THE DETERMINATION OF THE WORK DONE UPON THE CORES OF IRON IN ELECTRICAL APPARATUS SUBJECT TO ALTERNATING CURRENTS.[1]

When the case is one of a transformer, the problem may be solved by the employment of three dynamometers in the way I have already pointed out; but in that of an electro-magnet, where we have only one coil to deal with, the problem still admits of solution if we further employ a condenser of determined capacity, and possess a knowledge of the period by means of some speed indicator. The plan is as follows:—

Arrangement.—Having the machine and magnet in series, insert the three dynamometers in series immediately at one terminal of the electro-magnet, placing one pole of the condenser to the other terminal, and the second pole to that point of the middle dynamometer where its two coils join.

Observations.—Obtain good simultaneous readings of the three dynamometers, and if necessary of the speed indicator.

Elements of Calculation.—Let α_1, α_2, α_3 be the angles read upon the instrument (1) in the generating section, (2) in the electro-magnet section, (3) which has its coils divided.

Let the reducing formula for the three instruments be respectively,

$$(\text{Current})^2 = k_1\,\theta,$$
$$,, \quad = k_2\,\theta,$$
$$,, \quad = k_3\,\theta.$$

Let C be the capacity of the condenser.
R ,, ,, resistance of the electro-magnet.
T ,, ,, semi-period.

Then the entire power at work beyond the terminals, *i.e.* the heating of the wire, the heating of the core by induced currents, and the heating of the core due to hysteresis is expressed by the simple formula—

$$\frac{\mathrm{T}}{\pi \mathrm{C}}\sqrt{k_1 k_2 \alpha_1 \alpha_2 - k_3{}^2 \alpha_3{}^2}.$$

The expression itself is independent of the resistance, but if we desire to know the power heating the core, we must deduct from the above the power heating the wire, viz.:

$$k_2 \alpha_2 \mathrm{R}.$$

The difference between these two quantities also happens to be proportional to the tangent of the magnetic lag, another proof of the universal concurrency of lag and loss of power.

Royal Naval College, Greenwich, October.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—Dr. A. Macalister has been elected Chairman of Examiners for the Natural Sciences Tripos. Dr. C. H. Ralfe has been appointed an additional examiner in Medicine. Prof. Hughes has been elected a member of the General Board of Studies, Mr. J. Prior and Mr. C. Geldard members of the Botanic Garden Syndicate, Dr. Cayley a member of the Library Syndicate, Prof. J. J. Thomson and Mr. H. F. Newall members of the Observatory Syndicate, Dr. Bradbury and Dr. Ingle members of the State Medicine Syndicate, Mr. L. Humphry a member of the Special Board for Medicine, Mr. W. N. Shaw of the Fire Prevention Syndicate, Dr. Besant of the Mathematical Board, Mr. Newall of the Physics and Chemistry Board, and Dr. Gaskell of the Biology Board. Mr. E. H. Griffiths, Lecturer at Sidney, has been approved as a Teacher of Physics with reference to the regulations for medical degrees.

SOCIETIES AND ACADEMIES.

London.

Royal Society, November 20.—"On the Specific Heats of Gases at Constant Volume. Part I. Air, Carbon Dioxide, and Hydrogen." By J. Joly, M.A., B.E., Assistant to the Professor of Civil Engineering, Trinity College, Dublin. Communicated by Prof. Fitzgerald, M.A., F.R.S., F.T.C.D.

In this first notice the specific heats, at constant volumes, of air, carbon dioxide, and hydrogen are treated over pressures ranging from 7 to 25 atmospheres. The range of temperature is not sensibly varied. It is found that the specific heats of these gases are not constant, but are variable with the density. In the case of air the departure from constancy is small and positive; that is, the specific heat increases with increase of the density. The experiments afford directly the mean value 0·1721 for the specific heat of air at the absolute density of 0·0205, corresponding to the pressure of 19·51 atmospheres. A formula based on the variation of the specific heat with density observed in the experiments ascribes the value 0·1715 for the specific heat at the pressure of one atmosphere. The formula assumes the specific heat to be a linear function of the density, which must as yet be regarded only as an approximation, the exact nature of the relation being concealed by variations among the experiments.

These results appear to be in harmony with the experiments of Wiedemann on the specific heat at constant pressure, and of Rowland on the mechanical equivalent of heat, from which the value 0·1712 is deduced for C_v at 760 mm.

The experiments on carbon dioxide reveal a more rapid variation of the specific heat with density, the variation in this case being again positive in sign. The formula

$$C_v = \rho \times 0{\cdot}2064 + 0{\cdot}16577$$

appears with considerable reliability to express the relation between specific heat and density.

The relation between specific heat and density in the case of hydrogen is of a negative character; that is, the specific heat diminishes with increase of density. The experiments are chiefly directed to elucidate this point, for, owing to the difficulty of preparing pure hydrogen, it was found that variations in the quantitative results of experiments on different samples of the gas were unavoidable. Accordingly the experiments were directed to a comparison of the specific heats of like samples of the gas at different densities. The variation with density is small, but (with one exception) all experiments on the purer hydrogen ascribe a negative character to it.

The nature of these variations of specific heat with change of density is, in the case of the three gases, in accord with their behaviour as regards Boyle's law, within the range of pressure.

The experiments were effected in the steam calorimeter, a differential method being used in which an empty or idle vessel is thermally compared with the vessel holding the gas at high pressure. The vessels possessing approximately the same calorific capacity, the result, theoretically, is as if the gas was dealt with isolated from any containing vessel. Although practically this is not attained, many sources of error are eliminated by the procedure adopted.

November 27.—"On the Homology between Genital Ducts and Nephridia in the Oligochæta." By Frank E. Beddard, M.A., Prosector of the Zoological Society. Communicated by Prof. E. Ray Lankester, M.A., LL.D., F.R.S.

It is usually stated in text-books that the genital ducts of the Oligochæta are homologous with nephridia; but nevertheless the question is one which has not yet been satisfactorily settled, for the total independence of the two structures in *Lumbricus* and those aquatic Oligochæta of which the development is known is a difficulty in the way of accepting this view. Claparède, who first clearly formulated the arguments in favour of regarding the genital ducts as slightly modified nephridia, made a mistake in stating that the genital segments of the aquatic Oligochæta contain no nephridia; this error was pointed out by Vejdovsky, who discovered that the genital segments are originally furnished with nephridia, which atrophy on the ripening of the sexual products and the appearance of their ducts. Prof. Lankester pointed out that in *Lumbricus* the genital ducts and the nephridia have a close relation to one or other of the two pairs of setæ with which each segment is provided. He suggested that the genital ducts might represent the only portion left of a ventrally opening series of nephridia. M. Perrier's memorable investigations into the structure of exotic earthworms tended at first to confirm this theory. He discovered that in one earthworm (*Plutellus*) the nephridia alternated in position from segment to segment, thus suggesting that the supposed original two sets of nephridia had both partly persisted and partly disappeared. In other forms the nephridia were found to be related to the ventral setæ, and the genital apertures to

[1] By T. H. Blakesley, M.A., M.Inst.C.E., Hon. Secretary of the Physical Society.

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