Dec. 4, 1962 J. POTTIER 3,067,359

STRUCTURE FOR LINEAR ION ACCELERATORS

Filed April 28, 1959

Fig. 1

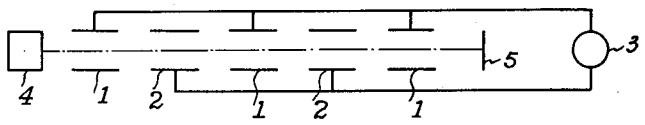


Fig. 2

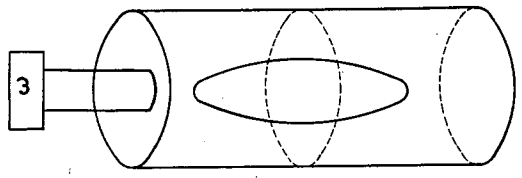


Fig. 3

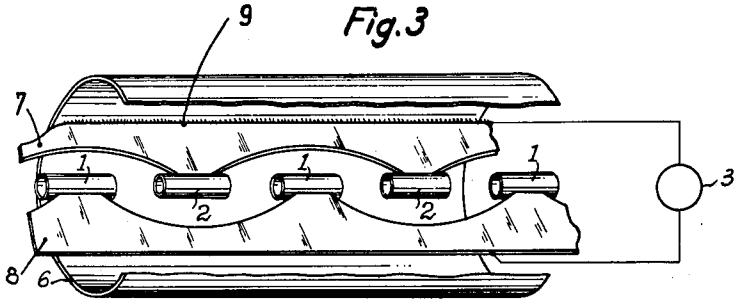
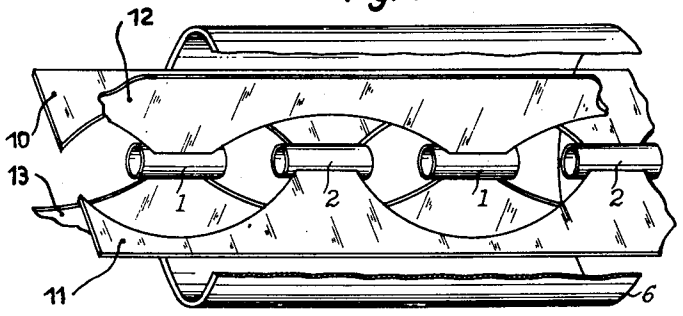


Fig. 4



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STRUCTURE FOR LINEAR ION ACCELERATORS

Jacques Pottier, Courbevoie, France, assignor to Commissariat a l'Energie Atomique, Paris, France

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The present invention relates to an apparatus for linearly accelerating ions and comprising in a known fashion a source for producing ionized particles, a structure for producing an accelerating electrical field capable of increasing the kinetic energy of the ionized particles and a target to be bombarded by them.

Several types of such accelerators are known of which a number are improved versions of the so-called "Wideroe" accelerator (FIG. 1). In this apparatus the tubes **1** and **2**, called sliding tubes, disposed along the axis of the accelerator, are connected alternatively to the two posts of a high frequency generator **3**.

The ions, injected by the source **4**, are accelerated within the space separating each tube from the next. The transit time in one cell, i.e. in one tube and one space of acceleration, corresponds to a half cycle of the high frequency. The ions finally reach the target **5**.

This simple embodiment has become obsolete, the high losses brought about by the Joule's effect and by radiation, being prohibitive.

In order to decrease the losses by radiation, it is necessary to offer to the current that travels through the capacitance existing between even and odd numbered tubes as high an impedance as possible, thus lowering the capacitance between these two series of tubes.

The present invention relates to linear ion accelerators having a new structure imparting to the apparatus a very high efficiency, particularly at low energy levels.

The new structure is essentially characterized in that in order to reduce the energy losses, sliding tubes are disposed inside a resonant cavity, means being foreseen to effect the transmission to the said sliding tubes of the high frequency energy applied to the resonant cavity.

A fairly low coefficient of overstrain is thereby achieved for the whole unit, which allows as in the case of pulsated accelerators the use of short duration pulses and a simultaneous concentration of energy in the vicinity of the axis, that is to say in the path of the particles to be accelerated, while reduced geometrical dimensions are being preserved for the cavity.

The introduction of a resonant cavity on such ion accelerators allows, according to the invention, the cancellation of losses due to radiation and the reduction, in an appreciable ratio of the losses brought about by the Joule's effect.

In a preferred embodiment of the invention, use is made for instance of a resonant cavity according to the mode H_{111} in the absence of charges (FIG. 2); upon linking alternatively the sliding tubes to the two zones of the cylinder within which the "tension" is greatest, the lines of the electrical field are distorted in such a way as to introduce an axial component in the vicinity of the axis.

Referring more particularly to FIGS. 3 and 4, hereinafter will be described various examples of embodiment of the present invention but these should be taken as having no limiting effect upon the scope of the invention. The embodiments to be described in relation to these examples are to be considered as being part of the invention, it being understood that equivalent embodiments could just as well be used without departing from the scope of the invention.

FIGURE 3 is a schematic blown up view of the cavity structure, resonating according to the mode H_{111}.

FIGURE 4 is a schematic blown up view of the cavity structure, resonating according to the mode H_{211}.

FIGURE 3 shows a cylindrical resonant cavity **6** into which is axially disposed a series of sliding tubes **1** and **2**, which are linked respectively to the two posts of a high frequency generator **3**. This simplified illustration of the feeding of cavity **6** by the generator **3** is purely symbolic since in practice such means of high frequency feeding as for instance a coupling by loops are used. In the example of FIGURE 3, the cavity **6** resonates according to the mode H_{111} and the means foreseen for transmitting to the sliding tubes **1** and **2** the high frequency energy provided by the generator **3** consist in two flat electrically conductive plates **7** and **8**, each being linked or connected to one of the two series of tubes **1** and **2**. The contact generatrixes of the plates **7** and **8** and the resonant cavity **6**, of which one only is visible in the blown up view (FIGURE 3) are those between which there exists the maximum amount of tension.

The charge held up by the capacitance existing between the two series of sliding tubes is very important, so that the diameter of the cavity **6** is considerably smaller than that of the uncharged cavity.

A simple calculation demonstrates that the radius of the cavity **6**, according to the invention, is inversely proportional to the spark gap frequency of the cavity **6**, considered as a wave channel; that is to say, of the order of fifty centimeters for a spark gap frequency of 50 mHz. This therefore leads to very reduced lateral dimensions for the cavity **6**, a feature of significant interest in the case of accelerators designed to operate at very low frequencies (i.e. in particular, the case of heavy ion accelerators).

The very similar structure illustrated in FIGURE 4 is that derived from the mode of resonance H_{211}. In this case the sliding tubes **1** and **2** are supported on each side by conductor plates **10**, **11**, **12** and **13**, which can render the construction of the particular structure easier.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A structure for linear ion accelerators characterized by the combination of a substantially cylindrical hollow resonant cavity fed at high frequency and having an inner surface, two series of drift tubes alternately disposed internally along the axis of said cavity, at least one electrically conducting flat plate parallel to the axis of the cavity electrically connecting all of the tubes of one of said series of drift tubes in a straight line to the inner surface of the cavity, at least one second flat plate electrically connecting all of the tubes of the other of said series of drift tubes in a straight line parallel to the axis of the cavity to the inner surface of the cavity, said lines of connection having a maximum amount of voltage therebetween and said conducting plates equalizing the resonant frequency in each section of the cavity.

2. A structure for linear ion accelerators as described in claim 1 wherein said cavity is symmetrical with respect to a diametric plane whereby oscillations of the H_{111} type are obtained, said plates are two in number, are indented between said drift tubes, are diametrically located within the cavity and support said drift tubes.

3. A structure for linear ion accelerators as described in claim 1, wherein said cavity is symmetrical with respect to two perpendicular diametric planes whereby oscillations of the H_{211} type are obtained, said plates are four in number, are indented between said drift tubes, are arranged in two perpendicular planes the intercept of which generally coincides with the axis of the cavity and support said drift tubes, two of said plates supporting each series of drift tubes and lying in the same plane and intersecting the wall of the cavity in diametrically opposite lines.

References Cited in the file of this patent

UNITED STATES PATENTS

2,289,952	Zworykin	July 14, 1942
2,547,061	Touraton et al.	Apr. 3, 1951
2,760,103	Salisbury	Aug. 21, 1956
2,770,755	Good	Nov. 13, 1956
2,853,642	Birdsall et al.	Sept. 23, 1958
2,891,191	Heffner et al.	June 16, 1959