not enter into the argument, only fourteen lines long, which I put forward as definitely disproving Marshall's conclusion.

Finally, I should not like to seem ungrateful for the many kind remarks in Prof. Punnett's review, which, in view of the distaste he inevitably feels for my opinions, whether rightly or wrongly understood, I must regard as extremely generous. I hope, however, it may be possible to correct these misstatements without making Prof. Punnett think, as he seems to fear, that I am trying to 'convert' him to any new ideas, or even that I am here challenging the excellence of his reasons for rejecting them. R. A. FISHER.

Rothamsted Experimental Station,
Harpenden, Herts, Oct. 22.

WITH regard to Dr. Fisher's six charges of misrepresentation I am glad to avail myself of the editor's courtesy and to make a few brief comments. These may conveniently fall under Dr. Fisher's six headings.

(*a*) This seems to me to be a mere quibble. Dr. Fisher states that "the types of mind which result from training in mathematics and biology certainly differ profoundly" (p. viii), and in speaking of a cleavage between them I fail to see that I am seriously misrepresenting him.

(*b*) In discussing the question of a critical point below which a mutational change may or may not have selection value Dr. Fisher writes, "If a change of 1 mm. has selection value, a change of 0·1 mm. will usually have a selection value approximately one-tenth as great" (p. 15)—a statement which seems sufficiently clear to serve as the basis of a "misrepresentation".

(*c*) So far as I am aware, no one has ever described a jungle fowl with a dominant domestic breed character, such as a crest, "not either completely dominant or completely recessive". Indeed, it is difficult to know what meaning to ascribe to the word *completely* when applied to a dominant such as a crest. For in my experience it is easy enough to distinguish between a crested and an uncrested bird, and in this sense the crest is always completely dominant. But the size of the crest may vary greatly, according to the comb factors, and doubtless also to other factors in the genetical make-up of the bird. Perhaps on some future occasion Dr. Fisher will explain to us what he means when he qualifies "dominant" by "completely".

(*d*) On this point I am at a loss to know what to add. For my own sake and for that of the readers of NATURE, I spent many hours in trying to translate Dr. Fisher's rather obscure account into language which should be intelligible to the ordinary geneticist; and now I am told that I have evolved a strange theory which has not been put forward by him. But if the mutant gene for crest did not come in through the wild cock, where did it come from? If it merely 'happened' in the domesticated form, Dr. Fisher's writings do not appear to bring us any nearer to a solution of the appearance of these dominant characters. For my own part, I should greatly welcome a clear account by Dr. Fisher—one intelligible to all of us mere geneticists—of what he considers to be the exact history of the crested gene, and of its manifestations, during the evolutionary history of a domesticated crested breed from the uncrested wild form.

(*e*) The "misrepresentation" here turns upon whether one accepts Dixey's answer as effectively neutralising Marshall's argument. Personally, I do not.

(*f*) On this point it is for the reader to judge between us. R. C. PUNNETT.

The Behaviour of Methane Molecules and Argon Atoms in Collisions with very slow Electrons.

IN a paper by E. Brüche on "Wirkungsquerschnitt und Molekülbau"[1] it is stated on p. 1105 that the curve which shows the variation of the effective cross-section of methane molecules with respect to slow electrons for different velocities of the electrons (we shall call these curves Q-$\sqrt{V}$-curves, since the velocity is given in terms of $\sqrt{\text{volts}}$) is of the argon type, namely, that as the velocity of the electrons decreases from 4 volts to 1 volt (that is, from $2\sqrt{V}$ to $1\sqrt{V}$) the Q-$\sqrt{V}$-curve passes through a maximum and then rapidly sinks to a much lower value. This result was also obtained by R. B. Brode.[2] In a later paper by C. Ramsauer and R. Kollath,[3] Brüche's Q-$\sqrt{V}$-curve is extended to still lower electronic velocities (to about $0{\cdot}39\sqrt{V}$) and is found to pass through a minimum. We have now determined the Q-$\sqrt{V}$-curve for methane by Townsend's diffusion method and have also found that the absolute value of the effective cross-section Q of methane molecules is very low, like that of argon, and that the Q-$\sqrt{V}$-curves of argon and methane closely resemble each other over the range of velocities investigated, which in our case was from $1{\cdot}74\sqrt{V}$ down to $0{\cdot}3\sqrt{V}$. The minimum Q obtained for methane by Ramsauer and Kollath was $4{\cdot}7$ cm.^{2}/cm.^{3} at a velocity of $0{\cdot}62\sqrt{V}$; our value is $4{\cdot}3$ cm.^{2}/cm.^{3} at a velocity of $0{\cdot}52\sqrt{V}$. The minimum in our curve is a little less sharp than in the curve of Ramsauer and Kollath.

The resemblance of the Q-$\sqrt{V}$-curve of methane to that of argon would suggest at first sight that the *molecule* of CH_4 behaves in collisions with slow electrons very much like the *atom* of argon. This is, however, by no means the case, as the following considerations show. It is a great advantage of Townsend's method that it gives information not only about the Q-$\sqrt{V}$-curve but also about the electronic temperature factor k, the drift velocity W in the direction of the electric force Z, and the average fractional loss of energy in collisions between the electrons and the gas atoms or molecules. These data cannot be obtained by Ramsauer's method, which gives the Q-$\sqrt{V}$-curve alone. In Townsend's method the shape of the Q-$\sqrt{V}$-curve for any particular gas is essentially determined by the succession of values of $W\sqrt{k}$ corresponding to successive values of Z/p, where p is the gas pressure. A comparison of the Z/p-k-curve obtained experimentally by us for methane with the Z/p-k-curve previously obtained by Townsend and Bailey for argon[4] shows great dissimilarity. For example, for $Z/p = 0{\cdot}2$ the k-values of argon, neon, and methane are 120, 62, and 4 respectively. The same is true of the Z/p-W-curves: at $Z/p = 0{\cdot}2$ the values of the drift velocity, W, of argon, neon, and methane are in the ratio $3{\cdot}25 : 5 : 27$. It will be noticed that whereas the k-values *decrease* as we proceed from argon to methane, the W-values *increase*. It is due to this compensating effect that the values $W\sqrt{k}$ run fairly parallel in the case of argon and methane.

A still more marked difference between the collisions of electrons with methane molecules and argon atoms is shown by the λ-$\sqrt{V}$-curves for these gases. These curves indicate that of all the gases so far investigated, including inert and non-inert gases, methane and argon occupy the two extreme positions within the region $0{\cdot}3\sqrt{V}$ to $1{\cdot}75\sqrt{V}$: the average fractional loss of energy in the collision of electrons with argon is less than in any other gas over this range. The fact that in the case of methane this loss is greater than for any