

PATENT SPECIFICATION

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(54) SEALING GLASS OBJECTS

(71) We, PHILIPS ELECTRONIC AND ASSOCIATED INDUSTRIES LIMITED, of Abacus House, 33 Gutter Lane, London, E.C.2., a British Company, 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:—

10 The invention relates to a method of sealing one glass object to one another glass object by passing an electric current through them, in which method preheated sealing edges of the glass objects form a
 15 seal joint to which the current is supplied by means of electrodes which are in contact with and stationary in relation to the seal joint, and to a glass article made with the aid of such a method. The invention is
 20 useful, for example, for sealing a face-plate to a tapered envelope portion of a colour television display tube.

Sealing glass objects to one another, in particular sealing a face-plate to a tapered
 25 envelope portion of a cathode-ray tube, is described in United Kingdom patent specification 524,126. The method described requires high electric voltages (of about 10 kv) because the current is supplied via ionized gas jets (burners). This
 30 method is unsuitable for use with cathode-ray tubes in which, before the face-plate is sealed to the tapered portion, electrodes, such as screens, a shadow mask, and a
 35 conducting wall coating are provided in the tube, because owing to the high electric sealing voltages, flash-over to these electrodes is produced.

In order to reduce the sealing voltage
 40 the electrodes may be made to contact the glass of the preheated seal joint and the number of electrodes may be increased. Thus, however, the seal joint cannot satisfactorily be moved in relation to the electrodes in the usual manner.

Sealing a face plate to a tapered envelope portion of a display tube by means of stationary electrodes is described *inter alia* in United Kingdom patent specification 751,196. In the method described a poly-
 50 phase current is used and more uniform heating is achieved by using a plurality of electrodes which belong to different current circuits which operate independently of one another and may successively be switched
 55 on and off. Switching on and off may be effected by mechanical means or by means of phase-shifted currents. However, in this method also the electric current is supplied to the seal joint via ionized gas jets (burners). As has been mentioned hereinbefore, this requires the use of comparatively high voltages. Furthermore United States patent specification 2,389,360 describes a method
 60 in which the electric current is supplied to the preheated seal joint by means of electrodes which are in direct contact with the joint. Thus two current circuits adapted to be switched on and off independently of one another can be used, the current being
 65 successively passed through each of the four sides of a rectangular glass article.

Because glass even when hot still has a comparatively high electric resistance, in sealing a face-plate to a tapered envelope
 75 portion of a colour television display tube, even when electrodes are used which are brought into direct contact with the preheated seal joint, a comparatively high electric voltage is still required between the
 80 electrodes. This voltage may be reduced by decreasing the spacing between adjacent electrodes. Because the electrodes when they are stationary in relation to the sealing joint must be evenly spaced along the
 85 periphery of the glass objects, a comparatively large number of electrodes must be used, in particular if the glass objects have large cross-sectional areas and hence the seal joint is long. When using the
 90

known arrangements a plurality of electrodes are interconnected in each circuit, so that there is much likelihood of uneven heating of the same portions of the joint, 5 because no compensation occurs when the joint locally has a higher resistance owing to local cooling. This may partially be avoided by the provision of chokes or ballast resistors in the secondary circuits, but 10 this again requires an increase of the electric voltage. United States Patent specification 2,428,969 describes the use of poly-phase current to obtain even heating, however, in this method also there is no compensation for areas of the joint of different resistance, because a fixed voltage is applied to each current source irrespective of the current it supplies.

The invention provides a method of sealing one glass object to another glass object, wherein preheated sealing edges of the glass objects are brought together to form a seal joint, electric current being supplied to the seal joint by means of electrodes 25 which are in mechanical contact with and are stationary in relation to the joint, the electric current being supplied to the electrodes through at least two current circuits, the electrodes of each current circuit being 30 evenly spaced along the entire seal joint, wherein each current circuit supplies a plurality of electrodes, wherein each current circuit comprises at least two similar transformers the primary windings of 35 which are connected in series, and wherein successive electrodes of each current circuit have potentials of opposite sign applied to them and are connected to the secondary windings of the said transformers, and 40 wherein each current circuit is energised periodically, only one current circuit being energised at a given time. In one aspect of the invention, each electrode belongs to only one current circuit. The secondary 45 windings of the series-connected transformers are connected in series by portions of the seal joint, and the primary windings are connected in series to the supply source, which generally will be the public mains. Alternate switching on and switching 50 off of the circuits may be effected by mechanical means or by phase shifting. The periods during which the various circuits are in the switched-on condition may 55 overlap.

It has been found that the series connection of the current sources and the successive switching of the current circuits produce temperature compensation so that 60 the joint is evenly sealed. The use of chokes or ballast resistors in the secondary circuits has proved to be unnecessary. However, steps are to be taken, preferably in the primary supply from the mains, to 65 prevent excessive increase of the power

owing to the negative temperature coefficient of resistance of the glass.

Some embodiments of the invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings, in which: 70

Figure 1 shows schematically an embodiment of a sealing apparatus according to the invention in which the current circuits are switched by mechanical means, 75 whilst

Figure 2 shows a manner in which in the apparatus of Fig. 1 the voltage is distributed over the seal joint and

Figures 3 and 4 each show an embodiment in which heating is effected by means of three-phase current. 80

Referring now to Figure 1, reference character C denotes a glass article, which in the present case has a rectangular cross-section, two components of which, for example a face-plate and a tapered envelope portion of a cathode-ray tube, are to be sealed to one another, the edges of the portions being preheated and forming a 90 rectangular seal joint having portions 1 to 8. Eight electrodes 13 to 20 are evenly spaced in contact with the seal joint. The said eight electrodes belong to two current circuits I and II which operate independently of one another and each include two series-connected transformers. 95 The circuits can alternately be switched on and switched off by means of a switch 21. The period of the switching frequency may be selected from arbitrarily short periods 100 to periods of from 5 to 10 seconds. With periods which are longer than 10 seconds, some portions of the seal joint are likely to be locally cooled excessively so that the electric resistance at these locations becomes too high to be sufficiently temperature compensated. 105

In the position of the switch 21 shown, the current circuit I is operative. The portions 8 and 1 are connected by the electrodes 13 and 19. The ends of the secondary windings the potentials of which momentarily have the same sign are indicated by circles. The voltages of the secondary windings of transformers Ia and 115 Ib are set up across the portions 1,8 and 4,5 respectively. However, the voltages of these transformers, viewed along the circumference of the seal joint, are added to one another, so that equal potential differences are set up across portions 2,3 and 6,7. Thus the same current will flow through the entire seal joint as long as the resistance of the latter is the same at all 120 points. However, if for example the resistance of a portion 1,2 of the seal joint should increase owing to locally increased cooling, the load on the transformer Ia will be reduced so that the impedance of the 130

relevant circuit is increased. As a result a higher voltage will be set up across the primary and secondary windings so that the current through 1,2 and hence the temperature will increase again, whereas the current through the remaining portions will decrease, because the transformer Ib will pass less current, until the temperature and hence the resistance in the portions of the seal joint again is the same at all points. Because the voltages across the portions 8,1 and 4,5 are equal to those across the portions 2, 3, 6 and 7 (see the circuit diagram of Figure 2) the circuit in which the highest resistance is produced is liable to be further cooled; if for example one or more of the portions 2, 3, 6 and 7 are given a higher resistance (are cooled), the portions 2, 3, 6 and 7 will be cooled even more, because the current will mainly flow through 8, 1, 4 and 5. This is prevented by timely switching of the circuits. Since the electrodes of these circuits are arranged in alternating order, the electrode of the circuit II which is in contact with the middle of the joint portion of increased resistance will have a higher voltage applied to it, so that this portion will pass more current and its temperature will rise, whereas less current is supplied to the remaining portions so that the latter will be cooled until the temperature is equal again at all points. The switching frequency may be arbitrarily high. The lowest switching frequency depends upon the degree in which the seal joint may locally be cooled, and its minimum value may be about 0.1 Hz. Switching must be effected before important temperature differences can be produced in the portions of the joint. Consequently the higher the switching frequency the better.

As an alternative, three-phase current may advantageously be used in the manner shown in Figure 3. The phase-shifted currents in the circuits R, S and T eliminate the need for switching.

The voltage required is about 5 volts per mm of the length of the seal joint. Hence with a spacing of 10 cm between electrodes which belong to the same circuit the voltage will have to be about 500 volts, which still is permissible since it will not give rise to flash-over when sealing the envelope portions of a colour television display tube. A display tube having a screen diagonal of 62 cm (26 inch) has a seal joint of a length of about 2 metres so that 20 electrodes are required for each circuit.

Because the electric contact between the electrodes and the glass of the seal joint may be unsatisfactory it is of advantage to restrict the number of electrodes. In the case of a three-phase supply this is obtainable by connecting each secondary

transformer winding to two adjacent electrodes and by connecting all the secondaries in series, as is shown in Figure 4. In this arrangement the voltage may be one-third of that required in the arrangement of Figure 3 and one-half of that required in the arrangement of Figure 1, with the same number of electrodes. If the same voltage of 500 volts between the electrodes of any one circuit is allowed, the number of electrodes required in the arrangement of Figure 4 need not be more than about one-third of the number of electrodes in the arrangement of Figure 3. Thus in the case of the aforementioned display tube having a screen diagonal of 62 cm the number of electrodes may be reduced from 40 to 12. With a three-phase current, the number of electrodes must be a multiple of 3.

WHAT WE CLAIM IS:—

1. A method of sealing one glass object to another glass object, wherein sealing edges of the glass objects are brought together to form a seal joint, electric current being supplied to the seal joint by means of electrodes which are in mechanical contact with and are stationary in relation to the joint, the electric current being supplied to the electrodes through at least two current circuits, the electrodes of each current circuit being evenly spaced along the entire seal joint, wherein each current circuit supplies a plurality of electrodes, wherein each current circuit comprises at least two similar transformers the primary windings of which are connected in series, and wherein successive electrodes of each current circuit have potentials of opposite sign applied to them and are connected to the secondary windings of the said transformers, and wherein each current circuit is energised periodically, only one current circuit being energised at a given time.

2. A method as claimed in Claim 1, wherein each electrode belongs to only one current circuit.

3. A method as claimed in Claim 1 or Claim 2, wherein three current circuits are used, and wherein each current circuit is supplied from a different phase of a three-phase current supply.

4. A method as claimed in any preceding Claim, wherein each secondary transformer winding is connected to electrodes which are placed in adjacent positions along the seal joint.

5. A method as claimed in any preceding Claim, wherein one of the glass objects is a face-plate of a cathode-ray tube and the other glass object is a tapered envelope of a cathode-ray tube.

6. A method of sealing glass objects

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relevant circuit is increased. As a result a higher voltage will be set up across the primary and secondary windings so that the current through 1,2 and hence the temperature will increase again, whereas the current through the remaining portions will decrease, because the transformer 1b will pass less current, until the temperature and hence the resistance in the portions of the seal joint again is the same at all points. Because the voltages across the portions 8,1 and 4,5 are equal to those across the portions 2, 3, 6 and 7 (see the circuit diagram of Figure 2) the circuit in which the highest resistance is produced is liable to be further cooled; if for example one or more of the portions 2, 3, 6 and 7 are given a higher resistance (are cooled), the portions 2, 3, 6 and 7 will be cooled even more, because the current will mainly flow through 8, 1, 4 and 5. This is prevented by timely switching of the circuits. Since the electrodes of these circuits are arranged in alternating order, the electrode of the circuit II which is in contact with the middle of the joint portion of increased resistance will have a higher voltage applied to it, so that this portion will pass more current and its temperature will rise, whereas less current is supplied to the remaining portions so that the latter will be cooled until the temperature is equal again at all points. The switching frequency may be arbitrarily high. The lowest switching frequency depends upon the degree in which the seal joint may locally be cooled, and its minimum value may be about 0.1 Hz. Switching must be effected before important temperature differences can be produced in the portions of the joint. Consequently the higher the switching frequency the better.

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2. A method as claimed in Claim 1, wherein each electrode belongs to only one current circuit.

3. A method as claimed in Claim 1 or Claim 2, wherein three current circuits are used, and wherein each current circuit is supplied from a different phase of a three-phase current supply.

4. A method as claimed in any preceding Claim, wherein each secondary transformer winding is connected to electrodes which are placed in adjacent positions along the seal joint.

5. A method as claimed in any preceding Claim, wherein one of the glass objects is a face-plate of a cathode-ray tube and the other glass object is a tapered envelope of a cathode-ray tube.

6. A method of sealing glass objects



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substantially as herein described with reference to Figures 1 and 2 or to Figure 3 or to Figure 4 of the drawings.

7. A glass article made with the aid of 5 a method as claimed in any preceding Claim.

C. A. CLARK,
Chartered Patent Agent,
Century House,
Shaftesbury Avenue,
London, W.C.2.
Agent for the Applicants.

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