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LIGHT ELEMENT TRANSPORT APPARATUS

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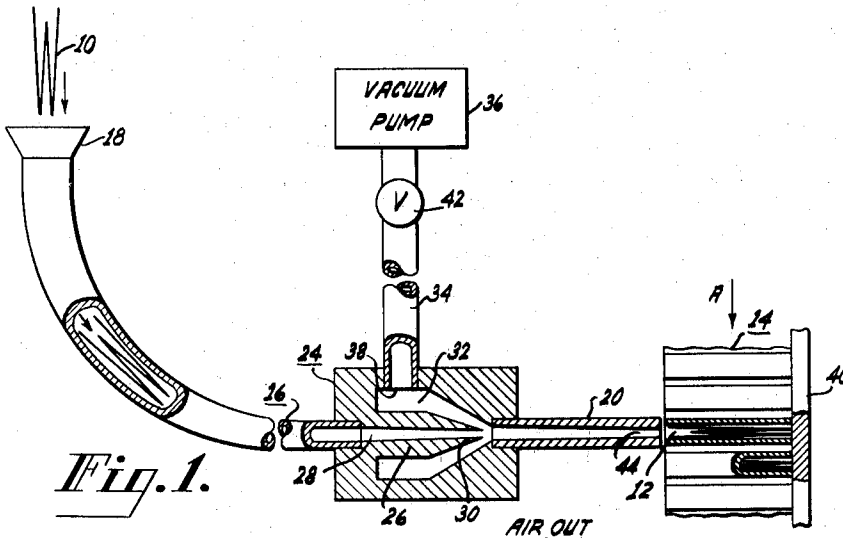


Fig. 1.

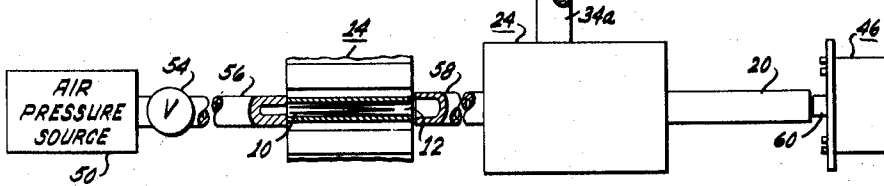


Fig. 2.

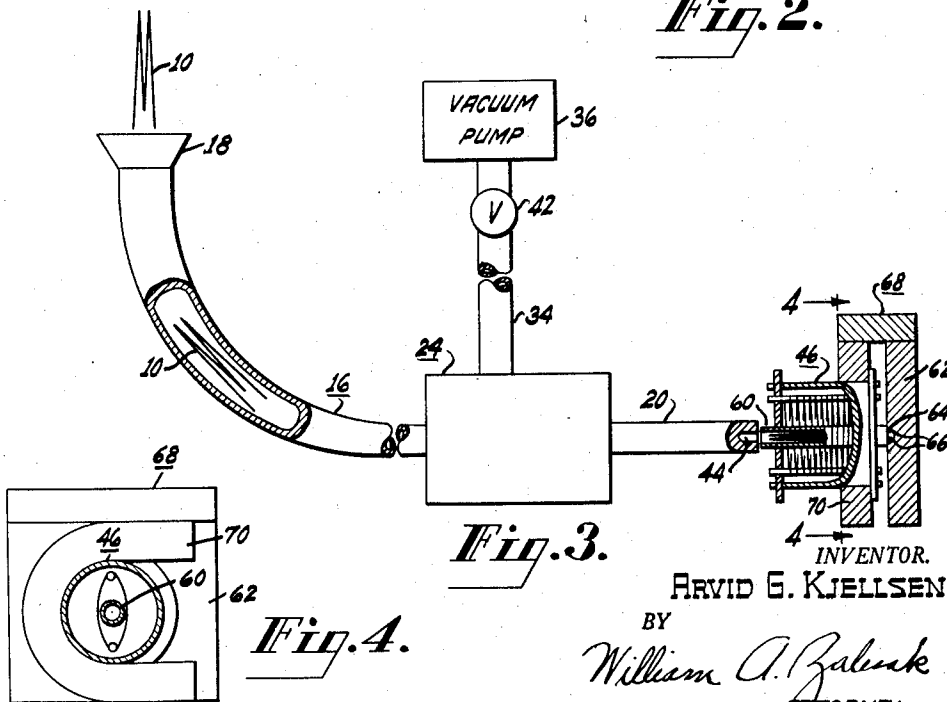


Fig. 3.

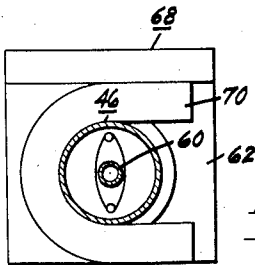


Fig. 4.

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LIGHT ELEMENT TRANSPORT APPARATUS

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7 Claims. (Cl. 53—236)

This invention relates to the art of transporting relatively light elements. While not limited thereto, the invention is herein described with reference to the transport of heaters for indirectly heated electron tube cathodes.

Electron tube heaters usually comprise a folded wire having a metallic core and a refractory, relatively brittle insulating coating. Such heaters are usually made on well known automatic heater making machines which form a continuous length of coated wire stock into a succession of separate folded heaters. In the cathode making art the finished heaters, as they are made, (1) are either directly loaded into the cathode sleeves in which they are to be used or are (2) loaded into receptacles where the individual heaters are stored (the heaters being later successively transported from the storage receptacles into cathode sleeves). The reason why it is sometimes desirable to store the heaters as they are made, is that heater making machines often produce heaters at a different rate of speed than that at which the cathode sleeves are produced. The use of the storage receptacles enables the loading of heaters into cathode sleeves to be effected at a rate independent of the rate of heater or cathode sleeve production.

Due to the small size and the fragile nature of the heaters resort has previously been made, in the transport of the heaters, to either the use of tedious and time-consuming manual loading of the heaters, or to the use of relatively expensive and complicated loading devices which often damaged the heaters.

It is, therefore, an object of the invention to provide improved automatic transport means for relatively light elements and which is characterized by its economy of time and cost and by its simplicity of operation.

Another object of the invention is to provide improved means for transporting electron tube heaters from a heater making machine and either directly into cathode sleeves or into heater storage receptacles, the heaters in the latter case being later transported from the storage receptacles into cathode sleeves.

The foregoing and related objects are realized in light element transport apparatus comprising element guiding means having an element entrance portion, an element discharge portion, and an exit for gas within the guiding means. The exit is positioned adjacent to the discharge portion and intermediate the entrance and discharge portions. Means are provided for subjecting the interior of the guiding means, in the region of the gas exit, to a lower gas pressure than the region of the interior adjacent to the entrance portion aforementioned. Consequently, when an element to be transported is positioned within the guiding means, and adjacent to the entrance portion thereof, the element is subjected to a force urging the element toward the discharge portion thereof.

In one embodiment of the invention a heater is transported from a heater making machine and inserted into a cathode sleeve in an electron tube mount. The heater to be inserted into the cathode sleeve is loaded from the heater making machine into a loading end of element

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guiding means in the form of a transfer tube, the cathode sleeve being at the other end of the tube. The tube is connected to a vacuum source at a place along the tube adjacent to the cathode sleeve. The rush of air from the loading end of the tube to the vacuum source propels the heater toward and into the cathode sleeve. The build-up of air pressure in front of the heater, in the region of the tube beyond the vacuum source connection and in the cathode sleeve, slows down the heater so that the heater comes to a gentle stop within the cathode sleeve.

The invention is described in greater detail in the accompanying drawing where like numerals refer to like parts and wherein,

Fig. 1 shows transport apparatus of the invention used for transporting an electron tube heater to a storage receptacle;

Fig. 2 shows storage apparatus similar to that in Fig. 1 and used for transporting an electron tube heater from a storage receptacle into a cathode sleeve of an electron tube mount;

Fig. 3 illustrates apparatus similar to that shown in Figs. 1 and 2 and depicting another aspect of the invention; and

Fig. 4 is a sectional view taken through line 4—4 of Fig. 3.

Referring now in greater detail to the drawing, there is illustrated in Fig. 1 apparatus for transporting an electron tube heater 10 from one location to another. For example, the one location may be a heater discharge location of a heater making machine (not shown) adjacent to a heater receiving portion 18 at one end of the apparatus, and the other location may be a chamber 12 in a heater storage receptacle 14.

The transfer apparatus comprises guiding means in the form of an elongated duct 16. The duct 16 has the aforementioned heater receiving end portion 18 adapted to receive a folded heater 10 and another end portion 20 adapted to be positioned in gas-tight register with the chamber 12 of the storage receptacle 14 for transferring a heater thereto. The one end portion 18 may have a funnel-like mouth for better directing a heater 10 into the duct 16. The duct 16 has transverse dimensions for snugly engaging the sides of the heater. In the apparatus shown by way of example in Fig. 1 the duct has a generally decreasing inside transverse extent, in a direction from the receiving end portion 18 to the discharge end portion 20 thereof, for gradually compacting the folded heaters 10 from their expanded form at the location where the heaters are received by the duct to a relatively compact form at the discharge end portion 20. The compacting of the heaters at the discharge end portion 20 contributes to the insertion of the heaters into the chambers 12 of the receptacle 14. To further aid in the insertion of the heaters into the receptacle chambers the inside transverse extent of the passageway 44 in the discharge end portion 20 of the duct 16 is smaller than the inside transverse extent of the chambers 12 of the receptacle 14 and is also smaller than that of the passageways in other portions of the duct other than the nozzle 26 for better assuring the ready passage of the heaters 10 into the receptacle chambers 12.

The duct 16 has heater propelling means including a vent 24 located adjacent to the discharge end portion 20 of the duct for urging heaters 10 in a direction from the open or heater receiving end portion 18 of the duct to the discharge end portion 20. The vent 24 comprises a nozzle 26 having a passageway 28 with a relatively small transverse extent at the free end 30 of the nozzle. The nozzle 26 communicates directly with the portion of the duct having the heater receiving end portion 18 with the free end 30 of the nozzle spaced in heater transfer relation with the portion of the duct having the heater discharge

end portion 20. The free end 30 of the nozzle 26 opens within the vent 24 into a chamber 32 adapted to have an air pressure at a lower pressure than the atmosphere at the open end portion 18 of the duct. This lower pressure in the chamber 32 is provided in this embodiment by a gas exit in the form of a pipe 34 between the chamber and a vacuum source, the vacuum source being indicated schematically in Fig. 1 by a vacuum pump 36.

As shown in Fig. 1, the free end 30 of the nozzle 26 is positioned closely adjacent to the portion of the duct at the discharge end portion 20 thereof, and the nozzle end is disposed at a closer distance to the discharge end portion than the distance between the opening 38 of the vacuum source pipe 34 to the discharge end portion 20. This arrangement assures that the air molecules emerging from the nozzle passageway 28 will exhibit a fairly abrupt turn at the nozzle end 30 on their journey into the pipe 34. As a consequence of this abrupt turn a heater traveling toward the nozzle end 30 will be subjected to a flow of air at the abrupt turn, in a direction away from the desired path of travel of the heater, for only a relatively small portion of its travel through the duct. The heater will be entrained in a flow of air in a direction toward the discharge end portion 20 for the greater portion of its travel.

A heater 10, inserted into the open end portion 18 of the duct 16, is propelled toward the vent 24 by the pressure differential between the open end portion 18 and the chamber 32. The momentum acquired by the heater during its passage to the vent 24 carries it beyond the vent, through the discharge end portion 20, and into the chamber 12 of the storage receptacle 14. A stop 40 is positioned closely adjacent to the end of the chamber 12 remote from the discharge end portion 20 in order to prevent any appreciable escape of air through this remote end of the chamber. Also, the receptacle 14 is positioned closely adjacent to the discharge end portion 20 to prevent the escape of an appreciable amount of air through the region between the receptacle and the duct. The foregoing closure arrangement in the region of the receptacle 14 substantially closes the discharge end portion 20 of the duct 16 and thus provides an air cushion within the discharge portion of the duct and the receptacle chamber 12 for bringing the heater to a gradual stop within the chamber. The pipe 34 is provided with a pressure control valve 42 for adjusting the flow of air through the duct so that the heater is propelled into the receptacle chamber 12 while being preserved from damaging impact against the stop 40. It has been found that the air cushion provision aforescribed brings heaters to a gentle stop within the receptacle chamber 12 over a fairly wide range of degrees of evacuation of the vent chamber 32 so that the adjustment of the control valve 42 is not critical. For example, a folded heater having a weight of a fraction of a gram has been propelled through one transport apparatus of the type shown in Fig. 1 and into a storage receptacle, without damaging impact, over a partial vacuum source pressure within the duct of from about 2 to about 8 pounds per square inch of absolute pressure.

After a heater 10 has been inserted into a chamber 12 the receptacle 14 is moved, say in the direction "A," to bring another chamber of the receptacle adjacent to the discharge end portion 20 for receiving a heater therefrom.

Reference is now made to Fig. 2. When a heater 10 is to be taken from the storage receptacle 14 and inserted into an electron tube cage 46 (Figs. 2, 3 and 4) transport apparatus similar to that shown in Fig. 1 may be used. While a vacuum source is used to provide the element transport force in Fig. 1, air under pressure above that of the atmosphere may instead be used, as shown in Fig. 2. Air from an air pressure source 50 is fed through an air pressure regulator 54 and through an air pressure outlet pipe 56 in register with a chamber 12 of the receptacle 14. There is positioned in register with the end of the cham-

ber 12 remote from the outlet pipe 56 a heater inlet pipe 58. The inlet pipe 58 is connected to a vent 24 having the same structure as the vent 24 of Fig. 1. However, the vent 24 in the apparatus of Fig. 2 is provided with an outlet 34a to the atmosphere instead of with a pipe connected to a vacuum source as in the apparatus of Fig. 1. The heater discharge end portion 20 is positioned closely adjacent to a cathode sleeve 60 of the electron tube cage 46.

Figs. 3 and 4 illustrate means by which the cage 46 may be maintained adjacent to the heater discharge end 20. The cage 46 is supported by a bracket 68 having a U-shaped member 70 adapted to snugly engage an outside wall of the cage 46 for maintaining the cage in a desired relation with respect to the discharge portion 20. A stop 62, similar in function to the stop 40 of Fig. 1, is secured to the bracket 68 adjacent to the end of the cathode sleeve 60 remote from the discharge end portion 20. The stop 62, which is preferably maintained in substantially gas tight relation with the remote end of the cathode sleeve 60 for aiding in bringing the heater to a gradual stop therewithin, has a hollow 64 to permit heater legs 66 to extend beyond the cathode sleeve 60 for a distance sufficient to enable the welding of the legs to electron tube stem leads (not shown).

Fig. 3 illustrates apparatus for transferring an electron tube heater 10 from a position adjacent to a heater making machine (not shown) where the heater 10 is received by the funnel-like opening 18 of the duct 16 of the transport apparatus and is transferred through the vent 24 and inserted into the electron tube cage 46 in a manner similar to that described with respect to Fig. 2. The apparatus of Fig. 3 makes use of the vacuum system described with respect to Fig. 1 where air sucked into the open end portion 18 of the duct 16 propels a heater 10 toward the vent 24. The momentum of the heater 10 carries it through the discharge end portion 20 of the duct 16 and into the cathode sleeve 60 of the cage 46. As indicated above, the close adjacency of the sleeve 60 to the discharge end portion 20 and the close adjacency of the stop 62 to the sleeve 60 creates a build-up of air to form a cushion for gradually bringing the heater 10 to rest within the sleeve 60.

The heater 10 in the apparatus of Figs. 2 and 3 is propelled legs end first through the duct 16 so that the heater legs 66 can be received in the hollow 64 of the stop 66 to provide the desired extension of the legs beyond the sleeve. However, where no such extension of the legs is required, as in receiving a heater 10 in a storage receptacle as shown in Fig. 1, the heater may be transported legs end last for reducing the friction of the heater against the walls defining the passageway in the duct 16.

It will be apparent from the foregoing description of the invention that improved means is provided for transporting electron tube heaters from one location to another location without subjecting the heaters to damaging handling or impact.

What is claimed is:

1. Apparatus for transporting relatively light, compactable elements, said apparatus comprising element guiding means having an element entrance portion and an element discharge portion, an exit for gas within said guiding means and positioned adjacent to said discharge portion and intermediate said entrance and discharge portions, and element propelling means connected to said guiding means intermediate said entrance and discharge portions for subjecting the interior of said guiding means adjacent to said exit to a lower gas pressure than the region of said interior adjacent to said element entrance portion, whereby an element positioned within said guiding means and adjacent to said entrance portion thereof is subjected to a force urging said element toward said discharge portion, said guiding means including a portion disposed intermediate said entrance portion and said propelling means and having a generally decreasing inside

transverse extent, in a direction from said entrance portion toward said propelling means, thereby to gradually compact an element during its passage during said guiding means.

2. Apparatus for transporting relatively light, compactable elements, said apparatus comprising element guiding means having an element entrance portion, an exit for gas within said guiding means and positioned adjacent to said discharge portion and intermediate said entrance and discharge portions, means for subjecting the interior of said guiding means adjacent to said exit to a lower gas pressure than the region of said interior adjacent to said element entrance portion, whereby an element positioned within said guiding means and adjacent to said entrance portion thereof is subjected to a force urging said element toward said discharge portion, said guiding means including a portion disposed intermediate said entrance portion and said exit and having a generally decreasing inside transverse extent, in a direction from said entrance portion toward said exit, thereby to gradually compact an element during its passage through said guiding means, and element receiving means spaced in close adjacency from said discharge portion and adapted to receive an element therefrom and to substantially prevent the escape of gas from said guiding means at said discharge portion for building up an element slowing down gas cushion in the region of said discharge portion, whereby said element is preserved from damaging impact.

3. Transfer apparatus comprising an elongated duct having one end adapted to receive an elongated, compactable workpiece, said duct having transverse dimensions for snugly engaging the sides of said workpiece, an elongated receptacle for said workpiece and having an open end spaced from and closely adjacent to the other end of said duct, the inside transverse dimensions of said other end of said duct being less than the inside transverse dimensions of said open end of said receptacle thereby to better transfer said compactable workpiece from said duct to said receptacle, the other end of said receptacle being substantially closed, and means communicating with the interior of said duct and engaging said duct at a portion thereof adjacent to said other end thereof, said means including a chamber adapted to have an atmosphere at a lower pressure than the atmosphere at said one end of said duct, whereby said workpiece is adapted to be propelled from said open end of said duct to said portion of said duct by the pressure differential of the atmosphere at said one end of said duct and said portion of said duct, and said workpiece is adapted to be propelled from said portion of said duct to said receptacle by the momentum of said workpiece at said portion of said duct, said receptacle having transverse dimensions for snugly receiving said workpiece, whereby travel of said workpiece into said receptacle produces an atmospheric pressure between the leading end of said workpiece and said substantially closed end of said receptacle for bringing said workpiece to a gradual stop.

4. Apparatus for transferring a compactable article from one location to another in compacted form, comprising a first duct having one end adjacent to said one location and another end adjacent to said another location, said duct having transverse dimensions for snugly receiving said article, said duct having a portion adjacent to said another location and terminating in a free end, a second duct joined to said first named duct at said portion and spaced from said free end, the inside transverse extent of said free end of said first duct being less than the inside transverse extent of the end of said second duct adjacent to said first duct thereby to better transfer said compactable article between said ducts in compacted form, and a source of atmosphere under a lower pressure than the atmosphere adjacent to the other end of said first duct and communicating with said second duct, whereby said article is adapted to be propelled through said first duct from

said one location to said portion by air pressure, and from said portion to said free end by the momentum stored in said article by said air pressure.

5. Apparatus for transporting relatively light, compactable elements, said apparatus comprising element guiding means having an element entrance portion and an element discharge portion, an exit for gas within said guiding means and positioned adjacent to said discharge portion and intermediate said entrance and discharge portions, said guiding means including a portion disposed intermediate said entrance portion and said exit and having a generally decreasing inside transverse extent, in a direction from said entrance portion toward said exit, thereby to gradually compact an element during its passage through said guiding means, an element receiving member in substantially gas-tight register with said discharge portion for closing said discharge portion, the interior of said guiding means communicating with a region of lower gas pressure than the region of said interior adjacent to said element entrance portion, whereby an element positioned within said guiding means and adjacent to said entrance portion thereof is adapted to be subjected to a force urging said element toward said discharge portion, and whereby the build-up of gas pressure in said guiding means between said element and said element receiving member, when said element travels beyond said exit, brings said element to a gradual stop within said element receiving member.

6. Electron tube folded heater transfer apparatus comprising a duct having a transverse extent for passing a heater therethrough, a free end adapted to receive a heater therethrough, and an end opposite said free end adapted to discharge a heater therefrom; and a vent communicating with the interior of said duct adjacent to said opposite end thereof for subjecting a heater within said duct to a force urging said heater in a direction from said free end toward said opposite end; said vent comprising a nozzle having a passageway communicating directly with the portion of said duct having said free end; said nozzle having an end spaced in heater transfer relation with the portion of said duct having said opposite end, and opening into a chamber adapted to have an air pressure therein at a lower pressure than the atmosphere at said free end of said duct, said nozzle having a gradually decreasing inside transverse extent in a direction toward said end thereof thereby to compact said heater during its passage through said nozzle, the inside transverse extent of said nozzle end being less than the inside transverse extent of the part of said duct spaced from and adjacent to said nozzle end; whereby a heater is propelled from said free end of said duct to said vent by the pressure differential between said free end and said chamber, and is carried to said opposite end of said duct by the momentum acquired during the passage from said free end to said vent, said opposite end of said duct being open to the atmosphere thereby to create a reverse air flow in a portion of said duct for reducing the velocity of said heater at said opposite end of said duct.

7. Electron tube heater transfer apparatus comprising a duct having a transverse extent for passing a compactable heater therethrough, a free end portion adapted to receive a heater therethrough, and an end portion opposite said free end adapted to discharge a heater therefrom; and a vent communicating with the interior of said duct adjacent to said opposite end portion thereof for subjecting a heater within said duct to a force urging said heater in a direction from said free end portion toward said opposite end portion; said vent comprising a nozzle having a passageway communicating directly with said free end portion; said nozzle having an end spaced in heater transfer relation with said opposite end portion and having a less inside transverse extent than that of said opposite end portion thereby to compact a heater during its passage through said nozzle for preserving said vent free of heater blockage in the region between said nozzle and said opposite end portion, and opening into a chamber adapted to

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have an air pressure therein at a lower pressure than the atmosphere in said free end portion of said duct; whereby a heater is propelled from said free end portion of said duct to said vent by the pressure differential between said free end portion and said chamber, and is carried to said opposite end portion of said duct by the momentum acquired during the passage from said free end portion to said vent; said opposite end portion of said duct being adapted to discharge into a heater receiving member and to be partially closed thereby for building up pressure in

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said duct between said vent and said opposite end portion for bringing said heater to a gradual stop within said heater receiving member.

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