May 19, 1959 A. W. FRANKLIN 2,886,854

RESISTOR GRID AND METHOD OF MAKING

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Fig. 1.

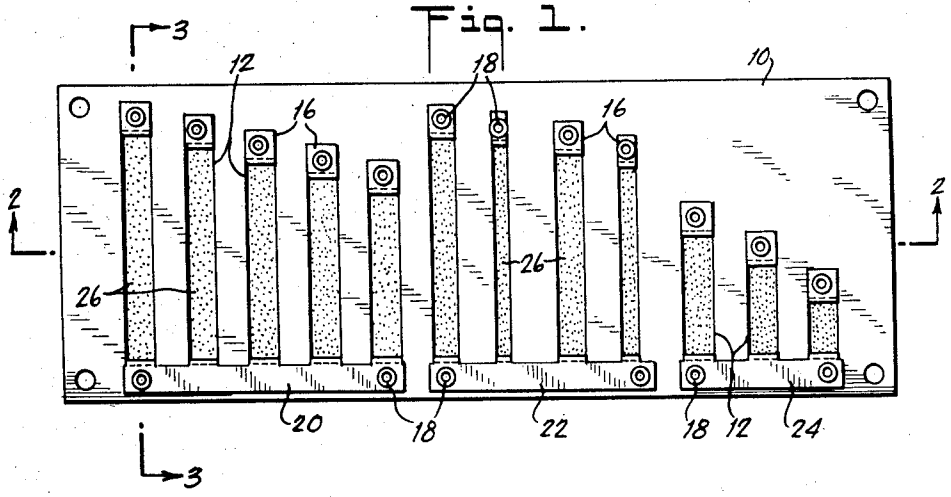


Fig. 2.

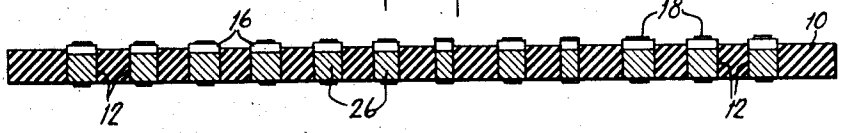


Fig. 3.

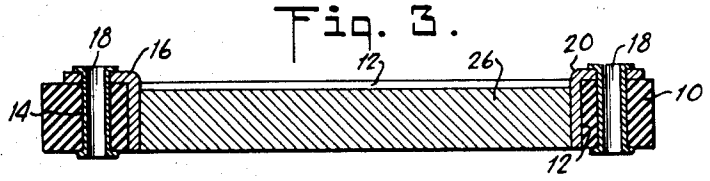


Fig. 4.

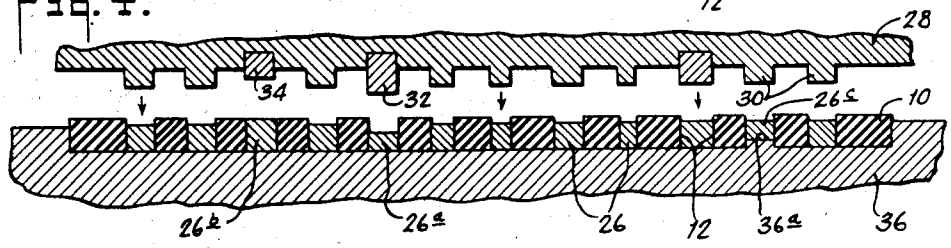
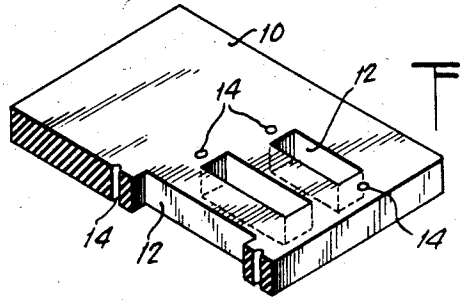


Fig. 5



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RESISTOR GRID AND METHOD OF MAKING

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1 Claim. (Cl. 18—59)

This invention comprises a novel form of resistor or resistor grid and methods by means of which it may be manufactured.

An object of this invention is to produce a resistor assembly comprising one or more separate resistors or groups of resistors for providing in some forms a unitary resistor grid having a substantial part or all of the required individual resistor elements for a complex electrical circuit.

Another object of the invention is to provide novel methods of manufacturing such resistor grids including as refinements procedures for controlling the unit resistivity of the individual resistors within close tolerances and conversely providing means for varying the unit resistivity to provide resistors of different values or resistors of the same value within narrow resistance tolerances.

One object of the invention is to provide novel methods of manufacturing resistors and resistor assemblies employing an insulating support therefor as a mold during the process of forming the resistors, which mold becomes a part of the final product.

Still another object of the invention is to provide resistors made of molded resistance powders and powder mixtures in which the insulating support therefor forms a substantially protective housing for the resistors molded from such powders and powder mixtures.

Still another object of the invention is to provide a novel method of incorporating the conductive contacts or connectors for the resistances.

Still another object of the invention is to form a novel type of resistor or resistor grid consisting of an insulating support and housing, the resistor elements per se, the terminal contacts therefor and the attachments for securing the parts together into a finished unit.

Other and more detailed objects of the invention will be apparent from the following description of the embodiments of the invention illustrated in the attached drawings.

In the drawings,

Figure 1 is a plan view of a resistor grid in accordance with this invention comprising three subdivisions each composed of a plurality of individual resistors of different resistance values;

Figure 2 is a cross-sectional view taken on the line 2—2 of Figure 1;

Figure 3 is a cross-sectional view taken on the line 3—3 of Figure 1;

Figure 4 is a longitudinal, vertical, cross-sectional view through a resistor assembly in the process of fabrication in accordance with this invention, showing the die members by means of which the resistance elements are formed in and secured in the insulating support;

Figure 5 is a perspective view of a portion of the insulating support.

Basically the resistor assembly of this invention consists of an insulating support having a plurality of suitably shaped apertures therethrough or recesses formed therein in which resistance powders or powder mixtures of suitable characteristics are compressed and formed and secured. The apertures or recesses are previously provided with terminal contacts, as will be explained in detail, so that when under pressure the resistance powder or powder mixtures have been finally formed terminal connections therefor will be automatically provided. An important feature of this invention is the use of the insulating support as the primary mold into which the resistance powder or powder mixtures are compressed for final formation and locking therein.

Referring to the drawings, the insulating support illustrated consists of a flat sheet of insulating or block material of the necessary characteristics, and of any required configuration. For example, as illustrated, the insulating support **10** can consist of a rectangular body of insulating material having the necessary electrical and mechanical characteristics for the job at hand, including sufficient form retaining characteristics under the forces of the processing, so as not to be distorted thereby.

Various forms of natural and synthetic materials can be used for this support, of which there are many commercially available. By way of example, the insulating support **10** can be made of "Bakelite," "Masonite," "nylon," fiberboard, and in fact any of the many available modern plastic compositions. The board **10** is provided with one or more apertures or recesses **12** which can be either punched in the support or formed by molding to suitable form and dimensions. It will be understood that the openings **12** can be apertures extending all the way through the support **10**, or they may be channels, closed on one side. Their cross-sectional configuration is not important, but the rectangular form is apparently desirable. It is to be noted that the cross-sectional dimensions of the openings **12** can be uniform or varied and/or their lengths may be varied, all as illustrated in the drawings.

Attached to the support **10** at the end of each of the apertures **12** is a metal contact **16** shown in this case in the form of an L-shaped metal piece dimensioned so that one arm thereof will overlie one end of the associated recess and the other arm will overlie the adjacent face of the support **10**. These terminal contacts **16** are secured in place in any suitable manner, as for example by means of the eyelets **18**. The terminal connectors at the opposite ends of the openings **12** can take many forms comprising, for example, individual terminal pieces similar to the terminal **16** or of the form illustrated at **20**, **22** and **24**. The terminal **20** comprises a metal strip as shown, having a plurality of right angled extensions or arms longitudinally spaced so as to fit accurately in the ends of the apertures **12** and the group interconnected thereby.

As shown in Figure 3, the connector terminal **20** consists of a continuous strip of metal which overlies one face of the support **10** and has a series of spaced fingers which extend into the adjacent ends of the openings **12**. The terminal **20** is secured to the support **10**, as for example by means of eyelets **18**. As illustrated in Figure 1, the complete assembly has three sub-resistor assemblies determined by the size of the terminal connectors **20**, **22** and **24**. Within the openings **12** is formed under pressure a series of individual resistors **26** by filling them with a resistance powder or powder mixture which when compressed will have the required unit resistivity to provide resistors **26** each of the desired individual resistance value. After compression the loose mixture or powder becomes a coalesced form sustaining body which is held in the openings **12** as a result of the

binding pressures produced as the powders are compressed to form the resistance bodies.

There are many forms and types of resistance powders and powder mixtures suitable for this purpose now commercially available and further details with respect thereto are unnecessary. As will be appreciated from examining the drawings, the terminal members are attached to the insulating support after the spaces **12** have been formed in the support and before the insulating powder is filled thereinto.

As suggested above, the support **10** forms the mold for the powders. It is placed in a cavity in a die body **36**, which cavity snugly fits the support to brace it against substantial distortion under the pressures involved. The powders are then filled into the spaces **12** and a die **28**, of any suitable form of power operated ram, is moved down to compress the powders. As will be appreciated the die **28** is provided with active die projections **30** which are sized and positioned so as to enter the openings **12** and form a ram to compress the powders. Since it is an advantage of this method that even with the same powder mixtures various resistance characteristics can be imparted to the resistors **26** by varying the pressure thereon as well as by varying the dimensions of the spaces **12**, it follows that as illustrated at **32** and **34** the male die members can have different lengths. Thus the die member **32** is longer than the die members **30**, so that it will compress the powder in the associated cavity to a greater degree to provide a resistor 26^a of greater compactness and less height than the resistors **26**. Conversely the male die **34** is shorter than the die members **30**, so that it does not compress the powder forming the resistor 26^b as much as in the case of resistors **26**. It will be understood, of course, that this will have marked and measured effects on the unit resistivity of the various resistors.

It follows as a natural development of this thought that some or all of the male die members **30**, for example as in the case of the die members **32** and **34**, may be made adjustable in a vertical direction, Figure 4. This can be accomplished in various ways, as for example in the case of the male die members **32** and **34** the ram or pressure member **28** can be provided with grooves into which the interchangeable male die members may be mounted. To illustrate this, for example, the male die member **32** can be interchanged with the male die member **34**, switching the effects which they produce with respect to the slots containing resistors 26^a and 26^b. It is also possible with this arrangement to use male die members of varying lengths to accommodate openings **12** of different lengths. These and other similar variations are contemplated as being within the scope of this invention.

For example, it is possible, as indicated at 26^a to in some cases form projections on the die body **36**, reducing the depth of the openings 12^a at such points any desired amount so that the resistor 26^c will be of still less vertical height if conditions dictate. The projections 36^a could be interchangeable just as could the male die members.

As a result of these variations it will be seen that the amount of compression, the vertical height, and the spacing of the top and bottom sets of resistors, can be varied over a wide range with resultant changes in mechanical and electrical properties. At this point it is to be noted that as suggested above the openings **12** instead of being apertures all the way through the support, could be closed on one side, and if in cases where the resistors are to be completely enclosed, the spaces at the top and/or bottom faces of the resistors can be filled in flush with the faces of the insulating support **10** to form a moisture and otherwise protected and fully or partially enclosed unit.

It is noted, although now clear, that when the powders are molded into final dimensions the resulting resistors are brought into electrical and mechanical contact at their respective ends with the contact terminals **16**, **20**, **22** and **24**.

It is within the scope of this invention in some forms to premold the resistor powders into resistance units **26**, which may then be inserted in the slots or recesses **12**, as form sustaining units which could be cemented or otherwise secured in place.

It is made amply clear from the above that the subject matter of this invention is capable of considerable variations in details, and I do not, therefore, wish to be strictly limited to the illustrative example herein disclosed, but only as required by the appended claim.

What is claimed is:

A method as disclosed comprising the steps of positioning an insulating support with openings on a fixed platform, filling a quantity of resistance powder in said openings and simultaneously subjecting said powder in said openings to different amounts of pressure to form a coalesced form-sustaining resistor body having different resistance values.

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