A PIG-TYPE HEAVY ION SOURCE AND ACCELERATION OF HEAVY IONS BY THE RCNP CYCLOTRON

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The RCNP AVF cyclotron is able to accelerate heavy ions to an energy of $E = 120\ q^2/A$ where q and A are charge and mass of ion in proton units. A "heat-insulated" cathode PIG-type ion source was built and now being used to accelerate C^{4+}, N^{4+}, N^{5+}, O^{4+}, Ne^{4+}, Ne^{5+}, Ne^{6+} ions, etc. The configuration of the ion source is shown in fig. 1. The head of the source is designed as a cartridge type so as to be exchanged easily. The "heat-insulated" cathode ion source is designed to insulate the Ta cathodes thermally from the cathode holders. The cathode temperature of this source rises easily with weak ion bombardments and this source is struck easily with low gas flow 1 ∿ 2 cc/min. The life time of this ion source is 10 ∿ 26 hours for N_2 and Ne gases. The sputtering rate of the Ta cathode is about 0.36 g/hr. The power supply for this ion source is constant current type with a starting voltage of 5.5 kV. The Westinghouse WL-23219B current-limiting control diode is used to stabilize the aec current by temperature limited current. The schematic diagram of the power supply is shown in fig. 3. A Ta plate, 2.5 mm in thickness and 40 mm in width, is mounted on the puller, 33 mm behind the slit, so as to block lower charge-state ions as illustrated in fig. 2. This puller system perfectly blocks intense lower charge state ions during the acceleration so the tune-up of the cyclotron becomes easy. The total operation time over the last one year are about 570 hours. The N^{4+}, N^{5+}, Ne^{4+}, beams were accelerated succesfully and used for several experiments. The Ne^{4+} beam was accelerated in the 3rd harmonic mode. The typical results obtained with the PIG-ion source are shown in table 1. The vacuum in the cyclotron chamber was $4 \sim 9 \times 10^{-7}$ Torr and there found no appreciable loss of the beam during the acceleration.

Table 1.

Ion	Energy MeV	Harm. No.	Arc voltage	Arc current	Gas-flow rate cc/min	External beam
$^{14}N^{4+}$	115	1	450V	4A	0.4	6.6μA
$^{14}N^{5+}$	225	1	700	2.6	0.3	420nA
$^{16}O^{5+}$	180	1				500nA
$^{20}Ne^{4+}$	95	3	480	4	0.6	800nA
$^{20}Ne^{5+}$	150	1	460	3	0.2	200nA*
$^{20}Ne^{6+}$	200	1	410	3	0.3	2.3nA
$^{40}Ar^{7+}$	150	3				90nA

* Contamination of the $^{12}C^{3+}$ and $^{16}O^{4+}$ ions are included.

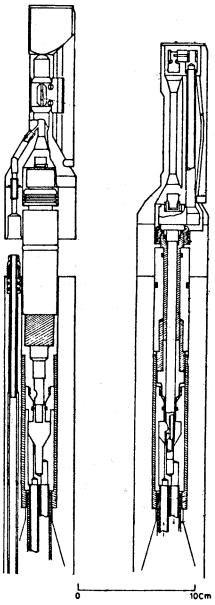

Fig. 1

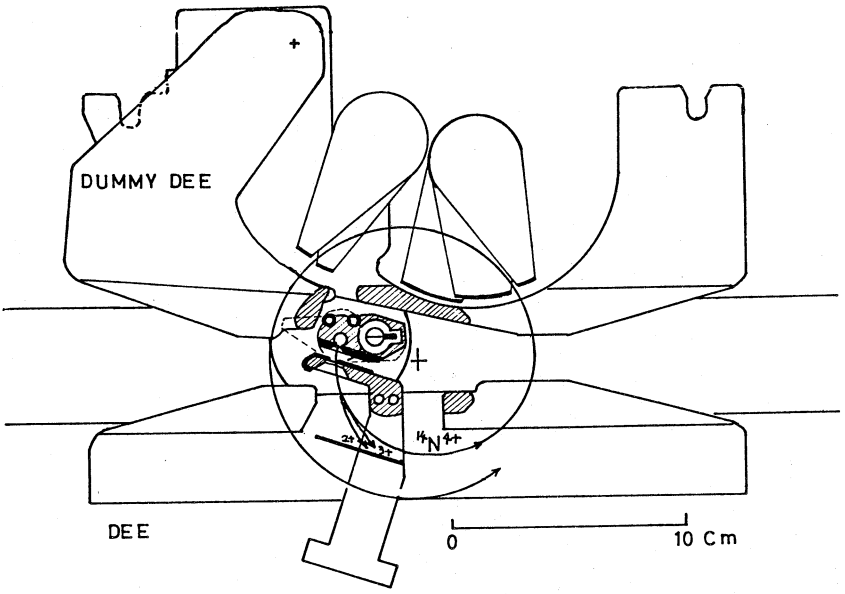

Fig. 2 Cross section of the cyclotron central region.

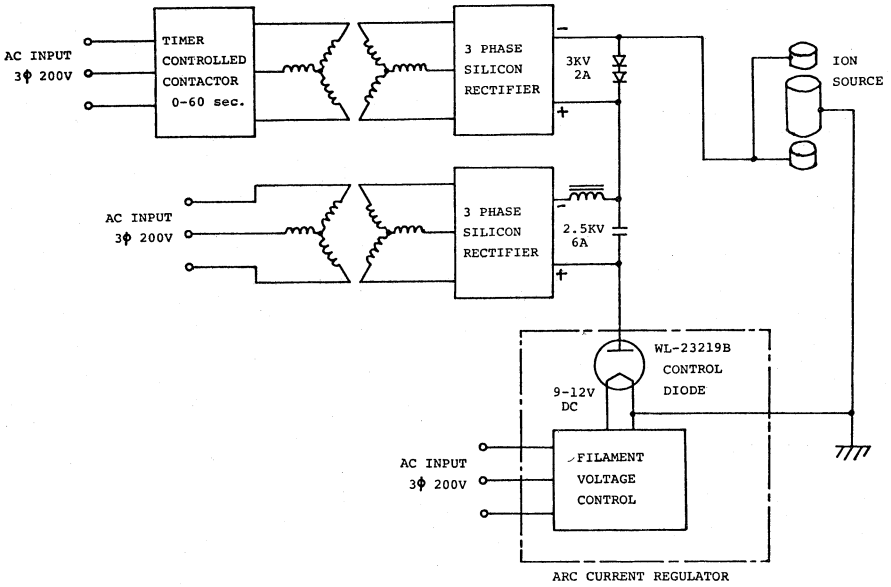

Fig. 3