LETTERS TO THE EDITOR.

German constructions.

I DISAGREE *toto coelo* with my learned fellow-citizen as to what he is pleased to call 'horrible construction' in German, but believe, on the contrary, that for one whose ear is trained to it the sentences of qualification are as clear as an assemblage of short phrases, and ever so much more powerful. As an example of the involved style (seldom if ever used by the best German writers and speakers, by the way), take this: —

Dem, der den, der die, das Verbot enthaltende Tafel abgerissen hat, anzeigt, wird hierdurch eine Belohnung zugesichert.

This is tough for the anti-Teuton, but it says in eighteen words and ninety-five letters what cannot be literally translated into English in less than nineteen words and one hundred and four letters.

PERSIFOR FRAZER.

Philadelphia, Feb. 8.

Inertia-force.

Will you allow me to draw attention to one point in Dr. E. H. Hall's recently published pamphlet on 'Elementary ideas, definitions, and laws in dynamics,' which he seems to me to have treated with less success than he has the other points raised?

On p. 6 Dr. Hall says, "We have spoken sometimes of the force which *is applied* to a body to change its motion, and sometimes of the resistance or counter-force with which the body meets the applied force. Each is necessary to the other. We could not exert force upon a body if the body offered no resistance. On the other hand, resistance would be impossible if there were no applied force to be met. We shall call the counter-force, which a body in virtue of its inertia exerts to meet a force applied, the *inertia-force*." On what body this counter-force is supposed to be exerted is not at once clear. At first it seemed to me to be the body by which the applied force was exerted, the applied force and the counter-force being thus the opposite aspects of the same stress. And this seemed especially probable from the fact that on p. 24 the third law of motion (which of course applies only to the two opposite aspects of one stress) is cited to prove the equality of the applied force (there treated as doing work) and the counter-force (there called a resisting force). But the following quotations show that this is not Dr. Hall's meaning: "The force, or resistance, exerted by a body varies greatly with the conditions of the experiment, being sometimes large, sometimes small, according to the following general law: When the ball's motion is changed slowly, it offers a slight resistance, — a small force suffices; when a considerable change is to be effected in a short time, we encounter a large resistance, — a great force is required" (p. 5); and, "There is no change of motion, and hence no inertia-force is developed" (pp. 6 and 7). The counter-force may thus become zero, though the stress still act; and hence it cannot be one aspect of that stress. The following quotation, however, seems to settle the matter: "If one of the opposing applied forces is greater than the other, the greater will prevail, and a change of motion will occur, occasioning an inertia-force, which will work *with* the smaller applied force *against* the greater" (p. 7). The inertia-force, therefore, is supposed to act on the body by which it is exerted.

The magnitude of this inertia-force is determined, according to Dr. Hall (see above quotation from p. 5), by the magnitudes of the forces applied to the body; and the following quotation — "The working force and the resisting force must also be equal" (p. 24) — shows that just sufficient inertia-force is called into play in any case to satisfy the conditions of equilibrium.

Now, this sounds very like the old notion of centrifugal force. It was formerly held that a body moving with uniform speed in a circular path was acted upon not only by a force directed towards the centre of the path, and applied, say, by means of a string, but also by an equal force directed from the centre, called the centrifugal force, and exerted on the body by the body itself, which was accordingly considered to be in equilibrium. Dr. Hall's inertia-force is thus just a generalization of the old notion of centrifugal force.

Although Dr. Hall thus proposes to re-introduce what seems to be an old error, the only evidence he brings forward for his inertia-force is the assertion contained in the first of the above quotations, that, of the applied and inertia-forces, each is necessary to the other. Yet he does not leave us without means of judging of his theory of the 'resistance' which bodies offer to applied forces; for according to his own account of this inertia-force, as shown above, it both acts on, and is exerted by, the same body. Now, on p. 18 he admits that "every force implies an action between *two* bodies." Hence the supposed inertia-force cannot be a force at all. And again, as we have seen above, according to Dr. Hall's own account, all bodies must be acted upon by equilibrating systems of forces, if this inertia-force be taken into account; and therefore, if this inertia-force be a force, a body's motion may be changing though it satisfy the conditions of equilibrium.

Apparently Dr. Hall has been led to postulate this inertia-force, because, 1°, he holds that a body resists an applied force (he even takes this to be a fact given in consciousness, for he says, p. 3, "One feels that the hand is *pulling*, that it encounters a *resistance*, which is offered in some way by the ball at the other end of the string"); and, 2°, he cannot understand a force as being resisted in any other way than by the exertion of an opposing force. I agree with him that the term 'resistance' should in dynamics be restricted to the opposition of forces. But the manifest consequence is, that a body ought not to be said to resist a force, and that Maxwell's queries, quoted by Dr. Hall (p. 32) — "Is it a fact that matter has any power, either innate or acquired, of resisting external influences? Does not every force which acts upon a body always produce exactly that change in the motion of the body by which its value as a force is reckoned?" — are to be answered, as Maxwell evidently intended them to be answered, the former in the negative, the latter in the affirmative, though some of his own definitions may be thereby shown to be worded in a faulty manner.

I hope I have not misrepresented Dr. Hall's position. I have read his pamphlet carefully several times, and can get only one meaning out of it. Were I reviewing the pamphlet, I would find many points to praise; and I draw attention to the above apparent error only because the excellence of the pamphlet generally is likely to cause it to take root and spread.

Dr. Hall, in his appendix, quotes a passage from Minchin's 'Uniplaner kinematics' which seems to