Rensselaer Polytechnic Institute each receive one tenth.

THE first number of a new quarterly, *Annals of Science,* devoted to the history of science since Renaissance times, will be published by Messrs. Taylor and Francis, London, on January 15, 1936, under the editorship of Dr. D. McKie, of University College, London, joint author of "The Discovery of Specific and Latent Heats"; Professor Harcourt Brown, of Washington University, St. Louis, author of "Scientific Organizations in Seventeenth Century France," and H. W. Robinson, librarian of the Royal Society of London, coeditor of "The Diary of Robert Hooke."

THE London *Times* reports that The Institute of Chemistry of Great Britain celebrated at a dinner held in London recently the completion of fifty years' existence under Royal Charter. The institute was founded in 1877 as "the result of a long pent-up feeling of dissatisfaction, particularly among the younger fellows of the Chemical Society, at the deficiency of means for chemists to exert a common action and influence," and the primary object of its formation was to ensure that those who practised the profession of chemistry were duly qualified for the proper discharge of the duties they undertook, by the thorough study of chemistry and allied sciences and of their application to public health, agriculture, the arts, industries and commerce. Sir Edward Frankland was the first president. The institute became incorporated under Royal Charter on June 13, 1885, and acquired the right to confer definite qualifications—A.I.C. and F.I.C. The register of the institute now includes the names of over 6,300 fellows and associates practising in all parts of the Empire, and of about 800 students who are in course of preparation for the profession of chemistry. Local sections have been established in twenty areas, including the Cape of Good Hope, New Zealand and Malaya.

Nature writes: "The Australian National Research Council, having come to the conclusion, at a general meeting last January, that it is not properly fulfilling its function as a national body representative of scientific thought and endeavor, will, during this year, examine the possibilities of effecting a federation of the various State Royal Societies, the Linnean Society of New South Wales and a number of professional organizations such as the Australian Chemical Institute, the Institute of Physics, the Institution of Engineers and the Australian Veterinary Association. The federation will be confined to bodies concerned with the physical and biological sciences. No constitution has yet been suggested, but the general proposal is that each constituent member shall retain its independence as at present and shall have the right to representation on the Federal Council. The nature of the representation and the definition of duties of the council will be the subject of discussion at a conference of delegates from the interested societies, to be called later by the present National Research Council."

DISCUSSION

VITALISM, IRRITABILITY AND PERPETUUM MOBILE

BLACKMAN[1] has called attention to the fact that our general terminology of irritability, stimulus and response has no basis in physical or chemical mechanics. The history of the development of the concept of irritability shows that it was built up in such a way as to make any such basis not only unnecessary but undesirable. It is not surprising, then, that frequently we should find ourselves in difficulty when we try to express some of these concepts in mechanical terms. One such difficulty is the postulate of perpetual motion which is often implied when we attempt to describe the simultaneous action of two or more different agents upon the same tissue or organism. When we remember that physicists as well as laymen believed in the possibility of perpetual motion at the time when the terminology of irritability was developed, we need not be surprised at its persistence in our heritage of dialectics, which still constitutes an orthodox part of physiology, pharmacology, psychology, and psychiatry, and others unnamed.

There is a general implication that irritability is in inverse ratio to the quantity of work which is necessary to elicit a reaction in an organism or tissue. The irritability is said to be high when the work necessary to stimulate is low. Thus, the irritability of a tissue requiring only 1×10^{-7} ergs for its stimulation is greater than that of a tissue requiring 1×10^{-4} ergs for excitation. Provisionally we may say that

$$I = \frac{1}{W},$$

where I is the irritability and W the quantity of work necessary to stimulate. Irritability may be expressed as the reciprocal of the work.

If W is the work necessary for stimulation, done by an electrical current, e.g., under control conditions, then some other agent acting upon the tissue may

[1] F. F. Blackman, *Nature,* 78: 557, 1908; *American Naturalist,* 42: 637, 1908.

reduce the amount of work necessary to stimulate done by the electrical current while the second agent is acting. The usual statement in such a case is to the effect that the second agent has increased the irritability of the tissue in question. There is a general reluctance in some quarters to consider, or admit, that the second agent has done any work on the tissue. Consider the consequences of the denial that the second agent has done any work on the tissue.

Under control conditions, a quantity of work W is necessary to stimulate while, under the second set of conditions, a quantity of work W_1 less than W is sufficient. Then, without doing any work upon the system represented by the tissue, but merely by increasing its irritability, we have induced a change of state such that the application of a smaller amount of work applied to the system in the form of a stimulus gets the same amount of work out of the system as before. That is, we have somewhere gained work without any corresponding expenditure of work. Such a condition would constitute a veritable perpetuum mobile.

It does not seem necessary, however, to postulate perpetual motion in biological processes. If we were to proceed on the assumption that some principles of mechanics, physical or chemical or both, apply even in irritability, we would suppose that our second agent, say a drug, which, by itself, will not produce any typical excitation of the given tissue, would do work W_d upon the tissue. The work done by the electrical current now need be only W_e, less than W. Our equation would become

$$I = \frac{1}{W_e + W_d},$$

in which $W_e + W_d$ might be equal to, or even greater than, W. (The inequality of $W_e + W_d$ and W would arise from the fact that the action of drugs is not 100 per cent. efficient thermodynamically.) Neither total quantity of work nor irritability need change.

A physical analogy might be a rock in the air, but so situated that it might be completely surrounded by water at will. A quantity of work x would be necessary to raise the rock when in the air, but only x–y units of work would be necessary when it was in the water. The water would not raise the rock by itself, but it would do y units of work on the rock.

Neither the total quantity of work nor the irritability of the rock need change. The converse of this case is also true. If the rock were originally surrounded by water which could be pumped off or drained off by the fall of the tide, more work would be necessary to raise it in the air. But we need not postulate any decrease of irritability in the rock. Nor would we say that the presence or absence of water added to or subtracted from the "levitation" in the rock.

We would probably get along faster and acquire somewhat clearer ideas of the processes involved if we were to consider the general case of two or more agents acting simultaneously upon a tissue or organism from the point of view of work done upon the system, even though our measurements at present are inadequate to give the notion quantitative exactness, than we would if we were to retain the seventeenth century concept of irritability and invent new words to show how the postulate of perpetual motion is to be avoided.

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THE EFFECT OF FLUORINE IN NATURAL WATERS ON THE TEETH OF SMALL FISH

THE world-wide dental distrophy known as "mottled enamel" has been definitely proved to follow the ingestion of drinking water containing small amounts of fluoride ion, during the formative period of the teeth.[1]

It has also been shown that the toxic concentrations of fluoride ion involved are of the order of one to five parts per million.[2]

It is difficult to get representative water analyses of fluoride ion at such low concentrations, and it is necessary to extend the analyses over a period of time to allow for variability in concentration. However, if small fish, found in practically all waters, should reflect in their teeth the average fluoride ion concentration of their habitat, they could serve as a criterion of fluoride ion concentrations.

With this aim in view, the teeth of *Gambusia affinis* (mosquito-fish) were examined from: (1) A region in which no mottled enamel had been reported in the children; (2) a region where mottling had been found; and (3) a region where the children showed severe cases of mottled enamel.

It was found that in passing from region 1 to region 3, the pulp cavities of the fishes' teeth became broader or wider in proportion to the length of the teeth, and the teeth took on an increasing "roughened" appearance, the roughening being extreme in some cases. In one section the teeth showed extreme wear, indicating a soft structure.

There thus seems to be a relationship between the amount of fluoride ion in a given water and the condition of the teeth of the fish living therein.

Fish are being raised in known concentrations of fluoride ion, and it is hoped that from them definite data will be available.

[1] M. C. Smith, *University of Arizona Tech. Bul. 45.*
[2] H. V. Smith, *Jour. Ind. Eng. Chem.*, Anal. Ed., 7: 23, 1935.