June 18, 1957 N. PRITIKIN ET AL 2,796,504

ELECTRICAL RESISTOR AND METHOD OF MAKING RESISTORS EN MASSE

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Fig. 1.

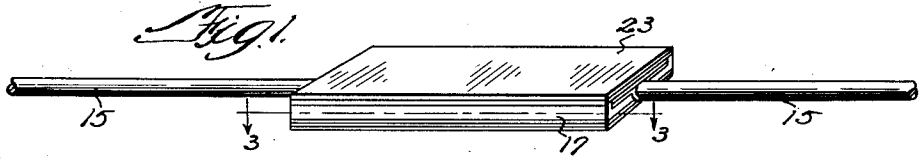


Fig. 2.

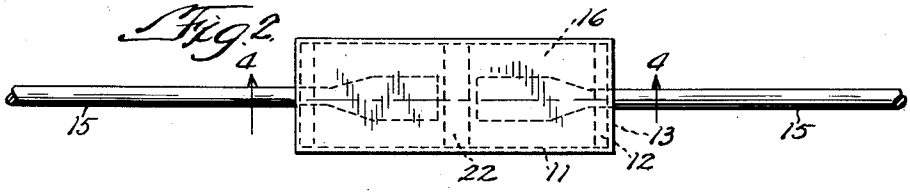


Fig. 3.

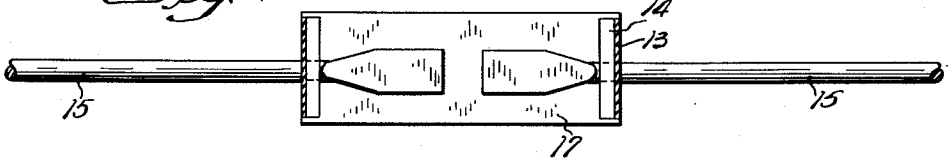


Fig. 4.

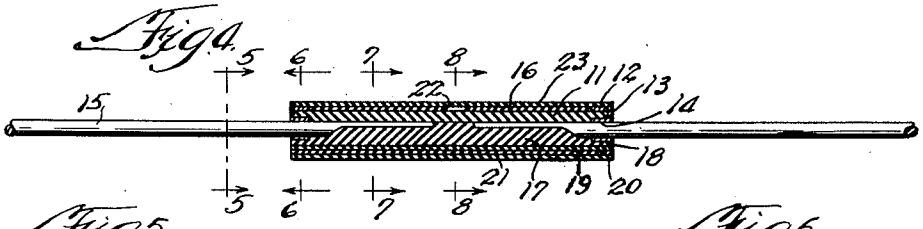


Fig. 5.

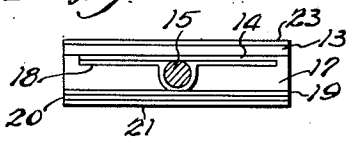


Fig. 6.

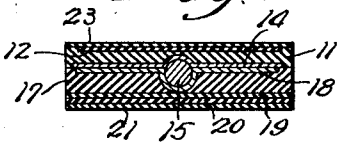


Fig. 7.

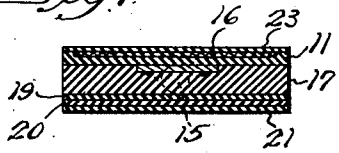


Fig. 8.

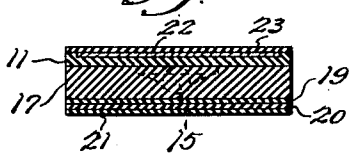
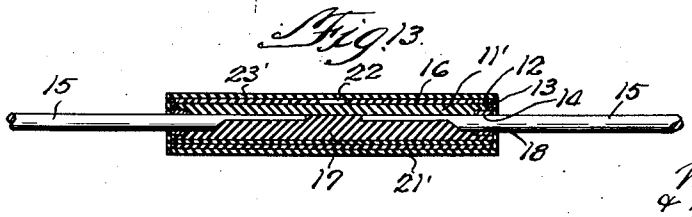


Fig. 13.



INVENTORS.
Nathan Pritikin
& Harold Weinstein.
By: Thiess, Olsen & Mecklenburger.
Attys.

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ELECTRICAL RESISTOR AND METHOD OF MAKING RESISTORS EN MASSE

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Fig. 9.

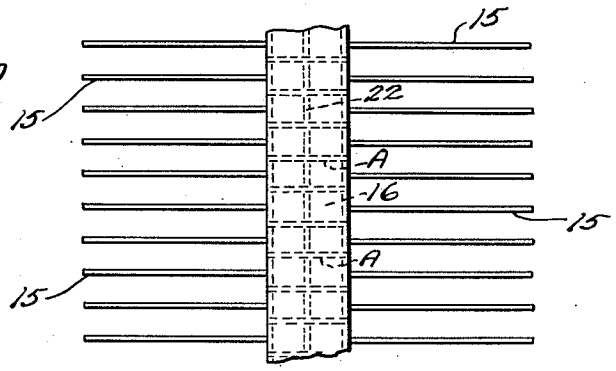


Fig. 10.

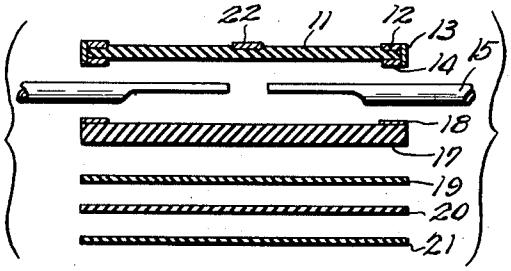


Fig. 11.

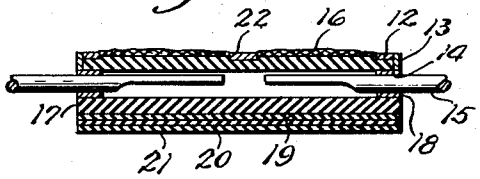
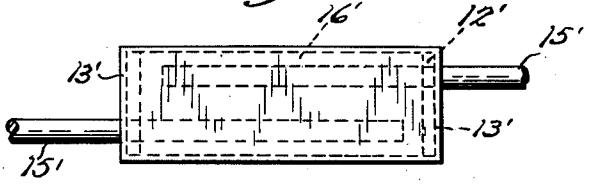


Fig. 12.



INVENTORS.
Nathan Pritikin
& Harold Weinstein.
By: Thiess, Olka & Mecklenburger.
Attys.

June 18, 1957 N. PRITIKIN ET AL 2,796,504

ELECTRICAL RESISTOR AND METHOD OF MAKING RESISTORS EN MASSE

Filed May 9, 1951 3 Sheets-Sheet 3

Fig. 14.

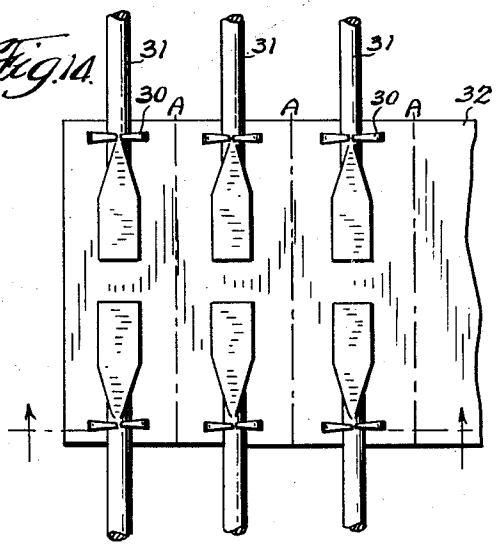


Fig. 18.

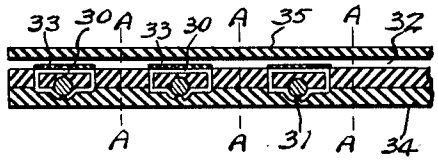


Fig. 19.

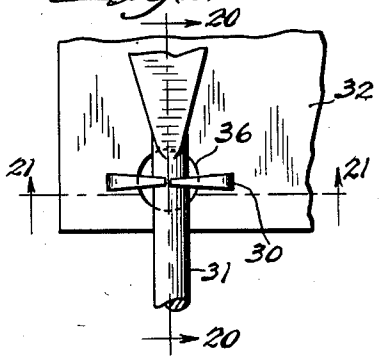


Fig. 15.



Fig. 16.

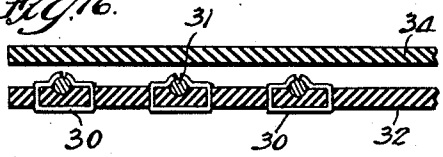


Fig. 17.

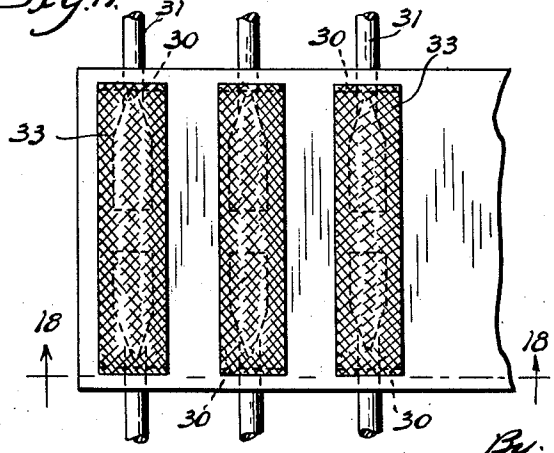


Fig. 20.

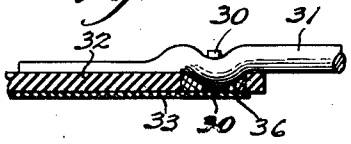
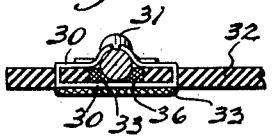


Fig. 21.



INVENTORS
Nathan Pritikin
& Harold Weinstein.
By: Thiess, Olson & Mecklenburger
Attys.

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2,796,504

ELECTRICAL RESISTOR AND METHOD OF MAKING RESISTORS EN MASSE

Nathan Pritikin and Harold Weinstein, Chicago, Ill.; said Weinstein assignor to said Pritikin

Application May 9, 1951, Serial No. 225,382

19 Claims. (Cl. 201—64)

This invention relates to an electrical resistor and to a method of producing electrical resistors en masse. It is an object of the invention to provide an improved resistor and an improved method of that character.

At the present time, resistors are generally produced by mass production methods but most if not all operations are performed seriatim on individual resistors or partially formed resistors. It is another object of the invention to provide an improved method of producing electrical resistors wherein a plurality of resistors are manufactured in a single body, each resistor being complete with leads when severed from the others.

Resistors constructed in accordance with the prior art are commonly uninsulated, and where resistors have been insulated, the insulation has conventionally been applied to the resistors individually. Also, resistors constructed in accordance with the prior art have dissipated their heat either directly to the atmosphere or along a substantial length of the resistance material to the resistor leads.

It is an object of the present invention to provide an improved resistor which is completely or partially insulated. It is another object of the invention to provide an improved method by which such resistors may be produced en masse.

It is another object of the invention to provide an improved resistor in which the resistor leads are arranged closely adjacent at least the major portion of the resistance element whereby heat generated in the resistance element may be readily dissipated along the resistor lead. It is another object of the invention to provide an improved method for producing such resistors en masse.

This invention, together with further objects and advantages thereof, will best be understood by reference to the following description taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

In the drawings in which like parts are designated by like reference numerals,

Fig. 1 is a perspective view of a resistor constructed in accordance with one embodiment of the invention;

Fig. 2 is a plan view of the same resistor;

Fig. 3 is a cross-sectional plan view of the same resistor taken along the line 3—3 of Fig. 1;

Fig. 4 is a cross-sectional view of the same resistor taken along the line 4—4 of Fig. 2;

Fig. 5 is an end view of the same resistor;

Fig. 6 is a cross-sectional view of the resistor taken along the line 6—6 of Fig. 4;

Fig. 7 is a cross-sectional view of the same resistor taken along the line 7—7 of Fig. 4;

Fig. 8 is a cross-sectional view of the same resistor taken along the line 8—8 of Fig. 4;

Fig. 9 is a plan view of a plurality of resistors produced en masse, each resistor being the same as that disclosed in the preceding figures;

Fig. 10 is an exploded view of certain elements of the same resistor;

Fig. 11 is a cross-sectional view of the same resistor elements shown in Fig. 10, assembled for heat and pressure treatment;

Fig. 12 is a plan view of a resistor illustrating a variation of the embodiment of the invention shown in Figs. 1–11;

Fig. 13 is a longitudinal cross-sectional view of a resistor illustrating another variation of the embodiment of the invention shown in Figs. 1–11;

Fig. 14 is a partial plan view of a bank of resistors partially assembled, illustrating another embodiment of the invention;

Fig. 15 is a cross-sectional view taken along the line 15—15 of Fig. 14;

Fig. 16 is a cross-sectional view similar to Fig. 15 but showing the resistor bank in a later stage of assembly;

Fig. 17 is a partial bottom plan view of the same bank of resistors in a still later stage of assembly;

Fig. 18 is a cross-sectional view of the same bank of resistors taken along the line 18—18 of Fig. 17 and illustrating its condition immediately prior to the last assembly operation;

Fig. 19 is an enlarged detail view of a variation of the embodiment of the invention shown in Figs. 14–18;

Fig. 20 is a cross-sectional view taken along the line 20—20 of Fig. 19; and

Fig. 21 is a cross-sectional view taken along the line 21—21 of Fig. 19.

The method which constitutes one feature of the invention is particularly adapted to the manufacture of a large number of resistors en masse. In the embodiments of this method disclosed in Figs. 1–13, an elongated strip of insulating material 11 is painted along its edges with a metallic or another conducting paint which, after drying or hardening, provides electrically conducting strips 12, 13 and 14 along both longitudinal edges of the sheet 11. These conducting strips serve to conduct current between the resistor leads 15 and a resistance film 16 which is subsequently applied to one surface of the sheet 11. In the drawings the thickness of the strips 12, 13 and 14, and others to be described subsequently, are greatly exaggerated in the interest of clarity.

Preferably, the insulating sheet 11 is of cured thermosetting plastic in order that it may aid in maintaining the desired shape and contour of the ultimate resistor or resistors during various steps in the manufacture of the same. The conducting paint which forms the strips 12, 13 and 14 comprises metallic or other conducting particles in a thermosetting carrier. The strips 12 are preferably applied first, one along each longitudinal edge of the sheet, after which the sheet 11, along with the strips 12, is subjected to heat to cause thermal setting of these strips.

Subsequent to the setting of the conducting strips 12, the conducting strips 13 and 14 are applied and permitted to dry in their uncured state. At the same time an uncured sheet of thermosetting plastic 17 is painted along its longitudinal edges with the same form of conducting paint to form conducting strips 18, which are also permitted to dry in their uncured state.

The resistor leads 15 are swaged or flattened over a substantial length at the resistor engaging ends thereof so that they form flat blades, as best seen in Figs. 3 and 4. The elements so far described are assembled with the leads 15 lying against the lower surface of the sheet 11 and contacting the conducting strips 14. The sheet 17 is then placed against the leads 15 with the conducting strips 18 contacting the leads. Additional sheets 19 and 20 of uncured thermosetting plastic and a final sheet 21 of a cured thermosetting plastic are next applied, all as best seen in Figs. 10 and 11. The entire assembly is

then subjected to heat and pressure to cure or set the plastic members and to bond all the elements firmly together as a unit.

If the sheets **11** and **21** are precured, as suggested above, an adhesive is preferably employed to assure a firm bond between these and adjoining sheets. The adhesive is, of course, so applied as not to interfere with the desired electrical contact between such elements as the leads **15** and the conducting strips **12** and **14**.

During the last-mentioned curing step, the sheet **17** flows around the leads **15** to assume a shape, in the region of the leads **15**, similar to that illustrated in Fig. 4. The conducting strips **18** also flow around the leads **15** and assume the shape illustrated in Figs. 5 and 6. The sheet **11** retains its original flat shape since it was cured prior to the assembly of the various elements of the resistor. Similarly the bottom sheet **21** having been cured prior to the final assembly serves to retain the desired contour of the lower surface of the resistor.

The conducting strips **14**, which, as noted above, are not cured prior to the final assembly, tend to flow over the upper surfaces of the leads **15**, while the conducting strips **18**, following the flow of the sheet **17**, flow around the respective leads **15** and join the corresponding conducting strips **14** adjacent the leads to form single conducting elements which surround the leads **15** and make secure mechanical bond and electrical connection therewith.

At each end of the resistor the single electrical conducting means formed by the conducting strips **14** and **18** is also bonded mechanically and electrically with the conducting strip **13** and hence with the conducting strip **12**. Accordingly, the various conducting strips **12**, **13**, **14** and **18**, and the resistor lead **15** are all electrically connected, while all of the elements so far described are mechanically bonded together in a strong and permanent unitary structure.

A film or strip of resistance material such as granular carbon mixed with a suitable carrier is applied to the upper surface of the insulating sheet **11** and permitted to dry or harden. The film is arranged to make electrical contact with the conducting strip **12** at each end of the resistor. It will now be apparent that a conducting path is provided between the two resistor leads **15—15**. This path may be traced from one resistor lead to the two conducting strips **14** and **18**, through the strips **13** and **12**, across the resistance film **16** to the other end of the resistor and through the conducting strips **12**, **13**, **14** and **18** to the other resistor lead. The resistance of the film **16** may, of course, be made of any desired value by controlling the length, width, thickness and nature of the film.

In accordance with one embodiment of the invention another conducting strip **22** is arranged near the center of the resistor. Where this strip is employed, it is preferably applied to the insulating sheet **11** at the same time as the conducting strips **12** and is cured at the same time as the latter strips. The resistance film **16** makes electrical contact with the conducting strip **22** as it does with the conducting strips **12**. The resistance film may or may not overlie the conducting strip **22**, even as it may overlie the strips **12**, but the effective length of the resistance film is the combined distance from the inner edges of the strips **12** to the adjacent or facing edges of the center strip **22**. Stated otherwise the conducting strip **22** short-circuits the centralmost portion of the resistance film even though the latter may be a continuous film extending over the top of the strip **22**.

With the arrangement of elements thus far described the great majority of the heat generated by the current passing through the resistance film **16** is dissipated through the conductors **15** rather than being transmitted directly to the surrounding atmosphere. The thermal conductance between the resistance film and the resistor leads is increased several fold by the flattening or swaging of the ends of the leads since this greatly increases the area of each lead. By extending these leads substantially to the center of the resistor, the flattened surfaces thereof are made to lie closely adjacent all portions of the resistance film except that portion which may lie at the center of the resistor. If compensation for this irregularity were not provided, it is apparent that the centralmost portion of the resistor would be the hottest and would thereby be the limiting factor in the power-rating of the resistor. It is for this reason that the conducting strip **22** is preferably employed, this strip overlying the gap between the ends of the resistor leads **15** and substantially eliminating the generation of heat in that area. The power-rating of the resistor is then determined by the temperature rise of the main body of the resistance film rather than being limited by one local hot spot.

Over the top of the resistance film **16** and the conducting strips **12** and **22**, there is preferably applied a layer of insulating material **23** to protect these elements against damage and to insure that they will be electrically insulated from any electrical conductor which they may contact when in use, particularly when they are used in the crowded chassis of a radio or television set. This sheet of insulating material may be of thermosetting plastic material and, optionally, may be applied, along with the resistance film **16**, prior to the final curing operation of the lower portion of the resistor unit.

Another embodiment of the invention is shown in Fig. 12 in which the leads **15'** are arranged out of alignment with each other. Each of the leads in this arrangement may extend substantially the entire length of the resistor. The need of the conducting strip **22** in the first described embodiment is eliminated since there is no longitudinal gap between the leads. This arrangement also provides a substantially uniform lateral disposition of the heat conducting means, namely the resistor leads. Other than in the arrangement of the leads, the resistor shown in Fig. 12 may be identical to that shown in the other figures.

As indicated above the resistor and its method of manufacture are particularly adapted to the construction of a large number of resistors en masse. The various sheets of insulating material **11**, **17**, **19**, **20**, **21** and **23** may be elongated, with pairs of leads **15** for the individual resistors arranged to extend laterally thereof, all as clearly seen in Fig. 9. It is preferable that the various noninsulative elements, including the resistance film **16**, be interrupted between the various individual resistors. In Fig. 9, it will be noted, for example, that the resistance film **16** is not a continuous strip but is in the form of rectangles which are individual to the various resistors. Similarly, the conducting strip **22** can be seen in Fig. 9 as being interrupted, each segment of the strip being substantially coextensive with the rectangles of resistance material **16** in a direction lateral to the individual resistors. Still further, the conducting strips **12**, **13**, **14** and **18** all are interrupted between the individual resistors.

The resistance film and the various conductors can readily be so arranged by any one of several well-known processes. Perhaps the most practical of these is the common practice known as screening, similar to stenciling. In this process, a screen is arranged over the insulating sheet **11**, for example, when it is desired to apply the conducting strips **12** and **22** to the upper surface thereof. By properly selecting the openings in the screen through which the conducting material for the strips **12** and **22** is applied to the surface of the insulating sheet **11**, and by properly aligning the screen, it is possible to control accurately the width, length, and position of the individual conducting strips. A similar process and screens may be employed to control the size and position of the resistance films **16** and the conducting strips **13**, **14** and **18**.

Since each of the noninsulative elements referred to above is interrupted between individual resistors in the assembly shown in Fig. 9, when the individual resistors

are ultimately separated as by cutting with a very fine saw through the channels indicated by the letter A in Fig. 9, none of these noninsulative elements will extend to the edges of the resistor. In this manner four surfaces of the completed individual resistors will be insulated, namely the top and bottom surfaces and the two longitudinal edges. This represents a substantial improvement over the conventional resistor since it eliminates the possibility of a short-circuit which might otherwise result if the resistor were to come into contact with another conductor in a crowded electrical device such as a radio or television receiver.

The two ends of the resistors so far described are not insulated since the surface of the conducting strip **13** is exposed at each end of the resistor. In many applications, it is not to great interest that these surfaces of the resistors be insulated since they are relatively small and in any event lie closely adjacent the resistor leads **15** which are normally uninsulated and hence must be spaced clear of any other conducting elements of a different potential. However, in Fig. 13 there is shown a variation of the resistors so far described which is insulated on all surfaces. In this construction, the insulating sheets **21'** and **23'** are wider than the remainder of the sheets making up the body of the resistor and both are of uncured plastic. The resistor is otherwise the same as that shown in the preceding figures. During the final thermal setting of the resistor assembly the ends of these sheets lap over the ends of the resistor body as shown in Fig. 13 and insulate the ends of the resistors. By this method, resistors are obtained which are insulated on all six surfaces.

In accordance with another variation of the resistors so far described, the various conducting strips **12, 13, 14** and **18** at the ends of the resistor may be eliminated and the resistance film **16** arranged to extend down over the edges of the sheet **11** to make electrical contact with the leads **15**. This is, of course, a simpler construction but has the disadvantage that local hot spots may be produced in the resistance film adjacent the leads **15**, where the current may be concentrated. Furthermore, the total resistance value of the resistor is less easily predetermined or controlled than in the resistors previously described wherein there is employed a resistance film of accurately controlled length and cross-section. This variation, in which the various conducting strips at the ends of the resistors are eliminated, may be desirable, however, where low cost is the predominating requirement. In this same variation, it is possible, of course, to insulate the ends of the resistor as well as the longitudinally extending surfaces by the means disclosed in Fig. 13 and described above.

In accordance with still another variation, not illustrated in the drawings, a second resistance film may be applied to the lower surface of the insulating sheet **17**, the ends of this resistance film being connected to the conducting strip **18** and hence to the two resistor leads **15** by conducting strips corresponding to the strips **12** and **13**. In such a resistor, it would be preferable, but not necessary, that both of the insulating sheets **11** and **17** be uncured until after the final assembly. This same construction could also be employed where the resistance films are brought over the edges of the sheets **11** and **17** thereby eliminating the necessity of the various conducting strips at the ends of the resistors. Similarly the ends of such resistors might be insulated in the manner disclosed in Fig. 13.

In any of the variations of the resistors so far described, any or all of the thermosetting portions of the resistors may be left uncured until the final assembly. A somewhat better bond may thereby be obtained between the various elements of the resistors. More specifically, where all of the insulating sheets are cured or thermally set after the final assembly, there is no need for the use of an adhesive and accordingly, the final resistor construction is less vulnerable to severe conditions of humidity and temperature changes. The curing of the insulating sheets **11** and **21** prior to the final assembly, as suggested above, has certain compensating advantages previously explained.

The embodiment of the invention and variations thereof shown in Figs. 14 to 21 are characterized by the use of staples **30** for temporarily holding resistor leads **31** to a sheet of uncured thermosetting plastic **32** and for conducting current from the leads **31** to a resistance film **33**. It will be noted in Fig. 14 that the leads **31** are arranged in pairs extending transversely of the elongated sheet **32**, similar to the arrangement shown in Fig. 9. With the leads **31** properly positioned with respect to the sheet **32**, the staples **30** are driven through the sheet adjacent the edges thereof to secure the leads **31** thereto. A second sheet **34** of uncured thermosetting plastic is then applied to the surface of the sheet **32** to which the leads **31** are secured, as shown in Fig. 16.

The assembly shown in Fig. 16 is next subjected to heat and pressure whereby the sheets are cured and firmly bonded together. During this operation the crowns of the staples **30** are forced into the sheet **32** and become flush with lower surface thereof.

The resistance films **33** are then applied to the surface of the sheet **32** opposite the leads **31**, and are arranged to extend between and to contact corresponding pairs of staples **30**. Each staple then may conduct current from one lead **31** through the sheet **32** to one end of a resistance film **33**. With this arrangement the leads may extend for substantially the entire length of the resistance film while being electrically insulated therefrom except at the ends thereof. The leads thereby serve as thermal conductors for carrying heat from the resistance film. If desired, a conducting strip similar to the strip **22**, employed in the previously described embodiment, may be used to eliminate the possibility of a local hot spot at the center of the resistance film.

Finally, a third sheet **35** of uncured thermosetting plastic is applied to that surface of the sheet **32** upon which the resistance films are laid, as may be seen in Fig. 18. The entire assembly is then subjected to heat and pressure to cure the sheet **35** and to bond it to the sheet **32**, an adhesive preferably being employed to improve such bonding. Alternatively, the three sheets **32, 34** and **35** may all be cured in the final curing operation.

As in the case of the embodiment previously described, the conducting elements of the resistors, and the resistance films **33** are interrupted longitudinally in the mass assembly. Accordingly, the assembly may be cut, as by a fine saw, along the lines designated A to separate the resistors, and each will be completely insulated along its longitudinal edges since none of the conducting elements extends to the lines A. The top and bottom surfaces are, of course, entirely insulated by the uninterrupted sheets **34** and **35**. The ends of the individual resistors are also completely insulated since no electrically conducting elements extend to the edges of the sheets other than the resistor leads **31**.

The staples **30** may be driven through the center sheet **32** in either direction. That is, either the legs or the crowns of the staples may be arranged to contact the lead **31**. It is believed to be preferable that the ends of the staples engage the leads, as shown in the drawings, since this leaves the uninterrupted head portion of each staple to carry current to the end of a resistance film **33** throughout the width thereof. It will be noted that the staples employed in this embodiment of the invention serve the same function as the conducting strips **12, 13, 14** and **18** of the embodiment disclosed in Figs. 1 to 12. Specifically, they conduct electricity from the resistor leads on one side of an insulating sheet to the resistance element on the other side of that sheet. This permits the ends of the leads to extend substantially to the center of the resistor in close proximity to the actual resistor element in order that they may serve as thermal conductors.

In Figs. 19, 20 and 21, there is disclosed a variation of

the embodiment of the invention employing staples. In those figures there is shown an opening **36** through the sheet **32** at the point of intersection of each lead **31** and the corresponding staple 30. When the staple is applied a substantial pressure is employed which bends the lead **31** or the staple 30, or both, to such an extent that the crown of the staple engages the lead **31** through the opening **36** as is illustrated in Figs. 20 and 21. This provides a more secure electrical connection between the resistor lead and the corresponding staple, and at the same time provides a firmer mechanical bond between the various elements of the completed resistor. The opening **36** is shown in the drawings as having a diameter larger than the diameter of the lead 31. This, however, is not necessary especially where the sheet 32 is thin relative to the diameter of the resistor leads.

The processes described have the particular advantage that a plurality of resistors may be produced en masse and subsequently separated, each resistor so produced being completely insulated if desired. Each operation performed in the construction of one resistor is readily applied simultaneously to the construction of many additional resistors. For example, the resistance material **16** or **33** and the various conducting strips or staples each may be applied simultaneously throughout the entire length of the plurality of resistors shown in Figs. 9 and 14, or may be applied in a single continuous operation effective over the length of the resistor assembly. Similarly the various insulating sheets employed may each be applied as a single sheet for an entire group of resistors. This economy of operation may extend right on through the construction of the resistors from beginning to end, including the color coding and testing of the resistors. A single stroke of a color coding wheel or brush may be employed to color code the entire assembly of a plurality of resistors shown in Figs. 9 and 18.

The method described and the product shown and described are such that no operations are required on the individual resistors after they have been separated from each other. After separation, the resistors are complete and insulated.

Still further, the method is well adapted to the production of resistors which are parallelepipeds in form. This is believed to be the most desirable form for a resistor in most applications, particularly where there are space limitations.

Individual resistors constructed in accordance with the preferred embodiment of the invention are believed to be superior to prior resistors on several counts. The two leads of each resistor, in combination, extend over substantially the entire length of the resistance material and in close proximity thereto, whereby they are in a position to dissipate heat rapidly from substantially all portions of the resistance material. The swaging of the end portions of the leads increases the surface thereof and hence increases the ability to assimilate heat given off by the resistance material. The use of the conducting strip 22 opposite the gap formed between the ends of the leads 15 prevents the generation of heat at this one spot which is farther removed from the heat removing means, namely the leads **15**, than any other portion of the resistance material. This eliminates a hot spot which might otherwise be the limiting factor in the power-rating of the resistor. The swaging of the end portion of the leads also strengthens the bond between the leads **15** and the body of the resistor.

The use of the conducting strips 12, 13, 14 and 18 or the staples 30 at each end of the resistor brings the current from the relatively small leads 15 to a broad line of contact with the resistance material 16, this line extending over substantially the entire width of the resistor. The current is thereby evenly distributed over the width of the resistance element whereby hot spots are eliminated which might otherwise develop at points of current concentration.

At least two embodiments of the invention and numerous variations thereof have been disclosed in the drawings and described above and it will be apparent that the various features of the invention thus disclosed may be employed in numerous other embodiments. For example, instead of employing a flat sheet **11** or **32** (see Figs. 4 and 14) a molded sheet may be employed which provides recesses for receiving the leads or the resistance material, or both. The principal features of the invention have been specifically set out above and while particular embodiments of the invention have been shown, it will be understood, of course, that the invention is not limited thereto since many modifications may be made, and it is, therefore, contemplated to cover by the appended claims any such modifications as fall within the true spirit and scope of the invention.

The invention having thus been described, what is claimed and desired to be secured by Letters Patent is:

1. The method of making electrical resistors which comprises connecting a plurality of pairs of opposed and aligned electrical conductors to one side of a sheet of insulating material by means of electrically conducting staples extending through said sheet, securing a plurality of resistance elements to the other side of said sheet in spaced-apart position with each element making electrical contact with two of said staples associated with a pair of said aligned electrical conductors, and severing said sheet between said resistance elements.

2. The method of making electrical resistors which comprises forming a plurality of holes through an elongated sheet of insulating material adjacent the longitudinal edges thereof, securing a plurality of pairs of opposed and substantially aligned electrical conductors to one side of said sheet by means of electrically conducting staples with said conductors and said staples intersecting over said holes, securing a plurality of resistance elements to the other side of said sheet in spaced-apart position with each element making electrical contact with two of said staples associated with a pair of said opposed electrical conductors, and severing said sheet between adjacent resistance elements.

3. A resistor comprising a resistor element, and a pair of conductors electrically connected respectively to opposed edges of said element, said conductors having portions extending outwardly of said element to form leads, said conductors also having heat conducting portions extending inwardly of said edges closely adjacent but insulated from said element, said heat conducting portions extending, in combination, over the major portion of the distance between said edges.

4. A resistor comprising a resistor element, and a pair of conductors electrically connected respectively to opposed edges of said element, said conductors having portions extending outwardly of said element to form leads, said conductors also having heat conducting portions extending inwardly of said edges closely adjacent but insulated from said element, said heat conducting portions extending, in combination, over the major portion of the distance between said edges, at least part of said heat conducting portions being flattened.

5. The method of making electrical resistors which comprises securing a resistance film to a preformed sheet of insulating material, securing a second preformed sheet of insulating material face-to-face to said first-mentioned sheet with end portions of a pair of leads disposed therebetween, said leads being arranged to electrically contact opposite ends of said resistance film, and to extend in combination over the major portion of the distance between said opposite ends of said resistance film.

6. The combination comprising, a sheet of insulating material, a plurality of independent resistance films adhering to one surface of said sheet, a second sheet of insulating material adhering face-to-face to said first-mentioned sheet, and a plurality of pairs of leads having end portions secured between said sheets, each pair of said leads being electrically connected respectively to op-

posite ends of one of said resistance films, and the end portions of said pair of leads secured between said sheets extending in combination over the major portion of the distance between said opposite ends of said one resistance film.

7. A resistor comprising a pair of insulated sheets secured in face-to-face relationship, a pair of leads having one end portion each secured between said sheets, and a resistance film adhering to at least one principal surface of at least one of said sheets, said leads being electrically connected to spaced points on said resistance film.

8. A resistor comprising a pair of insulated sheets secured in face-to-face relationship, a pair of leads having one end portion each secured between said sheets, and a resistance film and two spaced-apart films of conducting material adhering to at least one principal surface of at least one of said sheets, said resistance film extending between and being electrically connected to said two conducting films, and said leads being electrically connected one each to said conducting films.

9. A resistor comprising a pair of insulated sheets secured in face-to-face relationship, a pair of leads having one deformed end portion each secured between said sheets, and a resistance film and two spaced-apart films of conducting material adhering to at least one principal surface of at least one of said sheets, said resistance film extending between and being electrically connected to said two conducting films, and said leads being electrically connected one each to said conducting films.

10. A resistor comprising a pair of insulated sheets secured in face-to-face relationship, a pair of leads having one end portion each secured between said sheets, and a resistance film and two spaced-apart films of conducting material adhering to at least one principal surface of at least one of said sheets, said films of conducting material being located closely adjacent opposed edges of said one of said sheets, said resistance film extending between and being electrically connected to said two conducting films, and said leads being electrically connected one each to said conducting films.

11. A resistor comprising a pair of insulated sheets, a resistance element adhering to one principal surface of one of said sheets, and a pair of conductors electrically connected respectively to spaced points on said resistor element, said conductors having portions extending outwardly of said sheets to form leads, said conductors also having heat conducting portions extending inwardly between said sheets closely adjacent but insulated from said element, said heat conducting portions extending, in combination, over the major portion of the distance between said spaced points.

12. A resistor comprising a pair of insulated sheets, a resistance element adhering to one principal surface of one of said sheets, and a pair of conductors electrically connected respectively to spaced points on said resistor element, said conductors having portions extending outwardly of said sheets to form leads, said conductors also having heat conducting portions arranged between said sheets closely adjacent but electrically insulated from said element.

13. A resistor comprising a pair of insulated sheets secured in face-to-face relationship, a pair of wire leads having one end portion each secured between said sheets, and a resistance film adhering to at least one principal surface of at least one of said sheets, said leads being electrically connected to spaced points on said resistance film.

14. A resistor comprising a pair of insulated sheets secured in face-to-face relationship, a pair of wire leads having one end portion each secured between said sheets, and a resistance film and two spaced-apart films of conducting material adhering to at least one principal surface of at least one of said sheets, said resistance film extending between and being electrically connected to said two conducting films, and said leads being electrically connected one each to said conducting films.

15. A resistor comprising a pair of insulated sheets secured in face-to-face relationship, a pair of wire leads having one deformed end portion each secured between said sheets, and a resistance film and two spaced-apart films of conducting material adhering to at least one principal surface of at least one of said sheets, said resistance film extending between and being electrically connected to said two conducting films, and said leads being electrically connected one each to said conducting films.

16. A resistor construction comprising a pair of elongated insulated strips secured in face-to-face relationship, a plurality of pairs of leads, each lead having one end portion secured between said strips, each of said pairs of leads extending out from between said strips on opposite elongated sides thereof, and a plurality of resistance films adhering to at least one principal surface of one of said strips, each of said pairs of leads being electrically connected to spaced points on one of said resistance films.

17. A resistor construction comprising a pair of elongated insulated strips secured in face-to-face relationship, a plurality of pairs of wire leads, each lead having one end portion secured between said strips, each of said pairs of leads extending out from between said strips on opposite elongated sides thereof, and a plurality of resistance films adhering to at least one principal surface of one of said strips, each of said pairs of leads being electrically connected to spaced points on one of said resistance films.

18. A resistor comprising the elements of claim 7 in which a mass of insulating material is arranged between said sheets, firmly adhering to said leads and said sheets and filling the space between said sheets resulting from the presence of said leads therebetween.

19. A resistor comprising the elements of claim 7 in which said sheets provide recesses for receiving said end portions of said leads.

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