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[54] **SYSTEM FOR FEEDING ELECTROMAGNETIC ENERGY INTO A CYCLOTRON AND A CYCLOTRON INCORPORATING SUCH SYSTEM**

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[51] **Int. Cl.**.....**H05h 7/00,** H05h 13/00

[58] **Field of Search** 313/62, 63; 328/234

[56] **References Cited**

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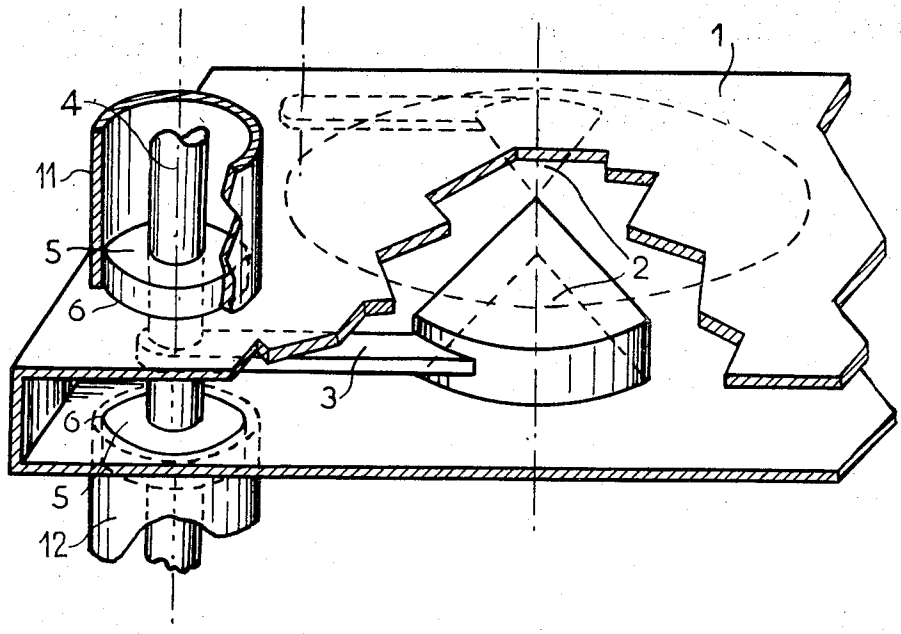
[57] **ABSTRACT**

The present invention relates to a system of supporting and electromagnetically connecting the sectoral elements of a cyclotron or D's.

It employs a vertical conducting element rigidly linked to a horizontal metal arm which supports one said sectoral elements; said conducting element passing through the parallel faces of the accelerating enclosure in conical insulators. Said conducting element forms the inner conductor of a transmission line and is equipped at one end with a capacitor means for connection to the high-frequency source, and at the other end with an adaptable short-circuiting stub.

The applications are in the field of circular ion accelerators.

6 Claims, 2 Drawing Figures



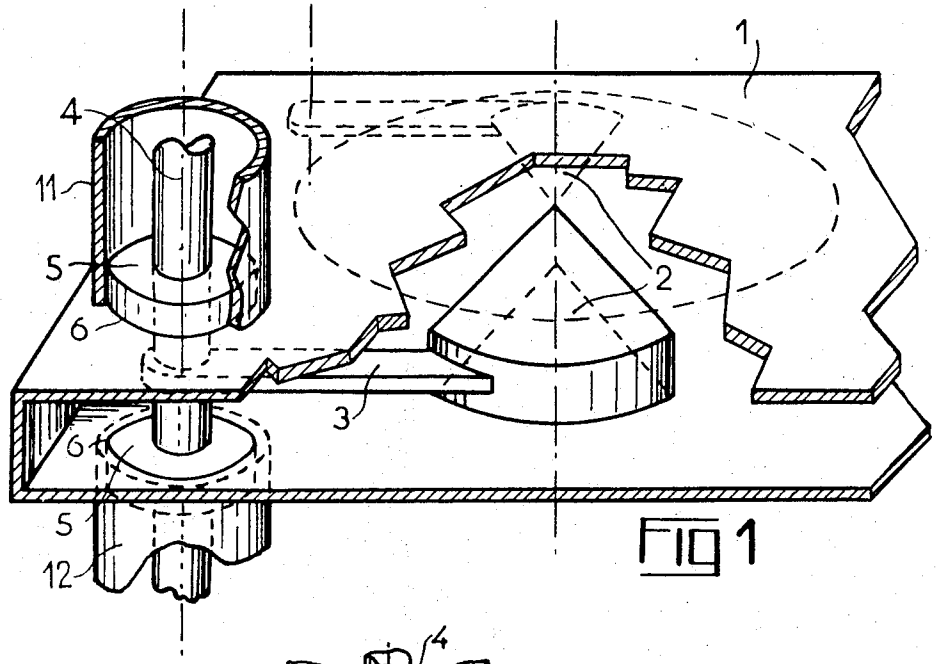


Fig 1

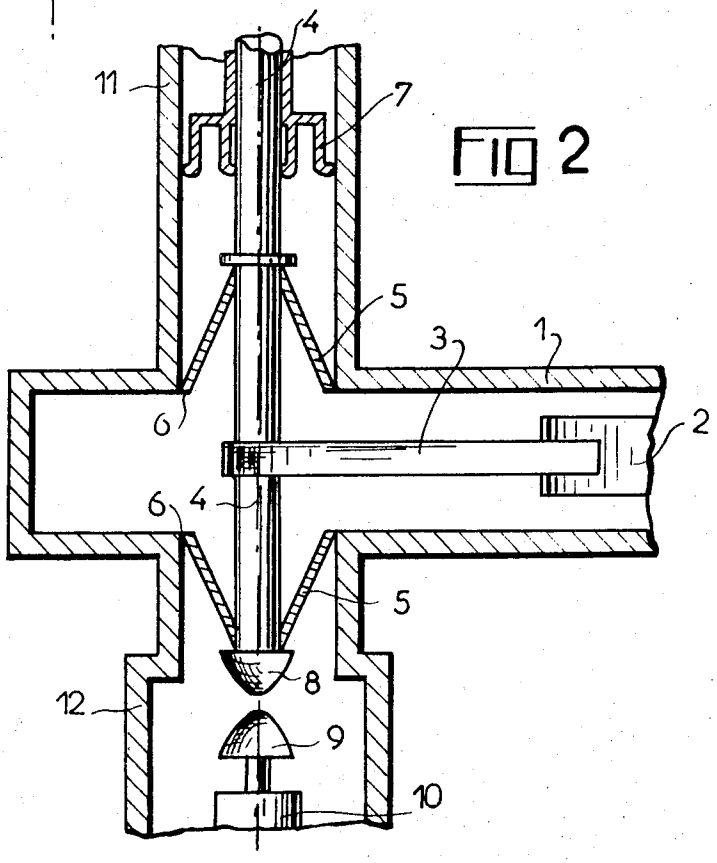


Fig 2

SYSTEM FOR FEEDING ELECTROMAGNETIC ENERGY INTO A CYCLOTRON AND A CYCLOTRON INCORPORATING SUCH SYSTEM

The present invention is concerned with circular particle accelerator devices of the cyclotron type. Devices of this kind essentially comprise an electromagnet in airgap of which a sealed metal evacuated enclosure is located, where the charged particles are accelerated by repeated passage through the H.F. electric fields developed, by one or more high-frequency generators, between two sectoral conductory elements commonly known as D's.

The fixing of said sectoral elements and the operation for feeding the high frequency energy in said evacuated enclosure constitute two major problems in cyclotron design, in particular as a consequence of the high electrical insulation which is necessary between said sectoral conducting elements or D's and the walls of said enclosure.

Each D is generally fixed to the end of the conducting bar doing duty at the same time as the support for the D, and the central conductor of a coaxial high-frequency transmission line. The length of said conducting bar along which there can also displace a metal piston enabling the electrical parameters of the line and the transmission to be modified, introduces in the structure a substantial "overhang" which is reduced by equipping said conductive bar with an electrically insulating support, although the presence of the latter has drawbacks, i.e., it limits the travels of the piston or gives rise to arcing at its surface, between bar and walls of said vacuum enclosure.

The present invention enables these drawbacks to be overcome.

It relates to a system for feeding the electromagnetic energy into the evacuated metal enclosure of cyclotron said enclosure having an upper and lower conducting face substantially parallel to each other; at least one sectoral conducting element positioned between said faces, characterized in that said feeder system comprises two outer conducting tubes protruding out of said faces and having a common axis perpendicular to said faces which are horizontally positioned; an inner conducting element positioned along said axis, insulator means for electrically insulating and positioning said inner element within said tubes; capacitive feeder means positioned at one end of said inner element and short-circuiting means positioned at the other end of said inner element: a conducting arm positioned between said faces and rigidly linking said sectoral element to said inner conducting element.

The invention will be better understood from a consideration of the ensuing description and the attached drawings in which:

FIG. 1 illustrates a system, in accordance with the invention, for feeding high-frequency energy in a cyclotron.

FIG. 2 illustrates a view of a preferred embodiment of a system in accordance with the invention.

FIG. 1 shows a teared view of a system in accordance with the invention.

In the evacuated accelerating enclosure 1, each of the two sectoral conducting elements 2 is fixed to the end of a conducting arm 3 parallel to two faces of the vacuum enclosure and constitutes, in relation thereto, a high frequency transmission line.

Each conducting arm is fixed to a inner conducting element 4 formed by metal cylinder perpendicular to the planes of the opposite faces of the enclosure said inner element passing through a circular opening 6 where it is centered by an insulator 5, for example of alumina, the structure and method of attachment of which also provide sealing means.

FIG. 2 illustrates a prefered realization of a system in accordance with the invention. It comprises elements for applying the high frequency energy into the vacuum enclosure described in FIG. 1. The inner element 4 is surrounded at each side of the evacuated enclosure, by respective cylinders 11 and 12 which do not touch it and which form in relation to it, two elements of a coaxial transmission line. One end has the high frequency power injected into it, for example by purely capacitive coupling between the electrodes 8 and 9 of a capacitor, one electrode of which is fixed to one end of the said inner element, whilst the other is connected to the high frequency voltage source 10; the other end of said inner element is equipped with a mobile short-circuiting piston 7 which enables optimum matching to the load impedance to be effected. The insulators 5 have a tapered form in order better to improve breakdown resistance, high frequency matching and mechanical rigidity.

The system in accordance with the invention therefore has a dual mechanical and electrical role and exhibits substantial advantages over the known devices.

From the mechanical point of view, the very reduced "overhang" of the D support makes it possible to achieve a very rigid assembly; from the electrical point of view, the vertical position of the coaxial line elements means that a smaller ground area is taken up, that more economic design and operation of the mobile, short-circuiting pistons, whose weight acts in the direction of their displacement, is obtainable, and that finally readier coupling with the high-frequency source is made possible, since generally this source is vertically orientated with its high-frequency connection located at the top.

The structure of the device in accordance with the invention lends itself to easy optimizing of certain parameters, such for example as the selection of a point of the transmission line where capacitive means are coupled with the high-frequency voltage source the source-voltage being lower than the accelerating voltage.

What I claim is:

1. A system for feeding electromagnetic energy into the evacuated metal enclosure of a cyclotron said enclosure having a upper and a lower conducting face substantially parallel to each other; at least one sectoral conducting element positioned between said faces; said feeder systems comprising two outer conducting tubes having a common axis perpendicular to said faces which are horizontal positioned, said tubes protruding out of said faces; an inner conducting element positioned along said axis; a conducting arm positioned between said faces; insulator means for positioning and electrically insulating said inner element within said tubes; capacitive feeder means positioned at one end of said inner element and short-circuiting means positioned at the other end of said inner element; said conducting arm rigidly linking said sectoral element to said inner conducting element.

2. A system as claimed in claim 1, having two sectoral conducting elements.

3. A system as claimed in claim 1, wherein said insulator means comprise two cones of insulating material extending coaxially of said axis.

4. A system as claimed in claim 1, wherein said capacitive feeder means comprise a first electrode coupled at one end of said inner element and a second electrode facing said first electrode for transferring the electromagnetic energy.

5. A system as claimed in claim 1, wherein said short-circuitry means comprise an adjustable stub.

6. A cyclotron comprising an enclosure having an upper and a lower conducting face substantially parallel to each other and a system for feeding electromagnetic energy into said enclosure; said feeding system comprising at least sectoral conducting element positioned between said faces; two outer conducting tubes having a common axis perpendicular to said faces which are horizontally positioned, said tubes protruding out of said faces; an inner conducting element positioned along said axis; a conducting arm positioned between said faces; insulator means for positioning and electrically insulating said inner element within said tubes; capacitive feeder means positioned at one end of said inner element and short-circuiting means positioned at the other end of said conducting arm rigidly linking said sectoral element to said inner conducting element.

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