set an example which is being eagerly followed by the historical bodies of most European countries. Germany, indeed, is, as well as America, already ahead of us in scientific methods of collecting and editing the more modern and political materials which may be gleaned from the archives of every state-paper office in Europe; while France, Austria, Belgium, and Sweden tread closely on our heels. The objects of modern history, therefore, though professedly national, are in fact cosmopolitan, each country opening up at times unexpected manuscript treasures for the more particular advantage of the other. Hitherto we have been content to rely chiefly upon the resources of our unrivalled national records; but every year affords fresh evidence of the extent and value of the outlying manuscript material which it is the special mission of the Historical manuscripts commission to incorporate with the main stock."

— Our retinal insensibility to the ultra-violet and infra-red rays has been recently discussed by Drs. Fox and Gould in the *American journal of ophthalmology*. The sufficient reason for the perception of the so-called 'light' rays is because the eye has learned to react to the strongest and most constant stimulus, and to extinguish or exclude those vibrations that would only confuse by their weakness or inconstancy, or that would with difficulty be focused with the rest. As to the range of vision along the spectrum, the remarkable fact is, not its narrow limits, but its extension. The marvel is that we have learned to see the violet rays at all, when they are so weak. The limit at the red end of the series is thought to be determined by the great absorption gap in the spectrum that separates the visible from the infra-red rays. It is then asked, how are the invisible rays excluded from stimulating the nerves? and although no satisfactory or final answer can be given, based on experiment, it is made at least probable that they are absorbed by the media of the eye before they reach the retina.

LETTERS TO THE EDITOR.

****Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

A sensitive wind-vane.

AN interesting discussion of this question has recently been initiated, and it may be well to give a portion of this and a few considerations bearing on the problem. I have seen it stated that a flat vane is always in a neutral line, and a sensitive one is made by fastening two plates together at an angle of about ten degrees. This statement has always appeared chimerical to me, for the reason that such a vane as described would have twice the weight and friction of a flat vane, and hence could not be as sensitive as the latter. We should gain, at the outset, a clear definition of what is meant by a sensitive vane. A very light structure, like a feather attached to a cord or balanced near one end, while tossed hither and yon by every breath, and exceedingly sensitive, could hardly be what is meant. I would say, as a first idea, that a sensitive vane is one that most readily assumes the wind-direction.

Professor Ferrel has discussed this question, from a mathematical stand-point, in the February number of the *American meteorological journal*. He assumes that the gyratory force (gy) of the wind upon a double-tailed vane varies as the square of the sine of one-half the angle between the tails, and gives the following expressions for the gyratory force. Let i = one-half the angle of tails, e = angle of deviation of wind, and F = wind-force upon unit surface of vane: then we shall have, with $i > e$, $gy = F \sin 2i \sin 2e$; with $i < e$, $gy = F \sin^2 (i + e)$ in the case of a double-tailed vane, and $gy = F \sin^2 e$ with a flat vane. Professor Ferrel finds, that, with $2i = 90°$, there is a maximum sensitiveness of the vane. Without entering upon a discussion of the theory developed by Professor Ferrel, it may be suggested that we cannot neglect the great pressure that the tails at an angle of 90° would have to bear in a high wind, and which would come upon the axis. This amounts to ten pounds per square foot in a wind, forty miles per hour, impinging normally upon a surface. The angle of the sides being 45°, the total pressure would be somewhat less, but would still be sufficient to prevent all free action of the vane.

Mr. G. E. Curtis has also very recently given a theoretical discussion of the question before the Washington philosophical society, and in this he differs very materially from the one just given. He assumes that the action of the wind varies as the sine of its deviation angle. He gives for vane with double tails, $gy = F \sin (i + e)$ when $i > e$, and $gy = 2F \sin i \cos e$ when $i < e$; for a flat vane, $gy = F \sin i$. In the original formula F is omitted; but I have supplied it, as it seems necessary. The notation is the same as in the previous case. There is a remarkable variance in these theoretical results, and it is a little difficult to state which is the more satisfactory. I hardly think that either can be accepted by the working meteorologist; but probably Professor Ferrel's is the more satisfactory, certainly for light winds.

No attention is paid in either of these discussions to the weight or friction of the vanes, yet it would seem as though either one of these is a far more important element than a single or double tail. In the discussion by Mr. Curtis we may very readily take these factors into account by placing the two tails of his double-tailed vane one above the other, edge to edge. We now have a flat vane whose weight, friction, and all other essentials are the same practically as those of the double-tailed vane; in fact, simply a transformation of the latter, without alteration except in the matter of surface. In fact, both vanes are directly comparable, while they were not before. We have, however, just doubled the surface of the flat vane, so that $gy = 2F \sin i$. Now, it is very easy to see that this expression has a greater value than $F \sin (i + e)$ when $i > e$, and also greater than $2F \sin i \cos e$ when $i < e$. This theoretical discussion, then, by Mr. Curtis, shows conclusively that the flat vane is the more sensitive. When we consider that Professor Ferrel regards the flat vane as much the steadier of the two, also that the

expense of manufacture and material is much less, it would seem as though it should be adopted, and attention turned to the weight, friction, shape of surface, etc.

Complaint is made of short, light vanes, that they often make a complete revolution in high winds. This could be obviated by increasing the weight, but this would not be as satisfactory as increasing the length. It is very evident that the same vane will not answer for both light and heavy winds. It would seem as though a long flat vane would do for the higher winds; and the lighter winds may be determined by the motion of smoke or a light banner, always being careful to keep the line of sight at right angles to the wind. This question is an eminently practical one. Experiments are much needed to determine the most satisfactory size of surface, length and weight of vane, for winds of different velocities, to satisfy the conditions first laid down.

Since writing the above, it has been suggested to me that the double vane can be so readily braced, it can be made out of very light material, and hence may be much lighter than the flat vane. The fallacy here consists in the implication that a single vane needs any bracing at all. Since there is no strain upon a flat vane, as it always turns immediately into the air-current, it need not be very stiff; but it is far otherwise with the double vane. Here the spreading of the tails at once brings a tendency to collapse, to each tail, which increases with the wind-velocity, and is never absent, being greatest when the vane is in the air-current. Each tail, then, must be far stiffer than the single tail, which has no strain at any time. But this is not all: the material used in the bracing will add much to the weight, especially with the greater angles of the tails. For example: take the most sensitive vane, where $2i = 90°$ and $e = 45°$. If the tails are 4 feet long, the spread at the tips will be 5.6 feet. A width of half a foot would give a strain of 30 pounds, with a wind-velocity of 40 miles per hour, and the tails must be very stiff. In addition, if the web bracing is as stiff as the tails, the total weight would be more than four times that of a single vane with double the surface and better fitted for service. H. ALLEN.

Philadelphia, March 15.

On certain electrical phenomena.

There are a few mystics in science (I am not one of them), but I fail, even upon a second reading, to discover that shroud of mystery enveloping my letter 'On certain electrical phenomena' (*Science*, No. 211), which seems to have impressed my critic, 'T. C. M.,' in a subsequent issue (No. 213).

My letter was copied into a number of the daily papers in the eastern and western cities, and I have letters from people who are strangers to me, in regard to it; but thus far, excepting 'T. C. M.,' no one seems to think it 'mysterious.' I am sure I did not when I wrote the account.

Your correspondent furcher advises me that I should 'possibly eliminate a few of the facts' in making such investigations, to which I can only reply that I am not in the habit of eliminating any of the facts in the premises of any scientific investigation I may be engaged in, whatsoever may be its character. Usually I gather and use all such *facts* as I can lay my hands on.

As the point is an important one, I would also like to say to Professor Mendenhall that he evidently misquotes me in the next paragraph of his letter, wherein he says that "Dr. Shufeldt states that he had never observed such exhibitions in Washington." I made no such statement, but did remark that "I had never observed (there) such exhibitions so far as my own person was concerned, and they only gradually developed at this place" (Fort Wingate, N. Mex.). The cases cited for that city by him are very interesting.

I repeat, that in my case the "electrical discharge was considerably greater from the tip of the index-finger than from any of the others of the hand, and gradually diminished in regular order as we proceeded to the little finger;" and this after careful experimentation. I nowhere even imply that this will be found to be universally the case.

Further, your correspondent seems to hold the opinion that every one exhibits such electrical phenomena in the same degree, when submitted to similar conditions to excite it. In this I thoroughly disagree with him; for further experimentation here, goes to show that phenomena similar to those I described in my letter to *Science* are exhibited in varying degree by my three children, whereas on the other hand, in the case of the mulatto child I referred to, it has thus far, after numerous trials, been impossible to excite them in her.

And I must believe, that, when Professor Mendenhall comes to make more extended inquiry among a greater number of people, he will discover that there are many of them who have absolutely never heard of such things, to say nothing of having observed them in the case of their own persons. Common it is, no doubt; and, ah, me! how wise we would all be if we were but only thoroughly informed upon all common phenomena! R. W. SHUFELDT.

Fort Wingate, N. Mex., March 10.

Comparative taxation.

It is true, as Mr. Atkinson says, that it is easier to criticise than to construct, and Mr. Atkinson deserves credit for his undertaking. Yet criticism of what has already been done may be of value in clearing the way for more perfect work in the future, and I therefore venture to offer a further criticism of some of the views expressed in Mr. Atkinson's letter of March 4.

Mr. Atkinson gives, as a reason for considering national taxation separately, the fact that in Europe so large a portion of the national revenue is expended for '*destructive* purposes,' by which I suppose is meant war purposes. The difference between Europe and this country is not so great as most people probably believe. If we consider the army and navy and pensions, which are a war expenditure, we find that in 1885–86 the German empire expended for the above purposes $110,500,784, and the United States $111,636,903. A comparison of the relation of these expenditures to total expenditures in the two countries is rendered difficult by the different character of the governments; but considering only the ordinary governmental expenditures, that is, omitting the consideration of railways, mines, etc., we find that in the United States war expenditures amount to 39 per cent of the whole; in the German empire, exclusive of the individual states, to 77 per cent; and in Prussia and the empire taken together, to 28 per cent.