

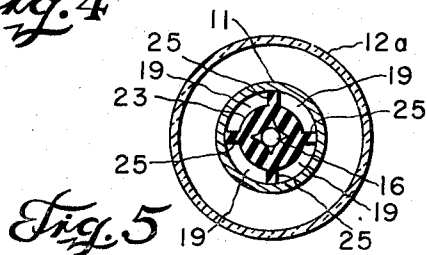
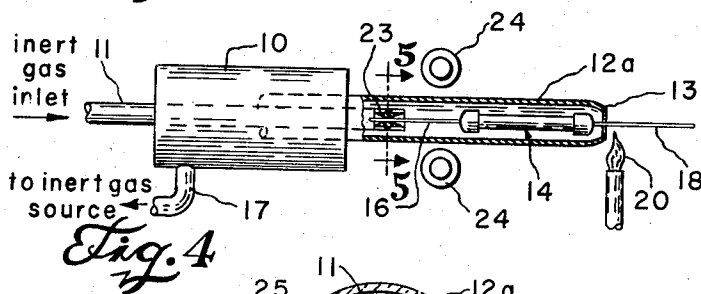
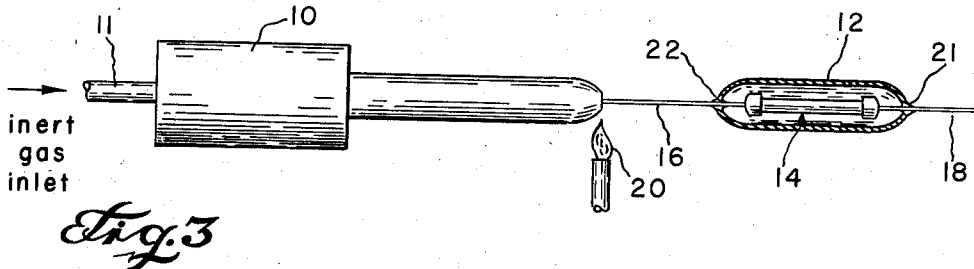
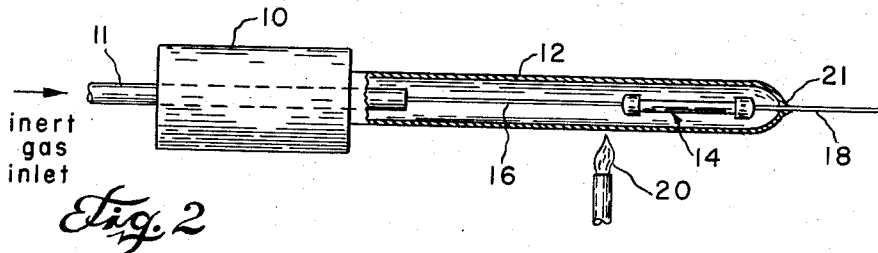
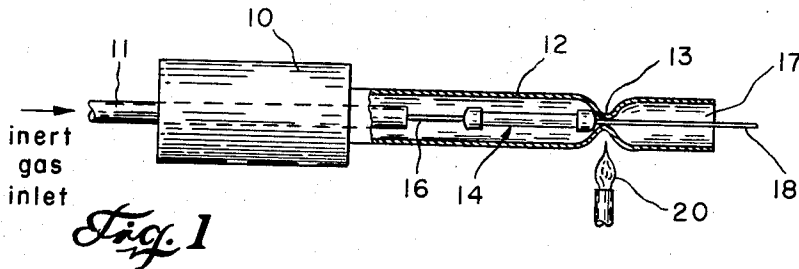
July 7, 1959

J. R. PIES

2,893,182

METHOD OF SEALING RESISTORS

Filed Dec. 20, 1957



INVENTOR
JOHN R. PIES

BY

Samuel M. Mims Jr.

ATTORNEY

1

2,893,182

METHOD OF SEALING RESISTORS

John R. Pies, Dallas, Tex., assignor to Texas Instruments Incorporated, Dallas, Tex., a corporation of Delaware

Application December 20, 1957, Serial No. 704,053

11 Claims. (Cl. 53—22)

This invention relates to a method for producing hermetically sealed resistors and in particular to a method of sealing resistors hermetically in an envelope containing an inert gas.

Heretofore the manner of sealing a resistor in an envelope filled with an inert gas has consisted of first forming and sealing an envelope around the resistor, evacuating the envelope, adding an inert gas, and resealing the envelope. The difficult step in these operations is in evacuating the envelope so as to get all of the air out before inserting the inert gas. Another difficulty with the aforementioned procedure is that it is relatively expensive to mass produce resistors in the described manner.

It has been discovered that by causing a heavy flow of the inert gas through a tube in which the resistor is placed prior to sealing that a superior expulsion of the air is achieved. It has further been discovered that by maintaining a flow of the inert gas and by sealing the tube at the end of the resistor remote from the source of inert gas, a quantity of this gas may be trapped within the tube to provide an improved packaged resistor upon sealing the nearer end.

Accordingly, it is an object of the present invention to provide a simplified method of insuring the complete removal of air from an envelope which encloses a resistor.

Another object of the present invention is to provide a method of producing a resistor hermetically sealed in an inert atmosphere in a manner that lends itself to inexpensive mass production techniques.

A further object of the present invention is to provide a method of producing a resistor hermetically sealed in an inert atmosphere in which a heavy flow of the inert gas is used to displace the air around the resistor before the sealing operation.

Other objects and advantages of the present invention will become readily apparent upon consideration of the following detailed description when taken in conjunction with the drawings in which:

Fig. 1 shows in a diagrammatic form a resistor placed in a glass tube prior to the sealing operation;

Fig. 2 shows the same resistor with one end sealed;

Fig. 3 shows the same resistor sealed at both ends;

Fig. 4 shows in diagrammatic form an alternative embodiment of the present invention for holding a resistor and forming a seal; and

Fig. 5 shows a sectional view taken along 5—5 of Fig. 4.

Referring now to the drawings, Fig. 1 shows a tube holder 10 which holds tubing 12. Extending through holder 10 is an inlet tube 11 for an inert gas such as helium, argon, or nitrogen. This tube extends through the holder 10 and within tubing 12. In the preferred form of the present invention this tubing 12 consists of a drawn tubular blank which has a necked down portion 13 preformed intermediate the two ends. A resistor 14 provided with leads 16 and 18 is inserted into the tubular blank 12 opposite open end 17 so that one end of the resistor 14 abuts the necked down portion 13 and lead 16

2

of the resistor 14 is supported within the inert gas inlet tube 11 on the other end as shown in Fig. 1. In this manner resistor 14 is suitably held in place. Open end 17 provides an exhaust port for the inert gas.

A heavy flow of the inert gas is introduced into tubing 12 through inlet 11 effectively flushing out all of the air within the tube 12. This heavy flow of inert gas is caused by a pressure differential between the source of the inert gas and the atmosphere within the tubing 12 in the order of magnitude of from one-half to one p.s.i.

After flushing out the tubing 12 with the inert gas, the pressure is reduced to the level required to maintain a minimum forward flow of the gas. The reduced pressure required for this is in the order of one-sixteenth to one-half p.s.i. The reduced flow of the gas over resistor 14 permits a seal shown at 21 in Fig. 2 to be made with relative ease. This sealing operation will be described presently.

The tubing 12 is heated by any suitable means such as by burner 20. It is possible, for example, to obtain uniform heating of the periphery of the necked down portion 13 by rotating either the tubular blank 12 or the burner 20. Alternatively, a ring flame may be employed which is of sufficient diameter to pass freely over the tubular blank 12.

After tubing 12 becomes pliable, portion 13 is further necked down by any suitable means. For example, the tubing may be grasped near open end 17 and pulled so as to stretch out and draw in the portion 13 and then attached and sealed at 21 to lead 18 by continued heating by the heater 20. Alternatively, a plurality of rollers may be used to contact the necked down portion 13. The rollers are progressively moved inwardly and they ultimately pinch off the pliable material in the vicinity of necked down portion 13 to sever the tubular portion between necked down portion 13 and open end 17 from the remainder of the tubing 12. When the seal is made at 21, the flow of inert gas is stopped, but the reduced pressure is maintained. It can be seen that the preferred form of tubular blank 12 provides a shield for the lead 18 and the resistor 14 from oxidation by virtue of the portion of the tube blank 12 between necked down portion 13 and the open end 17. Another advantage provided by the portion of the tube blank 12 between necked down portion 13 and open end 17 is that it prevents stray gases from being introduced into the vicinity of the seal 21 either by diffusion or by turbulence.

In Fig. 2 the next step of the complete sealing operation is shown as burner 20 begins to heat the tubing near the other end of the resistor which end is nearer the source of inert gas. Once again, when tubing 12 has become pliable, it is necked down and sealed to a wire lead 16 as shown at 22 of Fig. 3. Similarly, during this operation a constant pressure of the inert gas is maintained against seal 21 so that when seal 22 is made, an inert gas atmosphere is trapped around resistor 14. The encased resistor may now be removed to have its leads 16 and 18 cleaned and dipped in solder or tin.

An alternative method in the formation of seal 22 is to introduce a partial vacuum into the closed portion of tubular blank 12. Fig. 4 shows schematically how this partial vacuum may be obtained. A pipe 17 is shown leading from the holder 10 to the source of inert gas. Suitable pumping means (not shown), which may be positioned either within holder 10 or at the source of the inert gas, is used to withdraw by suction some of the inert gas from within the tubular blank 12a. It will be appreciated in this connection that suitable seals are provided both between the inlet end of pipe 11 into holder 10 and between the holder 10 and tubular blank 12a. Thus, the only inlet to the tubular blank 12a is through pipe 11, and the only exhaust from the tubular

3

blank 12a is through the exhaust pipe 17. This reduced pressure may be maintained at this stage of the operation because seal 21 has already been made and therefore provides an enclosed working area. The use of a vacuum will tend to withdraw some of the inert gas that surrounds resistor 14. However, the vacuum used is not sufficiently high to withdraw all of the inert gas so that the end product obtained from this alternative method will contain a less dense inert atmosphere surrounding the resistor 14 than those atmospheres produced by the previously described method. An advantage of using a partial vacuum in the sealing operation is that the reduced pressure facilitates the necking down in forming the seal 22. In this regard, it is to be noted that the ultimate desired pressure will be a certain amount lower than the pressure at which the sealing operation is performed because of gas expansion during the heat sealing and contraction thereafter upon cooling.

A still further modification is possible in the formation of the second seal 22. In Fig. 4, a different shape for tubular blank designated 12a is shown. In this modification a necked down portion 13 is disclosed at the end of the blank. By virtue of this, the blank itself may be shorter than that previously described and consequently there will be less wastage. However, there is a disadvantage in the use of a blank similar to that of 12a. Since there is a flow of gases under positive pressure through the tubing, there is a tendency for the inert gas to blow the flame from the burner 20 away. This disadvantage will not be present in the preferred form of tubing 12 because the inert gases are prevented from blowing the flame away by the presence of the glass between necked down portion 13 and opening 17.

In Fig. 4, rollers 24 are shown which may be used to engage the periphery of the glass tubing 12a and to mechanically roll the tubing into a necked down position to assist in forming the second seal. This mechanical rolling of the tubing is performed either simultaneously with the heating of the tubing or immediately thereafter. This mechanical working of the tube 12a to provide a necked down portion may be used in conjunction with a partial vacuum within the tube as described previously.

An additional modification shown in Fig. 4 is the disclosure of a friction holder 23 into which is inserted lead 16 of resistor 14. Friction holder 23 is supported within the outlet end of inert gas inlet tube 11 in such a manner as to permit the inert gases to continue to pass over the resistor 14 and to flush out the tubing 12a.

Fig. 5 shows one embodiment in which a friction holder 23 may be supported by legs 25 within the inert gas inlet pipe 11 so as to permit free admittance of the inert gas through passages 19. The lead 16 of the resistor is shown inserted within the central opening of friction holder 23 which holder may be of rubber or other resilient material.

Kovar, Dumet or other wire leads that will fuse to glass is acceptable for the resistor. In selecting the leads, however, it is desirable that the coefficient of thermal expansion of the wire be about equal to that of the tubular blank. This is desired in order to reduce stress and to remove the possibility of cracking the tubular blank because of the wide temperature variation to which the tubing is subjected.

In the preferred form of the present invention, the tubing blank is prepared from a typical glass of the type used for sealing to metal which includes heat resistant glass of the Pyrex type. However, other materials such as quartz glass or plastic materials may also be used.

Though the present invention has been shown and described in specific embodiments, various changes and modifications obvious to one skilled in the art are within the scope, purpose and intent of this invention.

What is claimed is:

1. A method of sealing a resistor in an inert atmos-

4

phere which comprises placing a resistor with a pair of leads attached thereto within a tubular blank, expelling the air within said blank with an inert gas, heating said blank and sealing it to one of said leads on a side remote from the source of said inert gas while continuing the flow of said gas, heating said blank about the other of said leads adjacent said source of said inert gas and sealing said blank to said other lead thereby entrapping an inert gas atmosphere about said resistor.

2. A method of sealing a resistor in an inert atmosphere which comprises placing a resistor with a pair of leads attached thereto within a tubular blank, expelling the air within said blank with a heavy flow of an inert gas, heating said blank and sealing it to one of said leads on a side remote from the source of said inert gas while continuing a decreased flow of said gas, heating said blank about the other of said leads adjacent said source of said inert gas and sealing said blank to said second lead thereby entrapping an inert gas atmosphere about said resistor.

3. A method of sealing a resistor in an inert atmosphere which comprises placing a resistor with a pair of leads attached thereto within a tubular blank that is provided with a necked down portion, supporting said resistor by said necked down portion, expelling the air within said blank with an inert gas, heating said blank and sealing it to one of said leads on an end remote from the source of said inert gas while continuing the flow of said gas, heating said blank about a second lead adjacent said source of said inert gas, and sealing said blank to said second lead thereby trapping an inert atmosphere about said resistor.

4. A method of sealing a resistor in an inert atmosphere which comprises placing a resistor with a pair of leads attached thereto within a tubular blank that is provided with a necked down portion intermediate its ends, expelling the air within said blank with an inert gas, heating said blank, shielding said resistor from a source of heat, sealing said blank to one of said leads on an end remote from the source of said inert gas while continuing the flow of said gas, heating said blank about a second lead adjacent said source of said inert gas, and sealing said blank to said second lead thereby trapping an inert gas atmosphere about said resistor.

5. A method of sealing a resistor in an inert atmosphere which comprises placing a resistor with a pair of leads attached thereto within a tubular blank, expelling the air within said blank with an inert gas, heating said blank and sealing it to one of said leads on an end remote from the source of said inert gas while continuing the flow of said gas, heating said blank about a second lead adjacent said source of said inert gas, drawing a partial vacuum within said blank to facilitate necking down said blank about said second lead, and sealing said blank to said second lead thereby trapping an inert gas atmosphere about said resistor.

6. A method of sealing a resistor in an inert atmosphere which comprises placing a resistor with a pair of leads attached thereto within a tubular blank, expelling the air within said blank with an inert gas, heating said blank and sealing it to one of said leads on an end remote from the source of said inert gas while continuing the flow of said gas, heating said blank about a second lead adjacent said source of said inert gas, mechanically working said blank to neck down said blank about said second lead, and sealing said blank to said second lead thereby trapping an inert gas atmosphere about said resistor.

7. A method of sealing a resistor in an inert atmosphere which comprises placing a resistor with a pair of leads attached thereto within a tubular blank that is provided with a necked down portion intermediate its ends, expelling the air within said blank with an inert gas, flame heating said blank and sealing it to one of said leads on an end remote from the source of said inert gas while continuing the flow of said gas, shielding the flow of inert

5

gas from said flame to prevent said inert gas flow from blowing away said flame, heating said blank about a second lead adjacent said source of said inert gas, and sealing said blank to said second lead thereby trapping an inert gas atmosphere about said resistor.

8. A method of sealing a resistor in an inert atmosphere which comprises placing a resistor with a pair of leads attached thereto within a tubular blank, supporting said resistor by a friction holder supported within said blank, expelling the air within said blank with an inert gas, heating said blank and sealing it to one of said leads on an end remote from the source of said inert gas while continuing the flow of said gas, heating said blank about a second lead adjacent said source of said inert gas and sealing said blank to said second lead thereby trapping an inert gas atmosphere about said resistor.

9. A method of sealing a resistor in an inert atmosphere which comprises placing a resistor with a pair of leads attached thereto within a tubular blank, expelling

6

the air within said blank with an inert gas, and heating said blank and sealing it to each of said leads thereby trapping an inert gas atmosphere about said resistor.

10. A method of sealing a resistor in an inert atmosphere which comprises placing a resistor with a pair of leads attached thereto within a tubular blank, expelling the air within said blank, introducing an inert atmosphere into said blank, and heating said blank and sealing it to each of said leads thereby trapping an inert gas atmosphere about said resistor.

11. A method of sealing a resistor in an inert atmosphere which comprises placing a resistor with a pair of electrical terminations attached thereto within a tubular blank, expelling the air within said blank, introducing an inert atmosphere into said blank, and heating said blank and sealing it to each of said electrical terminations thereby trapping an inert gas atmosphere about said resistor.

No references cited.