cases. It is not to be expected that his predictions will agree with fact in any case involving a p or d series electron either for regular or inverted terms.

A. G. SHENSTONE.

Palmer Physical Laboratory,
Princeton University,
Princeton, New Jersey.

The Invention of the Hot Blast in Iron-Smelting.

PROF. BONE's claim for Neilson of the invention of the hot blast cannot be allowed to pass unchallenged, for the regenerative principle of heating and cooling fluids had been patented by the Rev. Robert Stirling in 1816. After stating how he proposed to apply this principle in general terms, the inventor proceeds to describe his first modification, which was to be applied "to diminishing the consumption of fuel in glasshouse and other furnaces wherever a high degree of heat is required." Stirling's Scottish specification figured as an anticipation in the Neilson trials, but Stirling refused to appear as a witness against Neilson. The English specification was first printed in the *Engineer* for Dec. 14, 1917. I shall be pleased to send a copy of the reprint of this article to any person who applies to me.

E. WYNDHAM HULME.

37 East Street, Littlehampton.

HAVING read Mr. E. Wyndham Hulme's letter, together with a copy of the article in the *Engineer* to which he refers, and the specification of Stirling's Patent No. 4081 of 1816, I cannot see any ground for his supposition that it anticipated Neilson's subsequent invention of hot blast in iron-smelting. Stirling's specification describes and claims what is usually termed the 'regenerative' principle in furnaces, whereby heat from outgoing hot products of combustion is transferred to an inflowing air draught; and there is not a single word in it referring to the use of hot blast in iron-smelting. The central idea of Neilson's invention as applied to iron-smelting was that the use of an air blast preheated by combustion of small coal on a separate grate *outside* the blast furnace would save many times as much fuel *inside* it, which, paradoxical though it may and certainly then did seem, is nevertheless true; it is obviously different, and never could have been forecasted, from the principle of heat regeneration or recuperation. It was, indeed, one of those flashes of inspiration which sometimes come to a man of genius and through him revolutionise human affairs. In applying his idea at the Clyde Ironworks during the years 1829-32, when its success was so triumphantly demonstrated, Neilson did not use the regenerative principle at all, or indeed any means of preheating the blast described or foreshadowed in the Stirling patent; nor did he use any hot gases or products from the furnace for this purpose. The Stirling patent may be held to have anticipated Siemens' later inventions, but certainly not Neilson's process.

Moreover, when one remembers that in 1842-43 the validity of Neilson's patent was vindicated after two most fiercely contested actions at law in both the English and Scottish Courts, during which the Stirling patent was cited and fully examined, it seems presumptuous of Mr. Wyndham Hulme to ask us now to reverse the decision then arrived at in the Courts. His attempt to dim the lustre of Neilson's great achievement by raking up the embers of a past controversy which, after most exhaustive and searching inquiries, was decided in Neilson's favour at least two generations ago in the most decisive manner

possible, is to be strongly deprecated. As I said in my article, the scurvy treatment meted out to Neilson by the ironmasters of his day is perhaps one of the most disreputable chapters in the whole history of industry; fortunately, the law which he invoked gave him some material redress as well as a pronouncement in favour of the originality of his invention; and since that time the verdict of the law has become that of history also.

WILLIAM A. BONE.

Imperial College of Science,

South Kensington, S.W.7.

The Dissociation of Pure Mercury.

WITH reference to Mr. Bradley's letter on the dissociation of pure mercury in *NATURE* of Oct. 13, p. 573, I do not think that experimental evidence on the conductivity of other dilute amalgams confirms his calculation of the number of electrons per cubic centimetre of mercury.

If the amalgam contains c atoms of X to 100 atoms mercury, and if p , q are the average numbers of free electrons per atom of X and of mercury respectively, then

$$n/n_0 = d/d_0(1 + pc/100q)/(1 + cM/(100 \times 200.6)),$$

where d , d_0 are the densities of amalgam and mercury, and M is the atomic weight of X . For dilute amalgams the density may be calculated with sufficient accuracy on the assumption that there is no volume change on amalgamation, whence

$$n/n_0 = (1 + pc/100q)/(1 + \frac{M}{200.6} \cdot \frac{c}{100} \cdot \frac{d_0}{d_x}),$$

where d_x is the density of X . Hence the conductivity should be given by

$$\sigma/\sigma_0 = 1 + 2/3 \frac{c}{100} \left(p/q - \frac{M}{200.6} \frac{d_0}{d_x} \right) - 1/9 \left(\frac{c}{100} \right)^2 \left\{ (p/q)^2 + 4 \frac{M}{200.6} \cdot \frac{d_0}{d_x} - 5 \left(\frac{M}{200.6} \cdot \frac{d_0}{d_x} \right)^2 \right\}$$

By comparing the coefficients of c and c^2 with the empirical values, p/q may be estimated. In the case of cadmium amalgams at 14° C., the conductivities of which are represented by a quadratic formula, the agreement between the values of p/q calculated from the 2nd and 3rd terms of this formula is striking. Allowing for the fact that concentrations in E. J. Williams' paper (*Phil. Mag.*, 50, 599; 1925) are given in parts of cadmium per part of *amalgam*, I find the formula $\sigma/\sigma_0 = 1 + 0.0437c - 0.000873 c^2$, whence the calculated values of p/q are 7.44 and 7.46 respectively. This excellent agreement appears, however, to be fortuitous. The following table gives values of p/q calculated from the measurements of Williams (l.c.), Edwards (*Phil. Mag.*, 2, 1; 1926), and Johns and E. J. Evans (*Phil. Mag.*, 5, 271; 1928). In all cases where only one value of p/q is given, the experimental results are represented accurately by a linear formula, and the value of p/q that would be given by equating the coefficient of the quadratic term above to zero is very different from that obtained from the linear term.

In	7.24, 3.40	Ce (300°)	10.0
Mg	10.2, 6.81	Ga (300°)	9.02
Tl	4.22, (1.23)	Cu (300°)	10.2
Tl (100°)	4.53	Cd (100°)	7.70 7.55
Ge (300°)	7.92	Ag (15°)	6.69
Sb (300°)	11.1	Ag (100°)	8.63
Y (300°)	9.16	Ag (300°)	14.5 7.98

The conductivity of amalgams is probably far too complex a phenomenon for any such simple relation as that given above to be applicable to every case.

E. S. KEEPING.

University College of Swansea,
Oct. 19.