United States Patent [19]

Tyler

[11] **3,889,362**

[45] **June 17, 1975**

[54] **METHOD OF MAKING ELECTRICAL RESISTANCE ELEMENT**

[75] Inventor: **Hugh J. Tyler**, Santa Ana, Calif.

[73] Assignee: **Robertshaw Controls Company**, Richmond, Va.

[22] Filed: **Sept. 25, 1974**

[21] Appl. No.: **509,075**

Related U.S. Application Data

[62] Division of Ser. No. 410,539, Oct. 29, 1973, Pat. No. 3,852,570.

[52] **U.S. Cl.** **29/619**; 29/611; 29/612; 29/621; 29/628

[51] **Int. Cl.** **H01c 1/14**; H01c 17/00

[58] **Field of Search** 29/613, 612, 619, 621, 29/628, 610, 611; 219/523, 528, 529, 541, 544, 549; 338/25, 26, 29, 212, 195, 214, 203, 295, 287, 309, 320

[56] **References Cited**

UNITED STATES PATENTS

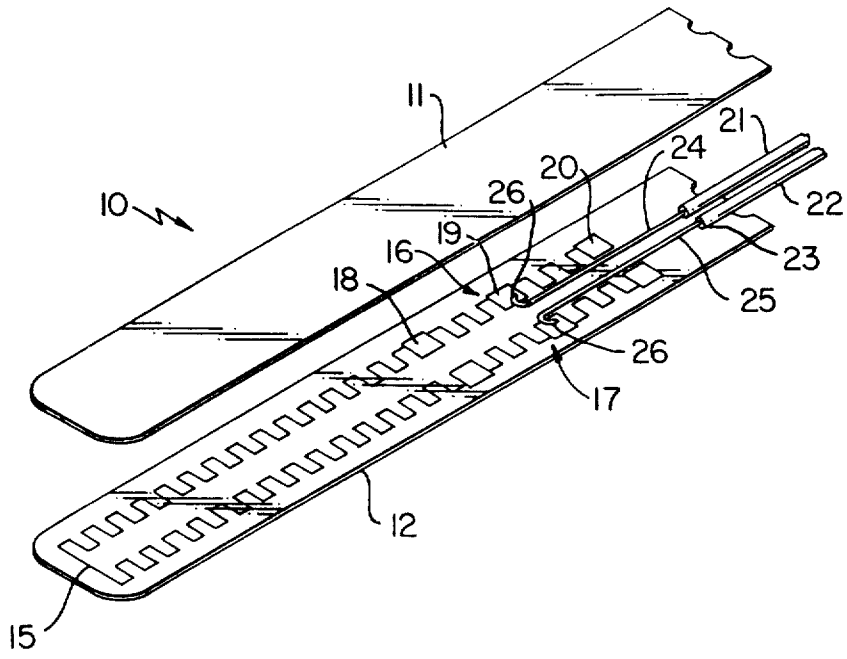
1,384,467	7/1921	Homan	338/212 X
3,537,053	10/1970	Snoberger et al.	338/212 X
3,541,491	11/1970	Worster	338/309 X
3,742,422	6/1973	Rozema et al.	29/612 X
3,745,508	7/1973	Bruder et al.	338/309 X
3,776,040	12/1973	Gould, III	29/612 X
3,781,749	12/1973	Iles et al.	29/612 X

Primary Examiner—C. W. Lanham
Assistant Examiner—Victor A. DiPalma
Attorney, Agent, or Firm—Candor, Candor & Tassone

[57] **ABSTRACT**

A method of making an electrical resistance element is disclosed comprising the steps of providing a conductor having a pair of lead attaching ends, forming each lead attaching end with a plurality of spaced and predetermined lead attaching parts therealong, attaching a pair of leads respectively to one preselected lead attaching part of each end of the conductor so that a desired electrical resistance is provided, and completely covering the conductor and part of the leads with an encasing structure.

10 Claims, 5 Drawing Figures



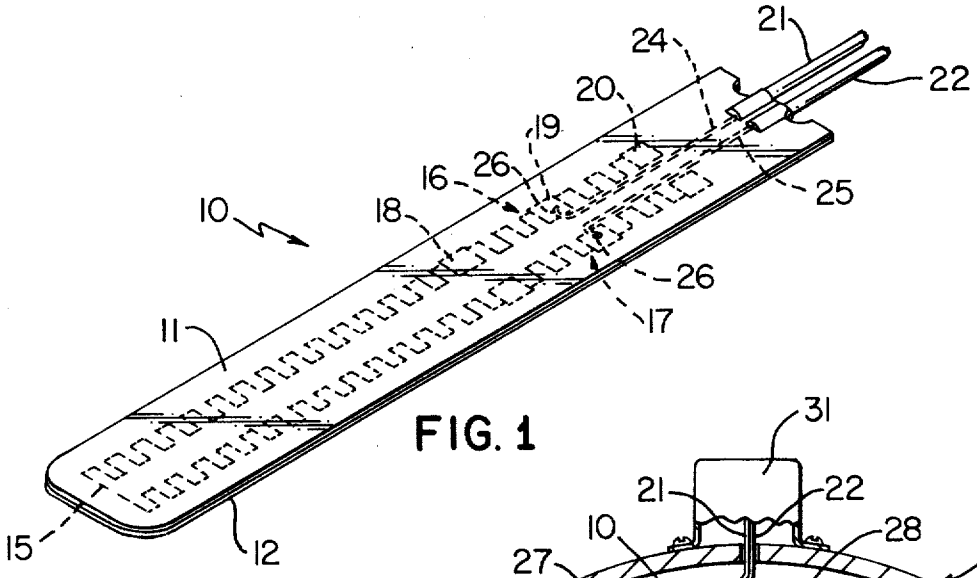


FIG. 1

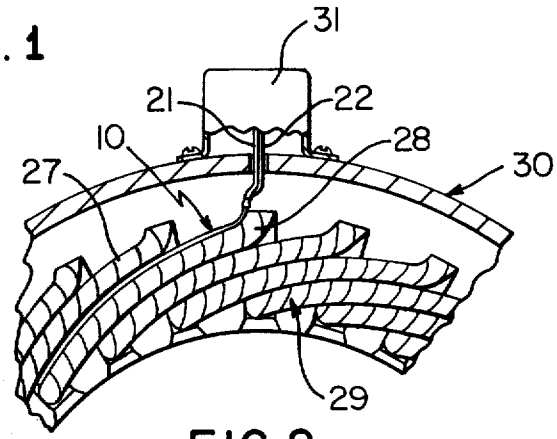


FIG. 2

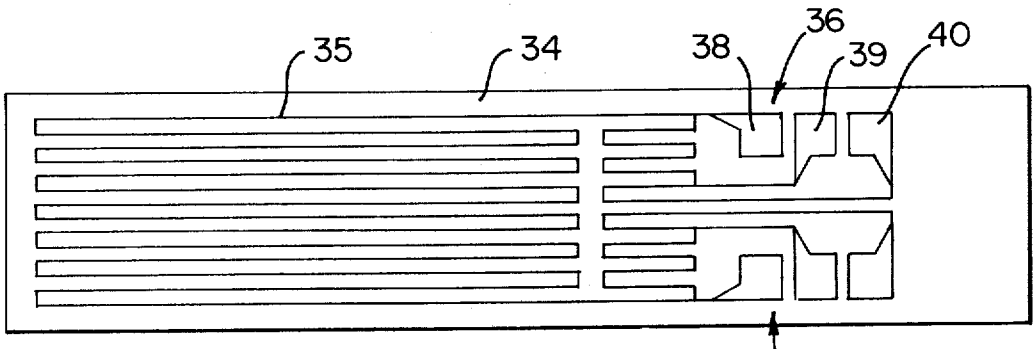


FIG. 5

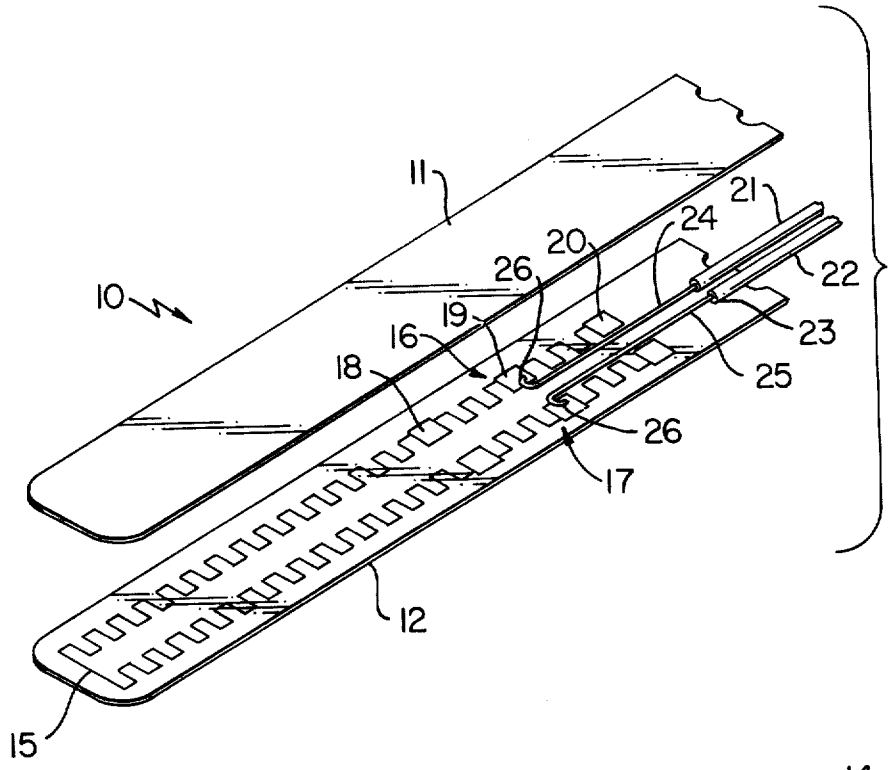


FIG. 3

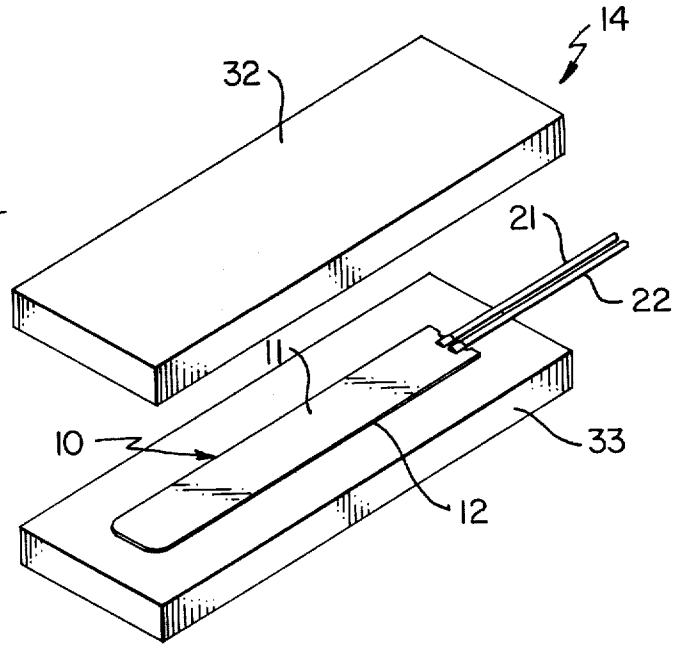


FIG. 4

METHOD OF MAKING ELECTRICAL RESISTANCE ELEMENT

This is a division of application Ser. No. 410,539, filed Oct. 29, 1973, now U.S. Pat. No. 3,852,570.

This invention relates to an improved electrical resistance element and to a method of making the same.

It is well known from the U.S. Pat. No. 3,537,053, to Snoberger et al, that a flexible temperature sensor can be provided for motor protection purposes and be formed by a conductor that is secured between two flexible stip-like members superimposed upon each other with a pair of leads being attached to the respective ends of the conductor so that the conductor will provide a certain electrical resistance between the leads at certain temperatures whereby such flexible temperature sensor can be utilized for motor protection purposes by being inserted in the coil means of an electrical motor to detect the temperature changes therein by having the changes in the electrical resistance of the encased conductor sensed by an appropriate sensor.

However, it has been found according to the teachings of this invention that the precision or accuracy of the above described temperature sensor depends upon the length of the wire between the soldered connections of the leads thereto as well as the uniformity of the conductor throughout its length and that measurement of the actual resistance of such conductor during assembly of the sensor is not feasible.

Accordingly, it is a feature of this invention to provide an improved electrical resistance element of the above type or the like wherein a desired electrical resistance of the conductor can be readily ascertained during the making of such electrical resistance element or the like.

In particular, one embodiment of the electrical resistance element of this invention comprises a conductor having a pair of lead attaching ends each having a plurality of spaced and predetermined lead attaching parts therealong. A pair of leads are respectively electrically attached to one preselected lead attaching part of each end of the conductor so that the desired electrical resistance is provided through the conductor between the attached leads because a testing of the electrical resistance of the conductor between various lead attaching parts thereof can be readily determined before the leads are attached thereto. After the leads have been attached to the preselected lead attaching parts of the lead attaching ends of the conductor, an encasing structure completely covers the conductor and the attaching parts of the leads whereby the remainder of the leads can extend from the encasing structure for control device attaching purposes or the like, the encasing structure comprising a pair of flexible tape-like strips superimposed on each other and securing the conductor and the attaching parts of the leads therebetween.

Accordingly, it is an object of this invention to provide an improved electrical resistance element having one or more of the novel features set forth above or hereinafter shown or described.

Another object of this invention is to provide an improved method of making such an electrical resistance element or the like, the method of this invention having one or more of the novel features set forth above or hereinafter shown or described.

Other objects, uses and advantages of this invention are apparent from a reading of this description, which

proceeds with reference to the accompanying drawings forming a part thereof and wherein:

FIG. 1 is a perspective view illustrating one embodiment of the improved electrical resistance element of this invention.

FIG. 2 is a schematic broken away, cross-sectional view of an electrical motor utilizing the electrical resistance element of FIG. 1 for motor protection purposes.

FIG. 3 is an exploded perspective view illustrating the various parts of the electrical resistance element of FIG. 1.

FIG. 4 is a perspective view illustrating the method of making the electrical resistance element of FIG. 1.

FIG. 5 is a top view of part of another electrical resistance element of this invention.

While the various features of this invention are hereinafter described and illustrated as being particularly adapted to provide a temperature sensor for motor protection purposes or the like, it is to be understood that the various features of this invention may be utilized singly or in any combination thereof to provide an electrical resistance element for other purposes as desired, such as for making an electrical heating element or the like.

Therefore, this invention is not to be limited to only the embodiments illustrated in the drawings, because the drawings are merely utilized to illustrate one of the wide variety of uses of this invention.

Referring now to FIGS. 1 and 3, the improved electrical resistance element of this invention is generally indicated by the reference numeral **10** and comprises a pair of flexible tape-like strips **11** and **12** formed of insulating material hereinafter set forth and being superimposed upon each other to be heat sealed together by an apparatus that is generally indicated by the reference numeral **14** in FIG. 4 and hereinafter described, the tape-like strip **12** having printed, etched or otherwise disposed thereon a conductor **15** formed in a predetermined tortuous path between two lead attaching ends thereof that are generally indicated by the reference numerals **16** and **17** in FIG. 3.

The lead attaching ends **16** and **17** of the conductor **15** are each provided with a plurality of flat rectangular lead attaching parts **18, 19** and **20,** spaced from each other along the respective lead attaching ends **16** and **17** so that the conductor **15** between each pair of adjacent lead attaching parts **18** and **19** or **19** and **20** has a length thereof also disposed in a tortuous path therebetween so that resistance can be added or subtracted to the remainder of the conductor **15** depending upon where leads are attached to the lead attaching ends **16** and **17** thereof as will be apparent hereinafter.

For example, it may be desired to make the electrical resistance element **10** so that the same has a resistance of approximately 75 ohms between the desired lead attaching location thereof when the element **10** is at approximately 75°F.

Thus, before a pair of leads **21** and **22** are attached thereto, the strip **10** with the conductor **15** thereon is maintained at 75°F. and the resistance of the conductor **15** is appropriately measured between the lead attaching parts **18** of the lead attaching ends **16** and **17,** the resistance of the conductor **15** is measured between the lead attaching parts **19** of the lead attaching ends **16** and **17** and the resistance of the conductor **15** is measured between the lead attaching parts **20** of the lead attaching ends **16** and **17** to find out which combina-

tion of lead attaching parts **18, 19** or **20** will provide a resistance closest to the desired 75 ohms. In fact, such testing or measuring could be between the lead attaching parts **18** and **19** of the respective lead attaching ends **16** and **17**, etc., as desired.

Such testing of the resistance of the conductor **15** on the strip **12** can be made at a location remote from the apparatus **14** and the resistance between the various lead attaching parts of the lead attaching ends **16** and **17** could be appropriately marked on the tape-like strip **12** so that subsequently a person can attach the leads **21** and **22** thereto at whichever resistance producing arrangement is desired.

In any event, it can be seen that the conductors **21** and **22** are adapted to have the insulation **23** thereof removed adjacent the ends **24** and **25** thereof with the ends **24** and **25** respectively having outwardly turned parts **26** so that the lead ends **24** and **25** can be disposed between the spaced and parallel lead attaching ends **16** and **17** while the outwardly turned parts **26** thereof will respectively contact the lead attaching parts **18, 19** or **20** as illustrated to be readily soldered or otherwise suitably electrically attached thereto, the lead attaching parts **18, 19** and **20** being substantially large rectangularly shaped conductor sections printed, etched or otherwise disposed on the tape-like member **12** as illustrated to facilitate lead attachment thereto.

After the lead ends **24** and **25** have been attached to the desired lead attaching parts **18, 19** or **20**, or any desired combination of the parts **18, 19** and **20**, of the conductor **15**, which in the embodiment illustrated in the drawings are the lead attaching parts **19** of the lead attaching ends **16** and **17** in the manner illustrated in FIG. **3**, the strip **11** can be superimposed thereon and be heat sealed thereto by the apparatus **14** whereby the conductor **15** and the end parts **24** and **25** of the leads **21** and **22** are completely covered or encased in the flexible strips **11** and **12** in the manner illustrated in FIG. **1** to complete the electrical resistance element of this invention. Thus, it can be seen that the actual resistance of the conductor **15** between the lead attaching parts **26** of the leads **21** and **22** has been accurately provided as the resistance between the lead attaching parts **19** of the lead attaching ends **16** and **17** of the conductor **15** was readily predetermined in the manner previously described so that the electrical resistance element **10** will be most accurate for its intended purpose.

For example, the completed electrical resistance element **10** is adapted to be readily disposed between various coils **27** and **28** of the coil means **29** of an electrical motor means **30** as illustrated in FIG. **2** and be interconnected by the leads **21** and **22** thereof to a control device **31** which will sense the change in the resistance of the conductor **15** as the motor **30** heats up so that should the temperature of the motor **30** exceed a certain limit, the sensor **31** can turn off the motor **30** to avoid an adverse situation whereby it can be seen that the element **10** of this invention can be utilized for motor protection purposes.

For further details of the use of the element **10** for motor protection purposes and the various advantages thereof over other known types of motor protection temperature sensing means, see the aforementioned U.S. Pat. No. 3,537,053, to Snoberger et al, which is incorporated in this application by reference.

As previously stated, the tape-like strips **11** and **12** are formed from non-conductive material and can each comprise a polyimide resulting from the polycondensation reaction between pyromellitic dianhydride and an aromatic diamine sold by the E. I. DuPont de Nemours & Company, Inc., of Wilmington, Delaware, under the trade name of "Kapton." The heat sealing facing surfaces of the strips **12** and **11** can be coated with a copolymer of tetrafluoroethylene and a hexafluoropropylene sold under the trademark of "Fep-Teflon" by E. I. duPont de Nemours & Company, Inc., of Wilmington, Delaware.

In this manner, when the teflon coated sides of the strips **11** and **12** are brought together in the manner illustrated in FIG. **4** and heated by heat sealing elements **32** and **33**, the facing sides of the strips **11** and **12** are completely heat sealed together in the manner fully set forth in the aforementioned U.S. Pat. No. 3,537,053, to Snoberger et al.

While one particular tortuous pattent of the conductor **15** of the element **10** of this invention is provided in FIGS. **1** and **3**, it is to be understood that various other patterns of the conductor **15** can be utilized and another such arrangement is illustrated in FIG. **5** wherein a flexible strip **34** has a conductor **35** printed, etched or otherwise disposed thereon in a tortuous pattern and having lead attaching ends **36** and **37** respectively provided with spaced lead attaching parts **38, 39** and **40** therealong for subsequently having leads attached thereto and be covered by a superimposed strip in the same manner as the strip **12** previously described.

However, it can readily be seen in FIG. **5** that the particular tortuous pattern of the conductor **35** between adjacent lead attaching parts **38** and **39** or **39** and **40** of the respective lead attaching ends **36** and **37** places a greater amount of the trim resistors in what would be considered the sensing area of the strip **34** than might be the case with the areas disposed between the attaching parts of the conductor **15** previously described.

Therefore, it can be seen that this invention not only provides an improved electrical resistance element, but also this invention provides an improved method of making such an electrical resistance element or the like.

While the form and method of this invention now preferred have been illustrated and described as required by the Patent Statute, it is to be understood that other forms and methods can be utilized and still come within the scope of the appended claims.

What is claimed is:

1. A method of making an electrical element comprising the steps of providing a conductor having a pair of lead attaching ends, forming each lead attaching end with a plurality of spaced and predetermined lead attaching parts therealong, attaching a pair of leads respectively to one preselected lead attaching part of each end of said conductor so that a desired electrical resistance is provided through said conductor between said leads, and completely covering said conductor and part of said leads with an encasing structure whereby the remainder of said leads extend from said encasing structure.

2. A method of making an electrical element as set forth in claim **1** and including the step of initially disposing said conductor generally in one plane in said encasing structure.

3. A method of making an electrical element as set forth in claim **2** and including the step of disposing said

conductor in a tortuous pattern between the lead attaching parts that provide the shortest electrical circuit through said conductor between said lead attaching ends thereof.

4. A method of making an electrical element as set forth in claim **3** and including the step of forming each lead attaching end in a tortuous pattern between adjacent lead attaching parts thereof.

5. A method of making an electrical element as set forth in claim **4** and including the step of forming the lead attaching parts of each lead end so that the same are disposed in aligned relation with each other.

6. A method of making an electrical element as set forth in claim **5** and including the step of forming the lead attaching parts of said lead ends so that the same are disposed in two rows disposed parallel and spaced from each other.

7. A method of making an electrical element as set forth in claim **6** and including the steps of disposing said leads between said rows, and securing outwardly turned ends of said leads to the desired lead attaching parts.

8. A method of making an electrical element as set forth in claim **1** and including the step of forming said encasing structure from a pair of flexible tape-like strips superimposed on each other and securing said part of said leads and said conductor therebetween.

9. A method of making an electrical element as set forth in claim **1** wherein said element comprises a temperature sensor.

10. A method of making an electrical element as set forth in claim **1** wherein said element comprises an electrical heating element.

* * * * *