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Calcium Metaphosphate as a Target for Bombardment of Phosphorus by High Voltage Ion Beams

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A Low Frequency Alternator

In seeking a source of a.c. power with a frequency less than ten cycles per second an extremely simple device was attained. Not only does it supply ample low frequency power but its frequency can be made continuously variable from zero up. Moreover the amplitude of the wave is entirely independent of the frequency.

A d.c. generator of suitable power rating is selected and rebuilt so that its brushes can be made to rotate continuously. The voltage delivered by the brushes is then an alternating voltage whose frequency is equal to the speed of rotation of the brushes and whose amplitude is the rated d.c. voltage of the generator used.

An automobile generator of the 30-ampere size served our purpose very well. It was provided with the rotating bushing and disk system shown at A in Fig. 1. This system carries the brushes C, C' and since it acts as the bearing for the shaft S it is made of bronze. Also mounted on the disk of A is an insulated slip ring R. The brush C' is connected to this ring while C connects directly to the disk and hence to the frame which becomes one terminal of the machine. A third brush mounted on, but insulated from, the housing makes contact with the slip ring as A rotates.

It was found necessary to modify the housing only by the welding in of the steel bushing D to provide a little more bearing surface for A. Although not shown in the figure, oil holes were drilled to provide lubrication for both bearing surfaces of A.

If a constant frequency is desired an extension can be put on the armature shaft and a system of gears arranged so that the brushes may be rotated with power from the shaft. On the other hand if A is turned by a variable speed rotator any frequency can be attained from zero up to the maximum speed of the rotator.

The converted automobile generator gives a very good wave form with only a barely noticeable commutator ripple. The frequency of this ripple varies with the direction of rotation of the brushes. The only trouble which has been experienced with this machine occurs when the brushes are rotating at the same speed and in the same direction as the armature. Under these particular conditions the brushes sometimes do not make good contact with the commutator segments.

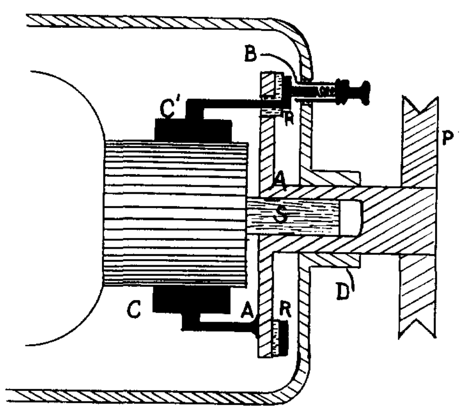

FIG. 1.

Although the device is now being used as a separately excited machine it would not be hard to mount two stationary brushes for the field excitation and thus make it self-excited.

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Calcium Metaphosphate as a Target for Bombardment of Phosphorus by High Voltage Ion Beams

It has not been a simple matter to find a target material for phosphorus which is satisfactory in all respects. Red phosphorus and phosphorus pentoxide, which have been commonly used, have an inconveniently high vapor pressure at the temperatures produced by the ion beam. Metallic phosphides are difficult to prepare and are, in general, decomposed by the action of ordinary moist air. Phosphates are more stable but most of them have a low percentage of phosphorus.

Calcium metaphosphate, $Ca(PO_3)_2$, is a compound which possesses none of these disadvantages. Its phosphorus content is such that one expects yields of approximately 30 percent of those possible from a pure phosphorus target under the same nuclear bombardment. It is easily prepared from monocalcium phosphate, $Ca(H_2PO_4)_2 \cdot H_2O$, by dehydrating the latter compound over a Meker burner. The orthophosphate undergoes a marked swelling and efflorescence during the dehydration, and leaves a hard, brittle residue of metaphosphate which may be ground to a powder. To mount it on a platinum foil, a suitable quantity of the powder placed on the foil is fused by directing the full heat of a gas-air torch upon the foil from below. The salt melts to a clear, glassy liquid which, upon cooling, hardens without crystallizing and adheres firmly to the platinum surface. (If an oxygen flame is used, care should be taken not to heat the material more than enough to melt it, since P_2O_5 can be lost at higher temperatures.)

The fused calcium metaphosphate is very insoluble in all ordinary reagents, but fusion with sodium carbonate renders it easily soluble in nitric acid. If it is desired to remove the calcium and prepare pure phosphoric acid or another compound of radioactive phosphorus, the following procedure, based on a method by Swift,[1] may be used. Dissolve the carbonate fusion in 0.5 N HNO_3. Add $Bi(NO_3)_3$ in excess to the boiling solution. Filter and wash the $BiPO_4$, then dissolve it in HCl. Saturate this solution with H_2S and filter out the Bi_2S_3. The filtrate from this last precipitation contains only H_2S, HCl, and H_3PO_4, and the latter may be recovered in the pure state by simply evaporating the solution to dryness.

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[1] Swift, *A System of Chemical Analysis* (Prentice-Hall, 1939), p. 305.