no attempt has been made to analyse the result of the British patent system with the view of determining how far it tends to the introduction of new industries. I agree with the writer that this should be done, and that the system should be subjected to a searching investigation by economists with the view of ascertaining the influence of the Law of Novelty upon industrial progress. E. WYNDHAM HULME.

Old House, East Street,
Littlehampton, October 4.

WITH regard to Mr. Hulme's first point, the accompanying graph, Fig. 1, which shows the number of patents surviving fourteen years from each of a large number of years, indicates that his selection of figures is not representative. The effect of the Acts of 1883 and 1902 is very clearly seen. It is true, however, that the figures for 1903, 1904 show the effect of the Act of 1902 (the figure for 1903 is differently given in different reports), while the slight increase for 1901, 1902 may or may not be a normal fluctuation. The rise in 1903, 1904 may be attributed to two causes : (*a*) The Act of 1902 probably owes its effect not so
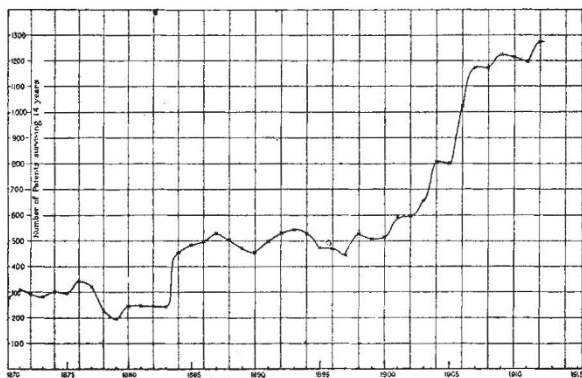

FIG. 1.

much to its direct action as to the enhanced prestige which it conferred on patents generally. It is not unnatural, although it is not strictly logical, that patents which escaped the official examination (first made in 1905) should nevertheless benefit by this general rise in the prestige of patents. (*b*) A number of specifications which would normally have been filed in 1905 or 1906 was rushed into the Patent Office in 1903 and 1904 in order to escape the examination : this is clearly indicated by the number of patents granted to foreigners, which were as follows :

1900	6424	1905	6255
1901	6573	1906	6503
1902	6509	1907	7373
1903	7455	1908	7522
1904	7019	1909	6485

These rushed-in patents would, on the whole, belong to the more serious class, for the academic type of patent is filed promptly, without waiting for experimental development, and cannot, therefore, be "rushed." Inventions coming from abroad are certainly selected inventions.

As regards Mr. Hulme's second point : the *percentage* figure for 1876 is not significant for the present issue, for the absolute figure for that year was only 341, as compared with 1200 or more in recent times. The fact is that the peculiar incidence of application and renewal fees in the early days favoured a high percentage of survival.

THE WRITER OF THE ARTICLE.

Explanation of the Spectra of Metals of the Second Group.

THE explanation of the complicated spectra of elements is now making rapid strides, thanks to the more complete and accurate knowledge of the structure of the atom which we owe to Stoner, and the development of the quantum principles of combination which we owe to Russell, Pauli, Heisenberg, and Hund. The latter authors have so far confined their attention to the explanation of the fundamental terms of the spectra. But the principles can be extended for finding out the higher members as well. The following is a brief sketch :

If we write out the different sub-levels according to Stoner (K_{11}, L_{11}, L_{21}, L_{22}, etc. . . .), and begin with the alkalies, the fundamental orbit is some X_{11}-orbit. But if we allow the electron to run through the successive sub-levels we get $2p_{12}$, $3d_{23}$ . . . $2s$ . . . terms. In the case of alkaline earths we keep one electron in any X_{11}-orbit, and allow the second to run through the successive sub-levels. The resultant orbit is calculated by applying the rules of quantum-addition for r (multiplicity-quantum number), and k (azimuthal-quantum number), but discarding Pauli's rule for the inner quantum number. This is quite justified, because Pauli's rule ought to hold only when the electrons close a sub-level. Thus, taking calcium, if both electrons are taken in the N_{11}-level the sub-group is closed, Pauli's rule holds, we get $^1S_0$ only and not $^3S_1$. But when one electron is in N_{11}-level, the second or vibrating one is in the O_{11}-level, Pauli's rule should not hold, we get the second Rydberg member of 2^1S_0, and 2^3S_1. Combination of the N_{11}-electron with the orbits just following or just preceding gives large prime terms ; thus N_{11}, N_{21}, or N_{22} gives us the large $^3P_{012}$, $^1P_1$ terms ; N_{11}, M_{21}, or M_{22} give us the large $^3D_{123}$, $^1D_2$, which are observed in calcium as well as in strontium and barium, but not in magnesium, because in magnesium there is no vacant D-level preceding the fundamental M_{11}-level. The theory thus explains the details of the normal spectrum of magnesium, calcium, barium, strontium, zinc, cadmium, mercury in a very simple and convincing way.

The success, however, applies not only to the regular terms, but also to the dashed terms which, according to Russell and Saunders, arise from the metastable ^2D-levels of Ca^+, Sr^+, or Ba^+. Taking calcium, we put the first electron in the M_3-levels, and then add the second electron either to these levels, or to any one of the higher levels in the Stoner-sequence. In this way we get not only $\bar{S}_0$, $\bar{P}$, $\bar{D}$, $\bar{F}$-levels of both singlets and triplets and their higher Rydberg sequences fixed up by Russell, but also the $^3P''$, $^3D''$, $^3F''$ terms. The latter terms are regular terms, and ought to be designated as b^3P, b^3D, b^3F. Thus Russell and Saunders' contention that these terms arise from the metastable D-level is completely justified. In short, the procedure accounts in a most convincing way for all the details in the spectra of elements of the second group, including the probable values of these terms.

A detailed paper will be published in the *Philosophical Magazine*.

The ideas in this communication are contained implicitly in the writings of Hund and others, but they have not been worked out in detail, nor has it been shown that they are capable of explaining in such details the structure of the spectrum.

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September 6.