ROTATING-DISK TYPE HIGH VOLTAGE GENERATOR

A. Isoya, K. Kobayashi, T. Nakashima and T. Maeda
Tandem Laboratory, Department of Physics, Faculty of Science
Kyushu University

A compact rotating-disk type high voltage generator, based on the electrostatic principle, has been constructed and used since the last year for the beam injection system of the tandem accelerator in Kyushu University. In the test of the present model the maximum voltage generated is about 350KV with the output current of several hundreds μA.

Electric charge is carried between the ground and high-voltage terminal sections by cylindrical conductors which are arranged in circular way on the rotating insulator disk. These conductors projected long to both sides of the disk to get a high enough charging capacity. In the ground and terminal sections transfer of charge to the conductors is performed with an inductive charging device. This is composed of a contact-taking belt and an inductor electrode. The former is a flat belt made of conductive rubber*, being mounted on a pair of pulleys. Its one wing is fit to the cylindrical surface of the periphery of the rotating disk, so that the belt is driven by the disk with the same speed, taking a smooth and quiet contact with the disk. Each charge-carrying conductors are electrically connected to the conductive rubber belt through small contact points imbedded on the contact surface of the disk. The inductor electrode is arranged to enclose the conductors over a wide angular range (90°). The inductor electrode is split into two parts (forward and backward). The voltage of the backward half determines the induced charge on the charge-carrying conductor. To the farward half is given a voltage of the same magnitude and opposite sign, as shown in Fig.1. It is taken to be the same as that at the backward half of the inductor in the other potential section with respect to both magnitude and sign. In this situation no potential difference appears in the contact point with the belt so that no corona discharge occurs. In the actual system, owing to the stray field effect, a little different magnitude of voltages have to be given to the both split parts of the inductor.
Transfer of the charge on each conductor takes place during the conductor passes through the split portion of the inductor and after passing it charge on the conductor changes the sign.

---

* Conductive rubber belts of various kinds of material and graphite powder content were manufactured and supplied for the present purpose by the Tsukiboshi Rubber Co. Ltd. Kurume.

The whole mechanism for the voltage generator is contained in a pressure vessel with SF_6 gas of several atomospheres. The size of vessel can be very compact but a huge terminal bushing is required if we want to take the high voltage to the outside of the vessel.

Fig. 2 shows the relation between the magnitude of generated current and the inductor voltage. The current output decreases slightly for the higher terminal voltage. This is because stray field reduces the effectiveness of the inductor action.

In the actual operation the voltages of each split parts of the inductors were carefully adjusted to stop the corona but it was not possible to do it completely for all contact points. This is probably due to the non-uniformity of the construction of the conductors. The corona produces small pits on the contact area of the conductive rubber belt. This is only damage that the present model has got after long time operation. The damage does not seem to be so serious that the duration time is expected to be a few thousands hours.

This high voltage generator is essentially a constant current machine with a very high output impedance. In the application to the acceleration system, therefore, some kind of provision for the voltage stabilization is required. In the present case a series of constant-voltage diodes (ZNR) are used in parallel. The intrinsic magnitude of ripple of the generated current is of the order of 1×10^{-3} with the cycle of 500 c/s.

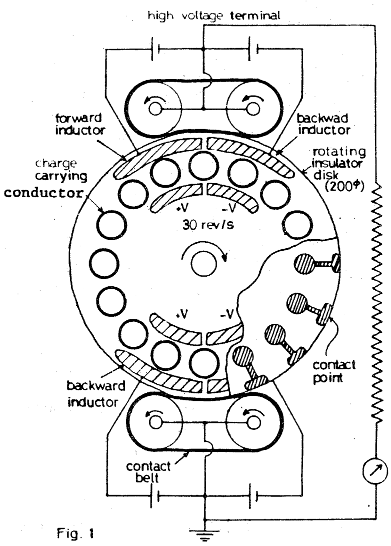

Fig. 1

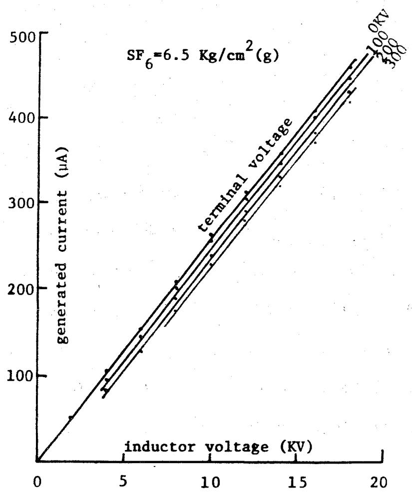

Fig.2