May 7, 1957 R. C. LARSON 2,791,480

METHOD OF MAKING AN ELECTRON TUBE

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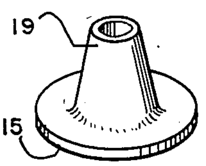

Fig. 2

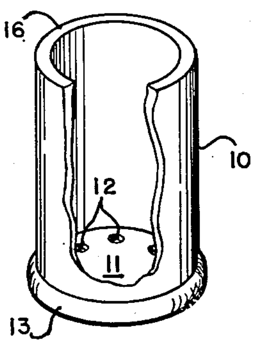

Fig. 1

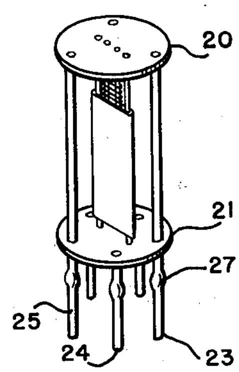

Fig. 3

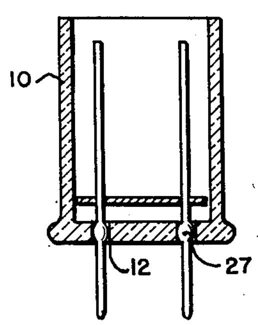

Fig. 4

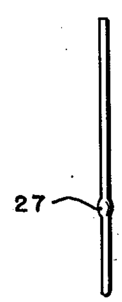

Fig. 5

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METHOD OF MAKING AN ELECTRON TUBE

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2 Claims. (Cl. 316—19)

(Granted under Title 35, U. S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment of any royalty thereon. This is a continuation of my copending application Serial No. 188,044, filed October 2, 1950, for "Electron Tube," now abandoned.

This invention relates to the manufacture of vacuum tubes and more particularly to a novel, simple and effective manner of mounting the electrodes, lead in wires, base pins and glass envelope for a vacuum tube. There are two principal types of standard glass vacuum tubes. One is the "pinch" seal type and the other is the "stem-button" type.

In the conventional form of this type the bottom or "stem-button" and the bulb are sealed together after the assembled electrode system has been fixed to the "stem-button."

The usual construction of a vacuum tube of this type consists of mounting the lead in wires in a glass base or button in a position corresponding to the holes in an appropriate receptacle or socket. Specifically, a "Dumet" wire, that is particularly suitable for a metal-glass seal, is butt-welded to nickel base pins and these units are pressed into molten glass to form the "pin button" with the base pins in the general position required for insertion in the tube socket. The tube elements are then mounted in mica spacers and welded to the extensions of the "Dumet" wires or, more likely, other nickel wires butt-welded to the "Dumet" wires at the button. This assembly is now forced into the tube envelope which is welded around the rim of the button. This requires temperature for slow sealing so high that the inside of the tube reaches some 500° centigrade. The temperature would even be higher if the sealing is to be done in a shorter time, hence there is a limit to the rate of production. Also, the electrode assembly must be raised a considerable distance away from the "stem-button" so that the heat will not distort the electrode system as regards the precision dimensions and exact alignments and so that the cathode will not risk becoming poisoned or having impaired emission. These difficulties naturally increase as the dimensions of the tube become smaller, for then the electrode system is closer to the edge that is being fused and is consequently more exposed to the high temperature. Another disadvantage is that the bottom of the tube becomes distorted by the heat, so that flexible pins, which can be straightened later, have to be used.

There are many other disadvantages to this system; the "Dumet" wire is relatively expensive, there are two or three welds between the base pins and their respective elements, the nickel wire—which must be used to allow straightening of the pins bent in manufacture—is relatively weak, and the connection between the pins and the elements is mechanically weak. Also, the mica spacers require very close tolerances between the walls of the glass tubes, and if the taper is out, as is usually the case, the spacer farther from the opening may not

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engage the walls rigidly. This may be a cause of microphonics as well as a form of gaseous contamination due to the mica striking the glass during acceleration. Spacers are not, in any case, desirable since they decrease the efficiency of the tube at high frequencies.

It is an object of this invention to show a method of constructing vacuum tubes.

It is a further object of this invention to show a method of construction of vacuum tubes wherein the lead in wires are rigidly attached to the tube elements and form a structural brace therefor.

It is a further object of this invention to provide a method of constructing vacuum tubes wherein the distance between the tube elements and their corresponding pins is a minimum.

It is a further object of this invention to provide a method of constructing vacuum tubes wherein the base pins are sealed to the tube base after the internal assembly of the tube is complete.

It is a further object of this invention to teach a method of constructing vacuum tubes where the glass envelope is not sealed around its base edge while the electrode structure is in the envelope.

It is a further object of this invention to provide a tube whose envelope can be of molded glass of non-critical dimensions.

It is a further object of this invention to provide an unusually rugged tube not requiring mica spacers to support the tube elements against the wall of the tube envelope.

Further objects and the advantages of this method of tube construction will become apparent from the following detailed description taken in conjunction with the drawing, of which:

Fig. 1 shows a typical glass envelope used for this tube construction;

Fig. 2 shows the tube cap and exhaust tip;

Fig. 3 shows a typical mounting arrangement for tube elements;

Fig. 4 shows a cross section of the glass envelope (of Fig. 1) with base pins in position; and

Fig. 5 shows a base pin.

The tube enevlope for this construction, as seen in Fig. 1, is a glass container with a perforated bottom and an open top ,somewhat like a salt celler with an open base. The perforations **12** in the closed end **11** are of a size and spacing to receive the base pins of the tube, and the glass envelope **13** is deep enough to contain the tube structure.

The molded or pressed bulb leads itself to methods and means of fastening the finished vacuum tube to the socket or to the chassis of the equipment. A projecting ledge **13** may be provided for a mechanical lock-in of a very simple and effective type. This ledge can be engaged by a spring clip mounted on the radio chassis when the tube is inserted in its socket.

Fig. 2 shows the cap and exhaust tip **19**. The rim **15** of the top is designed to correspond to the rim **26** of the open end of the tube envelope **10** seen in Fig. 1. After the structure of Fig. 3 has been mounted in the tube envelope, and the base pins have been sealed to the base **11** this top is fused to the tube envelope along rims **15** and **16**. The tube can be exhausted in the conventional manner through exhaust tip **19**, and the exhaust tip sealed to complete the construction of the tube.

This cap may be omitted and the tube envelope closed in the conventional manner. For this purpose the tube **10** would be longer to allow drawing into an exhaust tip and sealing.

One of the advantages of this tube is clearly seen here, the concentration of heat in this case is well away from the base pins and tube elements, so that the pins cannot be loosened in the base plate 11 to require re-setting, which happens when the seal is made at the base end of the tube envelope. This allows the use of a rigid metal such as chrome steel for the pins, which is structurally desirable.

Fig. 3 shows a typical structure of the element of this tube, which may be conventionally mounted in mica or ceramic spacers **20** and **21**. The base pins are also directly mounted in the lower spacer **21**, with at least 3 pins **23**, **24** and **25** extending through both spacers. These pins may be of rigid metal to provide structural support for the tube elements.

Fig. 5 shows a single pin, which may be of chrome steel alloy, or any other metal suitable to glass-metal sealing. A small globule of "low temperature" glass **27** surrounds the pin. This globule is also seen on the pins in Fig. 3.

Fig. 4 shows a cross section of the glass tube of Fig. 1 with the base pins as shown in Fig. 5, mounted in a position to be sealed. The seal is made between the "low temperature" glass **27** on the pins and the perforations **12** on the glass tube base which may also be lined with "low temperature" glass.

It can readily be seen that the heat necessary to make the pin seals can be introduced by heating the pins themselves either by an R. F. method, by inserting the pins in a heated block with holes for the pins or by direct impingement of flames. This can be done because heat will travel much faster through metal than through air or glass and until the bead of glass flows onto the glass in the bulb around the hole **12**, there will be an air space to insulate the heat flow from the glass bulb and the heat will be used in raising the temperature of the small amount of glass in the head **27** to tie flow temperature. Since the holes in the pressed bulb have been previously lined with the low-temperature glass an instantaneous seal is accomplished at the flow temperature which is less than one half that of glass seal temperature. Since the area of glass affected is small, sufficient annealing heat is contained in the pins.

An important object of the process is that the entire top of the tube is open during the seal of the pins and hence any or all parts of the electrode structure can be kept at a suitable low temperature so as not to distort the electrode structure or poison the cathode. This can be done by the usual methods such as heat shielding, passing streams of cool gases or providing rapid heat paths to the outside air.

Another advantage of this process is that, if necessary, parts of the electrode structure could be placed in the tube after the pins have been sealed. It is not beyond the art of tube making to weld cathodes, heaters, grids, anodes, getters, braces, or springs to contact the inside of the bulb on the structure since the pins could be used as one of the electrodes in the welding process.

The temperature required for this is so low and so confined to the immediate surrounding of the pins that; the shape of the glass bottom is not affected and hence rigid and strong pins can be used; the distance between the glass bottom and the electrode system can be reduced to mechanical limits without distortion of the electrode system or loss of cathode emission; the overall dimensions of the finished vacuum tube can now be less; the electrical and the mechanical properties of the valve are better and the production rate need not be slowed down because of high temperature effects.

It is of course obvious that since a pressed tube bulb can be used, impressions or configurations can be preformed in the bulb bottom adjoining the pin holes to accommodate corresponding protruding configurations stamped or formed on the pins. This would make the tube structure still more rigid and help in aligning the electrode structure during the pin sealing process. Also, this would help in positioning the low temperature glass beads, preformed on the pins, and act as a heat retaining device in the vicinity of the pin seal when the pin seal is made.

It will be obvious to anyone skilled in the art that the tube elements may be directly attached to or wound on certain of these structural pins if the interrelation of the tube elements will permit this.

What is claimed is:

1. A method for making vacuum tubes comprising: affixing base pins on insulating spacers, forming globules of low temperature fusing glass on said base pins, mounting tube elements on said base pins adjacent said globules, lining perforations in the bottom of a cylindrical cup-shaped container with low temperature fusing glass, inserting said tube structure in said cup-shaped container so that said base pins project through said perforations with said glass globules adjacent thereto, heating said base pins so that said globules of low temperature fusing glass fuse with the glass in said perforations, cooling the tube elements inside said glass container with a stream of air or inert gas during said heating process, sealing a cap to the top of said cylindrical container and evacuating and sealing said container.

2. The method of manufacturing vacuum tubes comprising; mounting elongated extensions of base contact pins on insulating spacers, pre-arranging other base contact pins on said spacers, pre-assembling tube elements on said base contact pins, forming beads of low temperature fusing glass on said base pins adjacent to said tube elements, inserting the pre-assembled structure in a cylindrical cup-shaped container having base perforations lined with low temperature fusing glass so that said base pins project through the perforations, positioning the base pin beads adjacent to the lined perforations, heating said base pins so that said beads of low temperature fusing glass fuse with the glass in said perforations, cooling the tube elements inside said container with a stream of air or inert gas during said heating process, sealing a cap to the top of said cylindrical container and evacuating and sealing said container.

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