

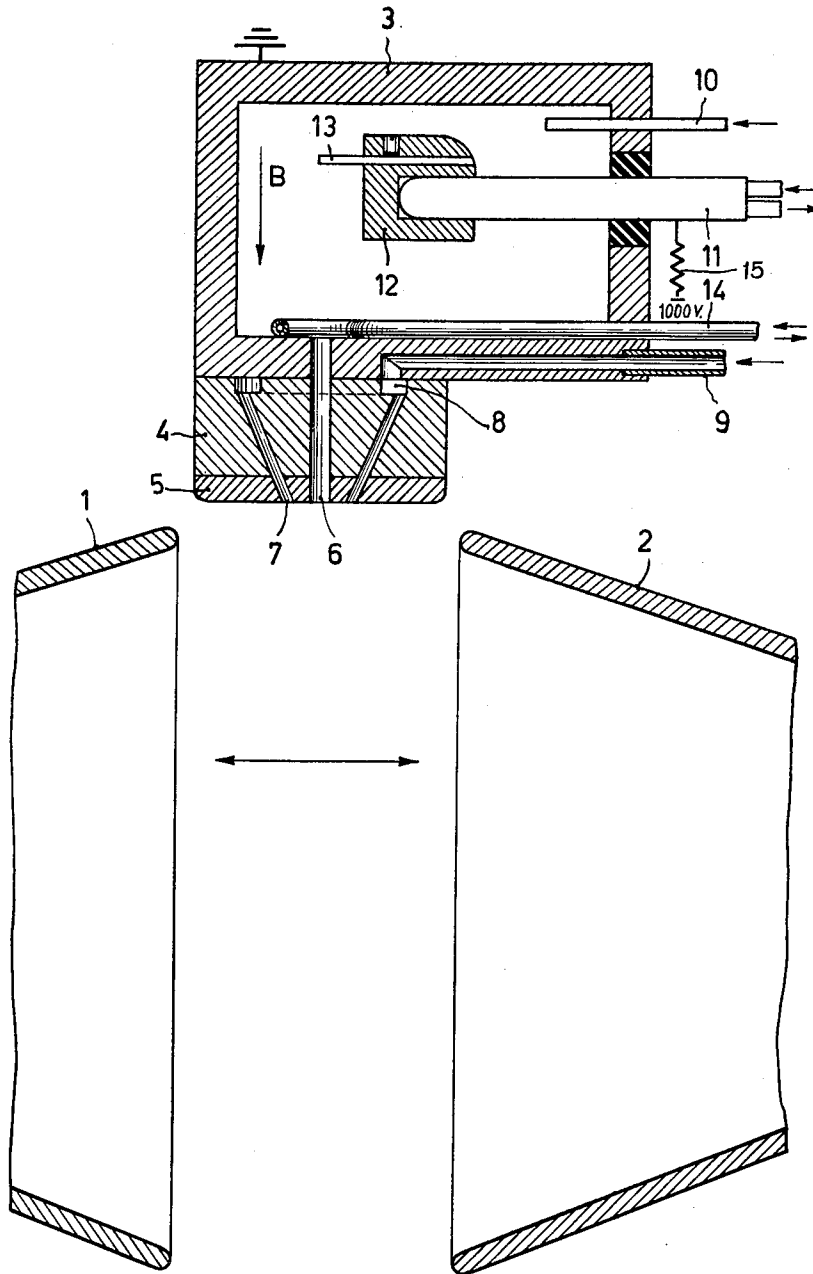
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SOURCE OF IONS FOR USE IN SYNCHRO-CYCLOTRONS

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SOURCE OF IONS FOR USE IN SYNCHRO-CYCLOTRONS

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4 Claims. (Cl. 315—111)

The invention relates to a source of ions for use in a synchro-cyclotron comprising a metal chamber in which an electrode is arranged in an insulated manner in line with the bore in a spout on that chamber, which bore extends parallel to the magnetic field of the cyclotron and which spout extends between the two D-shaped electrodes in the axis of the cyclotron, while the electrode in the chamber has a negative voltage of some hundreds of volts with respect to the latter, in a manner such that a gas discharge occurs in the gas introduced into the chamber, the aperture of the spout serving as an anode, as a result of which electrons and ions and non-ionised molecules or atoms emanate from the spout to enter into the high-frequency electric field between the two D-shaped electrodes. The charged particles move helically around the magnetic lines of force.

A source of ions of a construction as described above has been successfully used for years and is described in the "Philips Technical Review" 14, 267, 1952-53. The electrode in the chamber operating as a cathode is constituted by a tungsten pin which is arranged in a copper block cooled by water. The tungsten pin must be renewed from time to time. The gas introduced into the chamber consists of deuterium or helium. The spout must also be replaced from time to time, since a comparatively strong bombardment of ions occurs on the spout in the high-frequency electric field between the two D's. The pressure in the accelerating space proper amounts to 10^{-5} mm., that in the chamber to 10^{-2} to 10^{-3} mm. The invention has for its object to provide an improvement in the known source of ions as a result of which with the same flow of electrons from the spout-shaped aperture and the same consumption of gas a stronger formation of ions and consequently a higher output current of the synchro-cyclotron is obtained.

In a source of ions of the above type for use in a synchro-cyclotron, according to the invention, a number of channels are provided around the aperture in the spout on the chamber of the ion source, which channels are situated on a conical surface, the axis of which is formed by the discharge channel and the peak of which lies just inside the two D-shaped electrodes, about a fourth to a third of the total quantity of gas being supplied through these channels.

It has been found that with the described arrangement yields of ions may be obtained which exceed those with the known construction by 30 to 40%, which may be considered very important.

According to the invention, the supply through the secondary channels may be effected separately so that the supply is adjustable. According to the invention, the secondary channels may also be connected to the chamber of the ion source itself so that the distribution between primary and secondary channels depends on the dimensions and the number of the channels.

A further improvement in the source of ions in accordance with the invention is obtained by providing the end of the spout with a tungsten plate which has a higher resistance to ion bombardment than the copper spout itself and which may be readily replaced.

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The invention will now be described more fully with reference to the accompanying drawing which is a sectional view of the central part of a synchro-cyclotron and in which reference numerals 1 and 2 denote the parts of the D-shaped electrodes lying in the proximity of the axis and having rounded edges. Reference numeral 3 denotes the chamber for the source of ions which consists of copper and is provided with a copper spout 4 having a tungsten front plate 5. In the spout, provision is made of a channel 6 having a length of 30 mms. and a diameter of 3 mms., while around it eight channels 7 of 1 mm. diameter are bored at an angle of about 20° to the axis and at a distance such that the prolongation of these channels 7 intersects the axis just inside the D-shaped electrodes. The channels 7 open into an annular channel 8 which is provided with a separate supply 9. The primary supply of gas 10 opens into the chamber 3. A water inlet and outlet pipe 11 supports a copper block 12 in which the tungsten pin 13 is arranged. A cooling pipe 14 is placed around the aperture of the channel 6. The two supplies of gas and the two cooling-water pipes are united to form the support of the ion source, which support may be readily removed from the cyclotron in order to alter the spout or to replace the pin 13. The front plate 5 of the spout consists of tungsten having a density of 85% of that of compact tungsten which may be readily machined in a copper-impregnated state. The plate 5 is arranged on the spout 4 with the aid of bolts (not shown).

During operation, the pin 13 obtains a negative voltage with respect to the chamber 3, which voltage is supplied by a controllable voltage source from 0 to 1000 v. and which is provided with a series resistor 15 such that at a discharge current of about 250 ma. the burning voltage amounts to approximately 200 v. with a supply of deuterium such that the pressure in the chamber is 10^{-2} mm. An electron current of 200 ma. then emanates from the aperture 6. With a total supply of atmospheric pressure gas of 0.31 liters per hour after acceleration, an ion current of approximately 60 μ a. on a radius of 65 cm., measured from the axis of the D-shaped electrodes and, is obtained which is considerably higher than with the known construction. The high-frequency voltage between the two D-shaped electrodes has a peak value of 15 kv. The magnetic field has a value of 13,600 Gauss.

What is claimed is:

1. A synchro-cyclotron comprising a metal chamber, means to introduce an ionizable medium into said chamber, a pair of D-shaped electrodes located on opposite sides of a given axis, an electrode on said given axis within and electrically insulated from said chamber, means to apply a negative potential to said electrode relative to the chamber, and a spout connected with said chamber extending between the D-shaped electrodes, said spout having a bore therein coaxial with said given axis and extending parallel to a magnetic field constituting a channel for the discharge of the ionizable medium in the chamber, said bore opening into an aperture constituting an anode for ions and electrons moving helically around the magnetic lines of force emanating from the spout and entering a high-frequency field between the D-shaped electrodes, said spout having a plurality of channels lying on a conical surface having an axis coaxial with the bore and an apex lying just within the D-shaped electrodes for supplying about one-fourth to one-third of the ionizable medium being supplied through the spout.

2. A synchro-cyclotron comprising a metal chamber, means to introduce an ionizable medium into said chamber, a pair of D-shaped electrodes located on opposite

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sides of a given axis, an electrode on said given axis within and electrically insulated from said chamber, means to apply a negative potential to said electrode relative to the chamber, and a spout connected with said chamber extending between the D-shaped electrodes, said spout having a bore therein coaxial with said given axis and extending parallel to a magnetic field constituting a channel for the discharge of the ionizable medium in the chamber, said bore opening into an aperture constituting an anode for ions and electrons moving helically around the magnetic lines of force emanating from the spout and entering a high-frequency field between the D-shaped electrodes, said spout having a plurality of channels connecting with the chamber and lying on a conical surface having an axis coaxial with the bore and an apex lying just within the D-shaped electrodes for supplying about one-fourth to one-third of the ionizable medium being supplied through the spout.

3. A synchro-cyclotron comprising a metal chamber, means to introduce an ionizable medium into said chamber, a pair of D-shaped electrodes located on opposite sides of a given axis, an electrode on said given axis within and electrically insulated from said chamber, means to apply a negative potential to said electrode relative to the chamber, and a copper spout having a tungsten surface on the end remote from the chamber connected with said chamber and extending between the D-shaped electrodes, said spout having a bore therein coaxial with said given axis and extending parallel to a magnetic field constituting a channel for the discharge of the ionizable medium in the chamber, said bore opening into an aperture constituting an anode for ions and electrons moving helically around the magnetic lines of force emanating from the spout and entering a high-frequency

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field between the D-shaped electrodes, said spout having a plurality of channels lying on a conical surface having an axis coaxial with the bore and an apex lying just within the D-shaped electrodes for supplying about one-fourth to one-third of the ionizable medium being supplied through the spout.

4. A synchro-cyclotron comprising a metal chamber, means to introduce an ionizable medium into said chamber, a pair of D-shaped electrodes located on opposite sides of a given axis, a tungsten electrode on said given axis within and electrically insulated from said chamber, means to apply a negative potential to said electrode relative to the chamber, and a copper spout having a tungsten surface at the end remote from the chamber connected with said chamber and extending between the D-shaped electrodes, said spout having a bore therein coaxial with said given axis and extending parallel to a magnetic field constituting a channel for the discharge of the ionizable medium in the chamber, said bore opening into an aperture constituting an anode for ions and electrons moving helically around the magnetic lines of force emanating from the spout and entering a high-frequency field between the D-shaped electrodes, said spout having a plurality of channels lying on a conical surface having an axis coaxial with the bore and an apex lying just within the D-shaped electrodes for supplying about one-fourth to one-third of the ionizable medium being supplied through the spout.

No references cited.

JOHN W. HUCKERT, *Primary Examiner.*

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