reduce friction. The bearing (Fig. 2) is a parallel ball-bearing for which the friction is less than 1/10,000 of the couple acting on the stator. To eliminate friction, the wheels over which the above-mentioned wires pass are carried on steel knife-edges resting on hardened steel planes.

For the temperature measurements we use platinum thermometers which are connected differentially to a Wheatstone bridge made to Müller's design. During the course of a year the average variation of the fundamental interval from its mean value has been 1/20,000 for one thermometer and 1/80,000 for the other. This would imply that the thermometry is of satisfactory accuracy.

The evaluation of the heat lost has proved far the most difficult part of the experiment.

In the earlier designs the loss in some experiments

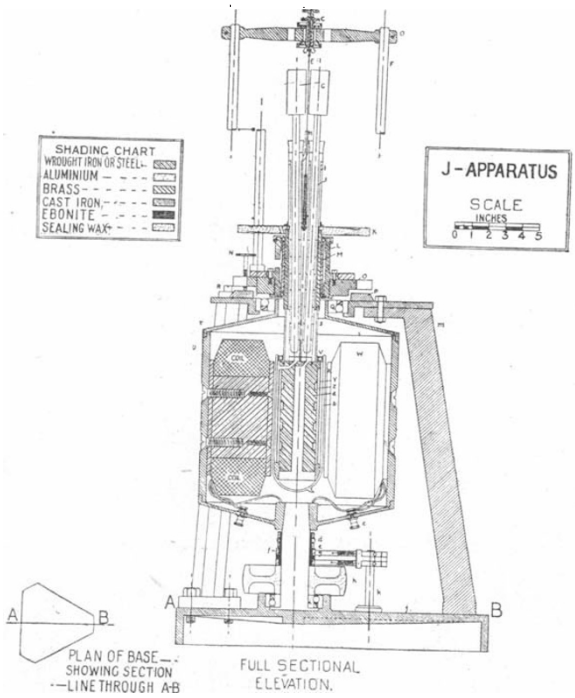

FIG. 2.

was as high as 2 per cent of the heat developed. All attempts to determine it correctly, or to eliminate it by taking the difference between a heavy and a light experiment failed, for reasons which cannot be given here. To overcome this difficulty the calorimeter system was reconstructed, by bringing the thermometers close to the vacuum flask and highly insulating them, as shown in the accompanying figures. This has reduced the heat loss to about 1/10 of its previous value. Means have been provided for determining the loss, and the stator is being modified so that the loss may be eliminated in the usual manner in continuous flow calorimetry by taking the difference between a heavy and a light experiment. It is expected that this alteration will increase the heat developed, and so reduce the percentage of heat lost still further.

T. H. LABY.

University of Melbourne, April 4.

The Transformation of Electronic into Electro-Magnetic Energy.

THE fundamental propositions given below, which do not refer to the excitation of characteristic but to that of the ordinary rays which have been called "independent" X-rays, have sufficient experimental evidence supporting them to justify the following statements so that they may serve as guiding principles for further investigations.

1. When a definite number of electrons in motion (cathode or β-particles) of definite velocity traverse very thin layers of different substances, the average fraction of their energy transformed into that of electromagnetic radiation (X- or γ-rays) is, per atom of any one substance, proportional to the square of its atomic number.

2. In these circumstances, for a given layer, the energy so transformed depends only on the mass per unit area of the layer and on the number of cathode or β-particles traversing it, being independent of their velocity.

By a very thin layer is meant one so thin that the ratio of the number of particles emerging from the layer to the number entering it is very nearly equal to unity.

The reason for the above statement is as follows. If cathode or β-particles of definite type and of total energy E traverse a layer of a substance of unit area and mass dm, the energy of the X-rays formed in the layer may be written as $\lambda E . dm$. We call λ the mass transformation coefficient. The atomic transformation coefficient, α say, is then obtained by multiplying λ by A/N, where A is the atomic weight and N is the number of atoms in a gram of hydrogen. I find that α, which gives the average fraction of the energy transformed per atom, varies approximately as the square of the atomic number Z, while λ varies as Z^2/A and both α and λ vary inversely as the energy of a single bombarding particle. Hence the above propositions hold approximately, since the total energy E is proportional to the energy of a single particle and their number n, so that $\lambda E . dm$ varies as $n . dm$.

With respect to the physical processes underlying the excitation of "independent" X-rays, certain considerations incline me to the provisional view that these X-rays are produced by a collision or by close interaction between the cathode or β-particles and the actual nuclei of the atoms rather than with the electrons surrounding them.

J. A. GRAY.

McGill University, Montreal,
May 21.

Dr. Kammerer's Alytes.

PROF. MACBRIDE'S letter in NATURE of June 23, p. 841, did not at first seem to require any rejoinder. But I find that some botanists, and perhaps others unfamiliar with zoological terms, suppose that the quotations from Boulenger contradict my statement that rugosities are not formed on the palmar surfaces. Boulenger, of course with perfect accuracy, states that rugosities in various genera appear on the *inner* side of the digits (italicised by Prof. MacBride). This is the *radial* side, as emphasised in both our letters, not the palmar surface, which was the part which bore the extraordinary structure visible in Dr. Kammerer's specimen.

W. BATESON.

June 24.

The Breeding Period of *Echinus miliaris*.

THE breeding period of the sea-urchin, *Echinus miliaris*, is very interesting from many points of view; and especially as this animal readily yields ripe eggs and sperm with which to carry out artificial fertilisation in inland laboratories for the observation