This wheel *H* runs along a metallic rim encircling *G;* the rim not being continuous, but having small breaks at the points touched by the wheel *H* when the vane points *N E, S E, S W, N W.* These breaks are so short that when *H,* in its revolution around *G,* leaves one segment of the rim, it almost instantly rests against the next.

The segment *L* is connected with the binding-screw of 4, by the wire passing through *O.* Similarly *K* is connected with 3, *N* is connected with 2, and *M* is connected with 1.

The wire *G F* is in metallic connection with *G H,* and is also connected with the free pole of the battery *E.*

We will now suppose that the anemometer and vane are exposed to the wind, and the wind is from the west. We shall then have the arrangement shown in the diagram.

The metallic connection *C* 7 3 *K H G F E D B* will be complete; and whenever the anemometer closes the circuit *B C,* the armature *R'* will be attracted by the double coil magnet 3 7. So, for any winds between *S W* and *N W,* the armature *R'* will indicate each mile or kilometre of wind. Similarly the armatures *R, R'', R'''* will indicate northerly, southerly, or easterly winds.

By attaching recording pencils to the armatures *R, R', R'', R,'''* and allowing a chronograph sheet to pass beneath them, we can register in separate columns the amount of wind from the four points. By doubling the number of segments, electro-magnets, and recording pencils, the velocities can be recorded for eight points of compass.

The recording pencils can be made to register their marks in lines running side by side and parallel, and within narrow limits, by bending the pencil-holders attached to the armatures in such a manner as to bring the pencil-points close together, and into an alignment transverse to the motion of the recording sheet.

In reading the record sheet, the sums of the registrations in the separate columns will give directly the amount of wind blowing from the different quarters.

So far as the apparatus for wind, direction, and velocity is concerned, the method that I have here described is applicable to most of the electrical registering anemoscopes and anemometers now in use, with very little change; but the registering apparatus (chronographs, pencils, electro-magnets, etc.) will require more alteration, especially for the American form of cylinder chronograph. The European chronographs, with the long narrow paper strips for recording sheets, will answer the purpose very well, and they are usually of much better construction than the cheaper American chronographs.

In actual practice a single wire connecting *C* 5 6 7 8 would be used in place of the four wires shown in the diagram (*C*5, *C*6, *C*7, *C*8).

It might perhaps also be found best to make a continuous record of the wind direction by means of a cylinder encircling the rod *G* with a sliding pencil, the motion of this last being regulated by the chronograph clock-work. FRANK WALDO.

Cincinnati, O., Dec. 14.

American Microscopes.

THE complaint which Dr. Minot makes in a recent number of *Science* (x. No. 252) about the tendency of American microscope-makers to furnish instruments which are much more decorative than useful, and which are seriously lacking in the optical excellence which the genuine scientific worker requires, expresses, I think, the feeling of every one who is frequently called upon to purchase microscopes, or advise about their construction.

It seems to me, however, a matter for regret that Dr. Minot, through inadvertence, I feel sure, should have made so sweeping and indiscriminate a condemnation of all American microscopes. I think that he must have been unaware of the excellent instruments which have been furnished of late from the workshop of J. Grunow in New York.

The useless and positively objectionable features which Dr. Minot so justly attributes to the American microscope in general, are absent from these new forms of stand, while the requirements which he so admirably summarizes are just those which Mr. Grunow has succeeded in covering.

A firm base; low, large solid stage, with simple clips for the slide; excellent brass-work; with or without knee, nose-piece, and rack and pinion, coarse adjustment, Abbé condenser, as the purchaser may desire; and optical qualities in the lenses which bring them strictly within the category of first-class, — these are the qualities which the new Grunow instruments present. Forty of these microscopes have recently been added to the supply of the laboratory of the Alumni Association of the College of Physicians and Surgeons, New York, after a full personal examination of instruments supplied by the more prominent continental makers.

I feel greatly indebted to Dr. Minot for clearly indicating, as only an accomplished microscopist like himself could, the direction in which American microscope-makers should work, and I am certain that he will learn with pleasure that by one American maker at least, his requirements are being scrupulously met.

T. MITCHELL PRUDDEN.

New York, Dec. 12.

THE issue of *Science* of Dec. 2 contained an article which is so sweeping in its denunciation "of any microscopes whatsoever of American manufacture," and its commendation of the German or French instruments, and places the motives of American manufacturers in such questionable light, that as one of them, and especially in consideration of circumstances hereinafter mentioned, I consider it proper to say something in answer.

The objections in the article can be enumerated as follows: —

1. "The fundamental error in microscopes of American manufacture is that they are for the most part constructed with a view of, I might almost say, entrapping inexperienced purchasers. The zeal of the maker is turned too much to decorative lacquering and nickel-plating; he adds to his stands as great a variety of mechanical contrivances and adjustments as the price of the stand will permit, and many of these contrivances are not really commendable for their utility."

The supply of a product is created and controlled by the demand for it. As the microscope is an instrument for scientific research, it is used by a class of people of more than ordinary intelligence; and, as most of the instruments purchased pass through the hands of persons of wide experience, they are fully capable of determining what is best suited to their wants, and will certainly not permit the maker to prescribe what they should take. The American instruments as constructed to-day are almost generally a combination of improvements, such as have suggested themselves to the practical mind of the advanced American worker, and which have been adopted and carried out by the maker; and this co-operation between worker and maker has long been a matter of congratulation. That the majority of American innovations are real improvements is shown by the fact that the need of them is felt abroad, and that many of them are being gradually embodied into foreign instruments. That the American maker "adds to his stands as great a variety of mechanical contrivances and adjustments as the price will permit," is certainly not to his discredit, neither is the fact that he endeavors to make the outward appearance of his instruments conform to that of its general workmanship.

2. "In the majority of cases the stands are made to tilt, which, for one that uses the microscope for real work, is an almost useless luxury."

Whether an instrument shall be used in an upright or inclined position depends upon the requirements of the worker. It is true that "in the majority of cases the stands are made to tilt;" but as this feature adds, not a considerable, but, on the contrary, a very trifling expense, there is no reason why it should not be used continually in an upright position if so desired; and it gives the additional advantage that it may be inclined, and there is no doubt that much real work is accomplished when it is in this position. However, instruments without the joint are catalogued by some makers, and may be had by those who desire them; but the fact that the maximum ratio of instruments without joint, as against those with them, is as 1 to 100, is sufficient evidence of the desirability and inexpensiveness of the hinge.

3. "This same fact . . . renders it indispensable that the microscope should not be too high, . . . so that we must put down the ten-inch tube as a bad feature for a student's microscope."

To the best of my knowledge, *all* American makers provide draw-tubes to their smaller instruments, by means of which they may be contracted to as great an extent as any of the foreign ones, and in my opinion the ten-inch tube is most decidedly not an undesirable feature. For a long time many of the best microscopists of this country, as well as of Europe, have complained of the want of unanimity among manufacturers in the construction of those parts which are absolutely necessary in the microscope. Thus the size of screw in objectives is probably definitely settled in favor of the English standard, as this is almost universally accepted; and when not, it is by a few German and French makers. The length of tube has for many years been the subject of agitation, and the tendency is slowly but surely in favor of the ten-inch standard, and by far the largest proportion of instruments are now constructed accordingly.

4. "The stage of the American microscope is very faulty."

The stage of the American microscope does not differ materially rom the majority of foreign ones. In almost all of the cheaper forms it is "large and flat, with nothing upon it except a pair of spring clips and a hole for a diaphragm." I am quite sure that it is not only the amateur or fancy collector who uses the supplementary glass stage; and as to the mechanical stage, I think that this originated in Europe, and is used even more there than in this country.

5. "Then the Iris diaphragm is often introduced to allure the inexperienced, but it is not a good form except in conjunction with an achromatic condenser."

The apparatus is a European invention: it is widely used, and highly valued by many persons. No doubt many would be pleased to know what optical or mechanical reason exists, which prevents it from being a good form. Besides this, the honesty of the American manufacturer will not permit him to stoop to any subterfuge whatsoever to allure a purchaser; and the application of the Iris diaphragm to an instrument can in no manner be construed to be such, especially as the purchaser may select the diaphragm of his preference.

6. "There are other details of construction which are equally open to unfavorable criticism, but it is unnecessary to go into their discussion." If there are any other points, it seems but proper that they should be stated.

7. "The eye-pieces and objectives are generally, though not always, of a decidedly inferior character: when they are really good, the lenses are very expensive."

This statement is a condemnation of American optical work, which, with a knowledge of the literature on the subject, and acquaintance of work which has been and is to-day produced, simply cannot be made. Many of the important improvements have been inaugurated by American opticians, and their work has been of a high character, — a fact which is willingly conceded by a large number of European microscopists who are fully qualified to judge. That they have not retrograded is evinced by what they are doing at the present day. Taken as a whole, I believe it can be safely claimed that American objectives are of a higher grade, and more uniform, than the European. More than this, the prices, comparing quality for quality, are to-day fully as low as, and have been the means of lowering, the prices of those which have been brought to this country. The quality and prices of objectives, more than any other part of the microscope, are less liable to conjecture and difference of opinion, from the fact that they can be determined by actual comparison.

8. "Many valuable members of the nation are sacrificed by being obliged to pay for the advantage of a small number of men who have never shown themselves willing to supply to those by whose sacrifices they benefit, the kind of instruments wanted. . . . Is it unreasonable to ask manufacturers of microscopes in this country to furnish us instruments of the kind we really need, as some sort of acknowledgment of the money they extract from us whether we will or not?"

This complaint is not borne out by facts. As already stated, there are, among all the manufacturers of microscopes, none more progressive than the Americans. They have ever been ready to accept suggestions and to make improvements when occasion to do so presented itself. They are of sufficient business sagacity to undertake to make whatever may be called for, when there is a prospect of a reasonable remuneration for the outlay. I hope I may be excused in mentioning my personal experience in this connection.

Some years ago it came to the notice of the firm of which I am a member, that there was at a certain quarter a decided opposition to American instruments, and an influence exerted on students in favor of certain foreign ones.

To find the cause thereof, I made a special trip to Boston, and, visiting a number of gentlemen, learned that the reason of their preference was the pattern of the European instruments. Among the gentlemen consulted was the writer of the article in *Science*. I expressed a willingness to undertake to make an instrument which should meet his views, and, after receiving a general outline of his preference, returned home and began to construct an instrument in accordance therewith.

After the completion of this, I made it the object of a second visit. The instrument was thoroughly inspected and criticised, and a number of minor changes recommended, which, upon my return home, were strictly carried out. The instrument was again sent for examination, April 23, 1884, accompanied by a letter, from which the following extracts are made: —

"As you will see, we have adopted the suggestions as made by you and Prof. ———, and believe that they add considerably to the value of the instrument. . . . We send the instrument for examination, and hope you will make it severe; for we are anxious to make just such an instrument, which you consider best suited to students' use, and are convinced that we are able to do it."

Later, in reply to an inquiry about his opinion of the instrument, we received the following: —

"We have examined the Harvard microscope, and find it to be very excellent in many respects, and the objectives good."

(Signed) CHARLES S. MINOT.

During my visits I was kindly treated, received every reasonable encouragement and the promise of support in the undertaking, and was therefore the more surprised to read such charges.

If European instruments are now happily gaining supremacy, it must be of exceedingly recent date. Many scientists of this country 'happily' manifest great interest and pride in home productions; and as the American manufacturers undoubtedly will endeavor to combine in their instruments efficiency with high standard of workmanship, as they are perfectly willing to make whatever may be required, and as they will ever welcome improvements by whomsoever suggested, there seems no reasonable doubt that the 'supremacy' will be in future, as it is now, on the American side.

EDWARD BAUSCH.

New York, Dec. 13.

DR. C. S. MINOT, the able histologist of Harvard Medical School, has, in a late number of this journal, given expression very freely to his views in regard to the respective merits of microscopes of foreign and domestic make. While the present writer cannot agree in detail with Dr. Minot's conclusions, many of the points made against American instruments are, unfortunately, justified more or less completely by the facts, and by the experience of teachers and pupils in biological schools throughout the country, but similar charges can be aimed with just as much truth and equal force against many of the instruments which are imported from abroad and commended as laboratory instruments. There are many of them that I would absolutely not take as a gift if I could get the best instruments of American make, and the best of those made abroad are open to objections when considered merely as tools for general biological work. A microscope is, or ought to be, an instrument of precision, and as such it is a tool which, according as it is well or poorly made, will work satisfactorily or unsatisfactorily in the hands of the skilled manipulator. I hold that nothing is too good as a tool for either pupil or teacher in biology. Histological research and technique have reached that degree of development and perfection within the past fifteen years, that the man who was a master in histology that long since, if he were to return to the work in one of the many recently founded biological laboratories in the United States, would find that in cytology both

pupils and teachers were speaking a language which he could scarcely understand. He would also find that it was a common thing for a teacher to demonstrate to his pupils with actual specimens, day after day, things which in his own day it was utterly impossible to demonstrate except by the most laborious and roundabout methods, and which at best gave unsatisfactory results. With this enormous advance in technique or in the processes of research, has arisen a demand for a better class of laboratory instruments, which, while they are compact, simple, and of moderate height and weight, are constructed with a view to durability, and at the same time admit of use for all the ordinary purposes of the investigator or student. Such instruments should possess such qualities as would enable one to use them for the most elementary as well as for the most advanced work requiring the highest grade of manipulative skill. The senseless catering of makers to the lovers of 'brazen elephantiasis' (as I once heard an eminent histologist express himself), with their large and costly instruments, has wrought a kind of mischief which teachers have every now and then to contend against, in the tendency of poorly informed tyros buying at large cost these brazen giants, which they soon find are not what they want.

My own deliberate conviction is, that the ideal microscope for the student and investigator still remains to be devised; that neither Europe nor America has yet produced it; and that any attempt to produce such an instrument, without considering every possible and reasonable demand that can ever be made of it as a table microscope, must end in failure. Looking over the vast amount of rubbish which is constantly being figured in microscopical journals as something new and valuable, one is often tempted to make the comment, "Why could not that person have been more usefully employed than in devising that perfectly useless piece of apparatus?" There are, however, many exceptions; and I do not mean to be understood as scoffing at all new pieces of apparatus, because many of them first devised within the last ten years have been of the greatest value.

How is this ideal microscope to be realized? Who will design it, and who make it after it is designed? I would suggest that every piece be made to a standard gauge, and that thus, if any parts are broken or worn out, they may be replaced with a minimum of trouble. I would advise that the existing rack and pinion be replaced by a better construction, as no rack and pinion yet made is so constructed as to remain firm and steady after prolonged use of the instrument. The fine adjustment can be made a part of the coarse adjustment, provided the cogs of the rack and pinion are accurately cut; and this adjustment can be placed at the back of the instrument, near the fingers of the manipulator. In this way a source of weakness in the construction of both American and foreign instruments may be avoided. The outside tube in which the optical tube slides must be fixed, and form a part of its support. The optical tube must be short; tube length, with draw-tube out, not over 155 millimetres, so as not to make the instrument uncomfortably high when the tube is vertical. The support for the tube must be in a single, solid piece, which may also support the simple, flat, wide stage covered with a thin piece of hard rubber firmly fastened to its upper surface. The stage clips must be so placed that they do not interfere with moving the slide over the whole width of the stage. The base or tripod upon which the whole rests must be cast in a single piece, and the joint at the back, between the base and the supporting piece for the tube, to be made simple and strong, and so that it may be quickly tightened by the manipulator if it should get loose. This joint for tilting I hold to be necessary for certain kinds of work and for photography. The mirror bar must be large and strong, and made as nearly concentric with the surface of the stage as possible. The attachment for the condenser should be made so that it is firm, and so that the condenser is easily swung into and out of position, and rapidly adjusted up or down with as little accessory mechanism as possible. A condenser of the Abbé type is of course the only one to be considered for general work, and it should be as short as possible, so as to make it possible to keep the stage as low down or near the table as is consistent with ready and successful illumination. The concave mirror should be larger than on the most of the laboratory microscopes used here and abroad.

Now a word as to the camera lucida. This absolutely necessary piece of apparatus must be adjustable to every eye-piece, and it should be available for use with the tube upright, inclined, or horizontal, without the addition of any desks or drawing-boards to the outfit of the microscope. If the rack and pinion is properly constructed, and an adjustable or sliding collar with the Royal Society screw fitted into the optical tube or body, with this camera, and a proper combination of eye-pieces and long or short focus objectives, drawings of objects may be made, ranging from 5 to 1,500 diameters, without difficulty, and the use of an embryograph largely if not entirely dispensed with. Searcher eye-pieces might be added to the combination, which would make the outfit still more complete and varied for the use of the investigator who needs to make figures of the subjects which he studies.

It will thus be seen that the prime requisites in the microscope for the investigator are simplicity and mechanically correct construction. No instrument yet made fulfils in the largest possible measure these requirements. Mr. Zentmayer has really added important improvements to the instruments constructed in this country; and for solidity and fewness of pieces, his work (which has always been honest) has been among the very best. American observers of world-wide reputation have used American instruments and objectives with success. Among these may be mentioned men no less famous than Profs. H. James Clark, Alpheus Hyatt, and Joseph Leidy, while Prof. J. F. Rothrock's studies with American lenses upon the strength of wood as illustrated by sections has started a most important line of practical inquiry.

But notwithstanding this, as stated at the beginning, the ideal microscope is still to be placed upon the market. To have the matter assume the importance which it demands, I would suggest that the American Society of Naturalists, at their next meeting, take into consideration the question of securing a satisfactory design for a standard instrument. Let this be done by offering a prize to be competed for, and let us for once have something like uniformity of pattern in this most important instrument of research. The teacher would then have no difficulty in suggesting to his pupils what make of microscope they should buy, and every maker would not be offering instruments departing more or less from a recognized standard.

And finally, as suggested by Dr. W. P. Wilson, now that the surplus from revenue and tariff is stirring the political wiseacres at Washington, where a plethoric treasury is threatening the financial prosperity of the country, let our universities and colleges make an appeal to members of Congress, in co-operation with the American Society of Naturalists, to have the absurd tariff on imported scientific books and apparatus removed. This senseless tax on knowledge, which it seems is to be catalogued among the 'luxuries,' is a glaring and shameful disgrace to American institutions. As it is, neither American publishers nor manufacturers are profiting to any extent from this absurd regulation, nor are they likely to, even after the duties are removed.

JOHN A. RYDER.

University of Pennsylvania, Dec. 15.

Sound-Blindness.

IN *Science* for Nov. 18, p. 244, I observe some remarks on certain phenomena of defective hearing, which, from their supposed analogy to color-blindness, is called 'sound-blindness.' I am very much interested in the facts, but the name I do not at all like. It seems to me very misleading. But neither is the term 'sound-deafness,' which was proposed as a possible substitute, any better. Comparing the eye and the ear, 'sound-deafness' corresponds with 'light-blindness;' but these terms express simply blindness and deafness without qualification. The correspondent of *color*-blindness is not *sound*-deafness, but *pitch*-deafness. But the phenomenon spoken of in the article referred to is neither *sound*-deafness nor *pitch*-deafness; for the characteristic of vowel-sounds is not musical pitch, but *timbre*. In so far as the phenomenon is physiological at all, the defect is therefore *timbre*-deafness. But it seems to me that the defect is probably, largely at least, a defect of perception, and not of sensation, and therefore psychological, not physiological.

JOSEPH LECONTE.

Berkeley, Cal., Dec. 9.