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REACTIONS PRODUCED BY NEUTRONS IN HEAVY ELEMENTS[1]

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THE nuclear reactions produced by neutron bombardment in heavy elements can be conveniently described, according to Bohr, with the assumption that, as soon as the bombarding neutron strikes the nucleus, it is incorporated into the nuclear structure with the formation of the so-called compound nucleus. This is a relatively stable system in the sense that its lifetime is very long compared with the frequencies of nuclear particles; in an absolute sense, however, the lifetime is very short, being sometimes of the order of 10^{-12} seconds and sometimes much less.

The ultimate result of the nuclear reaction depends upon the way in which the compound nucleus further disintegrates. And this mode of further disintegration depends in its turn, for any given nucleus, essentially upon the energy content of the compound nucleus. When the bombarding neutrons are slow the energy of the compound nucleus is equal to the binding energy of the neutron in the nucleus. Apart from irregular fluctuations from nucleus to nucleus, this binding energy has a general variation with the atomic number and is a maximum for elements of atomic weight about 40 where it is in the average about 9 Mev. From there on it decreases more or less regularly up to the heaviest elements where it attains an average value of about 5 Mev. If the bombarding neutrons

[1] Presented in a symposium on "Nuclear Physics," at the University of Pennsylvania Bicentennial Conference, September 19.

sleeve was cut out as shown in the sketch, and fastened to the free face of each bellows with a small amount of solder. Maximum range is secured for the couple by mounting the bellows under minimum compression. The fulcrum which carries the recording lever is adjustable on the short rod *d*. The recording lever and its axle are shown only in the lateral view in Fig. 1.

When coupled in this fashion, the elongation of each bellows for a given rise in pressure is reduced by one half, pressure in the other member of the pair remaining constant. Thus, with the diameter and flexibility given above the volume change for a pressure rise of 100 mm Hg is approximately 0.87 cc. Under most conditions the time required for the displacement of

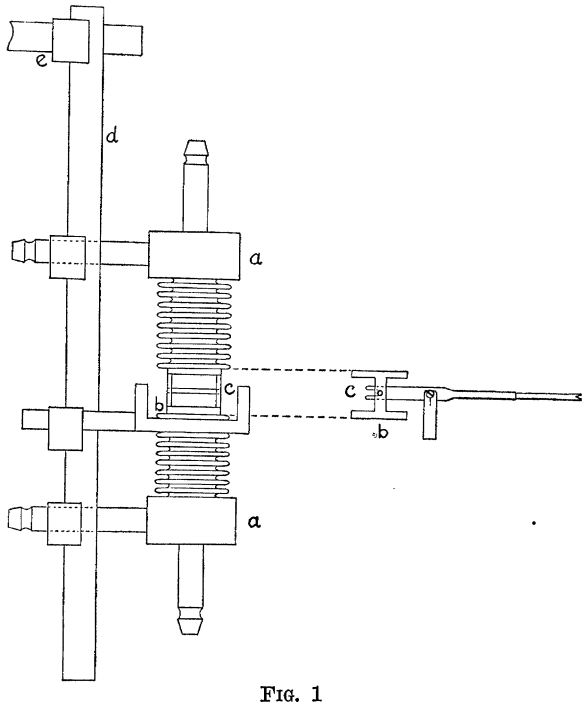

FIG. 1

this volume of fluid does not constitute a serious error. Unless pressures high enough to produce lateral deformation are employed, the behavior of the firmly joined apposed faces resembles that of a single elastic membrane, in response to pressure differences in the two members of the couple. Equal pressure increases in either member, pressure in the other remaining constant, will produce equal and opposite movements of the writing point from the zero line, regardless of differences in the separate flexibility of the two bellows. Furthermore, since fluid displacement for a given pressure change is equal in the two members, resistance to flow anywhere in the system has the same effect as resistance anywhere else.

The use of this type of manometer as a flow-meter for arterial blood flow was described in the earlier report. Water is used for filling the bellows and tubing, rather than citrate solution, as the latter corrodes the metal bellows. After cannulation and filling of the apparatus is complete, 5 per cent. chlorazol fast pink solution is injected into the cannulae and adjacent tubing as an anticoagulant. In filling the lower bellows, air is evacuated by rotating the couple on the rod *d* in the clamp *e* until the lower bellows is uppermost.

With arterial pressure acting on both bellows, there is usually a fairly wide swing of the writing point with each pulse wave, due to delayed arrival of the wave at the lower cannula. Up to a frequency of about 40 per min. in hydrostatic systems, equal but asynchronous pulsating pressures in the two bellows produce equal oscillations of the writing point about the true mean. With higher frequencies, such as occur in the arteries, there may be an error as great as 2 mm Hg in reading the true mean.

When the constricting clamp is placed on the artery between the two cannulae to permit the use of the apparatus as a flow-meter, the pulse wave as well as mean pressure in the lower bellows is reduced, and the now weakly opposed waves in the upper bellows produce large oscillations of the pointer. The legibility of the record may be improved by damping these with a screw clamp applied to the tubing leading to the upper bellows. The reading of the mean pressure difference is not affected by such damping.

The force acting at the apposed faces is approximately 5.85 gm for a pressure difference of 1 mm Hg. This permits the use of magnifying recording levers, giving 50–100 times magnification on the record. With a light lever giving a magnification of approximately 100 times, the apparatus in use has a period of 0.3 sec. Since this is of the same order as the natural period of most mercury manometers, the apparatus can indicate flow changes with such cyclic circulatory phenomena as can be recorded with a mercury manometer. The accuracy with which it records these is about the same as the accuracy of the usual laboratory mercury manometer in indicating pressure changes.

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BOOKS RECEIVED

CURTMAN, LOUIS J. and SYLVAN M. EDMONDS. *Calculations of Qualitative Analysis.* Pp. vii + 156. Illustrated. Macmillan. $2.00.

JONES, H. SPENCER. *Life on Other Worlds.* Pp. x + 299. Illustrated. Macmillan. $3.00.

MERRILL, PAUL W. *Spectra of Long-Period Variable Stars.* Pp. ix + 107. 6 plates. University of Chicago Press. $2.50.

STAIG, ROBERT A. *The Fabrician Types of Insects in the Hunterian Collection at Glasgow University. Part II.* Pp. x + 164. 59 colored plates. Cambridge University Press, Macmillan. $7.60.

NEW BOOK AND INSTRUMENT CATALOGUES

APPLETON-CENTURY COMPANY, D., New York. *Fall Books, 1940.* Pp. 56.

DUPONT DE NEMOURS AND COMPANY, E. I., INCORPORATED, Wilmington, Delaware. *The Neoprene Notebook 25; Facts About Neoprene for the Engineer.* Pp. 105–112. Illustrated.

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