

PATENT SPECIFICATION

(11)

1 383 735

1 383 735

- (21) Application No. 10663/73 (22) Filed 28 Feb. 1973 (19)
 (31) Convention Application No. 231 311 (32) Filed 2 March 1972 in
 (33) United States of America (US)
 (44) Complete Specification published 12 Feb. 1975
 (51) INT. CL.² H05K 13/00 B29F 3/10
 (52) Index at acceptance

H1R ICX 3C1

B5A 1G1

H1K 211 358 37X 37Y 385 38Y 412 41Y 424



(54) PROTECTED ELECTRICAL COMPONENTS AND METHODS OF FORMING THEM

(71) We, VARO SEMICONDUCTOR, INC., a Corporation organised under the laws of the state of Texas, United States of America, of 1,000 North Shiloh Road, Garland, Texas 75040, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates generally to the protection of a plurality of series connected electronic components, such as a plurality of series connected diodes of the type used for high voltage rectification in television sets or the like.

Heretofore, high voltage power supplies for television receivers have been relatively expensive in that they utilize high voltage rectifiers, either of the tube type or of the solid state type, which are themselves relatively expensive and which require much apparatus and insulation to prevent arcing between various components in the vicinity. Such high voltage rectifiers are generally connected to the flyback transformer of a television circuit and produce the ultor anode voltage for the picture tube. This may be of the order of 20 to 30 kilovolts. With such high voltage circuits arcing becomes a serious problem, and any elimination or reduction of elements in the vicinity of the circuit will reduce the possibility of arcing of high voltage to other components. Therefore, the sockets or other connecting terminals utilized in the high voltage circuits are also a source of trouble and should, if at all possible be eliminated.

When utilizing vacuum tube rectifiers to produce the high voltage for the picture tube anode it is possible to utilize a single rectifier element, as vacuum tubes generally have a high voltage characteristic. However, when utilizing solid state rectifier units it is often necessary to connect a plurality of solid

state rectifiers in series so that they act as a voltage divider network to distribute evenly the high voltage among the various individual rectifier components. Therefore, a solid state rectifier having a peak inverse voltage capability of 200 to 400 volts can be connected in series with ten other such devices and thereby provide a peak inverse voltage capability of 2,000 to 4,000 volts. Similarly, high voltage rectifiers having a peak inverse voltage of 1,000 to 2,000 volts can be connected in series to produce a total assembly having a peak inverse characteristic capable of withstanding 20,000 to 30,000 volts when ten or more of such units are used.

From one aspect, this invention provides an electronic component assembly comprising: a plurality of axially aligned electronic elements of comparable cross-sectional shapes and each having an elongated body with lead wires extending from the respective ends thereof; interconnecting wires between said elements, each of said interconnecting wires having a cross-sectional shape comparable to that of said elements; connecting joints joining each of said lead wires to the adjacent end of a said interconnecting wire thereby to form said electronic elements into a serially connected chain; and a homogeneous elongated covering of electrical insulating material formed over said electronic elements, said interconnecting wires and said connecting joints, in intimate contact with substantially the entire outer surfaces thereof, said covering having a substantially uniform cross-sectional size throughout its length.

From another aspect, the invention provides a method of encapsulating electronic elements having an elongated body and lead wires extending from the ends thereof comprising the steps of: connecting individual interconnecting wires to said lead wires by using connecting joints to form an elongated

serially connected assembly; passing said assembly through an extruding die which has an entrance portion to receive said assembly, an intermediate encapsulating material receiving portion and an exit portion; applying a quantity of encapsulating material to the interior of said die as said assembly passes therethrough; and extracting said assembly from said exit portion whereby said assembly is covered with a quantity of said encapsulating material in such amounts as to form an outer surface having a substantially uniform cross-sectional shape throughout.

In a preferred embodiment the invention extends to a method of manufacturing a diode rectifier structure having a length of wire connected respectively to the anode and cathode electrodes thereof and wherein adequate encapsulation is provided about the diode structure to provide a moisture barrier having an extremely high electrical dielectric constant so as substantially to minimize the possibility of electric arcing. The diode structure, when encapsulated in accordance with this invention, is mechanically superior at the connecting joints where the interconnecting wires are fastened because of the added strength obtained by the encapsulating material. The rectifier assemblies can be used for high voltage systems ranging in the order of about 20,000 to 30,000 volts.

Assembly of the series connected rectifiers is accomplished by fastening the interconnecting wires to the anode and cathode leads extending from the rectifier. The interconnecting wires have insulation formed thereon which is substantially the same size as the rectifier body. The wire connection formed between the rectifier and the interconnecting lead can be accomplished by any one of several means such as stapling, soldering, or welding. The rectifier and wire assembly can be made on a continuous basis with a relatively long length of such assembly wrapped on a spool for storage until ultimate encapsulation of the assembly is necessary.

The quantity of insulating material that remains on the components is determined by the size of the output member of the extruding die. By maintaining the diode body and size of interconnecting wires substantially the same and of the same configuration, they can be fed through the encapsulating die efficiently and at relatively high speed.

After the series connected components and associated interconnecting wires are encapsulated they can be respooled for storage and subsequent processing or they can be processed into discrete units at that time. The electrical component of this invention can then be assembled into a piece of electronic equipment. For example, if the component is a rectifier, it can be soldered into position by utilization of the interconnecting

wires and thus eliminate the use of a connecting socket.

Means can be used to locate the precise position of the rectifier element within the longitudinal encapsulated assembly. Such means can take the form of, for example, ultrasonic, magnetic, or sensing compressibility when the encapsulating material is a relatively soft rubber or plastics material. Once the actual diode position is located, the adjacent interconnecting wires fastened thereto can be severed and metallic end portions thereof exposed for soldering into a circuit.

The invention may be performed in various ways and a preferred embodiment thereof will now be described by way of illustration only, with reference to the accompanying drawing, in which:—

Fig. 1 is a diagrammatic illustration of a plurality of series connected electronic components to be encapsulated in accordance with the principles of this invention;

Fig. 2 illustrates an encapsulating die used to encapsulate the series connected components of Fig. 1;

Fig. 3 is an enlarged partially sectional view showing the series connected units after encapsulation; and

Fig. 4 is a schematic view showing a plurality of series connected diodes.

Referring now to Fig. 1 there is seen an assembly 10 of a plurality of serially connected electronic components 12, 13 and 14, etc. The electronic components 12, 13 and 14 are of a predetermined size and configuration. Preferably, the configuration is cylindrical but any configuration such as square, triangular or rectangular can be used. In the illustrated embodiment the electronic components 12, 13 and 14 are a plurality of series connected diodes having their anodes electrically connected to the cathode of the next diode and so on to provide a series of low resistance elements in one current direction and a series of high resistance elements in the other current direction.

Each of the electronic components 12, 13 and 14 is separated by an interconnecting wire 16 which is fastened to the lead wires thereof. The fastening is formed by a joint 17 which can be a stapling or crimping device. However, soldering or welding can be utilized also. The diameter of the interconnecting wire 16 is substantially the same as the diameter of the electronic components 12, 13 and 14. Should the electronic components have a square, rectangular or other configuration so also will the interconnecting wire have an outer configuration corresponding to that of the electronic components. After the electronic components are connected in series, as shown in Fig. 1, they can be stored on a spool, not shown, for future use. However, they can be encapsulated in

accordance with this invention immediately after connecting them in series as shown.

Referring now to Fig. 2 the series assembly 10 is fed into an encapsulating apparatus 20 which includes a quantity of encapsulating material 21. The encapsulating material 21 may be stored in any suitable extrusion apparatus providing the necessary temperature and pressure for feeding the material into the interior chamber of an extruding die 22 via a conduit 21a.

The extruding die 22 has an inlet portion 22a into which the electronic components are fed, a central portion 22b into which a quantity of encapsulating material in a somewhat fluid state is supplied, and an outlet 22c from which the encapsulated series connected components are extracted. In this way the series connected components are covered with a homogeneous layer 23 of sufficient electrical dielectric strength so as to prevent moisture or other low dielectric constituents from coming into contact with the diode or electrical leads extending therefrom. When the assembly 10 consists of series connected diodes it can be used as a high voltage rectifier component in a television set, or the like.

Referring now to Fig. 3 an enlarged detailed showing the encapsulated assembly is illustrated. Here the electronic component 13, which is a diode, has the lead wires 13a and 13b thereof extending toward the interconnecting wires 16 and fastened to the uninsulated portions 16a by means of a connector 17. As mentioned above the connector 17 can be of any suitable type.

Fig. 4 illustrates schematically a series of diodes 26 which can be separated in pairs as indicated by the sever line 27. It will be understood that more than two diodes per assembly can be incorporated. To ensure that the diodes are severed at locations between the diodes, i.e. through the interconnecting wire 16, appropriate means such as ultrasonic magnetic or sensing compressibility of the resilient outer layer 23 can be used. The diode units are then prepared at the ends thereof by stripping the encapsulating material and the insulation off the interconnecting wires 16 to expose the metal conductor passing therethrough for connection into the circuit.

What has been described is a simple and efficient means for providing a plurality of series connected electronic components, such as diodes, and encapsulating such components by passing them through an elongated extruding die apparatus. While only a specific embodiment of the invention is disclosed, it will be understood that variations and modifications of this invention can be effected without departing from the scope of the invention claimed herein.

WHAT WE CLAIM IS:—

1. An electronic component assembly comprising: a plurality of axially aligned electronic elements of comparable cross-sectional shapes, and each having an elongated body with lead wires extending from the respective ends thereof; interconnecting wires between said elements, each of said interconnecting wires having a cross-sectional shape comparable to that of said electronic elements; connecting joints joining each of said lead wires to the adjacent end of said interconnecting wire thereby to form said electronic elements into a serially connected chain; and a homogeneous elongated covering of electrical insulating material formed over said electronic elements, said interconnecting wires and said connecting joints in intimate contact with substantially the entire outer surfaces thereof, said covering having a substantially uniform cross-sectional size throughout its length.

2. An electronic component assembly according to Claim 1 wherein said electronic elements are diodes.

3. An electronic component assembly according to claim 1 or claim 2 wherein said elements and said interconnecting wires are of substantially identical cross-section throughout.

4. An electronic component assembly according to claim 3 wherein said electronic elements are cylindrical in shape.

5. An electronic component assembly substantially as herein described with reference to the accompanying drawing.

6. A method of encapsulating electronic elements having an elongated body and lead wires extending from the ends thereof comprising the steps of: connecting individual interconnecting wires to said lead wires by using connecting joints to form an elongated, serially connected assembly; passing said assembly through an extruding die which has an entrance portion to receive said assembly, an intermediate encapsulating material receiving portion and an exit portion; applying a quantity of encapsulating material to the interior of said die as said assembly passes therethrough; and extracting said assembly from said exit portion whereby said assembly is covered with a quantity of said encapsulating material in such amounts as to form an outer surface having a substantially uniform cross-sectional shape throughout.

7. The method of encapsulating electronic components according to claim 6 further including the step of cutting said assembly into a plurality of discrete units, said cutting taking place through said interconnecting wires.

8. The method of encapsulating electronic elements according to claim 6 or claim 7 wherein said components are of substantially identical cross-sectional shape and are



accordance with this invention immediately after connecting them in series as shown.

Referring now to Fig. 2 the series assembly 10 is fed into an encapsulating apparatus 20 which includes a quantity of encapsulating material 21. The encapsulating material 21 may be stored in any suitable extrusion apparatus providing the necessary temperature and pressure for feeding the material into the interior chamber of an extruding die 22 via a conduit 21a.

The extruding die 22 has an inlet portion 22a into which the electronic components are fed, a central portion 22b into which a quantity of encapsulating material in a somewhat fluid state is supplied, and an outlet 22c from which the encapsulated series connected components are extracted. In this way the series connected components are covered with a homogeneous layer 23 of sufficient electrical dielectric strength so as to prevent moisture or other low dielectric constituents from coming into contact with the diode or electrical leads extending therefrom. When the assembly 10 consists of series connected diodes it can be used as a high voltage rectifier component in a television set, or the like.

Referring now to Fig. 3 an enlarged detailed showing the encapsulated assembly is illustrated. Here the electronic component 13, which is a diode, has the lead wires 13a and 13b thereof extending toward the interconnecting wires 16 and fastened to the uninsulated portions 16a by means of a connector 17. As mentioned above the connector 17 can be of any suitable type.

Fig. 4 illustrates schematically a series of diodes 26 which can be separated in pairs as indicated by the sever line 27. It will be understood that more than two diodes per assembly can be incorporated. To ensure that the diodes are severed at locations between the diodes, i.e. through the interconnecting wire 16, appropriate means such as ultrasonic magnetic or sensing compressibility of the resilient outer layer 23 can be used. The diode units are then prepared at the ends thereof by stripping the encapsulating material and the insulation off the interconnecting wires 16 to expose the metal conductor passing therethrough for connection into the circuit.

What has been described is a simple and efficient means for providing a plurality of series connected electronic components, such as diodes, and encapsulating such components by passing them through an elongated extruding die apparatus. While only a specific embodiment of the invention is disclosed, it will be understood that variations and modifications of this invention can be effected without departing from the scope of the invention claimed herein.

WHAT WE CLAIM IS:—

1. An electronic component assembly comprising: a plurality of axially aligned electronic elements of comparable cross-sectional shapes, and each having an elongated body with lead wires extending from the respective ends thereof; interconnecting wires between said elements, each of said interconnecting wires having a cross-sectional shape comparable to that of said electronic elements; connecting joints joining each of said lead wires to the adjacent end of said interconnecting wire thereby to form said electronic elements into a serially connected chain; and a homogeneous elongated covering of electrical insulating material formed over said electronic elements, said interconnecting wires and said connecting joints in intimate contact with substantially the entire outer surfaces thereof, said covering having a substantially uniform cross-sectional size throughout its length.

2. An electronic component assembly according to Claim 1 wherein said electronic elements are diodes.

3. An electronic component assembly according to claim 1 or claim 2 wherein said elements and said interconnecting wires are of substantially identical cross-section throughout.

4. An electronic component assembly according to claim 3 wherein said electronic elements are cylindrical in shape.

5. An electronic component assembly substantially as herein described with reference to the accompanying drawing.

6. A method of encapsulating electronic elements having an elongated body and lead wires extending from the ends thereof comprising the steps of: connecting individual interconnecting wires to said lead wires by using connecting joints to form an elongated, serially connected assembly; passing said assembly through an extruding die which has an entrance portion to receive said assembly, an intermediate encapsulating material receiving portion and an exit portion; applying a quantity of encapsulating material to the interior of said die as said assembly passes therethrough; and extracting said assembly from said exit portion whereby said assembly is covered with a quantity of said encapsulating material in such amounts as to form an outer surface having a substantially uniform cross-sectional shape throughout.

7. The method of encapsulating electronic components according to claim 6 further including the step of cutting said assembly into a plurality of discrete units, said cutting taking place through said interconnecting wires.

8. The method of encapsulating electronic elements according to claim 6 or claim 7 wherein said components are of substantially identical cross-sectional shape and are



4

1,383,735

4

connected together by interconnecting wires having the same cross-sectional shape as said components.

- 5 9. The method of encapsulating electronic elements according to any of claims 6 to 8 wherein said components are cylindrical in configuration.

10. The method of encapsulating elec-

tronic elements substantially as herein described.

10

J. V. WYNNE-JONES,
Chartered Patent Agent,
22, Rodney Road,
Cheltenham.
Agent for the Applicants.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1975
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY
from which copies may be obtained.