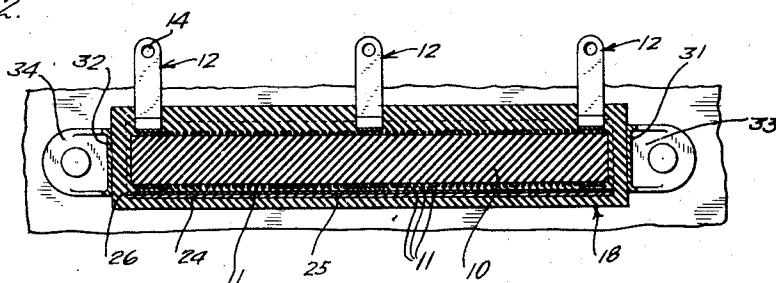


Fig. 3.

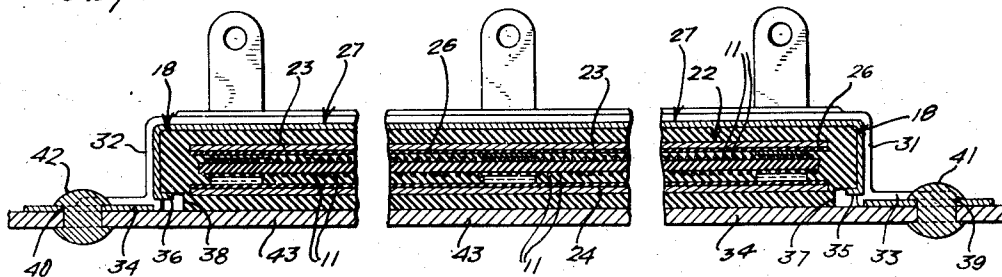


Fig. 5.

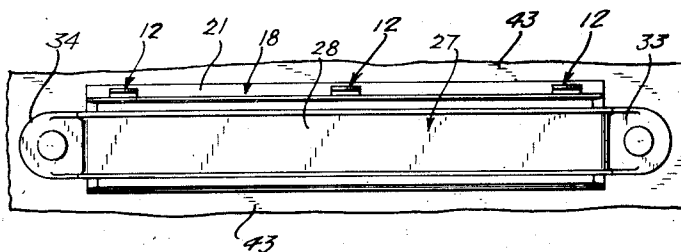
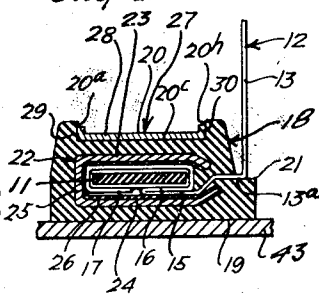


Fig. 4.



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Fig. 6.

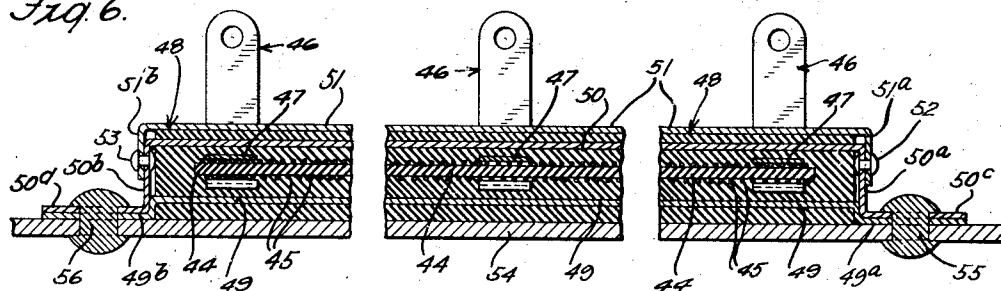


Fig. 8.

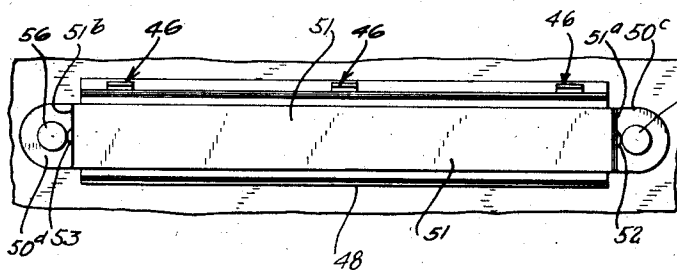


Fig. 7.

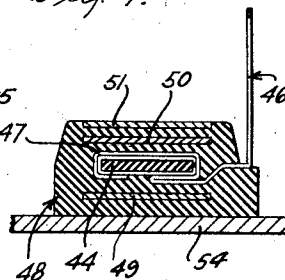


Fig. 9.

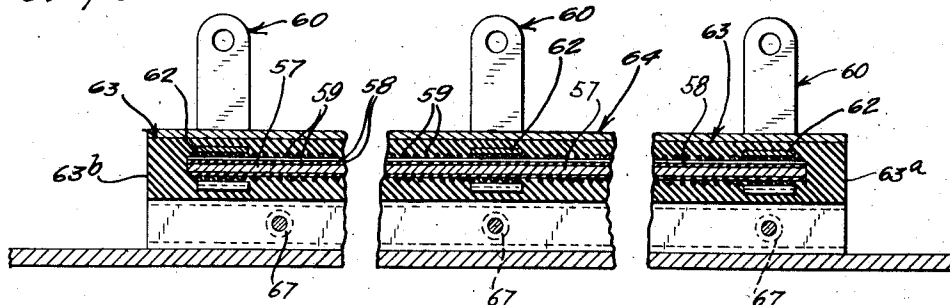


Fig. 11.

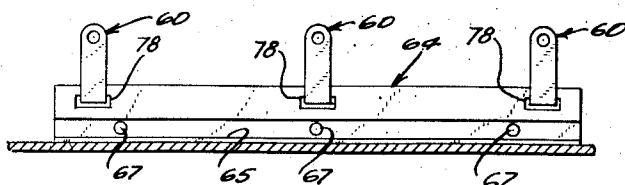
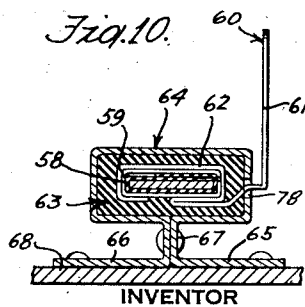


Fig. 10.



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Fig. 12

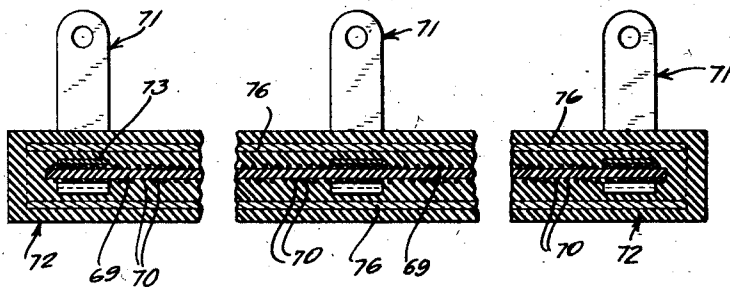


Fig. 13

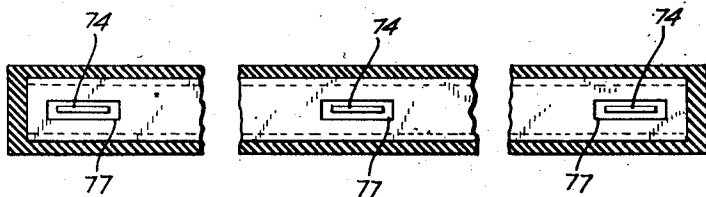


Fig. 14

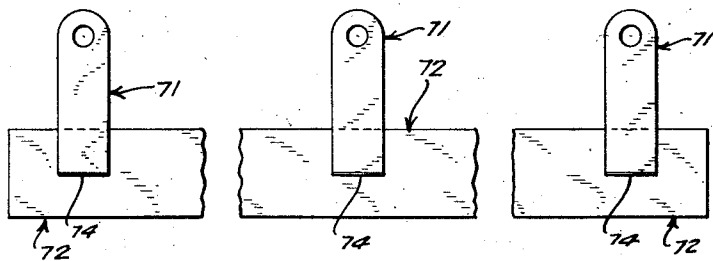
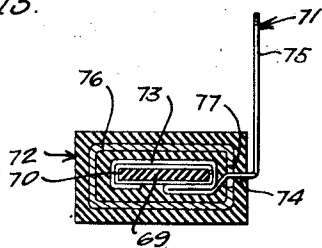


Fig. 15



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## UNITED STATES PATENT OFFICE

2,218,204

## RESISTOR CONSTRUCTION

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Application July 19, 1935, Serial No. 32,146

6 Claims. (Cl. 201—67)

This invention relates to a resistor construction.

One of the objects of this invention is to provide a simple and practical resistor which is sturdy and durable in construction. Another object is to provide a resistor of the above character which is able to withstand adverse weather and temperature conditions without variation in operation or deterioration of any of the parts thereof. Another object is to provide a resistor of the above character whose individual parts are simple in construction, thus making for an easy and quick assembly. Another object is to provide a resistor of the above character which may be produced from inexpensive materials with a marked saving of labor resulting in low cost of manufacture. Another object is to provide a resistor of the above character having high current carrying capacity in spite of the low critical temperature of some of the parts thereof. Another object is to provide a resistor of the above character utilizing a covering hermetically sealing delicate parts thereof against outside conditions. Another object is to provide a resistor of the above character, the temperature of which is maintained substantially constant throughout its length. Another object is to provide in a resistor of the above character and with an outer covering of material having a low critical temperature, means for cooling said covering to prevent deterioration thereof. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts as will be exemplified in the structure to be hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, in which are shown several of the possible embodiments of this invention,

Figure 1 is a plan view of a resistance device with terminals applied thereto and without an outer covering;

Figure 2 is a horizontal cross-section of the device shown in Figure 1 with the covering applied thereto;

Figure 3 is an enlarged longitudinal vertical sectional view of my resistor;

Figure 4 is a lateral vertical sectional view of my resistor;

Figure 5 is a top plan view of my resistor as mounted on a panel or the like;

Figure 6 is a longitudinal vertical sectional

view of a resistor forming another embodiment of my invention;

Figure 7 is a lateral vertical sectional view of the resistor shown in Figure 6;

Figure 8 is a top plan view of the resistor shown in Figure 6 as mounted on a panel or the like;

Figure 9 is a longitudinal vertical sectional view of a resistor forming another embodiment of my invention;

Figure 10 is a lateral vertical sectional view of the resistor shown in Figure 9;

Figure 11 is a side elevational view of the resistor shown in Figure 9;

Figure 12 is a longitudinal vertical sectional view of a resistor forming a further embodiment of my invention;

Figure 13 is a longitudinal vertical sectional view of the resistor shown in Figure 12, taken on a line closer to the points where the terminals project from the sides thereof;

Figure 14 is a side elevational view of the resistor shown in Figure 12, and

Figure 15 is a lateral vertical sectional view of the resistor shown in Figure 12.

Similar reference characters refer to similar parts throughout the several views of the drawings.

To facilitate a better understanding of several of the features of this invention, some of the deficiencies of resistor construction eliminated by this invention will be described. It is most important to seal the resistor device per se, as well as the contacting portions of the terminals, from weather conditions under which the resistor unit must operate. If such a seal is not provided, rapid deterioration of the parts results, and outside humidity conditions may make for serious variations in the resistance value of the unit during operation. Phenolic condensation products are admirably suited for use as such a sealing medium to encase the resistance device and protect it against the above-mentioned outside conditions. However, such products have a low critical temperature and thus the resistance device cannot develop an undue amount of heat during operation without seriously damaging the resistor unit. Furthermore, for economical reasons, it is often desirable to provide as a resistance device, a fiber core having resistance wire wound thereon. Fibers used for this purpose also have low critical temperatures and thus are unable to withstand appreciable temperatures. Accordingly resistor units having a covering of phenolic condensation product or a core of such

fibrous material, or both, cannot be operated at high temperatures. The greater the amount of current passing through a resistor, the greater the temperature generated thereby, and it naturally follows that units of this general character have, as a rule, a low current carrying capacity and thus their field of use is limited. One of the objects of this invention is to provide a resistor in which the several difficulties mentioned above are remedied in a practical manner.

Referring first to Figure 1, there is shown a flat elongated strip 10 which may be formed from any suitable fibrous material having good electrical insulating characteristics. For purposes of economy of structure, an inexpensive fibrous material is generally used, and such material has, as a rule, a low critical temperature.

The expression "critical temperature," as used hereinbefore or hereinafter, signifies the temperature at which a given material will commence to deteriorate as by partial or complete disintegration or decomposition.

A resistance wire 11 is wound about strip 10 in any suitable manner, this extending from end to end thereof. Wire 11 may have any desired resistance value according to the purpose for which the resistor unit is designed, and the turns thereof may be close together or substantially spaced apart, this also depending upon the resistance value desired in the completed unit. Usually an uninsulated wire is used for this purpose and accordingly the individual turns of wire 11 are maintained in spaced relationship. Strip 10 is desirably just soft enough to allow the individual turns of wire 11 to become slightly embedded therein so that they will not slip out of their spaced position after the winding operation.

Any suitable number of terminals generally indicated at 12 are connected to strip 10 to contact wire 11 at the desired points along the strip. Terminals 12 may be of any desired construction, but are preferably formed from sheet metal which is a good electrical conductor, and have projections 13 (Figure 1) extending away from the strip; projections 13 are preferably provided with apertures 14 so that they may be suitably connected to conductors.

As best shown in Figure 4, terminals 12 comprise a bottom portion 15 extending over a portion of the bottom of strip 10, a section 16 thereof being bent back upon portion 15. Section 16 extends about the strip, terminating in an outer longitudinal edge 17. Thus section 16 of the terminal is clamped upon strip 10 and makes a firm contact with the turns of wire 11 resting therebeneath.

An insulating block generally indicated at 18 is preferably molded about strip 10 and the connecting portions of terminals 12, as better shown in Figures 2, 3, and 4. Block 18 preferably encases strip 10 in its entirety, thus protecting wire 11 as well as the contacting portions of terminals 12 from outside weather conditions. Various resin compounds, such as phenolic condensation product, act as excellent seals against such weather conditions and have desired electrical insulating qualities; block 18 therefore preferably comprises such material. Phenolic condensation product may be molded about strip 10 when in a molten condition so that it seeps between the individual turns of wire 11 and into close engagement with strip 10. Thus block 18 further prevents any movement of the turns of wire 11 along the strip after assembly regardless

of the knocks or jolts which the unit may receive in use.

Although block 18 may take any convenient shape, it is preferably provided with a flat bottom 19 and a longitudinal channel 20 formed in the top thereof. Thus channel 20 has longitudinal walls 20a and 20b and a bottom 20c. Preferably a longitudinal shelf-like portion 21 is provided in the side of block 18 adjacent the projecting portions 13 of terminals 12 (Figure 4). Thus a portion 13a of projections 13 rests upon shelf-like portion 21 of the block, the projections preferably extending therefrom at right angles, although it will be understood that the projections may be bent in any direction according to the position which the completed unit occupies in use. If, however, projections 13 are bent downwardly, as viewed in Figure 5, shelf-like portion 21 of the block reinforces portion 13a of the terminals, helping to maintain it in a substantially horizontal position so that the block will not be broken down or cracked at this point; such cracking might form a leak through the block into the interior of the unit.

As best shown in Figures 3 and 4, a metallic heat distributor generally indicated at 22 is embedded in block 18. Distributor 22 is preferably formed from a metal having high heat conducting characteristics and is generally U-shaped in cross-section (Figure 4) having its top and bottom portions 23 and 24 in alignment with the opposite flat surfaces of strip 10 and in close proximity thereto. The vertical or closed portion 25 of distributor 22 is adjacent the side of strip 10 opposite projections 13 so that portions 13a of the projections extend through the open side of the distributor, as more clearly shown in Figure 4. A fibrous insulating strip 26 (Figures 3 and 4) is wrapped about strip 10 over wire 11 and terminals 12 and thus prohibits passage of current from the terminals and wire to the distributor. When the resistor unit is in operation, wire 11 being a resistance wire, generates heat, and a large portion of this heat is transferred to the distributor because of its close proximity to the strip 10.

A metallic strip generally indicated at 27 (Figures 3, 4 and 5) has a longitudinal portion 28 fitting within channel 20 (Figure 4). Strip 27 preferably has upturned edges 29 and 30 engaging walls 20a and 20b of the channel. As more clearly shown in Figures 3 and 4, the opposite end portions of strip 27 are bent downwardly to form vertical portions 31 and 32 (Figure 3) in substantial engagement with the opposite ends of block 18. The end portions of the strip are thence bent outwardly to form substantially horizontal fastening portions 33 and 34. Strip 27 is preferably attached to block 18 by projections 35 and 36 extending into notches 37 and 38 formed in the bottom of block 18. Thus strip 27 extends over a substantial portion of the top of block 18, as well as the opposite ends thereof, and is firmly secured thereto. End portions 33 and 34 of the strip preferably are provided with suitable apertures 39 and 40 (Figure 3) through which suitable rivets 41 and 42 or the like may extend to hold the unit in its operating position. Preferably the unit is thus connected by way of rivets 41 and 42 to a metal plate 43 or the like, the metal thereof having high heat conducting characteristics.

In operation, with current passing through wire 11, the natural tendency of the wire would be to develop various hot points along strip 10. However, a large portion of the heat thus generated

is immediately transferred to distributor 22 and, due to its high heat conductivity, the distributor remains at a substantially uniform temperature along its length. Accordingly it might be said that during operation, distributor 22 operates to continually draw heat away from potential hot points along the strip and distributes heat evenly throughout a substantial portion of the length of the unit.

Without distributor 22, the capacity of the resistor unit would be determined by the temperature of the hot points developed along the strip; the current carrying capacity of the unit would thus be limited to the amount of current which could be passed therethrough without raising any point on the strip above the critical temperatures of strip 10 or block 18. With distributor 22 and no local peak temperatures at any point along the length of the unit, the greater portion of the length of the unit may be raised to a point just below the above-mentioned critical temperatures. In other words, the wire 11 may generate a much larger total quantity of heat, and as the quantity of such heat is proportional to the amount of current passing through the unit, it follows that the current carrying capacity of the unit is materially increased.

Heat from wire 11 and distributor 22 finds its way to the outer surface of the unit and thus strip 27 also serves in the same capacity as distributor 22 but to a lesser extent. Strip 27 has a more important function, i. e., cooling the unit or conducting heat away from block 18. Thus the heat along block 18 is rapidly conducted by strip 27 to the horizontal portions 33 and 34 (Figure 3) thereof where it is dissipated. As pointed out above, portions 33 and 34 of the strip are preferably connected to a metal plate 43 and therefore metal plate 43 supplements the heat conducting action of strip 27 to further cool the resistor unit when in operation. Thus the resistor unit, when in operation, is being continually cooled and a substantially even temperature is being maintained therealong, both factors cooperating to substantially increase the current carrying capacity of the unit.

In Figure 6 there is shown another embodiment of my invention in which the resistance device per se is preferably substantially similar to that shown in Figure 1. Thus a fibrous strip 44 has wound thereabout resistance wire 45, and terminals generally indicated at 46 are connected thereto. Terminals 46 may be similar in construction to terminals 12 (Figure 4) having a connecting portion 47 embracing and clamped against wire 45 (Figure 7) and strip 44.

The resistance device comprising the strip, wire, and terminals applied thereto, is encased in a block of phenolic condensation product 48 or the like substantially similar in shape and construction to block 18 as will be seen from a comparison of Figures 4 and 5 with Figures 7 and 8.

Embedded in block 48 is a flat metallic strip 49 preferably formed from metal having high heat conducting characteristics. Strip 49, as best seen in Figures 6 and 7, is in alignment with and substantially parallel to fibrous strip 44 although it is separated from wire 45 and the connecting portions 47 of terminals 46 (Figure 7) by Bakelite so that it is amply insulated from the current carrying parts of the unit. As more clearly shown in Figure 6, strip 49 extends throughout the length of block 48 having horizontal portions 49a and 49b extending from the

opposite ends of the block substantially parallel with the base thereof.

Another strip 50 is embedded in block 48, this strip also having high heat conducting characteristics, and occupies a position immediately above fibrous strip 44 (Figures 6 and 7). Strip 50 is also spaced from wire 45 and the contacting portions 47 of the terminals, there being a section of block 48 therebetween. The opposite ends 50a and 50b of strip 50 are bent downwardly (Figure 6) and thence terminate in horizontal portions 50c and 50d immediately above and parallel to portions 49a and 49b respectively of strip 49.

A metal strip 51, having high heat conducting characteristics, is embedded in the top of block 48 (Figures 6 and 7) and has depending vertical portions 51a and 51b engaging portions 50a and 50b of the strip 50. Strip 51 is preferably connected to strip 50 by suitable rivets or the like 52 and 53 extending through the respective end portions of the parts. The entire assembly, as shown in Figures 6 and 8, is preferably secured to a metal plate 54 by rivets 55 and 56 or the like passing through portions 50c and 49a and 50d and 49b respectively.

In operation, strips 49 and 50 act as heat distributors in a manner substantially similar to the operation of distributor 22 (Figure 3). However, strips 49 and 50 also act as coolers for the interior of block 48 as the heat is continually conducted away from the block and along horizontal portions 49a, 49b, 50c and 50d (Figure 6). When these portions are connected to a metallic plate, such as plate 54, an appreciable amount of heat is extracted from the interior of block 48. The cooling action of strips 49 and 50 is supplemented by a substantially similar action of strip 51 which, as described above, has its portions 51a and 51b connected to strip 50. Accordingly an even temperature is maintained along the length of block 48, and block 48 is also continuously cooled when the unit is in operation, thus assuring a substantial increase in the current carrying capacity of the unit as described more fully hereinabove.

Another embodiment of my invention is shown in Figure 9, wherein a metal strip 57 is wrapped or otherwise encased in a fibrous insulating sheet 58 (Figure 10). Resistance wire 59 is wound about strip 57, over sheet 58, and a plurality of terminals generally indicated at 60 are connected to the strip at various spaced points therealong. Terminals 60 may take any suitable construction but are preferably similar to terminals 12 (Figure 4), thus having projections 61 and connecting portions 62. Strip 57, with the wire and terminals assembled thereon, is embedded in a block 63 of insulating material, preferably a phenolic condensation product as is true of block 18 (Figure 4) and block 48 (Figure 7).

Block 63 may take any convenient shape, although it is preferably rectangular in cross-section as shown in Figure 10. A metallic sheathing generally indicated at 64 extends about four longitudinal sides of block 63 (Figure 10) so that the majority of the surface area of block 63 is covered with metal, only the ends 63a and 63b of the block (Figure 9) being exposed. As best shown in Figures 10 and 11, sheathing 64 has apertures 78 formed along one side thereof through which projections 61 of the terminals extend. Thus terminals 60 are insulated from the sheathing. Sheathing 64 includes on its bottom side a pair of longitudinal bracket-like portions 65 and 66

which are preferably joined in any suitable manner, for example, rivets 67. Thus the unit may be supported in its operative position by bracket portions 65 and 66 and these parts are preferably connected to a metal plate 68. When connected to a metal plate, such as plate 68, the cooling capacity of sheathing 64 is increased, thus raising the current capacity of the unit as described above.

When operating, strip 57, which is desirably formed from a metal such as copper having high heat conducting characteristics, acts as a heat distributor in substantially the same manner as distributor 22 (Figure 4). Thus the heat along wire 59 is substantially uniform, avoiding hot points, and increasing the capacity of the unit as described above with reference to the preferred embodiment of my invention. At the same time, sheathing 64, also formed from metal having high heat conducting characteristics, is partially acting as a heat distributor although its more important function is to cool the block 63. Sheathing 64 continually conducts heat away from the block, dissipating a portion thereof in the air and conducting another portion thereof to metal plate 68 by way of bracket portions 65 and 66 (Figure 10). Accordingly, in operation, the temperature of the resistance device is maintained substantially uniform throughout its length, eliminating hot points, and the entire block 63 is being continuously cooled, thus resulting in a resistor unit having a high current carrying capacity, as more fully described above.

Turning now to Figure 12, there is shown a further embodiment of my invention which includes a fibrous strip 69 having resistance wire 70 wound thereon, and terminals generally indicated at 71 applied thereto. Strip 69, wire 70, and terminals 71 are substantially similar in construction to the corresponding parts shown in Figure 1. However, it will be understood that in every instance the resistance value of wire 70 may be varied according to the conditions under which the completed unit is to operate.

Strip 69, with the wire and terminals applied thereto, is embedded in an insulating block 72 preferably formed from phenolic condensation product as described above with reference to block 18 (Figure 4). Thus block 72 completely encases strip 69, wire 70, and connecting portions 73 (Figure 15) of terminals 71. As best shown in Figure 15, terminals 71 have horizontal portions 74 extending outwardly from the connecting portions and terminating in projections 75.

A metal sheathing 76 (Figures 12 and 15) having high heat conducting characteristics is embedded in block 72 and is preferably rectangular in cross-section (Figure 15). The sides of sheathing 76 are suitably spaced from wire 70 and connecting portions 73 of the terminals, this space being filled with material from which block 72 is formed so that sheathing 76 is electrically insulated from the current carrying parts of the unit. Preferably horizontal portions 74 of terminals 71 extend through suitable apertures 77 (Figures 13 and 15) formed in one side of sheathing 76. In operation, sheathing 76 distributes the heat generated by wire 70 evenly throughout the length of block 72 in the manner more fully described with reference to distributor 22 (Figure 4) thus making for a resistor unit having high current carrying capacity.

It will thus be seen that I have provided a practical and efficient resistor unit in which the

several objects hereinabove referred to are successfully accomplished.

As many possible embodiments may be made of the above invention and as many changes might be made in the embodiment above set forth, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In a resistor, in combination, a flat elongated strip of insulating material having a low critical temperature, a resistance conductor extending along said strip, a plurality of terminals connected to said conductor and extending away from said strip, an elongated part U-shaped in cross-section and formed from metal having high heat conducting characteristics, said strip being disposed between the longitudinal sides of said part and spaced therefrom so that said terminals project from the open side of said part, and a mass of phenolic condensation product molded about said strip, said part, and the connecting portions of said terminals.

2. In a resistor, in combination, a flat elongated strip of insulating material having a low critical temperature, a resistance conductor extending along said strip, a plurality of terminals connected to said conductor and extending away from said strip, an elongated part U-shaped in cross-section and formed from metal having high heat conducting characteristics, said strip being disposed between the longitudinal sides of said part and spaced therefrom so that said terminals project from the open side of said part, a mass of phenolic condensation product molded about said strip, said part, and the connecting portions of said terminals, and a metallic strip extending along the top of said mass in substantial alignment with said first-mentioned strip.

3. In a resistor, in combination, a flat elongated strip of insulating material having a low critical temperature, a resistance conductor extending along said strip, a plurality of terminals connected to said conductor and extending away from said strip, an elongated part U-shaped in cross-section and formed from metal having high heat conducting characteristics, said strip being disposed between the longitudinal sides of said part so that said terminals project from the open side of said part, insulating material disposed between said sides of said part and said strip, and a mass of phenolic condensation product molded about said strip, said part, and the connecting portions of said terminals.

4. In a resistor, in combination, an elongated resistance device, a plurality of terminals connected to said device and extending therefrom, a mass of insulating material having a low critical temperature encasing said device and the connecting portions of said terminals, a pair of strips extending through said mass in substantial alignment with said device and adjacent the opposite sides thereof, the ends of said strips projecting from said mass, said strips being formed from material having high heat conducting characteristics, and a metallic strip extending along the top of said mass and having its opposite end portions connected to one of said first-mentioned strips.

5. In a resistor, in combination, a flat elongated fibrous strip having a low critical temperature, a resistance wire wound about said strip substantially throughout the length thereof, a plurality of terminals contacting said wire at

spaced points and extending away from said strip, a block of phenolic condensation product encasing said strip and the contacting portions of said terminals, and a pair of elongated members  
5 formed from metal having high heat conducting characteristics extending through said block substantially adjacent the opposite sides of said strip but spaced from said wire, the ends of said members protruding from the ends of said block.

10 6. In a resistor, in combination, a flat elongated fibrous strip having a low critical tempera-

ture, a resistance wire wound about said strip substantially throughout the length thereof, a block of phenolic condensation product encasing said strip, and a pair of elongated members  
5 formed from metal having high heat conducting characteristics extending through said block substantially adjacent the opposite sides of said strip but spaced from said wire, the ends of said members protruding from the ends of said block.

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